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Targeting risk factors for type 2 diabetes in American Indian youth: the Tribal Turning Point pilot study

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Abstract

Background—American Indian (AI) youth are at high risk for type 2 diabetes.

Objectives—To partner with Eastern Band of Cherokee Indians and Navajo Nation to develop a culturally-sensitive behavioral intervention for youth (Tribal Turning Point; TTP) and assess feasibility in an 8-month randomized pilot study.

Methods—We enrolled 62 overweight/obese AI children (7–10 years) who participated with ≥1 parent/primary caregiver. Intervention participants (n=29) attended 12 group classes and 5 individual sessions. Control participants (n=33) attended 3 health and safety group sessions. We analyzed group differences for changes in anthropometrics (BMI, BMI z-score, waist

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

circumference), cardiometabolic (insulin, glucose, blood pressure) and behavioral (physical activity and dietary self-efficacy) outcomes.

Results—Study retention was 97% and intervention group attendance averaged 84%. We observed significant treatment effects (p=0.02) for BMI and BMI z-score: BMI increased in control (+1.0 kg/m^2, p<0.001) but not intervention participants (+0.3 kg/m^2, p=0.13); BMI z-score decreased in intervention (−0.17, p=0.004) but not control participants (0.01, p=0.82). There were no treatment effects for cardiometabolic or behavioral outcomes.

Conclusions—We demonstrated that a behavioral intervention is feasible to deliver and improved obesity measures in AI youth. Future work should evaluate TTP for effectiveness, sustainability, and long-term impact in expanded tribal settings.

Keywords

Obesity; pediatrics; American Indian; Native; behavioral research; prevention

INTRODUCTION

Obesity and type 2 diabetes are major health problems in American Indian (AI) youth, affecting more than twice as many AI youth as all other racial/ethnic groups in the United States (1–3). Given the accompanying increases in mortality (4), efforts to reduce obesity and diabetes risk among AI children are urgently needed.

The Diabetes Prevention Program (DPP) demonstrated that lifestyle modification promotes weight loss and prevents diabetes in high-risk adults, including AI populations (5). The Special Diabetes Program for Indians adapted the DPP curriculum for Native communities and demonstrated similar program success delivered in group-based community settings (6). Prior intervention efforts in AI youth have predominately utilized school-based approaches, and most (7–12), but not all (13, 14), had limited success. School-based programs are attractive because they can alter the environment and education of many children simultaneously, but they have limited caregiver involvement and individualized content. Given the cognitive immaturity of younger children, the role of caregivers in structuring the home environment, and the need to tailor strategies to the realities of daily life, a multi-component intervention that includes group-based learning and individual youth/caregiver dyad counseling may have greater success in pediatric prevention efforts (15). Among AI populations, culturally-tailored materials and engagement with community resources familiar to tribal members are also critical.

We used a community-based participatory research process to develop a multi-component, culturally-appropriate adaptation of the DPP called Tribal Turning Point (TTP). In an 8-month randomized pilot and feasibility study, we evaluated the effect of TTP on obesity measures, cardiometabolic measures, health behaviors, and self-efficacy.

METHODS

This work was a collaborative partnership between the Eastern Band of Cherokee Indians, Navajo Nation, the University of North Carolina at Chapel Hill (UNC), and the University of

Colorado in Denver (UCD). Our goal was to use pediatric weight management literature and diabetes prevention literature to develop a culturally-appropriate intervention to reduce youth type 2 diabetes risk. In 2008, UNC researchers partnered with Cherokee Choices, an on-going CDC-funded program of community-based health interventions in Cherokee (16), to develop diabetes prevention strategies for primary school youth (7–10 years). We conducted informal focus groups with parents and youth in 2008–2009 to gather information on priorities, challenges, and barriers to healthy living for youth. Based on this information, we developed a youth-centered adaptation of the Native DPP that we delivered three times to small groups of 10–14 youth/caregivers from 2009–2011, further modifying the program after each offering based on feedback. This work culminated in a 10-session group class supplemented with individualized motivational interviewing (MI) counseling. In 2013, we conducted focus groups with Navajo youth, parents, and community experts (providers, school and recreation health specialists) to discuss healthy living resources, participant engagement strategies, and appropriateness of the Cherokee materials. Working groups of academic and community partners developed a common curriculum with tribe-specific materials, striving to retain as much of the original DPP content as possible considering the number of sessions, cultural and community relevance, and participant ages. The final TTP program included Active Learning group classes, youth/caregiver dyad MI sessions, and a resource toolbox. It was designed to be delivered by lay health coaches who were members of the tribes or non-Native individuals already integrated with the tribes. Health coaches were trained during a 1 ½ day workshop in Denver with on-going support available as needed.

Active Learning group classes

The core curriculum was delivered through 10 group classes lasting 2 hours each over a 4-month period in the fall, with two booster classes held in the spring. Classes were youth-centered and attended by the youth and a participating caregiver. All classes included 10–20 minutes of physical activity; interactive learning with games, cooking demonstrations, discussions; culture through crafts and language; and a group meal. TTP goals were presented with “5-2-1-0” messaging (17), referring to daily targets of ≥5 servings of fruits/vegetables, ≤2 hours of screen time, ≥1 hour of physical activity, and 0 servings of sugary beverages. Dietary goals were presented using the Traffic Light Diet (18). Given the evidence for a dose-response benefit of physical activity on insulin sensitivity in youth (19), we emphasized increasing physical activity throughout the program. Each session was preceded by an optional 60min “Kids Work-Out” consisting of games and activities designed to help meet the physical activity goal. To promote engagement, youth earned “Wellness bucks” for attending class, completing goal-tracking forms, or attending community health events, which could be redeemed for prizes. Prizes were designed in a tiered-manner and ranged from $5–75 in value, with increasing Wellness bucks needed for higher value items. They were selected to complement the healthy living emphasis of the program, and included sports equipment (jump rope, basketball, yoga mat, mini trampoline, bicycle), food-related items (food scale, cookbooks), or portable music (mp3 players, iTunes gift cards).

MI sessions

Youth/caregiver dyads completed 5 individual MI counseling sessions (3 in the fall, 2 in the spring). Sessions explored the youth's health and behavioral goals developed from the group class content. Health coaches were trained to use interactive MI principles (20) to identify stages of change, work with youth/caregivers in progressing to the next stage, and help develop problem-solving skills related to behavioral goals, all while building a positive, supportive, and non-judging relationship with the dyads. The first session introduced the process of change and assessed the dyad's willingness and confidence to change. In subsequent sessions the health coaches reviewed prior goals, discussed successes and barriers to meeting those goals, and worked with the dyads to achieve behavior change. Suggested topics were provided as prompts, including stress, the challenges of parenting dynamics regarding nutrition and activity, and barriers to positive change. The particular content for each MI session reflected specific progress in past sessions and group classes.

Toolbox

The TTP toolbox was available as needed to facilitate goal attainment. Tools addressed the individual, home and family, school, community, and the health care system domains (21). Examples include phone reminder systems, education materials (e.g., topical materials to address knowledge gaps, recipes for locally grown produce), and review of the food and activity environment at participants' homes. Coaches also facilitated participation in school or community programs (e.g. sports leagues) and events (e.g. community 5K walk/run, health fairs) that encourage healthy eating or physical activity through increased awareness, encouragement, and discussion of barriers to participation. Coaches were available to help schedule appointments with health care providers for well-child visits or obesity-related concerns (orthopedics, hypertension, etc.). The Toolbox also included local community resources for healthy living compiled by the health coaches and Native partners.

Health and safety control

Control participants and caregivers attended group classes together covering general health and safety topics (bullying, drug and alcohol use prevention, first aid, fire safety, bike safety). Three 1-hour classes were held in the fall and each included a healthy group meal.

Pilot study overview

Participant recruitment began in July 2014. Baseline assessments were conducted August-September 2014, followed by randomization. The program ran from September 2014 through April 2015. Mid-point assessments were conducted within one month of completion of the core intervention, and final assessments in April-May 2015. Intervention and control participants received incentives for measurement visits ($60 at baseline and final, $20 at mid-point). The protocol was approved by the University of North Carolina Institutional Review Board, the Colorado Multiple Institutional Review Board, the Cherokee Institutional Review Board, and the Navajo Nation Human Research Review Board.

Participants

Potential participants were identified through existing relationships with schools, clinics, and community centers. We targeted youth aged 7–10 years because of the greater potential for changing health behaviors before they are well-established and before the metabolic transitions of puberty begin. Recruited youth were tribal members, overweight/obese (BMI ≥85th percentile for age and gender), with ≥1 primary caregiver willing to actively participate. Exclusion criteria included diabetes diagnosis, health concerns that could interfere with participation, or plans to move out of the area. We formally enrolled up to two youth per family; additional siblings were allowed to participate but not included in data collection. Caregivers provided written informed consent; youth provided written assent.

Randomization occurred by family in a 1:1 ratio, stratified by site and BMI (85th–95th percentile versus ≥95th percentile). For siblings, we selected the sibling with the highest BMI for randomization. Randomization and data storage was managed with the Sheps Integrated Research System, a secure enterprise database and programming framework designed for health-related research projects at the UNC Cecil G. Sheps Center.

Outcomes

Anthropometrics were measured with participants in light indoor clothing without shoes. Height was measured with a wall-mounted stadiometer, and weight with a calibrated electronic scale. We calculated BMI (kg/m^2) and age- and sex-specific BMI z-scores with the 2000 CDC growth charts and computer program (http://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm, accessed 14 November 2016). We used the "modified z-score" that is calculated similar to the usual z-score (number of standard deviations from the mean); we did not use the unmodified z-score produced by the CDC program because it compresses z-scores at very high values, reducing variability in populations with very high obesity (22, 23). Natural waist circumference (midway between the lowest rib margin and the iliac crest below the center of the axilla) was measured against the skin with a non-tension tape measure. Two measurements were taken for each outcome, with a third obtained when the difference between the first two was above threshold (0.5 cm for height, 0.5 kg for weight, 1.0 cm for waist). Blood pressure was measured three times on the right arm with an aneroid manometer after five minutes of seated rest, with at least 30 seconds between readings; the average was used for analysis.

Blood samples were obtained after an 8-hour fast. Whole blood was drawn into EDTA vacutainers for analysis of hemoglobin A1c and refrigerated until shipment. Samples obtained for analysis of glucose and insulin were processed for separation of serum, and frozen (−20°C or −80°C) until shipment. All assays were conducted at the Northwest Lipid Metabolism and Diabetes Research Laboratories at the University of Washington (Seattle, WA). We calculated HOMA-IR as (fasting insulin [uU/mL] * fasting glucose [mg/dl]) / 405.

Physical fitness was assessed with the Progressive Aerobic Cardiovascular Endurance Run (PACER) (24). Individuals run a 20-meter course in progressively shorter intervals, with greater laps indicating greater aerobic capacity. Activity was assessed with the validated Previous Day Physical Activity Recall (25). Participants reported prior day activities and intensity levels in 30-minute blocks. We present the number of 30-minute blocks of moderate-vigorous physical activity and screen time. We measured dietary and physical activity self-efficacy with the validated Pathways study form (25).

Attendance was tracked by study staff at all sessions. Program acceptability was evaluated among intervention participants using an open-ended customer satisfaction-style survey.

Statistical analyses

This pilot study was designed to obtain effect size and variability estimates to inform power calculations for a randomized controlled trial. While our aim was not to formally test the intervention's effectiveness, *a priori* calculations indicated that a sample size of 60 (n=30 per group) would provide 80% power to detect a −0.62 kg/m^2 BMI treatment effect with alpha set at 0.05.

Analyses were conducted in SAS 9.4 (SAS Institute, Cary, NC, USA). The intention-to-treat analysis evaluated the difference between groups in terms of change from baseline to final measurements. For missing outcome data, the last observation was carried forward. We used linear mixed models to account for non-independence between sibling pairs, with family entered into the model as a random effect. Residuals were inspected visually for normality and all regression assumptions were met. We present unadjusted results and results adjusted for age, sex, tribe, and baseline values (e.g., BMI analysis adjusted for BMI at baseline). The BMI z-score analysis was adjusted for tribe and baseline values only. Two-sided $p<0.05$ was considered statistically significant. We also report feasibility data for attendance, retention, and program acceptability.

RESULTS

We enrolled 62 participants from 52 families, with 29 participants (26 families) randomized to the intervention group and 33 participants (26 families) to the control group. Participating caregivers were mothers (42%), fathers (2%), both parents (34%), and grandparents (23%). Baseline measures (Table 1) were similar between groups with the exception of physical activity self-efficacy being slightly higher in the intervention group (p=0.05).

Intervention attendance averaged 88% for group classes and 87% for the MI sessions during the first four months of the program. Attendance during the spring booster period was slightly lower, averaging 69% and 76%, respectively. Group class attendance for control participants averaged 54%. All participants completed baseline measurements and 60 (97%) completed final measurements.

We observed statistically significant treatment effects for anthropometric outcomes (Table 2). BMI significantly increased over time among control participants (+1.0 kg/m^2, $p<0.001$) but not intervention participants (+0.3 kg/m^2, p=0.13), resulting in a significant treatment effect (unadjusted p=0.02, adjusted p=0.08). BMI z-score significantly decreased in the intervention group (−0.17, p=0.004) but did not change in the control group (+0.01, p=0.82), resulting in significant treatment effects (unadjusted p=0.02, adjusted p=0.049). Waist circumference significantly increased in the control group (+3.7 cm, $p<0.001$) but not the intervention group (+1.2 cm, p=0.09), and the treatment effect was statistically significant (unadjusted p=0.01, adjusted p=0.01).

There were no significant within or between group changes for fasting insulin, glucose, HbA1c, HOMA-IR, or blood pressure. PACER laps and self-reported moderate-vigorous physical activity increased significantly in both groups (all p<0.01) with no difference between groups (all p>0.10). Self-reported screen time, dietary self-efficacy, and physical activity self-efficacy did not change in either group. Satisfaction surveys of participants and caregivers indicated that acceptability of TTP was excellent (data not shown).

DISCUSSION

In this pilot and feasibility trial, we report that an age- and culturally-appropriate DPP adaptation was feasible to deliver, acceptable to participants, and had high retention among 7–10 year old AI children. We observed significant intervention effects on BMI, BMI z-score, and waist circumference compared to the control group. We did not observe treatment effects on cardiometabolic or behavioral outcomes, although, as a pilot, this study was not powered to detect such differences. The high program acceptability and anthropometric improvements demonstrate notable potential of TTP for reducing childhood obesity in this high-risk population and contributing to the primordial prevention of type 2 diabetes.

In contrast to previous school-based AI interventions (7–12), we designed TTP to be delivered to children and caregivers. The efficacy of family-based treatment for pediatric obesity has been well documented over the last 30 years (15), but this approach has not previously been applied to AI populations. By including the caregivers, we were able to target barriers to behavioral goals that were within caregiver control. The individual youth/caregiver MI sessions further allowed for tailoring of the program to specific families. Even though we did not observe significant intervention effects on health behaviors, we did observe significant intervention effects for multiple obesity measures, indicating that behavioral changes were made by the participants. Further evaluation of TTP with more rigorous assessment of health behaviors is needed to better understand how the program improved obesity measures.

The intervention effects we observed for BMI, BMI z-score, and waist circumference were similar or greater than two recent studies among First Nations children in Canada (13, 14). Both of these studies reported improvements in health knowledge and self-efficacy (25), but neither assessed dietary intake or physical activity. Other studies reported some improvements in health knowledge and/or health behaviors, but these did not translate to improvements in BMI (7–12). While the treatment effect we observed for BMI z-score was not sufficient to shift intervention participants from obese to overweight or normal weight status, it did demonstrate a stabilization of weight instead of the continued gain that is observed in normally growing children (26) and did, in fact, occur among our control participants. This acute effect may become even more meaningful as participants continue to grow. Further work is needed to determine if TTP can result in long-term improvements for childhood obesity and diabetes risk.

We did not observe treatment effects for cardiometabolic outcomes, although this pilot study was not designed to do so. Three prior interventions in AI youth reported pre-post improvements in fasting insulin and/or glucose, but none included pre-post control groups (9, 27, 28). These metabolic measures, especially fasting glucose, are highly variable in youth. Some studies have reported that BMI z-scores must be reduced by 0.25–0.50 over 1 year to improve insulin sensitivity in obese youth (29), which is greater than -0.18 treatment effect we observed. We also did not observe between-group differences in physical activity, which has been shown to improve insulin sensitivity even in the absence of weight loss (30). Given the dose-response relationship between physical activity and improvements in BMI and insulin resistance reported among school-aged children (19), it is plausible that the intervention dose must be increased to produce metabolic effects.

Our study has some limitations and several strengths. As a pilot and feasibility study, the sample size and duration of follow-up was limited. However, by using a randomized design, we were able to provide evidence for a positive short-term effect of TTP on multiple obesity measures. Due to limited resources we did not measure dietary intake (e.g., 24-hour recalls) or obtain objective measures of daily activity (e.g., pedometers), which may have prevented detection of behavioral changes. We are unable to draw conclusions about the individual impact of each component of the intervention (caregiver involvement, group classes, individual counseling, toolbox) on the outcomes; future studies could be designed in a stepped approach to examine this. A notable strength of our study was building on long-standing partnerships with Cherokee and Navajo, which allowed us to conduct the study with high scientific rigor and mutual respect.

In conclusion, the TTP intervention successfully improved multiple obesity measures among 7–10 year old AI youth. We have shown that a culturally-sensitive, youth-centered adaptation of the DPP that includes caregiver participation, group classes, and individual MI counseling sessions is an effective model for extending the success of this program into the high-risk AI youth population. Further work is needed to evaluate the effectiveness of TTP in expanded tribal and community settings, examining its sustainability and long-term impact on diabetes risk.

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References

1. Styne DM. Childhood obesity in American Indians. J Public Health Manag Pract. 2010; 16:381–387. [PubMed: 20689385]

2. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011–2012. JAMA. 2014; 311:806–814. [PubMed: 24570244]

3. Dabelea D, Mayer-Davis EJ, Saydah S, et al. Prevalence of type 1 and type 2 diabetes among children and adolescents from 2001 to 2009. JAMA. 2014; 311:1778–1786. [PubMed: 24794371]

4. Cho P, Geiss LS, Burrows NR, Roberts DL, Bullock AK, Toedt ME. Diabetes-related mortality among American Indians and Alaska Natives, 1990–2009. Am J Public Health. 2014; 104(Suppl 3):S496–503. [PubMed: 24754621]

5. Knowler WC, Barrett-Connor E, Fowler SE, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med. 2002; 346:393–403. [PubMed: 11832527]

6. Jiang L, Manson SM, Beals J, et al. Translating the Diabetes Prevention Program into American Indian and Alaska Native communities: results from the Special Diabetes Program for Indians Diabetes Prevention demonstration project. Diabetes Care. 2013; 36:2027–2034. [PubMed: 23275375]

7. Caballero B, Clay T, Davis SM, et al. Pathways: a school-based, randomized controlled trial for the prevention of obesity in American Indian schoolchildren. Am J Clin Nutr. 2003; 78:1030–1038. [PubMed: 14594792]

8. Saksvig BI, Gittelsohn J, Harris SB, Hanley AJ, Valente TW, Zinman B. A pilot school-based healthy eating and physical activity intervention improves diet, food knowledge, and self-efficacy for native Canadian children. J Nutr. 2005; 135:2392–2398. [PubMed: 16177202]

9. Teufel-Shone NI, Gamber M, Watahomigie H, Siyuja TJ Jr, Crozier L, Irwin SL. Using a participatory research approach in a school-based physical activity intervention to prevent diabetes in the Hualapai Indian community, Arizona, 2002–2006. Prev Chronic Dis. 2014; 11:E166. [PubMed: 25254984]

10. Teufel NI, Ritenbaugh CK. Development of a primary prevention program: insight gained in the Zuni Diabetes Prevention Program. Clin Pediatr (Phila). 1998; 37:131–141. [PubMed: 9492122]

11. Story M, Hannan PJ, Fulkerson JA, et al. Bright Start: Description and main outcomes from a group-randomized obesity prevention trial in American Indian children. Obesity (Silver Spring). 2012; 20:2241–2249. [PubMed: 22513491]

12. Paradis G, Levesque L, Macaulay AC, et al. Impact of a diabetes prevention program on body size, physical activity, and diet among Kanien'keha:ka (Mohawk) children 6 to 11 years old: 8-year results from the Kahnawake Schools Diabetes Prevention Project. Pediatrics. 2005; 115:333–339. [PubMed: 15687441]

13. Ronsley R, Lee AS, Kuzeljevic B, Panagiotopoulos C. Healthy Buddies reduces body mass index z-score and waist circumference in Aboriginal children living in remote coastal communities. J Sch Health. 2013; 83:605–613. [PubMed: 23879779]

14. Eskicioglu P, Halas J, Senechal M, et al. Peer mentoring for type 2 diabetes prevention in First Nations children. Pediatrics. 2014; 133:e1624–1631. [PubMed: 24819579]

15. Epstein LH, Wrotniak BH. Future directions for pediatric obesity treatment. Obesity (Silver Spring). 2010; 18(Suppl 1):S8–12. [PubMed: 20107466]

16. Bachar JJ, Lefler LJ, Reed L, McCoy T, Bailey R, Bell R. Cherokee Choices: a diabetes prevention program for American Indians. Prev Chronic Dis. 2006; 3:A103. [PubMed: 16776864]

17. Rogers VW, Motyka E. 5-2-1-0 goes to school: a pilot project testing the feasibility of schools adopting and delivering healthy messages during the school day. Pediatrics. 2009; 123(Suppl 5):S272–276. [PubMed: 19470603]

18. Epstein LH, Paluch RA, Beecher MD, Roemmich JN. Increasing healthy eating vs. reducing high energy-dense foods to treat pediatric obesity. Obesity (Silver Spring). 2008; 16:318–326. [PubMed: 18239639]

19. Davis CL, Pollock NK, Waller JL, et al. Exercise dose and diabetes risk in overweight and obese children: a randomized controlled trial. JAMA. 2012; 308:1103–1112. [PubMed: 22990269]

20. Rollnick, S., Miller, W., Butler, C. Motivational interviewing in health care: helping patients change behavior. Guilford Press; New York, NY: 2008.

21. Sallis, J., Owen, N., Fisher, E. Ecological models of health behavior. In: Glanz, K.Rimer, BK., Viswanath, K., editors. Health Behavior and health education: Theory, research, and practice. 4. Josey-Bass; San Francisco: 2008. p. 462-484.

22. Centers for Disease Control and Prevention. Modified z-scores in the CDC growth charts. 2011 Ed.
23. Vijayakumar P, Wheelock KM, Kobes S, et al. Secular changes in physical growth and obesity among southwestern American Indian children over four decades. Pediatr Obes. 2016
24. Leger LA, Mercier D, Gadoury C, Lambert J. The multistage 20 metre shuttle run test for aerobic fitness. J Sports Sci. 1988; 6:93–101. [PubMed: 3184250]
25. Stevens J, Cornell CE, Story M, et al. Development of a questionnaire to assess knowledge, attitudes, and behaviors in American Indian children. Am J Clin Nutr. 1999; 69:773S–781S. [PubMed: 10195602]
26. Krebs NF, Himes JH, Jacobson D, Nicklas TA, Guilday P, Styne D. Assessment of child and adolescent overweight and obesity. Pediatrics. 2007; 120(Suppl 4):S193–228. [PubMed: 18055652]
27. Carrel A, Meinen A, Garry C, Storandt R. Effects of nutrition education and exercise in obese children: the Ho-Chunk Youth Fitness Program. WMJ. 2005; 104:44–47. [PubMed: 16138515]
28. Ritenbaugh C, Teufel-Shone NI, Aickin MG, et al. A lifestyle intervention improves plasma insulin levels among Native American high school youth. Prev Med. 2003; 36:309–319. [PubMed: 12634022]
29. Ford AL, Hunt LP, Cooper A, Shield JP. What reduction in BMI SDS is required in obese adolescents to improve body composition and cardiometabolic health? Arch Dis Child. 2010; 95:256–261. [PubMed: 19966092]
30. Duncan GE, Perri MG, Theriaque DW, Hutson AD, Eckel RH, Stacpoole PW. Exercise training, without weight loss, increases insulin sensitivity and postheparin plasma lipase activity in previously sedentary adults. Diabetes Care. 2003; 26:557–562. [PubMed: 12610001]

What is already known about this subject

- Native youth have the highest incidence and prevalence of obesity and type 2 diabetes among all racial/ethnic groups in the United States
- Prior efforts to reduce diabetes risk factors in Native youth have had limited success in improving health behaviors and little-to-no effect on obesity measures

What this study adds

- We report that the culturally-sensitive adaptation and expansion of the Diabetes Prevention Program is feasible to deliver to youth aged 7-10 years in Native community settings
- TTP significantly improved BMI, BMI z-score, and waist circumference in intervention youth compared to control youth over an 8-month period
- Further work is needed to evaluate TTP for effectiveness, sustainability and long-term impact on diabetes risk in expanded tribal settings

Table 1

Sample demographics and baseline characteristics.*

	Overall			Cherokee			Navajo		
	Intervention	**Control**	***P***	**Intervention**	**Control**	***P***	**Intervention**	**Control**	***P***
Participants (n)	29	33		15	10		14	23	
Families (n)	26	26		12	9		14	17	
Demographics									
Child age (years)	9.3 (1.0)	9.1 (1.1)	0.51	8.9 (1.0)	9.4 (1.2)	0.37	9.7 (0.9)	9.0 (1.1)	0.06
Male (n, %)	13 (45%)	19 (58%)	0.32	8 (53%)	7 (70%)	0.41	5 (36%)	12 (52%)	0.34
Parental education									
High school or less	2 (7%)	2 (6%)	0.30	1 (7%)	0 (0%)	0.14	1 (7%)	2 (9%)	0.86
Some college	11 (38%)	5 (15%)		7 (47%)	1 (10%)		4 (29%)	4 (17%)	
Bachelor's degree	10 (34%)	17 (52%)		4 (27%)	7 (70%)		6 (43%)	10 (43%)	
Graduate degree	6 (21%)	9 (27%)		3 (20%)	2 (20%)		3 (21%)	7 (30%)	
Household income									
Less than $25,000	8 (28%)	10 (30%)	0.84	3 (20%)	0 (0%)	0.28	5 (36%)	10 (43%)	0.33
$25,000 – $49,999	9 (31%)	11 (33%)		5 (33%)	3 (30%)		4 (29%)	8 (35%)	
$50,000 – $74,999	7 (24%)	8 (24%)		2 (13%)	5 (50%)		5 (36%)	3 (13%)	
$75,000 or more	2 (7%)	3 (9%)		2 (13%)	1 (10%)		0 (0%)	2 (9%)	
No answer	3 (10%)	1 (3%)		3 (20%)	1 (10%)		0 (0%)	0 (0%)	
Insurance									
Government	3 (10%)	0 (0%)	0.13	3 (20%)	0 (0%)	0.52	0 (0%)	0 (0%)	0.09
Private	1 (3%)	2 (6%)		1 (7%)	1 (10%)		0 (0%)	1 (4%)	
Indian Health Service	10 (34%)	7 (21%)		2 (13%)	2 (20%)		8 (35%)	5 (22%)	
Other	15 (52%)	24 (73%)		9 (60%)	7 (70%)		6 (26%)	17 (74%)	
Obesity measures									
BMI	26.4 (4.7)	26.1 (4.5)	0.82	25.8 (5.0)	26.5 (4.0)	0.61	27.1 (4.4)	25.9 (4.8)	0.39
BMI z-score	2.65 (1.40)	2.65 (1.16)	1.00	2.68 (1.66)	2.73 (1.31)	0.93	2.62 (1.12)	2.61 (1.12)	0.99
Waist circumference (cm)	83.1 (12.0)	85.9 (13.1)	0.39	78.2 (11.7)	80.7 (10.1)	0.59	88.3 (10.5)	88.2 (13.8)	0.97
Cardiometabolic measures									
Fasting insulin (uU/mL)	20.8 (19.9)	15.5 (10.5)	0.22	20.0 (20.9)	13.6 (9.0)	0.36	21.6 (19.5)	16.3 (11.2)	0.30

	Overall					Cherokee					Navajo				
	Intervention		Control		*P*	Intervention		Control		*P*	Intervention		Control		*P*
Fasting glucose (mg/dL)	90.9	(8.1)	91.4	(6.4)	0.77	89.5	(8.4)	93.8	(8.3)	0.23	92.3	(7.9)	90.4	(5.2)	0.43
HbA1c (%)	5.2	(0.3)	5.3	(0.3)	0.22	5.1	(0.3)	5.2	(0.2)	0.35	5.4	(0.3)	5.4	(0.3)	0.90
HOMA-IR	4.7	(4.5)	3.5	(2.4)	0.25	4.5	(4.8)	3.3	(2.4)	0.48	4.9	(4.3)	3.6	(2.4)	0.27
Systolic BP (mmHg)	101.6	(11.1)	99.3	(7.8)	0.39	101.4	(12.0)	99.9	(8.6)	0.76	101.8	(10.6)	99.0	(7.7)	0.42
Diastolic BP (mmHg)	58.0	(6.0)	61.1	(6.7)	0.06	55.7	(7.2)	60.6	(9.8)	0.20	60.5	(2.7)	61.4	(5.2)	0.52
Behavioral measures															
PACER (laps)	8.1	(4.0)	8.0	(4.3)	0.64	9.4	(5.1)	9.5	(6.1)	0.80	6.6	(1.5)	7.4	(3.3)	0.93
MVPA (30 min blocks)	3.2	(3.8)	2.6	(3.1)	0.88	5.1	(2.6)	5.7	(2.6)	0.70	1.2	(4.0)	1.3	(2.3)	0.78
Screen time (30 min blocks)	8.2	(9.0)	7.3	(8.6)	0.63	7.3	(8.1)	8.6	(9.2)	0.97	9.1	(10.0)	6.7	(8.4)	0.18
PA self-efficacy	10.5	(2.0)	9.6	(1.9)	0.05	10.1	(2.7)	10.2	(1.4)	0.86	10.9	(0.8)	9.4	(2.1)	0.004
Dietary self-efficacy	25.3	(4.5)	25.5	(3.6)	0.82	26.7	(3.0)	26.4	(4.1)	0.83	23.8	(5.4)	25.2	(3.3)	0.40

BMI, body mass index; HbA1c, glycated hemoglobin; HOMA-IR, homeostatic model of insulin resistance; BP, blood pressure; PACER, Progressive Aerobic Cardiovascular Endurance Run; MVPA, moderate-to-vigorous physical activity; PA, physical activity

*Values are arithmetic means (standard deviations) or n (%). P-values determined with t-tests for continuous measures and Cochran-Mantel-Haenszel test for categorical values. Variables requiring log-transformation for t-tests included BMI, insulin, HOMA-IR, systolic BP, PACER, MVPA, screen time, PA self-efficacy

Table 2

Change from baseline to final measurements in obesity, cardiometabolic, and behavioral measures*

	Unadjusted							Adjusted†						
	Intervention Final - Baseline			Control Final - Baseline			Group effect	Intervention Final - Baseline			Control Final - Baseline			Group effect
	Mean	(SE)	p	Mean	(SE)	p	p	Mean	(SE)	p	Mean	(SE)	p	p
Obesity measures														
BMI	0.3	(0.2)	0.13	1.0	(0.2)	0.0001	0.02	0.4	(0.2)	0.10	0.9	(0.2)	0.0001	0.08
BMI z score	−0.17	0.06	0.004	0.01	(0.05)	0.82	0.02	−0.17	(0.05)	0.004	−0.01	(0.05)	0.81	0.049
Decrease in BMI z-score (n)	21	(72%)		14	(42%)		0.02	21	(72%)		14	(42%)		0.02
Waist circumference (cm)	1.2	(0.7)	0.09	3.7	(0.7)	0.0001	0.01	1.3	(0.7)	0.07	3.7	(0.7)	0.0001	0.01
Cardiometabolic measures														
Fasting insulin (uU/mL)‡	0.8	(1.8)	0.67	1.3	(1.7)	0.45	0.83	1.3	(1.7)	0.45	−0.4	(1.6)	0.81	0.48
Fasting glucose (mg/dL)	0.6	(1.7)	0.74	1.9	(1.6)	0.26	0.58	0.3	(1.2)	0.78	−0.1	(1.2)	0.93	0.80
HbA1c (%)	0.0	(0.0)	0.59	−0.1	(0.0)	0.07	0.39	0.0	(0.0)	0.23	0.0	(0.0)	0.36	0.83
HOMA-IR	0.3	(0.5)	0.59	0.5	(0.4)	0.29	0.73	0.3	(0.4)	0.43	0.0	(0.4)	0.99	0.57
Systolic BP (mmHg)	−1.9	(1.4)	0.18	−1.7	(1.3)	0.22	0.91	−1.6	(1.3)	0.21	−1.0	(1.3)	0.45	0.73
Diastolic BP (mmHg)	0.6	(1.2)	0.62	−2.4	(1.2)	0.05	0.09	−0.1	(1.1)	0.91	−1.2	(1.1)	0.29	0.51
Behavioral measures														
PACER (laps)	1.8	(0.7)	0.01	1.9	(0.6)	0.004	0.87	1.8	(0.6)	0.005	1.4	(0.6)	0.02	0.69
MVPA (30 min blocks)	4.2	(1.2)	0.001	6.1	(1.2)	0.0001	0.29	4.1	(1.0)	0.0001	6.1	(1.0)	0.0001	0.14
Screen time (30 min blocks)	−0.6	(1.9)	0.77	−0.9	(1.9)	0.64	0.91	0.1	(1.4)	0.93	−1.5	(1.4)	0.29	0.42
PA self-efficacy	0.1	(0.5)	0.79	0.7	(0.4)	0.14	0.40	0.6	(0.3)	0.05	0.4	(0.3)	0.19	0.65
Dietary self-efficacy	1.6	(1.0)	0.12	0.6	(1.0)	0.58	0.46	1.3	(0.7)	0.07	0.6	(0.7)	0.41	0.48

BMI, body mass index; HbA1c, glycated hemoglobin; HOMA-IR, homeostatic model of insulin resistance; BP, blood pressure; PACER, Progressive Aerobic Cardiovascular Endurance Run; MVPA, moderate-to-vigorous physical activity; PA, physical activity

*Values are LS means and standard errors, unless otherwise noted. Data were analyzed by intent-to-treat with the last value carried forward. P-values for each group represent pre-post changes. Treatment effect p-values obtained from mixed models analysis comparing change scores between groups.

†Adjusted for tribe, sex, age, and baseline values.

‡Box Cox transformation applied for analysis; values are back-transformed LS means and SE.