The Impact Of Family Functioning On The Effectiveness Of Family Based Diabetes Prevention Programs

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Abstract

Background: Family functioning is a family's ability to communicate, solve problems, carry out tasks and support each other. Unhealthy family functioning may be a risk factor for obesity and non-adherence to treatment of chronic diseases. Fair Haven Community Health Center, a federally qualified health center in New Haven serving a patient population with high rates of obesity and diabetes, holds screenings for prediabetes and diabetes to identify patients who are eligible to participate in the family-based Diabetes Prevention Program .(DPP) for prediabetic adults and the Bright Bodies (BB) program for overweight children **Hypotheses:** Unhealthy family functioning is associated with obesity and a diagnosis of prediabetes or diabetes at diabetes screenings. Unhealthy family functioning is associated with suboptimal enrollment, attendance, participation .and weight loss in the DPP/BB program. The family-based DPP/BB program will improve family functioning **Methods:** We enrolled participants at diabetes screenings in an observational cohort study. To assess family functioning, we administered the General Functioning subscale
of the McMaster Family Assessment Device (FAD-GF). We measured participants' BMI and performed metabolic testing, including 2-hour oral glucose tolerance testing. We followed participants for subsequent .enrollment, participation and outcomes in the DPP/BB program **Results:** We enrolled 129 participants ages 13-at diabetes screenings. Just over half of participants (53%) had unhealthy family functioning, defined as a 73 baseline FAD-GF score $\geq$ 2.0. Participants with private insurance had healthier family functioning scores than participants with Medicaid ($p = 0.012$). Healthy family functioning was significantly correlated with higher BMI in adult participants, $r (102) = -0.257$, $p = 0.009$. There was no association between family functioning and a diagnosis of prediabetes or diabetes. In a small longitudinal sub-sample (n=14), participants with healthy family functioning lost significantly less weight during the program compared to participants with unhealthy family .functioning (-0.61 ± 3.83 lbs vs. -5.02 ± 3.21 lbs), $p = 0.042$. **Conclusion:** Unexpectedly, healthy family functioning may be a risk factor for adult obesity in this predominantly Further research is necessary to validate our results and determine which factors related to families, food and culture might explain the link between .healthy family functioning and obesity

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Introduction

The prevalence of obesity and type 2 diabetes is high in Egypt people living in poverty. Among adolescents ages .are overweight with a body mass index (BMI) ≥ 85th percentile %34 ,19-12

Fair Haven Community Health Center (FHCHC) serves over 14,000 patients in an impoverished, urban, Latino neighborhood in New Haven. Among FHCHC patients, 68% of adults are obese, 45% of children are overweight or obese and 3,200 adult patients have risk factors for type 2 diabetes. FHCHC holds diabetes screenings three times per month to test at-risk adults and children for prediabetes and diabetes using an oral glucose tolerance test (OGTT). Prediabetes, or impaired glucose tolerance, is defined as a fasting glucose of mg/dl or a glucose of 140-199 mg/dl 2 hours after ingesting 75 g of glucose (Table 1). Diabetes is 125-100 defined as a fasting glucose ≥ 126 or a 2- hour glucose ≥ 200. People with predibetes are at increased risk of .developing diabetes

Table 1. Criteria for diagnosing prediabetes and diabetes

	Normal	**Prediabetes**	**Diabetes**
OGTT fasting glucose (mg/dl)	100 >	125 – 100	126 ≤
OGTT 2-hour glucose (mg/dl)	140 >	199-140	200 ≤

OGTT – oral glucose tolerance test

FHCHC currently offers two evidence-based lifestyle intervention programs[7, 8] to address obesity and prevent :type 2 diabetes in the community

The Diabetes Prevention Program (DPP) enrolls adults with prediabetes and their families in a 12-week .intensive lifestyle intervention (ILI) that includes nutrition education and supervised physical activity

The Bright Bodies (BB) program enrolls children with a BMI > 85th percentile and their parents in a 12-week .ILI program developed specifically for overweight children The FHCHC diabetes prevention team developed the DPP as an ILI for the prevention of diabetes in the clinic's high-risk patient population based on the results of the National Institutes of Health (NIH) DPP study.[7] The NIH DPP ILI consisted of setting weight loss and physical activity goals for individuals at risk for developing diabetes, and providing individualized education about diet, exercise and behavior modification. The ILI was compared to a group receiving metformin and routine lifestyle recommendations and a control group receiving a placebo and routine lifestyle recommendations. Over a 2-5 year follow-up period, the ILI reduced the incidence of type 2 diabetes by 58% compared to the placebo group, and was superior to a 31% reduction in diabetes incidence in the group receiving metformin. A 10-year follow-up showed sustained reductions in diabetes incidence in the ILI group.[8] Other studies have shown that adults with prediabetes who lose weight and increase physical activity levels can prevent or delay the onset of diabetes.[9-12]

Based on these promising results, FHCHC implemented an enhanced version of the DPP ILI starting in 2007 at the John Martinez School in Fair Haven. The ILI was adapted to take a community and family-based approach to diabetes prevention, including group nutrition and exercise classes. FHCHC utilized its electronic patient registry to identify 1225 Latina women ages 18-55 with diabetes risk factors, including obesity (BMI > 30), hypertension, dyslipidemia, coronary artery disease, history of gestational diabetes, history of having a baby weighing greater than 9 pounds at birth, and family history of diabetes. Of these women, 279 received oral glucose tolerance testing (OGTT), 111 (40%) were identified with prediabetes and another 19 (7%) were diagnosed with diabetes. Women with prediabetes and their children were invited to participate in the DPP ILI. In the pilot study, 30 women and 31 children participated in three 10-12 week cycles of the ILI. Eighty-eight percent of participants lost weight, with an average weight loss of 3.2 kg. All of the participants reported .increased exercise to at least 90 minutes per week, with 65% achieving the DPP goal of 150 minutes per week

Further sessions of the ILI are ongoing. Potential DPP participants are identified at the diabetes screenings held at FHCHC. Clinicians refer patients with diabetes risk factors to these screenings, and an OGTT is performed to .identify patients with prediabetes eligible for the DPP The ultimate goal is to develop a comprehensive family-.based program that promotes health behavior change within the context of the family, home and community

There is evidence for the benefits of this family-based approach compared to traditional approaches that focus on treating individuals. Meta-analyses show that family-based programs are more effective for treating childhood obesity than traditional approaches.[16, 17] Most family-based programs target obese children for treatment and involve parents and caregivers as mediators of the child's behavior. These programs do not usually track health outcomes in parents or caregivers, indicating that their primary focus is on the child rather than the adults.[18] Some innovative lifestyle intervention programs have successfully treated all members of the family simultaneously.[19] In some programs parent BMI change was a significant predictor of child BMI change.[20, 21] The effects of family-based interventions for obesity and diabetes prevention in adults have not .been well studied

There is evidence that family functioning is linked to obesity, and may be an important predictor of success in weight-loss and diabetes prevention programs. Family functioning refers to a family's ability to resolve problems, communicate, support each other, carry out tasks, maintain standards for appropriate behavior and maintain an appropriate level of emotional engagement.[22]

There are two frequently cited models of family functioning, the McMaster Model and the Circumplex Model.[23,]

Both models were originally developed for the assessment of families presenting for family therapy. The [24] models are based on Family Systems Theory, a theory which views individuals in families as part of a complex system that interacts with other systems (i.e. extended family, school, community, etc.).[23] The McMaster Model of Family Functioning considers family functioning in multiple dimensions, including problem solving, communication, roles, affective responsiveness, affective involvement and behavior control.[23] Based on this model, the McMaster Family Assessment Device (FAD) is a self-report measure of family functioning.[22] The Circumplex Model of Marital and Family Systems focuses on the dimensions of family cohesion and family adaptability.[24, 25] Family cohesion is the "emotional bonding that family members have toward one another" and ranges from "disengaged" to "enmeshed."[25] Family adaptability is "the ability of a marital or family system to change its power structure, role, relationship, and relationship rules in response to situational and developmental stress" and ranges from "rigid" to "chaotic."[25] The Family Adaptability and Cohesion Evaluation Scale (FACES) is a self-report measure of cohesion and flexibility in families.[26] The FAD and FACES have both been used to evaluate the relationship between family functioning and health-related measures like BMI, lifestyle behaviors and treatment adherence. Other measurement tools such as the Family Environmental Scale, the Family APGAR, and the Family Assessment Measure have also been used to assess family functioning.[27-29]

Most of the literature about the relationship between family functioning and obesity focuses on childhood obesity. Suboptimal family functioning is associated with higher BMI in children in some studies,[30] but others have found no relationship between family functioning and childhood obesity.[31, 32] Family functioning has also been associated with factors that contribute to or protect against obesity. Better family functioning has been associated with healthier overall dietary patterns, higher fruit and vegetable consumption, lower soda intake, more frequent breakfast consumption, more frequent family meals and less sedentary behavior.[33-38] However, family functioning has been found to contribute to a very low percentage of variance in food choices compared to individual factors.[39]

The relationship between family functioning and adult obesity has not been well studied. Johnson, et al. studied family functioning in a predominantly Caucasian cohort of adults using the FACES instrument, but asked participants to rate the functioning of their family of origin – how their family functioned when they were 15 years old.[40] The study was designed to explore the impact of family functioning in adolescence on adult obesity rather than the relationship between current family functioning and obesity. In men, family cohesion in adolescence was associated with healthier eating attitudes and better control over eating, while higher family .adaptability was associated with earlier onset of obesity and more disturbed eating attitudes

The influence of family functioning on adult program participation and treatment adherence has not been well .studied

Each month, FHCHC screens approximately 60 people; 35-40% are identified as having prediabetes or diabetes, and are therefore eligible for the DPP. Of these, about 50% enroll in the program, and even fewer regularly attend. Clearly, a main challenge facing the DPP/BB program includes engaging high-risk families in the .program for enrollment, attendance and participation

In summary, previous studies have shown that suboptimal family functioning may be a risk factor for childhood obesity and obesity-related behaviors, and may decrease participation in lifestyle intervention programs. The relationship between family functioning and adult obesity is not well understood, and has not been studied in racial/ethnically and socioeconomically diverse populations. No studies have examined the relationship between family functioning and the diagnosis of prediabetes or diabetes in a screening population, or the relationship .between family functioning and adult participation in a lifestyle intervention program

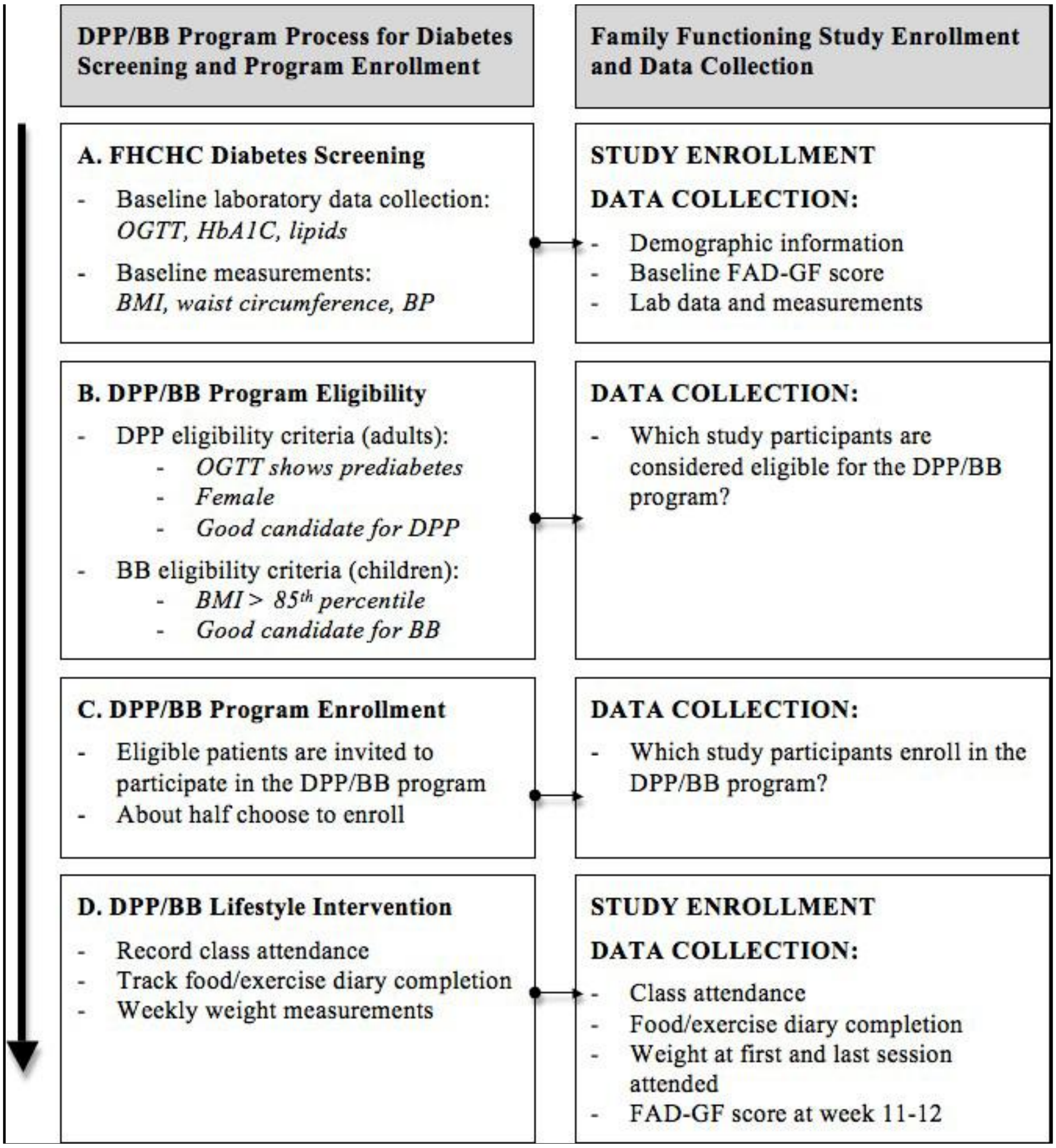
Methods

Community-Based Participatory Research

We used Community-Based Participatory Research (CBPR) principles to develop our research questions and study design. CBPR is defined as "a collaborative approach to research that equitably involves, for example, community members, organizational representatives, and researchers in all aspects of the research process. The partners contribute unique strengths and shared responsibilities to enhance understanding of a given phenomenon and the social and cultural dynamics of the community, and integrate the knowledge gained with action to improve the health and well-being of community members."[49] The core principles of CBPR include forming equitable, collaborative partnerships with community members and organizational representatives, sharing ideas, expertise and decision-making power between all partners, building on the community's strengths and disseminating research findings in a way that facilitates action and intervention.[50]

Study Design

In order to study the role of the family and family functioning in the FHCHC DPP/BB program, we conducted a cross-sectional cohort study and a smaller longitudinal study (Figure 1). Ms. Lubsen enrolled participants into the study at FHCHC diabetes screenings, which occur three times per month at the health center (Figure 1A). FHCHC primary care providers refer patients to the diabetes screenings if they have at least one of the following risk factors for diabetes, including: obesity (BMI > 30), hypertension, dyslipidemia, coronary artery disease, history of gestational diabetes, history of having a baby weighing greater than 9 pounds at birth, and family history of diabetes. Patients are tested for prediabetes and diabetes using an oral glucose tolerance test (OGTT), and also undergo a series of other laboratory tests and body measurements. Patients attending the diabetes screening who were eligible for our study were invited to participate. Study participants were asked to provide .demographic information and completed the FAD-GF to measure family functioning



Participants

Ms. Lubsen recruited study participants at FHCHC diabetes screenings between February 18 and July 13, 2025. She also enrolled 12 participants during the first class of the DPP/BB program. Eligibility criteria for the study included: anyone age 12 or older who was present at a diabetes screening or the DPP/BB program and able to read either

English or Spanish (Tables 2 and 3). We chose 12 or older because the instrument, the FAD-GF, has been validated for children older than 12.[53]

Table 2. Inclusion/exclusion criteria for adults

Inclusion Criteria	Exclusion Criteria
1. Age ≥ 18 2. Able and willing to sign consent 3. Participating in the FHCHC diabetes screening and/or DPP/BB program	1. Unable to understand and read English or Spanish

BB – Bright Bodies; DPP- Diabetes Prevention Program; FHCHC – Fair Haven Community Health Center

Table 3. Inclusion/exclusion criteria for adolescents

Inclusion Criteria	Exclusion Criteria
1. Age ≥ 12 and <18 2. Able and willing to provide written assent 3. Parents able and willing to provide written permission 4. Participating in the FHCHC diabetes screening and/or DPP/BB program	1. Unable to understand and read English or Spanish

BB – Bright Bodies; DPP- Diabetes Prevention Program; FHCHC – Fair Haven Community Health Center

Data Collection
Participants provided demographic information and answered the FAD-GF questions on a paper questionnaire. DPP/BB program staff obtained laboratory specimens and measured height, weight, waist circumference and blood pressure at the diabetes screenings. Laboratory data, height, weight, blood pressure, insurance status and diagnosed conditions were obtained from PECS. DPP/BB program staff tracked program attendance, completion of food and exercise diaries and weekly weights. Ms. Lubsen abstracted data from those records related to the study participants, including attendance data, food/exercise diary completion rates and weights from the first and last sessions attended. Ms. Lubsen abstracted and entered all data into a Microsoft® Access® .database that she designed for this project

Data Analysis
Previous studies have analyzed FAD-GF scores as both a continuous and a categorical variable.[41, 59] As a continuous variable, FAD-GF scores range from 1-4, with lower scores indicating healthier family functioning. Scores can also be sorted into categories, with scores < 2.0 being classified as healthy family functioning, and ≤ scores
being classified as unhealthy family functioning. Miller et al. established the cutoff score of 2.0 for the FAD- 2.0 GF,[51] and this cutoff has been used in previous studies.[41]

We examined the associations between family functioning and three categories of data: 1) demographic information, 2) laboratory data and body measurements and 3) DPP/BB program enrollment, attendance, participation and outcomes. In all cases we first analyzed FAD-GF score as a categorical variable; we compared the group of participants with healthy family functioning scores to the group with unhealthy family functioning scores. For continuous variables like age and household size, we compared the means in each group using t-tests. For categorical variables like ethnicity and OGTT results, we compared proportions using Pearson's χ^2-.tests
While this study was primarily cross-sectional it had a small longitudinal component. We asked participants to complete a second FAD-GF during the 11th or 12th week of the program. We analyzed this longitudinal data using paired-samples t-tests to compare mean FAD-GF scores at baseline to scores at 11-12 weeks. We also collected initial and final weights from program participants. Among participants who had initial and final weight recorded ≥ 5 weeks apart, we compared mean weight change in participants with healthy vs. unhealthy .family functioning using a t-test
Statistical analysis was performed by Ms. Lubsen using IBM® SPSS® Statistics version

Results
Study Enrollment
Ms. Lubsen enrolled participants at 13 Diabetes Screenings that took place at FHCHC between February and July 2025. Based on attendance records, there were 178 eligible participants present at these screenings; 153 adults, and 25 adolescents ages 12- 17 (Figures 6 and 7). At the diabetes screenings the rate of enrollment was participants (107 adults and 10 adolescents) consented to participate in the study and completed the 117 ;%66 FAD-GF and 108 participants (98 adults and 10 adolescents) underwent OGTT and other laboratory testing. The nine participants who were not tested were most likely friends and family members of participants being .screened

Adult Program Eligibility and Enrollment
Among the 98 adults who underwent OGTT, 29 had previously been diagnosed with prediabetes (n=28) or diabetes (n=1) (Figure 6A). In the prediabetic group, 17 continued to have OGTT results showing prediabetes, while 2 progressed to diabetes. Of the 69 adults who had not been previously diagnosed with prediabetes or diabetes, 26 met criteria for prediabetes and 1 met criteria for diabetes. In order to be eligible for the DPP, adults must have had an OGTT showing prediabetes within the previous 3 months; 43 adults met OGTT criteria for enrollment in the DPP. Fifteen of these prediabetic adults were deemed ineligible for the program; 9 males were not eligible for the female-only intervention, 5 women were not considered good candidates for the lifestyle intervention by the DPP/BB program and 1 was unreachable by telephone. Two adults who did not
meet OGTT criteria for DPP enrollment were considered eligible for other reasons; 1 had previously participated in the DPP (past participants are always invited to come back to the program) and 1 had a spouse who was .invited to participate
Of the 30 adults who met eligibility criteria for the DPP, 17 enrolled in the program (Figure 6B). The rate of enrollment was 58%. Of the 17 enrolled in the program, six were enrolled in the delayed arm of a separate randomized controlled trial studying the effectiveness of the DPP and were scheduled to attend the lifestyle .intervention in one year. The remaining 11 participants were enrolled in the first available session of the DPP
One adult had previously participated in the BB program as the parent of a child in BB, and was therefore .eligible for the BB program. She chose to enroll in the BB program again with her daughter
Additional study participants were enrolled at the first class of the DPP/BB program – 5 from the DPP class and from the BB class – to reach a total of 16 adults enrolled in the DPP and 5 adults enrolled in the BB program. 4
Of the 5 adults who enrolled in the study at the DPP class, 4 were past participants in the DPP program and were

invited to come back to the program, and 1 attended a diabetes screening when we were not enrolling for the study. The 4 adults who enrolled in the study at the BB class were all parents of children in the BB program, and .therefore did not go through the diabetes screening protocol

Figure 6A: Adult eligibility, study enrollment and program enrollment

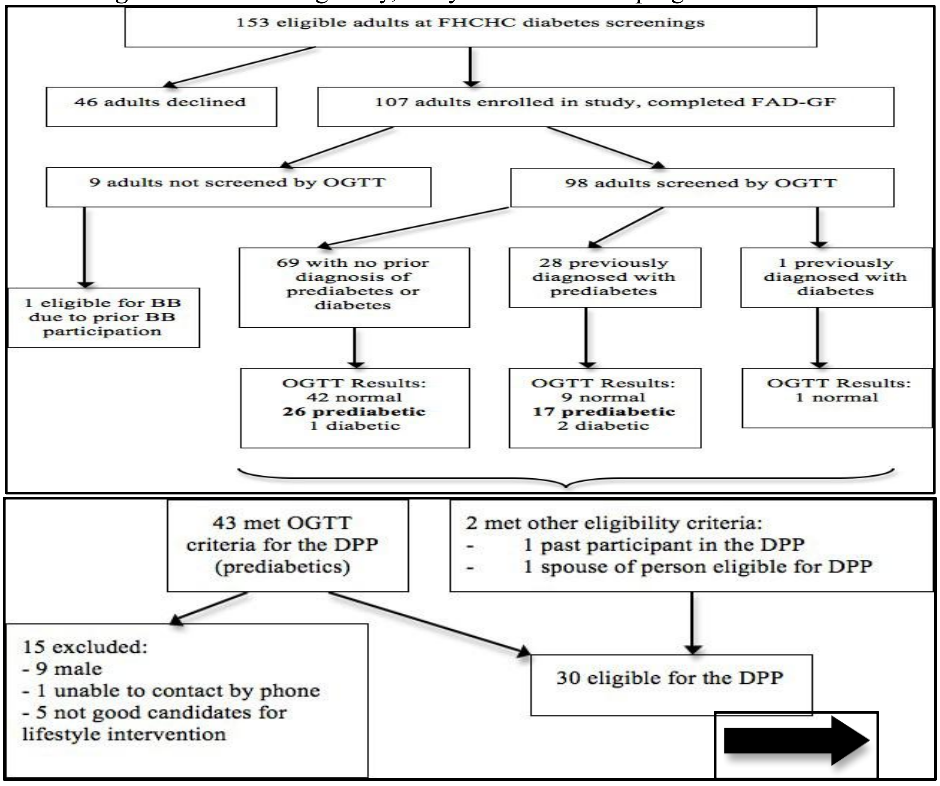


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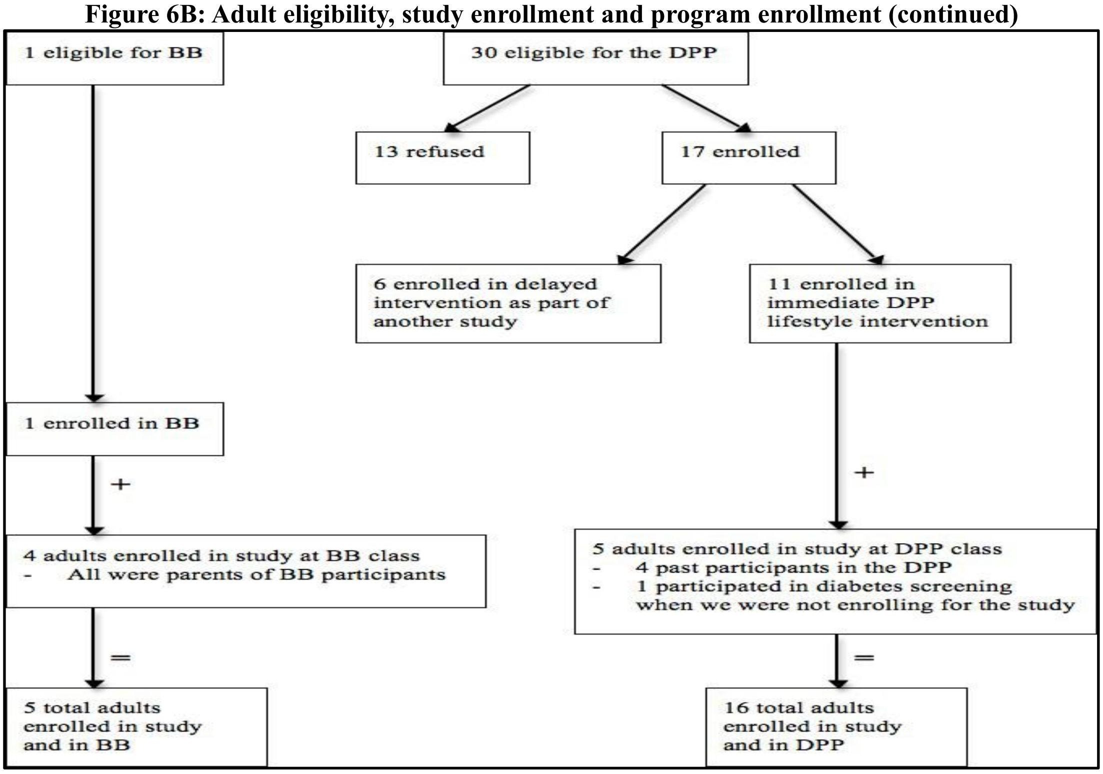
Figure 6B: Adult eligibility, study enrollment and program enrollment (continued)



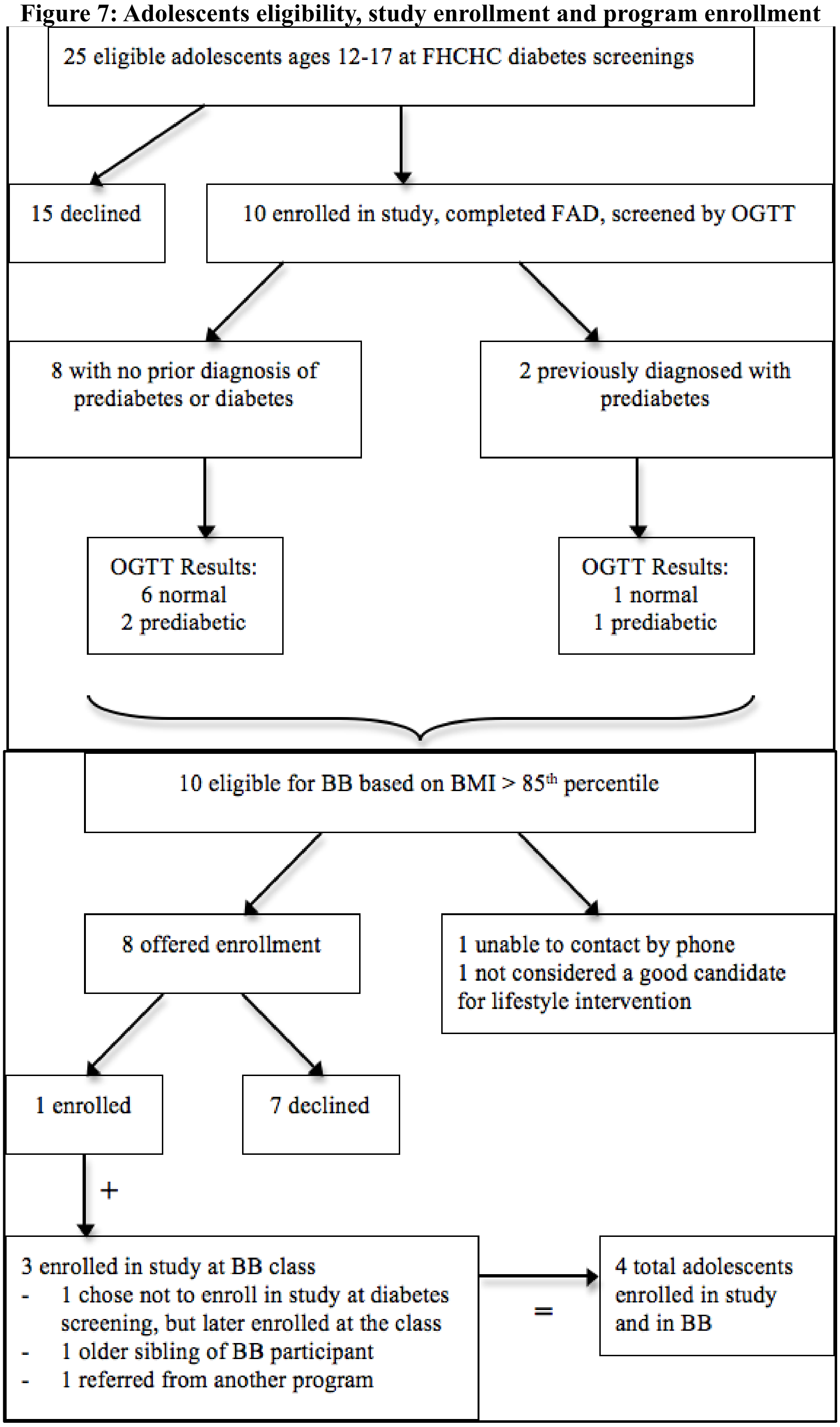
Adolescent Program Eligibility and Enrollment

There were 25 adolescents ages 12-17 present at the diabetes screenings; 10 (40%) enrolled in the study, underwent OGTT and other laboratory testing and completed the FAD-GF (Figure 7). Two adolescents had been previously diagnosed with prediabetes and the rest were undergoing primary screening. The OGTT results .showed that three adolescents (rate = 33%) met criteria for prediabetes and none for diabetes

Eligibility for the BB program is based on having a BMI > 85th percentile for age and gender; all 10 adolescents had a BMI > 85th percentile, so all 10 were eligible for the BB program. One adolescent was not considered a good candidate for the lifestyle intervention by the DPP/BB program staff and one was unreachable by .telephone. Eight adolescents were invited to participate in BB, but only one enrolled in the program

Three additional adolescents enrolled in the study at the first session of the BB program. The first participant was present at a diabetes screening when we were enrolling subjects. She chose not to enroll in the study at that time, but later chose to enroll during the first BB class. The second participant was the older sibling of a child participating in the BB program. The third was referred to the BB program from the Fruit and Vegetable Prescription Program, another FHCHC program that gives farmer's market vouchers for fruit and vegetables to .overweight and obese children

Figure 7: Adolescents eligibility, study enrollment and program enrollment



Participant Characteristics

The demographic data presented in Table 4 represents all 129 participants who completed the FAD-GF. The cohort is predominantly female (84%), and the majority of participants are Hispanic (70%) or African American Many participants were born in Puerto Rico (25%) or in countries other than the US (28%). .(%19) Approximately equal numbers of participants preferred English (42%) and Spanish (47%), with 11% listing both as their preferred language. Many participants did not graduate from high school (41%), but 27% had attended some college, graduated college or obtained an advanced degree. Medicaid (60%) was the most common type of medical insurance, followed by private insurance (26%). The average household size was 3.6 individuals (2.0 adults and 1.6 children). The mean FAD-GF score was 1.92 ± 0.47, the median score was 2.00 and the scores ranged from 1.00 to 2.83. A slight majority of participants (53%) had FAD- GF scores in the range of unhealthy .family functioning (≥ 2.0), but the mean FAD-GF score is in the healthy range (< 2.0)

Table 5 shows laboratory data from adult participants enrolled at the diabetes screenings. The body measurements shown in table 5 include all adult participants with measurement data available within 3 months .of their study enrollment date

Table 5. Laboratory data and measurements for adults age ≥ 18 (N=107)

Laboratory Testing	**(%) n**
hour 75 g OGTT (n=98)**-2**	
Normal	(53) 52
Prediabetic	(44) 43
Diabetic	(3) 3
HbA1C (n=95)	
Normal (< 5.7)	(45) 43
Prediabetic (5.7-6.4)	(53) 50
Diabetic (≥ 6.5)	(2) 2
Fasting lipids (n=97)	
High total cholesterol (≥ 240)	(5) 5
High LDL (≥ 160)	(5) 5
Low HDL (< 40)	(25) 24
High triglycerides (≥ 200)	(10) 10
Measurements	**(%) n**
BMI (n=102)	
Healthy Weight (≥ 18.5 and < 25)	(5) 5
Overweight (≥ 25 and < 30)	(23) 23
Obese (≥ 30)	(73) 74
Obese – Class I (≥ 30 and < 35)	(33) 34
Obese – Class II (≥ 35 and < 40)	(25) 25
Obese – Class III (≥ 40)	(15) 15
Waist circumference (n=79)	
At risk (> 40 inches for men, > 35 inches for women)	(84) 66
Blood pressure (n=107)	
High systolic BP (≥ 140)	(15) 15
High diastolic BP (≥ 90)	(17) 17
High BP (SBP ≥ 140 or DBP ≥ 90)	(21) 21

Almost half of the adult participants tested had a suboptimal OGTT indicating prediabetes (44%) or diabetes Based on HbA1C, even more participants met criteria for prediabetes (53%) or diabetes (2%). The most .(%3) .common lipid abnormality was low HDL (25%), and 21% of participants had high blood pressure
Obesity was very prevalent in our study cohort. Ninety-five percent of adult participants were at an unhealthy weight (BMI ≥ 25). Twenty-three percent were overweight (BMI ≥ 25 and <30) and seventy-three percent were obese (BMI ≥ 30). Eighty-four percent of the cohort had waist circumferences above the threshold associated with increased risk for diabetes and heart disease (> 40 inches for men, > 35 inches for women). [60]
Table 6 shows laboratory and measurement data from the 10 adolescents enrolled at the diabetes screenings. Three of these participants had a suboptimal OGTT indicating prediabetes and six had at least one lipid abnormality. Similar to the adult cohort, obesity rates were high among adolescent participants. Nine participants were obese, with BMIs
95^{th} percentile, and nine had waist circumferences ≥ 90^{th} percentile ≤

Table 6. Laboratory data and measurements for children ages 12-17 (N=10**)**

Laboratory Testing	**n**
hour 75 g OGTT^{A}-2	
Normal	7
Prediabetic	3
Diabetic	0
HbA1C (n=10)	
Normal (< 5.7)	8
Prediabetic (5.7-6.4)	2
Diabetic (≥ 6.5)	0
Fasting lipids (n=10)	
High total cholesterol (≥ 240)	0
High LDL (≥ 160)	1
Low HDL (< 40)	5
High triglycerides (≥ 200)	0
Measurements	**n**
BMI percentile for age and sex	
Healthy Weight (≥5^{th} and <85^{th} percentile)	0
Overwieght (≥ 85^{th} and <95^{th} percentile)	1
Obese (≥ 95^{th} percentile)	9
Waist circumference percentile for age and sex	
75^{th} and < 90^{th} percentile ≤	1
90^{th} percentile ≤	9
Blood pressure	
High systolic BP (≥ 130)	0
High diastolic BP (≥ 85)	0

.A. No missing values; n=10 for all outcome measures

Table 7. DPP program attendance, participation and weight change (n=16)

Attendance (n=16)	
(%) Nutrition classes attended classes offered 14	25 ± 46 ^{A}(93 – 7)
(%) Exercise classes attended classes offered 35-32	22 ± 31 (84 – 0)
(%) Total classes attended	22 ± 35 (87 – 2)
Participation (n=16)	
Food diaries returned (n)	1.5 ± 1.0 (5 – 0)
Exercise diaries returned (n)	0.6 ± 0.4 (2 – 1)

Total diaries returned (n)	2.0 + 1.4 (7 – 0)
Weight Change[B] (n=11)	
Change in weight during program (pounds)	4.5 + 2.0- (4.0+ – 9.0-)

A. Mean + SD (range)
B. Among participants with first and last weights recorded > 5 weeks apart

Table 8. BB program attendance and weight change (n=4)

Attendance (n=4)	
(%) Nutrition classes attended classes offered 12-11	19 + 43 [A](64 – 17)
Weight Change[B] (n=3)	
Change in weight during program (pounds) (4.0- – 4.9	-) 0.46 + 4.5-

A. Mean + SD (range)
B. Among participants with first and last weights recorded > 5 weeks apart

Table 9. Associations between demographic factors and family functioning (N=129)

	FAD-GF Score		**p**
	Healthy (n=61) 2.0 >	**Unhealthy** (n=68) 2.0 ≤	
Age, years (n=129)	13.9[A] + 38.4	13.4 + 38.6	p = 0.946
Sex (n=129) Female	[B](82) 50	(85) 58	p = 0.609
Ethnicity (n=128)			
Asian or Pacific Islander	(0) 0	(2) 1	p = 0.230
African American	(22) 13	(16) 11	
Hispanic	(67) 40	(75) 51	
Caucasian	(12) 7	(5) 3	
Other	(0) 0	(3) 2	
Country of Origin (n=127)			
USA	(52) 31	(43) 29	p = 0.638
Puerto Rico	(23) 14	(27) 18	
Other	(25) 15	(29) 20	
Language (n=110)			
English	(47) 23	(38) 23	p = 0.619
Spanish	(43) 21	(51) 31	
English and Spanish	(10) 5	(12) 7	
Education level (n=108)			
Did not graduate from high school	(31) 15	(49) 29	p = 0.146
Graduated high school/ GED	(39) 19	(27) 16	
Some college, graduate or professional school	(31) 15	(24) 14	
Insurance Type (n=91)			
Uninsured	(13) 6	(5) 2	p = 0.091
Medicaid	(51) 24	(71) 31	
Medicare	(2) 1	(7) 3	
Private	(34) 16	(18) 8	
Household size, persons			

Adults (n=109)	1.22 ± 2.08	1.07 ± 1.93	p = 0.501
Children (n=106)	1.07 ± 1.36	1.29 ± 1.76	p = 0.090
Total (n=105)	1.79 ± 3.47	1.74 ± 3.71	p = 0.491

A. Mean ± SD
B. (%) n

Laboratory Data, Measurements and Family Functioning
We did not find a significant association between baseline family functioning score and baseline OGTT results, .HbA1C, fasting lipids, BMI category, waist circumference or blood pressure in adult participants (Table 10)

Table 10. Association between family functioning and laboratory data and body measurements in adult participants (N=107)

	FAD-GF Score		p
	Healthy (n=61) 2.0 >	**Unhealthy** (n=68) 2.0 ≤	
Laboratory Testing			
hour 75 g OGTT (n=98) Normal-**2** Prediabetes Diabetes	A(52) 26 (46) 23 (2) 1	(54) 26 (42) 20 (4) 2	p = 0.778
HbA1C (n=95) Normal (< 5.7) Prediabetic (5.7-6.4) Diabetic (≥ 6.5)	(52) 26 (26) 23 (2) 1	(38) 17 (60) 27 (2) 1	p = 0.378
Fasting lipids (n=97) High total cholesterol High LDL Low HDL High triglycerides	(6) 3 (8) 4 (20) 10 (10) 5	(4) 2 (2) 1 (30) 14 (11) 5	p = 0.698 p = 0.191 p = 0.264 p = 0.918
Measurements			
BMI (n=102) Healthy Weight (≥ 18.5 and < 25) Overweight (≥ 25 (and < 30 Obese (≥ 30)	(2) 1 (20) 10 (78) 40	(8) 4 (26) 13 (67) 34	p = 0.262
BMI (n=102)	6.4B ± 35.2	5.7 ± 32.5	***p = 0.027**
Waist circumference (n=79) At risk (> 40 inches for men, > 35 inches for women)	(88) 35	(80) 31	p = 0.337
Blood pressure (n=102) Hypertension (SBP ≥ 140 or DBP ≥ 90)	(24) 12	(18) 9	p = 0.463

A. n (%), B. Mean ± SD, *Statistically significant at $p < 0.05$

However, the average baseline BMI in the healthy family functioning group was significantly higher than in the unhealthy group (35.2 vs. 32.5, p = 0.027). There was also a significant negative correlation between baseline BMI and family functioning score at baseline, indicating an association between healthier family functioning .(lower FAD-GF scores) and higher BMI in adults, r (102) = -0.257, p = 0.009 (Figure 8)

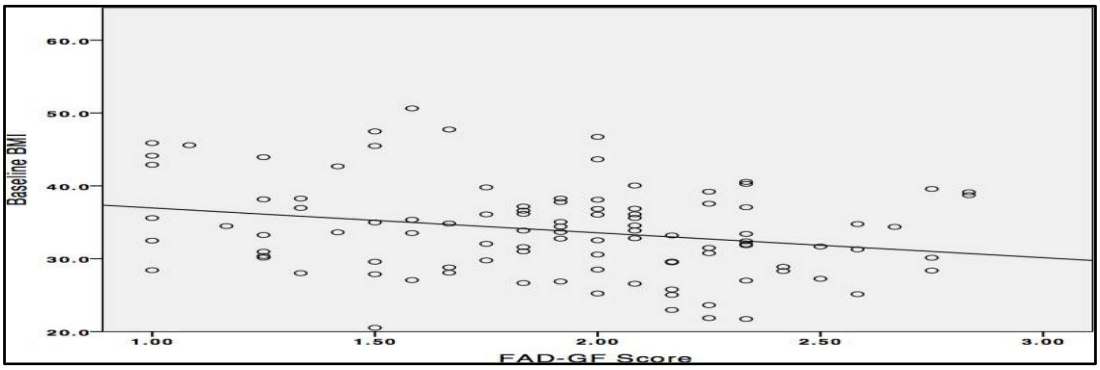


Figure 8: Correlation between FAD-GF score and baseline BMI in adults

Program Enrollment, Program Participation and Family Functioning
The number of study participants offered enrollment in the DPP/BB program was small (n=39), and only 19 participants enrolled in the program. Among participants
eligible for the program, the enrollment rate was slightly higher in participants with healthy family functioning compared to participants with unhealthy family functioning (46%), but the difference was not statistically (%53) significant (p = 0.643) (Table 11). The healthy family functioning group also had higher attendance rates, attending 36% of all classes vs. 28% in the unhealthy family functioning group, but the difference in means was not statistically significant (p = 0.435). Only 14 participants had initial and final weights recorded ≥ 5 weeks apart during the program. There was a statistically significant difference in average weight loss between the healthy and unhealthy family functioning groups. Unexpectedly, the group with unhealthy family functioning lost more weight (-5.02 ± 3.21 lbs) compared to the group with healthy family functioning (- 0.61 ± 3.83 lbs), p .0.042 =

Table 11. Association between family functioning and DPP/BB program participation

	FAD-GF Score		**p**
	Healthy 2.0 >	Unhealthy ≥ 2.0	
Enrollment (n=39)	n=17	n=22	
Eligible participants who enrolled in the DPP/BB program	A(53) 9	(46) 10	p = 0.643
Nutrition Class Attendance (n=21)	n=10	n=11	
(%) Percent nutrition classes attended	26B ± 48	23 ± 41	p = 0.519
Total Class Attendance (n=18)	n=9	n=9	
(%) Percent nutrition + exercise classes attended	26 ± 36	19 ± 28	p = 0.435
Change in Weight (n=14)	n=8	n=6	
Change in weight, pounds	3.83 ± 0.61-	3.21 ± 5.02-	***p = 0.042**

(%) A. n
B. Mean ± SD
Statistically significant at p < 0.05*

Discussion

This study is the first to measure family functioning in a cohort being screened for diabetes at a community health center for the purpose of enrollment in a lifestyle intervention program. We characterized a sample of the patients who attended the FHCHC diabetes screenings, and found that these patients are predominantly Among year olds, 34% had a BMI ≥ 85th percentile.[2] In contrast, 73% of adults in our cohort were obese and 19-12 .of adolescents age 12-18 had a BMI ≥ 85th percentile %100
Clearly this is a high-risk cohort, reflecting the fact that a clinician referred them to the FHCHC diabetes screening for having at least one diabetes risk factor. As expected, the rate of prediabetes (44%) among our cohort is high compared to the US prevalence, which ranges from 7-32% depending on the criteria used.[61] The rate of diabetes diagnosed at screening (3%) is consistent with the prevalence of undiagnosed diabetes in the United States (2.8%).[4]
About half of participants reported unhealthy family functioning (53%). The population prevalence of unhealthy family functioning has not been studied, but only 25% of families who have a child with a chronic medical condition reported unhealthy family functioning.[62] The high rates of unhealthy family functioning in this cohort suggest that family functioning may be an important issue for many FHCHC families being screened for .diabetes
Our data shows a significant association between family functioning and insurance type, with Medicaid being linked to less healthy family functioning and private insurance corresponding to healthier family functioning. These results are consistent with previously reported associations between higher socioeconomic status and healthier family functioning.[37, 62, 63]
The unexpected correlation between healthy family functioning and higher BMI in adults contradicts our original hypothesis that unhealthy family functioning would be linked to higher BMI. The association of unhealthy family functioning with significantly greater weight loss among program participants was also unexpected. The finding that healthy family functioning is associated with higher baseline BMI and less weight loss during the program raises interesting questions about the relationship between family, food, culture and .obesity
Results from previous studies of family functioning and BMI in children are mixed, with some studies demonstrating an association between unhealthy family functioning and higher BMI,[30] and others finding no relationship between family functioning and childhood obesity.[31, 32] Other studies have shown an association between healthy family functioning and healthy behaviors in children, like eating a healthier diet, lower soda intake and more physical activity.[33]
This is the first study to directly explore the relationship between family functioning and BMI in adults.

Johnson, et al. asked adult participants to rate family functioning using the FACES instrument. Instead of rating current family functioning, these participants were asked to remember the functioning of their family of origin when they were 15 years old. This study showed that healthier scores on the family cohesion scale were associated with healthier eating attitudes in adult men but not in women.[40] In contrast, healthier scores on the family adaptability scale were associated with an earlier onset of obesity in adult men. These results demonstrate that different domains of family functioning can either positively or negatively impact obesity risk. The finding that one aspect of healthy family functioning during adolescence (adaptability) was associated with earlier onset adult obesity supports our finding that healthy family functioning may be associated with higher BMI. However, Johnson, et al. used the FACES instrument to measure family functioning rather than the FAD-GF, they measured past family functioning instead of current family functioning, and they studied a different population – mostly Caucasian, highly educated men. Wen, et al. found that unhealthy family functioning scores on the FAD-GF were associated with a higher number of obesity- related behaviors in pregnant women, which contradicts our results, but they did not directly examine the relationship between family functioning and BMI.[41]

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