QUALITY OF LIFE AND LIFESTYLE CHANGES IN A DIABETES PREVENTION PROGRAM

by

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ABSTRACT

The increasing prevalence of type 2 diabetes mellitus is a concern in the United States and throughout the world. Diabetes places a burden on physical and mental health as well as the economy of affected nations. Prediabetes, classified as impaired fasting blood glucose, is also on the rise, and those classified as prediabetic are at an increased risk of developing diabetes later in life. Prevention of diabetes is possible, preferable, and key in those who are prediabetic.

The Diabetes Prevention Program, originally conducted in 1999, demonstrated that lifestyle changes, consisting of dietary changes and increased physical activity, was effective in preventing or delaying the onset of diabetes. However, not everyone who participates in these programs sees the same degree of success. One factor that has not been examined is to what extent quality of life plays a role in determining success in making nutritional changes and improving diet quality within a prevention program.

This study analyzed potential relationships between diet quality and quality of life, as measured by the Flanagan scale. Data from 48 participants of the University of Utah's Diabetes Prevention Program were analyzed and assessed. Anthropometric and biochemical measurements and markers were analyzed, as well as 24-hour recalls and quality of life scale scores. Diet recalls were processed through the Automated Self-Administered 24-hour Recall (ASA24) system. Diet quality was assigned by utilizing the Healthy Eating Index-2010 criteria and scores. Independent t-tests were used to assess any changes pre- and post-intervention, and linear regression was used to assess any relationship between quality of life and diet and quality of life and anthropometric measurements.

Participants saw overall improvements in quality of life, weight loss, blood glucose tolerance, and a positive trend in Healthy Eating Index-2010 scores. No significant linear relationship was found between quality of life and diet quality, but significant relationships did exist for BMI, hip and waist circumferences, and oral glucose tolerance tests, indicating that a higher quality of life led to decreased values in these areas. In summary, this study shows the importance of a prevention program in increasing healthy behaviors and outcomes. Further research is necessary to track dietary changes throughout the intervention period.

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INTRODUCTION

Background and Literature Review

Type 2 diabetes mellitus (T2DM) is a growing public health concern throughout the United States and the world. As of 2014, 29.1 million people in the United States are living with T2DM, approximately 9.3% of the population.[1] The defining characteristic of T2DM is impaired glucose tolerance due to cellular insulin resistance.[2] According to the American Diabetes Association (ADA) guidelines, an official diagnosis of T2DM occurs when one has a fasting plasma glucose ≥126 mg/dL, a 2-hour plasma glucose ≥200 mg/dL during a 75-g oral glucose tolerance test (OGTT), or a hemoglobin A1C of 6.5% or higher.[2] This long-term hyperglycemia is associated with diverse health problems, including an increased risk of various infections, heart disease, kidney disease, and multiple neuropathies.[3,4]

Although not fully understood, the development of T2DM is based on the interaction of genetics, behaviors, and environmental risk factors.[5] Non-modifiable risk factors for T2DM include age, race, family history, and ethnicity. Studies have shown that modifiable behavioral risk factors include obesity, physical inactivity, and diet.[6-8] While dietary components are complex, research indicates that a diet high in refined carbohydrates appears to increase the risk of T2DM.[8,9] Additionally, epidemiological studies had shown a link between disease development and a high-fat diet[10,11]; however, subsequent research has questioned this relationship.[12]

In addition to its effects on health, the financial burden of T2DM is heavy. In 2012, the financial costs totaled an estimated $245 billion. This included both direct costs, such as medical bills and healthcare resources, and indirect costs, including reduced productivity at work and home and decreased labor force participation.[13] After adjusting for population age and sex differences, the average medical expenses for people with diabetes are 2.3 times higher than for those without diabetes.[1,3,13] These added expenses are due not only to the direct treatment of the disease, but for the medical conditions and complications attributed to poorly controlled diabetes as well.[13] Even though more than half of direct medical costs are attributed to the population aged 65 years and older, about 88% of indirect costs are carried by those under 65 years of age.[13]

Moreover, diabetes has a negative impact on quality of life (QOL), affecting both those diagnosed with the disease as well as family members. Quality of life, as defined by the Constitution of the World Health Organization (WHO), is "individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns."[14] A multitude of studies have looked at the effects of diabetes-related distress and its effects on QOL in T2DM patients.[4,15-21] Furthermore, those with diabetes have an increased risk of mental health disorders, psychological disturbances, and functional problems, including depression, anxiety, and distress.[22] This distress may in turn lead to an increased risk of complications and higher mortality rates. For example, a systematic review of the literature conducted by Egede and Ellis found that depressive symptoms are twice as likely to occur in those with T2DM and that the occurrence of diabetes and depression was associated with increased morbidity, mortality, and healthcare costs.[16] Other research has concluded that people with T2DM generally report a low to moderate QOL that decreases as the duration of the disease increases and as complications become more prevalent.[17,20,21]

As a specific example of the studies conducted, the major focus of the Diabetes Attitudes, Wishes, and Needs 2 (DAWN-2) study was to examine the psychosocial issues and healthcare provision of people with diabetes. Although participants included both those with type 1 diabetes as well as T2DM, the majority of subjects, approximately 85%, were diagnosed with the latter. Utilizing responses from over 8500 participants in 17 different countries, researchers concluded that more than 10% of those with diabetes most likely were affected with depression and a poor QOL, with 44% of participants reporting a high level of diabetes-related distress.[19] In addition, many participants of the study felt that important aspects of their care, specifically diet and anxieties, were not discussed with their healthcare team.[19]

Even though less than 10% of the U.S. population live with T2DM, 86 million more people, nearly 1 in 3 Americans, live with prediabetes.[1] Those with this condition, defined as impaired glucose tolerance with blood glucose or A1C levels higher than normal but not increased to satisfy the diagnosis of diabetes, are at an increased risk of developing T2DM later in life.[1,5] Diagnostic criteria for prediabetes includes a fasting plasma glucose of 100 to 125 mg/dL, a 2-hour plasma glucose of 140 to 199 mg/dL following a 75-g OGTT, or a hemoglobin A1C level between 5.7% to 6.4%.[2]

Given the tremendous burden that T2DM places upon individuals and societies, prevention is possible and preferred to treatment. The onset of T2DM in those at risk can be delayed and potentially prevented. Research has demonstrated that the incidence of

T2DM can be reduced in those with prediabetes through intense lifestyle changes, including altering diet to increase fiber intake and decrease total fat and saturated fat intake and increasing physical activity.[5,23] The Centers for Disease Control and Prevention (CDC) predicts that if no intervention occurs in those 86 million people with prediabetes in the U.S., specifically weight loss and an increase in physical activity, 15% to 30% of these individuals will develop T2DM within the next 5 years.[1]

Based on the conclusions of earlier studies showing effective prevention of T2DM, in 1999 the Diabetes Prevention Program (DPP) Group implemented a large, randomized clinical trial.[24] The original purpose of the study was to compare the effectiveness of intensive lifestyle changes to treatment with metformin, a biguanide hyperglycemic medication, and the potential of these 2 treatments to prevent or delay the onset of diabetes at those with high risk. Researchers recruited 3234 nondiabetic persons diagnosed with impaired fasting glucose and assigned them to 1 of 3 groups: a placebo group, a metformin group, and an intense lifestyle intervention group. Participants in the placebo group were encouraged to attend a 20 to 30-minute annual meeting and received written materials - encouraging them to lose weight, decrease their dietary cholesterol intake, and follow the recommendations found in the USDA food pyramid. Those in the metformin group received 850 mg of the medication twice a day. Participants in the intense lifestyle changes group participated in a 16-part curriculum that encouraged its members to increase physical activity and follow a low-calorie, low-fat diet, with the end goal of at least a 7% weight loss and 150 minutes of physical activity each week.

The study ran for 2.8 years and was terminated 1 year earlier than planned due to the beneficial changes seen in both the metformin and intense lifestyle changes groups.

The results demonstrated that both metformin and lifestyle changes led to a lower incidence of diabetes when compared to the placebo group, with incidence rates of T2DM 58% and 31% lower than the placebo group, respectively. Nevertheless, of the 2 interventions, the intense lifestyle changes group proved to be more effective.

Interested in the extent of the benefits of the lifestyle intervention, researchers followed 2776 of the original members.[25] The researchers' main purpose was to look at incidence of T2DM among the 3 different arms of the original study. Lifestyle sessions were offered to all participants every 3 months and included educational materials to reinforce original weight loss and physical activity goals. During the follow-up period, incidence rates of T2DM among the 3 different groups did not differ significantly. This was attributed to the possibility that those at highest risk in the placebo group developed T2DM early, leading to dropping rates in the placebo group. Despite this drop, researchers still found that T2DM was lower in the intense lifestyle changes and metformin groups, with incidence rates of T2DM at 27% and 18%, respectively.

This landmark study has shown the effectiveness of preventing T2DM through lifestyle interventions as well as the duration of positive changes. Moreover, translational studies have shown that the DPP lifestyle intervention can be successfully implemented into primary care and other settings.[26,27] However, success in making these adaptations and delaying diabetes onset is not seen to the same degree with every participant who attempts to implement intensive changes. For example, in the original DPP study, only 49% of individuals in the intense lifestyle changes treatment successfully lost the 7% weight loss, and less than half of participants achieved this goal in translational studies of the DPP.[24,26,27] One study that examined factors affecting rate of success for women in prevention programs specifically found that lack of incentives, lack of time or motivation, and costs were all potential barriers to success.[28] Similarly, related factors that have been correlated with success include more physical activity compared to non-successful individuals and more frequent dietary monitoring.[29] One factor that has not been examined is how QOL at the onset of the program will affect change and success. It should be noted that in clinical trials examining T2DM, measures of quality of life and emotional well-being are often not accounted for in outcome measures.[22]

Significance of Problem

To our knowledge, there is no study that examines the relationship of QOL with success in making nutritional changes and improving diet quality as part of a diabetes prevention program. Diet quality can be measured via the US Department of Agriculture's Healthy Eating Index-2010 (HEI-2010).[30] As documented, nutritional and lifestyle changes are vital to preventing/delaying the onset of T2DM, which is crucial in stopping the increasing incidence of T2DM in the United States.[1,25]

Purpose and Hypothesis of Research

The purpose of this study was to compare the relationships among QOL, HEI-2010 scores, weight loss, and metabolic and biochemical markers in participants of the DPP from the University of Utah.

The specific aims for the research were:

1. To analyze QOL surveys, diet-recall records, and anthropometric measurements from approximately 48 individuals enrolled in the University's DPP to evaluate

their QOL score, HEI-2010 diet score, pre- and post-study weight, BMI, waist circumference, and waist-to-hip ratio.

2. To assess any relationship between QOL at beginning of the program and weight loss or HEI-2010 score of the diet at the end of the program.
3. To identify any improvements in metabolic markers (mean HbA1c, OGTT) associated with a higher QOL score.

For the first specific aim, we hypothesized that those with a higher QOL score will have more success in implementing lifestyle changes, as evidenced by improved HEI-2010 score and weight loss, compared to those with a lower QOL score. The null hypothesis for this aim is that there will be no difference between the 2 groups in terms of lifestyle changes success.

METHODS

University of Utah Diabetes Prevention Program

In brief, recruiting for the DPP at the University of Utah began in 2013. Advertising for the program occurred through flyers and in-person discussions with faculty and staff at the University Hospital and campus departments and divisions. Referrals were also received from the Utah Diabetes Education Center. Individuals interested in participating underwent testing to confirm a diagnosis of prediabetes, either by the CDC Prediabetes Screening Test, fasting blood glucose levels, or an OGTT. Of 109 individuals who were screened and tested, 68 participants were classified as prediabetic and began the program. Baseline testing for participants included a collection of biometric data and a completion of 4 surveys. Body weight (kg) was assessed via a self-calibrating digital scale (Seca 840 Bellissima-digital, Snoqualmie, WA), and height measured with a stadiometer (Seca 216 Accuhite, Snoqualmie, WA). Waist and hip circumference measurements were taken in accordance with the WHO guidelines and a waist-to-hip ratio calculated.[31] Additionally, participants were instructed on how to complete a 24-hour diet recall as well as a QOL survey. The self-reported 24-hour recall was recorded to assess dietary intake using standard protocols.[32] To assess QOL, participants were asked to fill out the Flanagan Quality of Life Scale (QOLS) survey. The same testing process was repeated 12 months later at the conclusion of the intervention.

Data collected from this study were managed using REDCap electronic data capture tools. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies.[33] Baseline characteristics of the 48 participants who completed the program are listed in Table 1.

Flanagan Quality of Life Scale

The Flanagan QOLS is a 16-item instrument designed to evaluate 6 different areas of quality of life: 1. material and physical well-being, 2. relationships with other people, 3. social, community, and civic activities, 4. personal development and fulfillment, 5. recreation, and 6. independence.[33] Items are scaled via a 7-point scale, and the survey is scored by adding up the individual items to yield a total score. Scores can range from 16 to 122, with an average score for healthy populations around 90. Studies have shown that groups with chronic diseases generally score lower on average, but the QOLS is responsive to change due to treatment.[34]

Healthy Eating Index-2010

Diet quality was entered and recorded into the Automated Self-Administered 24-Hour (ASA24) Dietary Assessment Tool system and then measured by the HEI-2010. The ASA24 is a dietary recall system created by the National Cancer Institute that is web-based and allows entry of multiple 24-hour recalls that are automatically coded.[35] The HEI-2010 is a validated tool that assesses conformance to the Dietary Guidelines for Americans (DGA).[30] Participants' diet quality is calculated via a scoring metric that is applied to the 24-hour recall. The most recent HEI-2010 is based on the 2010 DGA and is composed of 12 components. The scores from the individual components are then summed up to yield a total HEI-2010 score, which has a maximum of 100 points.[30]

Statistical Methods, Data Analysis, and Interpretation

Participants' dietary recalls, stored in REDCap, were processed in the ASA24 system and then analyzed to compute HEI-2010 scores. The ASA24 output contained information on caloric intake, nutrients, and food groups (MyPyramid Equivalents). Individual scores for each of the 12 components within the HEI-2010 were calculated and then summed to produce a total HEI-2010 score. Score calculation was conducted using SAS® software's capabilities (SAS, University Edition for OS X, 2014). The SAS code is available through the ASA24 website for calculating HEI-2010 scores per person.

Statistical analyses were conducted using Stata (Stata, MP Parallel Edition 14.1, 2015). Paired t-tests with a significance level set at a P-value <0.05 were used to assess differences in HEI-2010 scores, BMI, anthropometric measurements, and metabolic values at baseline and post-intervention. To investigate the relationship between diet quality and quality of life, multiple linear regression was used. The dependent variable was HEI-2010 scores. The independent variables included QOLS scores, race, sex, and education. All P-values were based on 2-sided tests and a P-value < 0.05 was considered to be statistically significant. Additional models were run using simple linear regression to look at potential relationships between QOLS score and anthropometric and biometric measures. Models that utilized measures taken pre-intervention were run with QOLS scores taken pre-intervention, and models run with post-intervention measurements used post-intervention QOLS scores.

Table 1

Baseline Characteristics of the
Utah Diabetes Prevention Program Participants

Characteristic	n=48
Male	10
Female	38
Age (yr)	49.8 ± 11.05
Weight (lbs)	219.91 ± 54.54
BMI	35.62 ± 7.43
Waist Circumference (cm)	109.28 ± 19.04
Hip Circumference (cm)	122.04 ± 17.63
Waist-to-Hip Ratio	0.90 ± 0.10
Education	
Did Not Complete High School	1
High School Diploma	1
Attended some College	15
Bachelor's Degree	20
Advanced Degree	11
Race	
White	47
Asian American	1

Plus-minus values are means ± SD

RESULTS

Quality of Life Scale Scores, Healthy Eating Index-2010, and Anthropometric Measurements

Participants' scores from the Flanagan QOLS pre-and post-intervention are presented in Table 2, both categorical and total. In every category, scores trended in the positive direction. Scores improved significantly in 9 of the 16 categories. Likewise, overall scores were statistically higher post-intervention compared to pre-intervention (P=0.0001).

A comparison of HEI-2010 scores for participants pre- and post-intervention is found in Table 3. Although total scores were not significant, individual components of the HEI-2010 were statistically different. Compared to pre-intervention, post-intervention showed an increase in total fruit (P=0.013), whole fruit (P=0.0048), and empty calorie consumption (P=0.039) with a decrease in whole grains (P=0.0103).

Changes in anthropometric and biomarkers are seen in Table 4. The average weight loss for participants over the course of 1-year was 10.3 lbs (P=0.0001), a loss of 4.6% body weight. Similarly, participants reduced waist and hip circumferences on average by 4.89 cm (P=0.0004) and 5.52 cm (P=0.001), respectively. Furthermore, improvements were seen in a 2-hour post OGTT, with an average decrease in blood glucose of 10.08 mg/dL (P=0.0245) as well as in HbA1c levels, indicating an improvement in glycemic control over a 3-month period.

Linear Regression

Linear regression models are found in Table 5. The findings of the linear regression between HEI-2010 as the dependent variable and QOLS scores as the only independent predictor showed that the model was not significant. The addition of other predictors, including race, gender, and education, did not change the significance of the model.

Simple linear regression was used to examine relationships between QOLS scores and anthropometric and biochemical measures. Significant associations were found between QOLS scores pre-intervention and BMI, hip circumference, and a 2-hour OGTT, and QOLS scores post-intervention and BMI, waist circumference, and hip circumference.

Table 2

Flanagan Quality of Life Scale Scores

Quality of Life Scale	Pre-intervention Scores	Post-intervention Scores	P-value
1. Material comforts home, food, conveniences, financial security	5.42 ± 0.94	5.90 ± 0.93	0.0038*
2. Health - being physically fit and vigorous	3.79 ± 1.16	4.94 ± 1.12	<0.0001*
3. Relationships with parents, siblings, & other relatives - communicating, visiting, helping	5.65 ± 0.93	5.81 ± 1.10	0.27
4. Having and rearing children	5.67 ± 1.31	6.00 ± 0.99	0.0108*
5. Close relationships with spouse or significant other	5.70 ± 1.23	6.11 ± 1.04	0.0034*
6. Close friends	5.89 ± 0.96	5.92 ± 0.85	0.6993
7. Helping and encouraging others, volunteering, giving advice	5.71 ± 1.03	6.02 ± 0.80	0.0063*
8. Participating in organizations and public affairs	5.38 ± 0.96	5.67 ± 0.95	0.0376*
9. Learning - attending school, improving, understanding, getting additional knowledge	5.63 +0.94	5.85 ± 0.95	0.0623
10. Understanding yourself - knowing your assets and limitations - knowing what life is about	5.60 ± 0.99	5.79 ± 0.85	0.1725
11. Work - job or in home	5.38 ± 1.20	5.63 ± 0.96	0.0766
12. Expressing yourself creatively	5.27 ± 1.23	5.5 ± 1.03	0.1817
13. Socializing - meeting other people, doing things, parties, etc.	5.21 ± 1.22	5.63 ± 0.98	0.0168*
14. Reading, listening to music, or observing entertainment	6.00 ± 0.83	6.11 ± .97	0.5431
15. Participating in active recreation	4.63 ± 1.28	5.35 ± 1.30	<0.0001*
16. Independence, doing for yourself	5.75 ± 1.08	6.13 ± 0.96	0.0054*
Total score	85.82 ± 11.35	91.33 ± 10.23	0.0001*

Plus-minus values are means ± SD
Items marked with as asterisk (*) are statistically different at the P < .05 value

Table 3

Diabetes Prevention Program Participants'
Healthy Eating Index-2010 Score Pre- and Post-Intervention

HEI-2010 score	Total Maximum	Pre (Average)	Post (Average)	P-Value
Total Fruit	5	2.13	3.00	0.013*
Whole Fruit	5	2.46	3.51	0.0048*
Total Vegetables	5	3.29	3.09	0.58
Greens and Beans	5	2.2	2.11	0.842
Whole Grains	10	3.21	1.85	0.039*
Dairy	10	5.44	5.92	0.4243
Total Protein Foods	5	4.2	4.27	0.8189
Seafood and plant proteins	5	2.6	2.13	0.29
Fatty acids	10	5.72	5.99	0.7122
Refined grains	10	4.22	3.86	0.2429
Sodium	10	5.74	6.52	0.51
Empty Calories	20	14.01	16.89	0.0103*
Total	100	55.23	59.14	0.1168

Items marked with as asterisk (*) are statistically different at the $P < .05$ value

Table 4

Selected Anthropometric Measures and Biomarkers Pre- and Post-Intervention

Measure	Pre-Intervention	Post-Intervention	P-Value
Weight (lbs)	219.91 ± 54.54	209.61 ± 52.65	0.0001*
BMI (kg/m^2)	35.62 ± 7.43	33.80 ± 7.10	0.0001*
Waist Circumference (cm)	109.28 ± 19.04	104.39 ± 17.85	0.0004*
Hip Circumference (cm)	122.05 ± 17.63	116.53 ± 15.55	0.001*
Waist-to-Hip Ratio	0.896 ± .097	0.897 ± .108	0.9538
Fasting Glucose (mg/dL)	94.31 ± 9.35	92.88 ± 8.95	0.2352
2-Hour Post Oral Glucose Tolerance Test (mg/dL)	123.39 ± 36.74	113.31 ± 27.31	0.0245*
HbA1c	5.56 ± .35	5.63 ± .31	0.035*

Table 5

Linear Regression Models for HEI-2010 Scores and Other Selected Measures

Linear Regression Model	Slope of Linear Fit	R^2	P-value
HEI-2010 scores pre	0.2495	0.139	0.1597
HEI-2010 scores post	0.0698	0.1118	0.2659
BMI pre	-0.21259	0.1055	0.0243*
BMI post	-0.2598	0.1399	0.0088*
Weight pre	-1.252	0.0678	0.0738
Weight post	-1.439	0.0781	0.0543
Waist circumference pre	-0.3836	0.0523	0.1181
Waist circumference post	-0.5719	0.1074	0.023*
Hip circumference pre	-0.5032	0.105	0.0247*
Hip circumference post	-0.5405	0.1265	0.0131*
Waist-to-hip ratio pre	0.00053	0.0038	0.6759
Waist-to-hip ratio post	-0.0006	0.0032	0.701
Fasting blood glucose pre	-0.062	0.0057	0.6112
Fasting blood glucose post	-0.08836	0.0104	0.5011
OGTT pre	-1.078	0.1121	0.0214*
OGTT post	-0.5768	0.0474	0.1463
HbA1c pre	-0.0122	0.0015	0.791
HbA1c post	-.0053	0.03	0.244

Items marked with as asterisk (*) are statistically different at the $P < .05$ value

DISCUSSION

The majority of the participants in the University's DPP were female, of the same racial background, and had attended some college or earned a bachelor's degree. Similar to other translational studies of the DPP, participants were successful in losing weight, with 39 participants losing weight over the 1-year period. Of the 39 participants, only 13 achieved the goal of 7% weight loss or more. It should be noted that the average weight loss of 10.3 lbs, approximately 4.6% body weight, was accompanied by other health benefits, including a reduced waist and hip circumference, and improved glycemic control. This is consistent with other studies, which have shown improved health outcomes without significant weight loss.[36,37]

Furthermore, ASA24 data output showed that, on average, participants were consuming 260 fewer calories per day. The P-value for this caloric difference was just above statistical significance ($P = 0.0528$); however, from a clinical perspective, a decrease of 260 calories per day is a significant reduction in intake, with the potential of greater weight loss over time.

Although differences between total HEI-2010 scores were not significant, scores were trending upwards in a positive direction and are comparable to the most recent HEI-2010 scores of the NHANES 2011-2012 reference population (59.00).[38] Moreover, participants in this study significantly increased their whole fruit intake, and their total fruit intake increased to a score comparable to the national average (3.00). Also, participants increased their score for the empty calories category. The score for empty calories was more than 4 points above the national average post-intervention (16.89 vs.12.60). A higher score for the empty calories category indicates that participants were consuming fewer calories from solid fats, added sugars, and alcoholic beverages. A perfect score of 20 is assigned to a diet with less than 20% coming from these sources, while a score of 0 is assigned to a diet with more than 50% of calories coming from these sources.[39]

Additionally, consideration must be given to the amount of whole grains consumed. A decrease in whole grains might be interpreted as an unhealthy behavior, but this may be related to an overall decreased carbohydrate intake. Dietary output from the ASA24 indeed shows that participants decreased their daily carbohydrate intake by 40.4 g, on average (P = 0.0286).

Regression models did not show a linear relationship between diet quality and quality of life. This contrasts with similar studies, which examined and found an inverse relationship with HEI scores and symptoms of depression.[40] This may due to the fact that dietary recalls were written down by interviewers and later placed into the ASA24 system, with differing levels of detail. For this data input, various assumptions, such as serving size or type of food, had to be made, which may have affected the interpretation.

Inverse relationships did exist between QOLS scores and the 2-hour OGTT values pre-intervention, waist circumference post-intervention, and BMI and hip circumference, both pre- and post-intervention. Although the R^2 value for these linear fits were not large, bivariate R^2 values are rarely big, and these relationships were statistically significant. These regressions indicate that how one perceives his or her quality of life may influence other health parameters and lifestyle changes, leading to greater success in the long run.

The strengths of this study include the number and variety of measurements taken pre- and post-intervention. The University-based DPP gathered a multitude of anthropometric and metabolic measurements, including weight, waist and hip circumference, and OGTTs, and used standard, reliable, and validated questionnaires to gather information about QOL as well as other aspects of health.

Limitations include the small number of participants who completed the DPP as well as the lack of dietary measurements taken throughout the 1-year course of the intervention. These missing data from the intervention period limit our ability to detect changes in dietary habits throughout the DPP. It is difficult to ascertain one's dietary quality from two 24-hour recalls, especially given 1 year apart. Not only are there the inherent limitations of a 24-hour recall, including inaccurate reflections of overall diet and health, but 2 recalls offer only a restricted view on potential changes in dietary habits. For future research, it is recommended that more dietary recalls be recorded at regular intervals to look at trends throughout the intervention period.

CONCLUSION

This study did not find a significant relationship between QOLS Scores and HEI-2010 scores in participants of a DPP. Improvements in weight, waist circumference, oral glucose tolerance tests, and hemoglobin A1c were seen in the participants. More research is necessary to measure and track dietary changes throughout the intervention period as well as to increase understanding of how to improve diet quality and quality of life in participants. Participants made positive shifts in diet, as evidenced by individual components of the HEI-2010 scores, and decreases in caloric intake. Given the financial, physical, and mental burdens of T2DM, increasing prevention and outcome measurements is important to combat this national health concern.

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