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Effects of a Community-Based Diabetes Prevention Program for Latino Youth with Obesity: A randomized controlled trial

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Abstract

Objective: This study examined the short- and long-term effects of a community-based lifestyle intervention among Latino youth with obesity.

Methods: Latino adolescents (14–16 years old) were randomized to a 3-month lifestyle intervention (*N*=67) or comparison control (*N*=69) and followed for 12-months. The intervention included weekly nutrition and health classes delivered to groups of families and exercise sessions (3 days/week) delivered to groups of adolescents. Comparison youth received laboratory results and general health information. Primary outcomes included insulin sensitivity and weight-specific quality of life (QoL) with secondary outcomes of BMI%, waist circumference and percent body fat.

Results: At 3-months, youth in the intervention group exhibited significant increases in insulin sensitivity ($p<0.05$) and weight-specific QoL ($p<0.001$) as well as reductions in BMI%, waist circumference and percent body fat compared to controls. Increases in weight-specific QoL and reductions in BMI% and percent body fat remained significant at 12-months ($p<0.001$) while changes in insulin sensitivity did not. In a subsample of youth with prediabetes at baseline, insulin sensitivity ($p=0.01$), weight-specific QoL ($p<0.001$), and BMI% ($p<0.001$) significantly improved at 3-months.

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Conclusions: Lifestyle intervention can improve cardiometabolic and psychosocial health in a vulnerable population of Latino adolescents at high risk for developing type 2 diabetes.

Keywords

Latino; lifestyle intervention; community; diabetes prevention; youth

INTRODUCTION

Latino youth are more insulin resistant and exhibit higher rates of prediabetes compared to non-Hispanic white youth (1, 2). Disparities in type 2 diabetes (T2D) emerge early in life and it is estimated that up to 50% of Latino children will develop T2D in their lifetime (3). Obesity and T2D are also associated with lower health-related quality of life (QoL), which may further contribute to premature morbidity and mortality (4). Given that Latino youth are the fastest growing pediatric subpopulation in the U.S. and experience a disproportionate burden of obesity and T2D, there is a critical need for effective diabetes prevention efforts in this population (5, 6).

The Diabetes Prevention Program (DPP) demonstrated that comprehensive lifestyle intervention that includes nutrition education, physical activity, and behavior change strategies can prevent or delay the onset of T2D in adults with prediabetes (7). The DPP has been successfully adapted for a variety of adult populations (e.g. elderly, minority, pregnant women) and across delivery settings (e.g, churches, worksite, YMCA’s) (8). Despite the increasing prevalence of prediabetes and T2D in younger populations, the evidence describing effective T2D prevention programs in youth is limited (9).

Although the pediatric diabetes prevention literature is sparse, the evidence describing successful weight management interventions for children and adolescents is more robust. A recent evidence report on randomized controlled trials from the US Preventive Services Task Force (USPSTF) found that lifestyle interventions of at least 26 contact hours led to significant reductions in excess weight while trials of at least 52 contact hours had additional effects on blood pressure (10). While some trials reported improvements in measures of glucose regulation or insulin resistance, there were insufficient data to draw conclusions regarding T2D risk reduction. Diabetes prevention studies differ from obesity studies in that they evaluate T2D outcomes or proximal risk factors (e.g. glucose tolerance, insulin resistance) and focus on high risk populations such as minority adolescents with obesity (11). Similar to T2D outcomes, the USPSTF was not able to answer the key question of whether intervention efficacy differs according to age, degree of obesity, or race/ethnicity due to lack of data (10).

The complexity of diabetes disparities in minority youth underpins the need for T2D prevention interventions to build upon what works for pediatric weight management and integrate broader social and ecological factors that contribute to T2D (12). From a disparities framework, the most effective obesity interventions for minority youth are culturally-tailored, incorporate family, and utilize a multilevel, community focused approach (13). With the above context, the purpose of this study was to examine the short-term (3-months) and long-term (12-month) outcomes of a culturally-grounded, community-based lifestyle intervention on insulin sensitivity and QoL in Latino adolescents with obesity.

METHODS

Theoretical Framework and Approach.

This study was guided by an expanded ecodevelopmental model, which maps the complex interactions among individual, peer, family, and community-level factors that influence health behaviors and outcomes during development (14). Implementation was supported through an academic-community collaboration that engaged an accredited diabetes education program from a Latino-serving health clinic (St. Vincent de Paul Family Wellness Program) and a local YMCA. Community stakeholders within the partnership have worked collaboratively since 2010 to develop a diabetes prevention program that integrates Latino cultural values such as familismo (familism) and respeto (respect). The construct of familismo is leveraged by encouraging the entire family, including extended members living in the household, to attend the program and make healthy lifestyle changes as a family. The construct of respeto is leveraged to discuss roles and responsibilities of parents and children for making decisions about health, modeling healthy behaviors, selecting, preparing, and consuming healthy foods, communicating within and outside of the family, and honoring traditional gender roles as well as cultural and religious celebrations. The program is delivered by bilingual/bicultural health educators who appreciate the cultural norms within the local community and use examples from their lives to establish rapport, foster dialogue, and discuss challenges and opportunities around health (15, 16).

Participants.

160 Latino boys and girls were enrolled through a network of schools, community centers, and healthcare organizations in Phoenix, Arizona. Participants were screened for the following inclusion criteria: 1) self-identification as Latino, 2) age 14–16 at enrollment, and 3) obesity, defined as a BMI ≥ 95th percentile for age and sex or a BMI ≥30 kg/m^2. Exclusion criteria included: 1) taking medication(s) or diagnosed with a condition that influences carbohydrate metabolism, physical activity, or cognition, 2) diagnosed with T2D, 3) currently enrolled (or within previous 6 months) in a formal weight loss program, or 4) diagnosed with depression or any other condition that may impact QoL. This study was approved by the Arizona State University (ASU) Institutional Review Board and written informed consent and assent were obtained prior to any study procedures. Recruitment commenced in October 2012 and continued through July 2015. The last participant completed final data collection in August, 2016.

Procedures.

All outcomes were assessed in the ASU clinical research unit. Height and weight were assessed to the nearest 0.1 cm, 0.1 kg to determine BMI and BMI percentiles. Height was measured using a portable stadiometer (SECA 213, SECA North America, Chino, California) and weight was measured using a bioelectric impedance scale (TBF-300A, Tanita Corp of America, Arlington Heights, Illinois). All measurements were assessed by trained research staff. Participants completed the Pubertal Development Status to assess pubertal stage (17). After an overnight fast, a 2-hour 75-gram oral glucose tolerance test (OGTT) was administered to assess T2D risk. Participants identified as diabetic (fasting glucose ≥ 126mg/dl or 2-hour glucose 200mg/dl) were excluded from the study and referred to a physician. Given the rapid conversion from prediabetes to overt T2D in youth, (18) participants who met the American Diabetes Association criteria for prediabetes (fasting glucose ≥ 100mg/dl or 2-hour glucose ≥ 140mg/dl) were automatically assigned to the intervention arm of the study and analyzed separately. Participants were randomized by a research team member using the automated random sample function in SPSS to ensure equal distribution across intervention (INT) and comparison control (COMP). Given the nature of the intervention as a behavioral intervention, blinding was not integrated into the trial. In addition to baseline (T1), data collection occurred at 3-months (T2), 6-months (T3), and 12-months (T4).

Intervention

The comprehensive lifestyle intervention consisted of nutrition and health education, exercise, and behavior change strategies (15) that have been shown to be efficacious in the adult Diabetes Prevention Program (DPP) (7). The curriculum was informed by key constructs from Social Cognitive Theory (SCT) including enhancing self-efficacy for healthy lifestyle behaviors through goal-setting, vicarious experience, role modeling, and verbal encouragement. In addition, building and encouraging social support from family and peers for making healthy behavior changes was offered in the form of appraisal, informational, instrumental, and emotional support. The behavior change strategies of goalsetting and self-monitoring were integrated and tailored to the psychosocial and developmental characteristics of adolescents (15). In sessions, families documented and monitored their progress towards weekly behavioral goals and progress towards fitness goals were monitored through monthly fitness assessments. Given the psychosocial consequences associated with pediatric obesity, a class session was dedicated to emotional well-being by discussing self-acceptance, body-image, selfaffirmation, and coping mechanisms. All sessions were held at the YMCA where lifestyle classes (1 day / week for ~60 minutes) were delivered to groups of 8–10 families. A parent or guardian was required to attend the nutrition education classes with their participating child and siblings were encouraged to attend. Childcare was provided at the YMCA to facilitate participation of parents with young children.

The exercise curriculum was delivered by YMCA fitness instructors (3 days/week for 60 minutes) to groups of 8–10 youth. Structured components included aerobic activities (e.g. running, spinning), anaerobic activities (e.g. athletic drills) and resistance exercises. Unstructured components included team sports and games that promoted social support and bonding among youth. Youth learned to provide encouragement to one another for reaching individual and collective fitness goals. Sessions were designed to elicit an average heart rate of ≥150 beats per minute for the majority of the session. Heart rate was monitored during sessions using a Polar Heart Rate monitor (Polar USA, Bethpage, NY).

Following the 3-month intervention, youth returned for monthly booster sessions over a 3-month period. Boosters reinforced and celebrated healthy behavior changes, addressed any challenges youth and families had experienced in maintaining healthy behaviors, and provided ongoing social support and encouragement.

Comparison Control

At baseline, the COMP youth were provided their lab results and a handout with general information on healthy lifestyle behaviors. COMP youth were contacted on a monthly basis to maintain a sense of connection with the study team, keep current with contact information, and remind youth of scheduled testing visits in the lab throughout the 12-month study period. Upon completion of the study, COMP youth were offered an abridged version of the intervention and 1-year YMCA membership.

Primary Outcomes

Insulin Sensitivity—Insulin sensitivity was estimated using insulin and glucose concentrations during the OGTT at fasting, 30, 60, 90, and 120 minutes. The whole-body insulin sensitivity index ranges from 0 to 12 and (19) was calculated as:

$$\frac{10{,}000}{\sqrt{(fasting\ Glucose\ (mg/dl) \times fasting\ Insulin\ (\mu lU/mL))\ [(mean\ Glucose\ (mg/dl)) \times (mean\ Insulin\ (\mu lU/mL))]}}$$

Quality of life—The 15-item Youth QoL Instrument Short Form was used to assess generic QoL (20). Weightspecific QoL was assessed using the 26-item weight-specific module which measures domains of self, social relationships, and environment as they pertain to weight-related concerns (21). Both instruments are specific to adolescents (11–18 years), have been used with Latino youth, and designed to evaluate interventions in clinic and community settings (21). The generic QoL instrument shows strong psychometric properties including test-retest reliability (ICC >0.74) and construct validity (r = 0.73, P<0.05) with other pediatric QoL measures (20). The Weight-specific QoL instrument shows good reliability (ICC =0.77) and construct validity (r=0.57, P<0.01) with the Children's Depression Inventory in adolescents (21).

Secondary Outcomes

Body Composition—Total body fat was assessed using bioelectrical impedance analysis (TBF-300A, Tanita Corp of America, Arlington Heights, Illinois). Waist circumference (WC) was measured in triplicate to the nearest 0.1cm at the level of the umbilicus using a Gulick II flexible tape measure (Baseline© Measurement Tapes, USA).

Statistical Analyses—This study was powered using data from our pilot study that demonstrated significant increases in the primary outcomes of insulin sensitivity (from 2.4±0.3 to 3.1±0.3, p=0.01) and weight-specific Quality of Life (from 70.8±5.4 to 86.2±4.3, p=0.0003). Using these mean differences, Cohen's d effect sizes were calculated. For insulin sensitivity, the effect size was d=0.60. For weight-specific Quality of Life the effect size was d=1.04. These effect sizes are indicative of medium to large effects for the 12-week lifestyle intervention among 15 Latino adolescents with obesity (22, 23). Using the smaller effect size (d=0.60), a sample of N=128 would provide 80% power at p<0.05 to detect a medium effect for 12-week changes in insulin sensitivity between INT and COMP groups. We assumed 20% attrition over time and oversampled to enroll 160 youth.

All analyses were conducted in Mplus 7.0 (24) and utilized full-information maximum likelihood (FIML)(25) to conduct intent-to-treat analyses that accounted and adjusted for attrition. Using Mplus Auxillary command, we incorporated all variables into the FIML process at baseline (T1) that predicted attrition: cohort of the youth, the presence of parks in the neighborhood, self-esteem, social support from friends around eating low-fat foods, fruits, and vegetables.

Latent-change modeling was used to assess changes in insulin sensitivity and QoL across T1 (pretest), T2 (post-test), and T4 (12-months) among randomized youth. Latent-change models adjust for measurement error and reduce estimate bias (26) and allow for the simultaneous assessment of changes between the INT and COMP group from T1 to T2 and from T1 to T4. Thus, this statistical technique assess differences within and between the INT and COMP group, the time point at which group differences occur, and the magnitude and direction of the differences. Separate latent-change models were conducted for the prediabetic subgroup that was not randomized. Data are presented as means ± standard deviations. Because traditional fit criteria, Chi-square (χ^2), is sensitive to sample size, we used the comparative fit index (CFI) to evaluate goodness-of-fit in all models with CFI >0.95 considered a good fit (27).

RESULTS

In total, 160 youth were enrolled with 67 randomized to the INT group, 69 randomized to the COMP group, and 24 youth exhibited prediabetes at baseline and were automatically assigned to the lifestyle intervention (Figure 1). Retention over the 12-month follow-up period for all youth was 82.5%. The number of randomized youth who completed data collection visits at each time point were as follows: 136 at T1 (COMP=69; INT=67), 124 at T2 (COMP=65; INT=59), 120 at T3 (COMP=62; INT=58), and 120 at T4 (COMP=62; INT=58). The number of non-randomized, youth with prediabetes who completed data collection visits at each time point were as follows: 24 at T1, 19 atT2, 17 at T3, and 18 at T4. There were no demographic, anthropometric, or metabolic differences between randomized youth with data at T2 (n=124) and those without (n=36). Baseline descriptive, anthropometric, metabolic, and QoL data for randomized youth are presented in Table 1. There were no group differences between INT and COMP youth ($p>0.05$).

Changes in insulin sensitivity over time are presented in Figure 2 and display significant shortterm increases among INT youth (from 1.8±0.1 to 2.2±0.1, $p<0.01$) in contrast to COMP youth who did not change (1.7±0.2 to 1.7±0.1, $p>0.05$). The between-group difference in change at 12-weeks (i.e., delta difference) was significant ($\Delta=0.37$, $p<0.05$). However, by 12-months there were no significant within or between group effects of the intervention on insulin sensitivity ($\Delta=0.21$, $p>0.05$).

Results from the latent-change models for total weight-specific QoL are presented in Figure 3. Significant short-term increases were observed among INT youth (from 63.9±2.9 to

79.6±2.2, p<0.001) but not in COMP youth (from 64.6±3.1 to 67.1±2.8, p>0.05) and the between-group difference in change at 12-weeks was significant (Δ=13.1, p<0.001). Furthermore, within and between-group differences in total weight-specific QoL were maintained at 12-months (Δ=13.0, p<0.001). Changes in the self, relationships, and environment sub-domains of weight-specific QoL (self, relationships, and environment) as well as general QoL are presented in Table 2. All sub-domains of weight-specific QoL were significantly increased in the short and long-term among INT youth compared to COMP youth (all p≤0.002). Additionally, general QoL was increased significantly following the intervention (79.3±1.6 to 84.7±1.2, p<0.001) but not in COMP youth (79.2±1.6 to 80.17±1.2, p>0.05) and the delta between groups was significant (Δ=4.4, p=0.007). Increases in general QoL were sustained at 12-months within the INT but not when changes were compared to the COMP group (Δ=2.2, p>0.05).

Changes in adiposity measures are presented in Table 2. The INT youth significantly reduced weight, BMI%, BMI, WC, and percent body fat (all p<0.05) compared to COMP youth at T2. At 12-months, between group differences in BMI% and percent body fat remained significant (all p<0.01); however, changes in WC did not (p=0.078).

Within group changes for non-randomized prediabetic youth are presented in Table 3 and demonstrate significant short-term increases in insulin sensitivity (from 1.3±0.1 to 2.6±0.5, p=0.01) and weight-specific QoL (from 62.4±4.8 to 75.9±4.3, p<0.001). In addition, we observed significant reductions in BMI, BMI%, fasting glucose, 2-hour glucose, and 2-hour insulin (all p<0.05). At 12-months, increases in weight-specific QoL (Δ=14.7, p=0.007) and decreases in 2-hour glucose (Δ= −25.7, p=0.03) remained significant.

DISCUSSION

Few diabetes prevention programs have been developed to address the unique cultural, developmental, and behavioral factors that underpin diabetes risk in Latino youth (28). This study demonstrates the short-term efficacy of a community-based lifestyle intervention on insulin sensitivity and the short-and long-term efficacy on QoL in Latino adolescents with obesity. These findings extend the benefits of intensive lifestyle intervention for improving both metabolic and psychosocial health in a high-risk pediatric population. Given the growing number of Latinos in the United States and extent of diabetes disparities in this population, this study offers an important contribution to the field.

Community-based lifestyle interventions for obese youth have demonstrated positive effects on weight outcomes but few include cardiometabolic risk indicators as primary outcomes (29). Extending these interventions, the current study was designed to enhance insulin sensitivity as a proximal physiologic risk factor for T2D. Because 80% of obese youth will become obese adults, (30) reducing cardiometabolic risk factors may represent an important target for T2D prevention among high-risk youth. Decreased insulin sensitivity (i.e., insulin resistance) is one of the earliest pathophysiologic processes in the trajectory towards T2D in youth and is associated with multiple other chronic diseases, independent of adiposity (31). Therefore, increasing insulin sensitivity may have beneficial health effects that extend beyond diabetes risk reduction. However, increases in insulin sensitivity were not sustained at 12-months, suggesting that longer intervention periods may be necessary. The Yale Bright Bodies Weight Management Program demonstrated that an intensive 6-month intervention for obese youth, led to significant increases in insulin sensitivity that were maintained for up to 2 years, supporting the efficacy of longer intervention periods for sustaining metabolic improvements (32).

In addition to insulin sensitivity, we observed significant short- and long-term improvements in weight specific QoL. A landmark study by Schwimmer et al (33) demonstrated the devastating impact of severe obesity on QoL among youth. Youth with obesity are often stigmatized and feel socially isolated, experiencing bullying or weight-based discrimination, which can reduce QoL (33). Beyond obesity, cardiometabolic disease risk has been independently linked with worsening QoL in adolescents (9). Very few studies have examined the impact of lifestyle interventions on QoL and none have specifically integrated an emotional or mental well-being component to improve QoL (34). A recent review of community-based interventions reported that interventions that include a psychosocial component addressing factors such as QoL can lead to more sustained improvements in health outcomes; however, the mechanisms by which this occurs are unknown (29). In addition to the emotional component in the nutrition education curriculum, physical activity has been shown to increase QoL in children (35) and may be a mechanism by which QoL is increased. Furthermore, the intervention was group-based and designed to foster social support from peers and family members and create a supportive social environment, which may further contribute to increased QoL (15). These findings underscore the importance of comprehensive interventions that integrate nutrition, exercise, and emotional well-being to improve metabolic and psychosocial health in obese youth (36).

The short-term reductions in adiposity among INT vs COMP youth included weight, BMI%, BMI, WC, and percent body fat, yet only reductions in BMI% and body fat were sustained over time. At 12-months, weight, BMI, and WC increased in both groups; however, the increases were significantly smaller in INT youth compared to COMP youth suggesting that the intervention slowed the trajectory of weight gain and body fat accumulation that occurs during development (37). There is a need for more comprehensive, long-term evaluation of the effects of lifestyle interventions on adiposity trajectories during adolescence (29).

Despite short-term improvements in whole-body insulin sensitivity and adiposity, we did not observe significant differences in 2-hour glucose between INT and COMP groups. Both groups exhibited normal glucose tolerance at baseline, thus the lack of difference suggests appropriate β-cell compensation for the degree of insulin resistance (18). In contrast, the youth who exhibited prediabetes at baseline exhibited both short and long-term improvements in glucose tolerance as measured by reductions in 2-hour glucose and nearly 80% reverted to normal glucose tolerance at 3-months postintervention with 77% remaining normal glucose tolerant at 12-months. These youths also experienced short-and long-term increases in general and weight-specific QoL. It is difficult to generalize these findings as the group is relatively small and there was no control group for comparisons. Because obese youth with prediabetes can rapidly decompensate and develop T2D these youth were not randomized (18). Our community partners and stakeholders advised against randomizing these high risk youth who already experience disparities in access to health promotion and diabetes prevention opportunities (38).

While the program has a strong community focus, it is important to consider the clinical significance of the findings as diabetes prevention and weight management efforts for youth with obesity are often integrated within healthcare systems. The Cohen's d effect size for 12-week increases in insulin sensitivity was 0.53 but the fact that changes in insulin sensitivity were not sustained at 12-months dampens the clinical significance of these findings. Although insulin sensitivity is not a standard clinical measure, it remains an important health outcome of prevention and treatment programs for youth with obesity (39). Less is known about the clinical significance of improving QoL among obese youth as the importance of patient-reported outcomes in pediatric clinical research has only recently gained traction in the literature (40). The observed effect size for changes in weight-specific QoL were 0.97 at 12-weeks and 0.73 at 12-months. A recent meta-analysis of 22 pediatric obesity interventions found a smallmedium effect size for changes in health-related QoL (34). It was suggested that weight loss was necessary to observe clinically significant improvements in QoL. However, the studies in the metaanalysis were focused on treating obesity and designed to produce significant weight-loss through lifestyle (n=16), 5 bariatric surgery (n=5), or 1 pharmacotherapy study. Furthermore, the majority utilized generic QoL measures and the authors hypothesized that weight-specific QoL measures may result in greater treatment-related gains. In support of this notion, the observed effect sizes for changes in generic QoL scores in our study were 0.51 at 12-weeks and 0.19 at 12-month, considerably smaller than the observed effect sizes for weight-specific QoL (0.97 and 0.73). As interventions for youth with obesity move beyond a singular focus on weight loss to improving cardiometabolic and psychosocial health outcomes, the field may benefit from a broader definition of clinical significance (41).

The DPP has been effective in reducing T2D risk in high-risk adults and has been adapted to be delivered in community settings to diverse populations (7). However, these adaptations were not designed for high-risk minority youth and do not incorporate family (8, 42). Similar to the DPP, the core intervention constructs were derived from the SCT, yet the intervention content was grounded in the needs, values, beliefs, and life context of Latino families (15). This study further extends the DPP model by adapting it to Latino youth and families in a community setting. Adolescent peers who share the same community and cultural experiences are well-positioned to give and receive support for healthy behavior change (4). In addition to peers, parents play a central role in supporting lifestyle behaviors by shaping their child's food and physical activity environments, through parenting practices, and by serving as role models (43). Thus, parents are critical agents in interventions and providing parents with the skills and resources needed to support behavior change at the family level can lead to behavior changes that reduce T2D risk (43). At the community level, this integrated partnership brought together key clinical and community partners with strong ties to the Latino community. Academic-community partnerships can provide greater access to hard-to-reach populations and allow for the testing of interventions in real-world settings, expediting the translation of research and knowledge to vulnerable populations that have the most to gain (44). At the macro-level, adapting an evidence-based intervention to the sociocultural context of a specific ethnocultural group, and grounding the intervention into the local context, including the needs and preferences of the local community, can increase engagement, acceptability and sustainability (45). This study supports the view that multi-level (individual, family, community level) evidence-based interventions that are culturally grounded can lead to more efficacious prevention models that address diabetes-related health disparities in vulnerable populations like Latino youth with obesity (45).

CONCLUSION

This community-based intervention integrated social support, family engagement, and leveraged important cultural factors to improve health and QoL in a community sample of Latino youth with obesity. Improvements in diabetes risk, QoL, and adiposity were also observed in a subgroup of Latino youth with prediabetes. This innovative approach was guided by the ecodevelopmental model to fit the sociocultural context of the focus population and implemented in a community setting. Adapting and rigorously testing culturally-grounded, evidence-based interventions may be an approach for implementing diabetes prevention programs with greater external validity (45).

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KEY POINTS

- The most effective obesity interventions are intensive, culturally-tailored, incorporate family, and utilize a multi-level approach.
- This study demonstrated that a community-based lifestyle intervention can increase insulin sensitivity and quality of life as well as slow the trajectory of adiposity among Latino adolescents with obesity.
- Diabetes prevention programs that leverage the unique cultural, developmental, and behavioral factors may be most effective for reducing diabetes risk and improving quality of life in high-risk, vulnerable populations of youth.

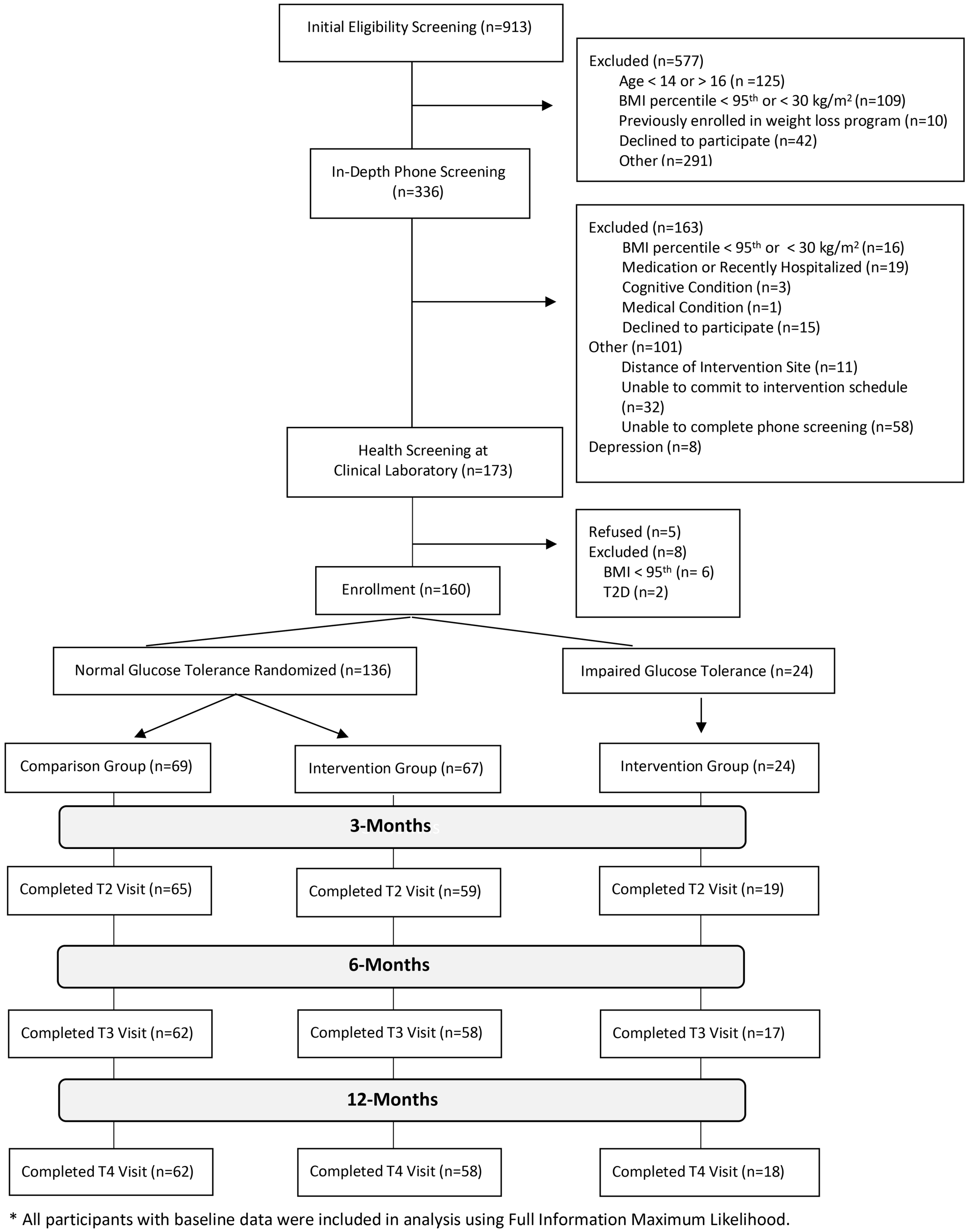

Figure 1.

Consort diagram of the study. The flow of participants through screening procedures, randomization, and post-intervention testing.

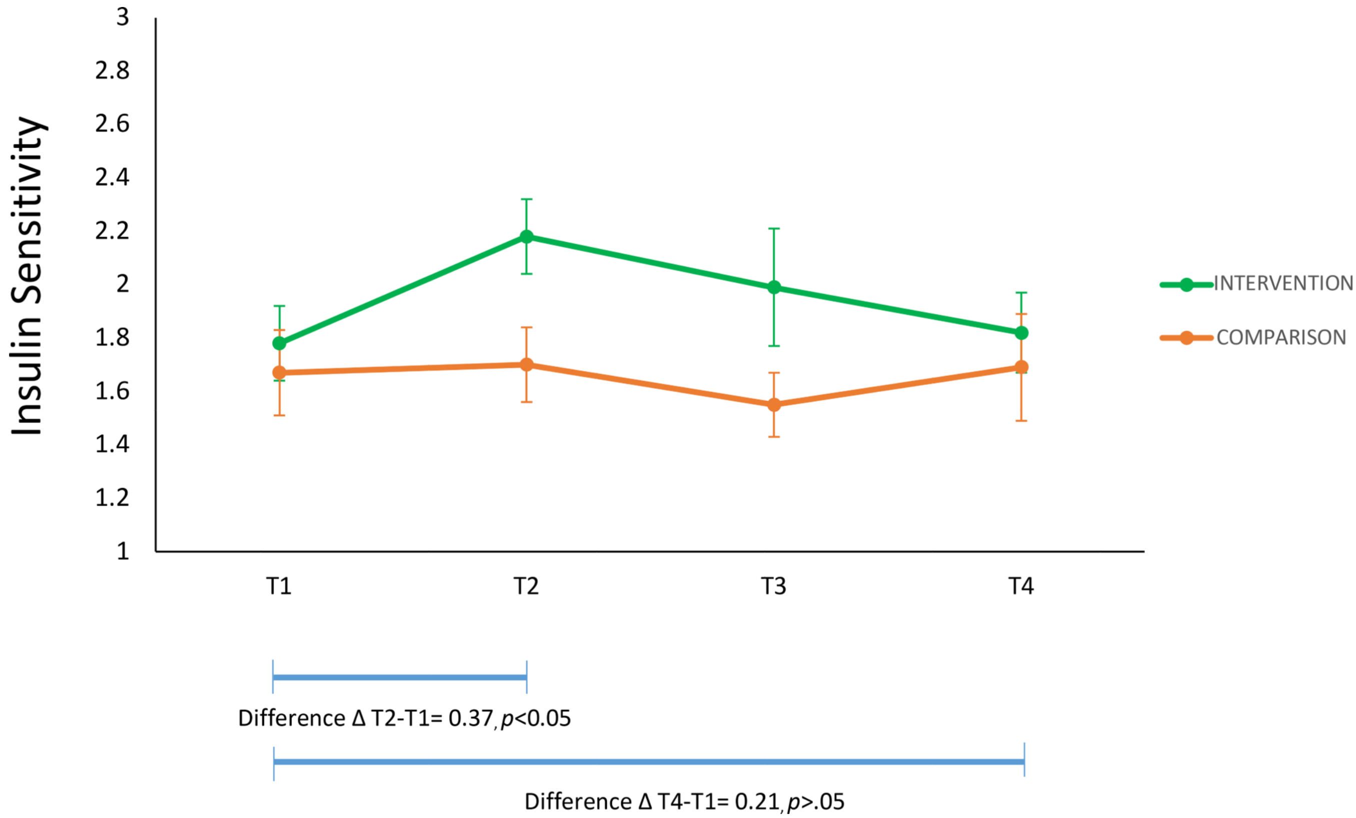

Figure 2.

Changes in whole-body insulin sensitivity index over time by randomization group. Data are adjusted means ± standard error at baseline (T1), 12-weeks (T2), 6-months (T3), and 12-months (T4). Deltas (Δ) and *p*-values reflect between-group differences over 12-weeks (T2-T1) and 12-months (T4-T1).

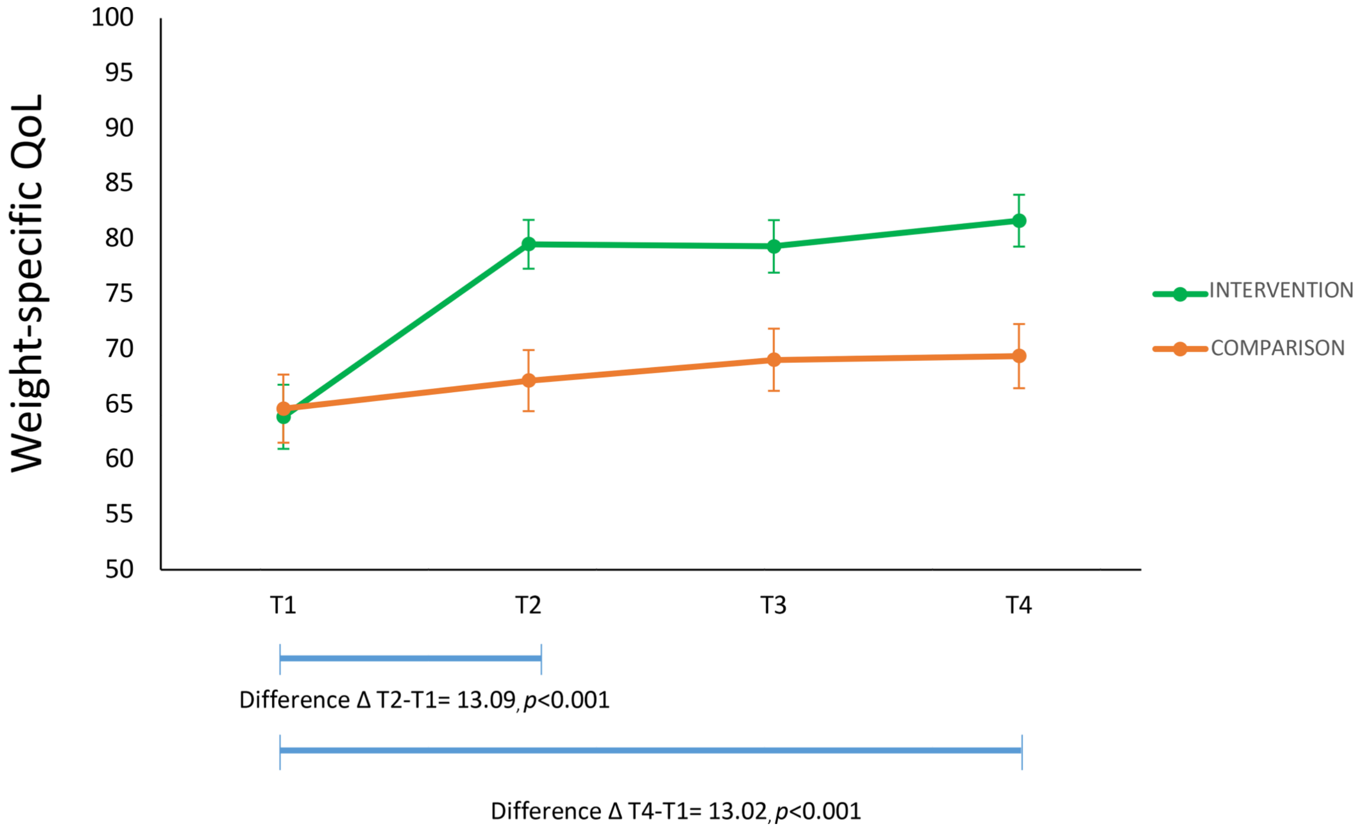

Figure 3.

Changes in weight-specific quality of life over time by randomization group. Data are adjusted means ± standard error at baseline (T1), 12-weeks (T2), 6-months (T3), and 12-months (T4). Deltas (Δ) and *p*-values reflect between-group differences over 12-weeks (T2-T1) and 12-months (T4-T1).

Table 1.

Baseline Participant Characteristics.

Variable	Comparison (M±SD)	Intervention (M±SD)
Age (years)	15.3±0.9	15.4±1.0
Gender (N)		
Boys	35	27
Girls	34	40
Boys Pubertal Stage (%)		
Pre-Early Pubertal	17.2%	14.8%
Mid Pubertal	57.1%	48.1%
Late-Post Pubertal	25.7%	37.0%
Girls Pubertal Stage (%)		
Pre-Early Pubertal	0%	0%
Mid Pubertal	18.2%	25.0%
Late-Post Pubertal	81.8%	75.0%
Body Mass Index (kg/m^2)	34.6±5.7	34.7±5.2
Body Mass Index (%)	98.3±1.2	98.1±1.4
Body Fat (%)	44.7±7.6	45.2±7.1
Waist Circumference (cm)	110.3±13.7	108.5±12.8
Fasting Glucose (mg/dl)	93.5±5.7	92.4±5.7
Fasting Insulin (μIU/mL)	25.2±12.7	24.2±12.7
2-Hour Glucose (mg/dl)	122.4±20.8	121.9±19.9
2-Hour Insulin (μIU/mL)	281.0±210.1	283.7±190.1
Insulin Sensitivity	1.6±1.2	1.7±1.9
Generic Quality of Life	79.2±13.6	79.3±13.2
Weight-specific Quality of Life		
Total	64.6±25.7	63.9±24.0
Self	58.7±30.1	55.9±28.2
Relationships	70.2±25.7	70.4±23.9
Environment	60.2±27.1	58.7±25.8

Table 2.

Changes in anthropometrics, diabetes risk factors, and quality of life across post-tests by group.

	Within Group				Within Group				Between Groups			
	Comparison (n=69)				Intervention (n=67)				Short-term Effect		Long-term Effect	
	T1 Baseline Mean	T2 Post (3-months)	T3 Follow Up (6 Months)	T4 Follow Up (12 Months)	T1 Baseline Mean (	T2 Post 3-months)	T3 Follow Up (6 Months)	T4 Follow Up (12 Months)	T2-T1	***p***	T4-T1	***p***
Weight (kg)	96.5±2.4	97.9±2.4	99.9±2.4	102.912.5	96.212.2	95.112.3	96.312.4	99.612.7	-2.55	*<001*	-3.06	*.013*
Height (cm)	166.6±1.0	167.211.0	167.6±1.0	168.111.1	166.3±0.9	167.211.0	167.411.0	167.811.0	0.14	*.385*	-0.08	*.860*
BMI %	98.3±0.1	98.3±0.2	98.5±0.1	98.5±0.1	98.110.2	97.710.2	97.7±0.2	97.710.3	-0.37	*.001*	-0.59	*.002*
BMI (kg/m^2)	34.6±0.7	34.9±0.7	35.4±0.7	36.4±0.7	34.7±0.6	33.910.7	34.210.7	35.210.7	-1.02	*<001*	-1.21	*.004*
Waist Circumference (cm)	110.3±1.7	110.6±1.6	111.911.6	113.8±1.6	108.5±1.6	107.1±1.5	107.5±1.6	110.011.8	-1.86	*.016*	-2.17	*.078*
Total Fat (%)	44.7±0.9	44.8±1.0	46.2±0.9	46.311.1	45.210.9	42.8±0.8	43.311.0	43.511.0	-2.52	*.001*	-3.36	*.004*
Fasting Glucose (mg/dl)	93.5±0.7	95.0±0.8	95.7±0.7	95.7±0.9	92.4±0.7	92.6±0.8	94.310.8	94.710.7	-1.01	*.331*	-0.81	*.435*
Fasting Insulin (µIU/mL)	25.2±1.5	26.3±2.0	29.512.7	30.213.1	24.211.6	20.711.2	24.311.7	23.611.6	-4.28	*.033*	-5.25	*.103*
2-Hour Glucose (mg/dl)	122.4±2.5	112.7±3.2	114.313.1	113.813.6	121.9±2.4	110.713.1	111.213.2	116.214.1	-1.53	*.742*	2.93	*.578*
2-Hour Insulin (µIU/mL)	281.0±25.5	179.2±16.0	199.2118.6	196.4±19.3	283.7±23.1	129.8±13.5	144.4±14.9	165.1114.9	-50.61	*.107*	-32.56	*.337*
Generic Quality of Life	79.2±1.6	80.2±1.6	79.811.8	82.9±1.7	79.311.6	84.711.4	85.111.4	85.211.7	4.40	*.007*	2.21	*.319*
YQOL-W - Self	58.7±3.6	60.6±3.3	63.213.1	63.613.4	55.9±3.4	73.212.8	73.013.1	77.112.7	15.46	*<001*	16.22	*<001*
YQOL-W - Relationships	70.2±3.1	72.3±2.8	74.8±2.8	74.1±3.1	70.4±2.9	83.6±2.2	83.6±2.3	86.212.1	10.97	*<001*	11.77	*.001*
YQOL-W - Environment	60.2±3.3	64.3±2.9	64.113.3	65.913.0	58.713.2	77.612.4	77.512.6	76.612.8	14.20	*<001*	11.65	*.002*

Data presented as means ± standard error for T1 and FIML adjusted means ± standard error for T2-T4.

Table 3.

Within group changes in anthropometrics and diabetes risk factors over time in IGT youth.

	IGT (n=24)				Within Group Short-term Effect		Within Group Long-term Effect	
	T1 Baseline Mean	**T2 Post (3-months)**	**T3 Follow Up (6 Months)**	**T4 Follow Up (12 Months)**	**T2-T1**	***p***	**T4-T1**	***p***
Weight (kg)	93.8±3.6	92.513.8	94.413.9	98.914.0	-1.29	*.089*	5.15	*<.001*
Height (cm)	166.Oil.8	166.712.0	167.711.9	168.012.0	0.72	*.007*	1.97	*<.001*
BMI %	97.910.4	97.410.5	97.51.5	97.910.4	-0.52	*<.001*	-0.1	*.953*
BMI (kg/m^2)	33.911.0	33.211.0	33.311.1	35.111.1	-0.68	*.002*	1.16	*.001*
Waist Circumference (cm)	107.512.3	105.912.3	104.212.4	109.312.1	-1.72	*.255*	1.68	*.290*
Total Fat (%)	44.411.5	42.212.4	38.912.6	43.712.1	-2.20	*.244*	-0.63	*.653*
Fasting Glucose (mg/dl)	94.411.9	90.612.5	96.111.8	99.012.8	-3.75	*.025*	4.63	*.100*
Fasting Insulin (μIU/mL)	35.819.5	28.418.4	32.619.6	30.915.5	-7.38	*.060*	-4.87	*.502*
2-Hour Glucose (mg/dl)	166.112.9	125.716.9	131.719.4	140.4111.9	-40.39	*<.001*	-25.73	*.031*
2-hour Insulin (μIU/mL)	398.2142.9	183.4141.0	233.0175.4	274.3171.8	-214.82	*<.001*	-123.99	*.147*
Insulin Sensitivity	1.210.1	2.610.5	2.110.4	1.710.4	1.37	*.011*	0.44	*.270*
Generic Quality of Life	78.613.1	86.012.2	87.113.2	88.613.6	7.43	*.006*	10.05	*.013*
Weight Specific Quality of Life- Total	62.414.8	75.914.3	76.715.8	77.016.0	13.51	*<.001*	14.67	*.007*
YQOL-W - Self	56.315.8	67.716.5	69.2111.1	71.419.4	11.42	*.030*	15.10	*.093*
YQOL-W - Relationships	64.415.2	78.914.7	80.517.4	85.019.7	13.15	*.003*	19.26	*.037*
YQOL-W - Environment	61.314.9	77.014.6	80.815.0	75.015.5	15.70	*.001*	13.72	*.010*

Data presented as means ± standard error for T1 and FIML adjusted means ± standard error for T2-T4.