ORIGINAL RESEARCH

CURRENT DEVELOPMENTS IN NUTRITION

Eating Behavior and Qualitative Assessments

Usual Dietary Intake and Adherence to Dietary Recommendations among Southwest American-Indian Youths at Risk of Type 2 Diabetes

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ABSTRACT

Background: American Indians are disproportionately affected by obesity and diabetes, and American-Indian youths have the highest prevalence of obesity and diabetes among all ethnic groups in the USA.

Objectives: The purposes of this study were to assess the usual dietary intake in American-Indian youths who attended a wellness camp program; adherence to the Dietary Guidelines for Americans 2015–2020 (DGA) and to the Healthy People 2020 Objectives; and to compare pre- and postcamp reported diets.

Methods: A total of six 24-h dietary recalls were conducted in person with American-Indian youths (aged 10–15 y; $n = 26$) from 3 different Southwest tribes. Three recalls were conducted before the wellness camp, and 3 were conducted after the camp. A series of 2-factor ANOVA were conducted, using a mixed model, to compare the nutrition differences before and after the health camp using a statistical program, R.

Results: Adherence to federal dietary recommendations was low, with few of the youths meeting the DGA recommendations for fruits (15%, average serving 0.69 cup/d) and vegetables (35%, average serving 0.59 cup/d). All of the participants exceeded the DGA recommended limit on empty calories. Nutrient analysis of total fat intake showed a significant decrease in intake after the camp, $F(1, 52) = 5.68$, $P = 0.02$.

Conclusions: Diet is a modifiable risk factor for obesity and chronic diseases such as type 2 diabetes and needs to be an integral part of any healthy lifestyle intervention. The camp-based nutrition education had a positive effect on youths, as observed through the total fat intake decreasing after camp. To reinforce nutrition education, future nutrition education should involve parents, be delivered beyond the week at camp, and encompass social determinants of health and access to healthy foods. *Curr Dev Nutr* 2019;3:nzz111.

Introduction

American-Indian (AI) youths have the highest prevalence of obesity and diabetes among all ethnic groups in the USA (1, 2). In 2015, Bullock et al. reported the prevalence of overweight and obesity in AI/Alaska Native (AN) children aged 2–19 y was 18.5% and 29.7%, respectively (3). They reported boys had higher obesity prevalence than girls (31.5% compared with 27.9%) and children aged 12–19 y had a higher prevalence of overweight and obesity than younger children (3). This high rate of overweight and obesity among children has important implications because obese

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Abbreviations used: AI, American Indian; DGA, Dietary Guidelines for Americans; HbA1c, Hemoglobin A1c; HP, Healthy People.

and overweight children are more likely to become obese/overweight adults (4, 5). The growing prevalence of overweight and obesity is related to lifestyle behaviors – notably diet (6).

Previous dietary studies have reported that the diets of AI youths do not meet current dietary recommendations; they are high in sugar and saturated fats and low in fruits and vegetables (7). In an attempt to increase healthy lifestyle among Southwest AI children, the AI Youth Wellness Camp was established in 1991 with a focus on physical activity and nutrition (8, 9). Youths who attend camp are self-selected or referred by local tribal health programs based on the presence of risk factors for type 2 diabetes. Higher rates of type 2 diabetes have been reported among Southwest tribes and type 2 diabetes is increasingly diagnosed among children and adolescents from these populations (10).

The purposes of this study were to assess the usual dietary intake in AI youths who attended a wellness camp program; adherence to the Dietary Guidelines for Americans 2015–2020 (DGA) (11) and to the Healthy People (HP) 2020 Objectives (12); and to compare pre- and postcamp reported diets.

Methods

The youth wellness camp

The participants in this study were all participants of the AI Youth Wellness Camp during the summer of 2016. The 1-wk intensive residential camp program includes AI youths from several tribes in Arizona. The AI Wellness Camp program is described elsewhere (8).

Subjects

The participants in this study were 26 AI youths from 3 different Southwest tribes aged 10–15 y who participated in camp. A priori power analysis calculations to determine the minimum number of subjects needed to show significant results were not performed. AI youths who completed the 24-h recalls were included.

Youths who attend camp are self-selected or referred by local tribal health programs based on the presence of risk factors for type 2 diabetes, including family history (type 2 diabetes in a first-degree relative), obesity, impaired glucose tolerance, hyperinsulinemia, metabolic syndrome, and gestational diabetes (8).

Clinical characteristics

FCG, the camp pediatrician and nurse, and trained undergraduate and graduate research assistants collected data on each participant's clinical characteristics related to obesity and diabetes risk upon arrival at camp (8). Clinical measures included height, weight, waist circumference, fasting cholesterol, fasting blood glucose, glycated hemoglobin A1c (HbA1c), blood pressure, and heart rate. BMI was calculated from height and weight.

Diet assessment

The participants' usual diets were assessed by conducting 24-h dietary recalls following the USDA multiple-pass method (13) along with recall instructions from the USDA Expanded Food and Nutrition Education Program (14). Local tribal health personnel worked with youths and parents to complete sets of 24-h dietary recalls before and after camp. Tribal health personnel, including registered dietitians, Community Health Representatives, wellness center staff members, and certified physical activity instructors, were trained by a registered dietitian to conduct the 24-h recalls within their respective tribal communities. All trained personnel were affiliated with the AI Youth Wellness Camp including serving as instructors and/or counselors.

Each set of recalls were completed separately and were comprised of 3 d, 2 weekdays and 1 weekend day. The recalls were completed within 6 wk before camp and within 6 wk after camp. Standard 24-h dietary recall multiple-pass procedures were followed. Youths were asked to identify all foods and beverages consumed during a 24-h period. A second pass was made to probe for forgotten foods. A third pass collected eating times and meal names (breakfast, lunch, dinner, snack). The fourth pass probed for food details and quantity consumed. Tribal health personnel used measuring cups and spoons and pictures with lengths and circles depicted to estimate serving sizes. A fifth pass was made to review information and any missing details were added.

Modifications included the addition of a visual prompt for often forgotten foods and food details; for example, whether a slice of cheese was added to a hamburger, whether nachos included melted cheese or cheese sauce, brand name of hot chips, or approximate amount of salt or sugar added to flavor foods.

Data analysis

Dietary recall data were entered into Nutritionist Pro™ software (Axxya Systems LLC). Nutritionist Pro calculated the average consumption (and SD) of a variety of dietary components including grains, vegetables, fruits, dairy, and fiber, along with kilocalories, macronutrients, and micronutrients. For each of these items, the program also calculated the percentage of the recommended dietary intake that was consumed.

A 2-factor ANOVA was conducted using a mixed model, to compare intake differences for each of the dietary components before and after the health camp; P values <0.05 were considered significant. Sex and the interaction of time and sex on the average nutrition of food eaten were also analyzed. We determined the percentage of participants whose diets complied with recommended DGA diets and whether youths met the target set in HP 2020 objectives. The calculations were completed using computing environment R (15).

Human subjects

Youths received school supplies, a basketball, hygiene products, and a camp t-shirt for participating in the overall camp. The study was performed in accordance with the ethical standards specified in the 1964 Declaration of Helsinki and its later amendments. The University of Arizona Human Subjects Protection Program approved the study protocol (Institutional Review Board #1506946623). All participants and their parents or guardians gave their informed consent prior to participation in the study.

Results

Clinical characteristics

A total of 26 youths (17 girls, 9 boys) attending the Wellness Camp completed the 24-h dietary recalls (**Table 1**). Their average age was 11.4 y with most of the participants in school grades 5–8. **Table 2** presents

TABLE 1 American-Indian Youth Medical Wellness Camp, 24-h dietary assessment participants, summer 2016 ($n = 26$)

Variable	Value
Mean age (range), y	11.4 (10–15)
Sex, n (%)	
Male	9 (34.6)
Female	17 (65.4)
Grade, n (%)	
4th	1 (3.8)
5th	6 (23.1)
6th	6 (23.1)
7th	7 (26.9)
8th	5 (19.2)
9th	1 (3.8)

their clinical characteristics in relation to risk of metabolic syndrome and type 2 diabetes. Most (78%) of the 26 participants were classified as overweight or obese, with 59% of the 26 classified as obese (over the 95th percentile for BMI), which is ~4 times the HP 2020 objective of 14.5%.

Fasting plasma glucose concentrations averaged 91 mg/dL, and the average HbA1c was 5.8%. Over 40% of the youths had HbA1c values that met the criteria for prediabetes or type 2 diabetes.

Diet assessment

Reported dietary intakes of total energy, fiber, and various macro- and micronutrients for girls and boys, pre- and postcamp, are shown in **Table 3**. Overall, the youths reported diets that were higher than recommended in calories, fat, and sodium, and low in fiber, calcium, and potassium. The percentage of youths meeting the recommendations set forth in the DGA 2015–2020 are listed in **Table 4**. A third of youths (35%) met the recommendations for servings per day of vegetables, 40% and 60% met the daily recommendations for grains and dairy, respectively. None of the youths in this study met the DGA

TABLE 2 Clinical characteristics of participants, American-Indian Youth Medical Wellness Camp, summer 2016 ($n = 26$)

Mean ± SD or (range)	Value
Height, cm	155.1 ± 8.9
Weight, kg	68.3 ± 22.1
BMI, kg/m^2	28.1 (18–40)
BMI percentile	89.1 ± 16.2
BMI *z* score	1.7 ± 0.9
Waist circumference, cm	90.9 ± 17.1
Fasting total cholesterol, mg/dL	171 (143–258)
Fasting glucose, mg/dL	91.0 (70–163)
Hemoglobin A1c, %	5.8 (4.7–11.1)
Blood pressure	
Systolic blood pressure vs. age	
Height percentile	68.8 ± 23.6
Z-score	0.1 ± 1.2
Percentile	50.1 ± 32.5
Diastolic blood pressure vs. age	
Height percentile	68.8 ± 23.6
Z-score	1.0 ± 0.73
Percentile	79.4 ± 18.3
Heart rate, beats per minute	95.4 ± 16.8

recommended limit on intake of empty calories (defined as calories from solid fats and added sugars). Empty calories accounted for ~40% of total energy intake. The main contributors to empty calories in study participants, across all participating tribes, were sugar-sweetened beverages, cookies, cake, candy, hot chips, French fries, fried chicken (i.e. chicken tenders), and frybread. During the 24-h dietary recalls, youths reported drinking >1 sugar-sweetened beverage per day and eating deep-fried foods such as French fries or potato chips more than once per day.

Table 5 compares the nutrition and weight status of the wellness camp youths with the targets set by HP 2020. The HP 2020 goals for food and nutrients were not met by the youths attending the AI Youth Wellness Camp.

The ANOVA results indicated that the total fat significantly decreased after the health camp ($F(1,52) = 5.68$, $P = 0.02$). However, there was no significant change in the total calories, saturated fat, and protein.

Discussion

The AI Youth Wellness Camp was started because the founders were concerned about youths and cared about their health. That concern persists today and through the evolution of the camp program, more baseline data for eventual impact assessments are being collected – these 24-h dietary recalls represent our most recent program addition. Our findings that over half of our youths are obese and 40% meet the criteria for type 2 diabetes underscores the need for interventions. The suboptimal diet reported by youths in this study are like other reports (16–18) and underscore the need to address the broader and larger issues (19) such as food insecurity, limited access to healthy foods, reliance on commodity foods, family finances, transportation, employment, and housing, for example. Limited access to fruits and vegetables and easier access to foods high in empty calories most likely contributed to the dietary patterns reported by the youths.

The high contribution of empty calories to total daily caloric intake in the youths' diets is especially concerning. During the 24-h dietary recalls, youths reported drinking >1 sugar-sweetened beverage per day and eating deep-fried foods such as French fries or potato chips more than once per day. Calories from solid fats and added sugars add little to no nutritional value to the diet and can displace more nutrient-dense foods. These findings will inform the development of targeted nutrition education focused on the energy density of foods, how to choose tasty low-calorie beverages and drink less sugary drinks, how to find the best items at the grocery store or convenience store, for example. Targeted nutrition education in a family-focused diabetes prevention program for diverse youths aged 9–12 y has been successfully implemented (20, 21). These findings also support the need to incorporate more native traditional approaches (22) and foods including plant-based diet interventions, historically staple foods for native people.

The total fat significantly decreased after camp. These results are promising because constituent saturated and *trans* fats can raise the concentrations of total cholesterol and LDL or "bad" cholesterol in the blood, which in turn could increase the risk of developing chronic diseases, including cardiovascular disease (23). As the postcamp recalls are completed within 6 wk, we do not know if the reduction in

TABLE 3 Average reported dietary intakes of various macro- and micronutrients for girls and boys, pre- and postcamp

Micro- and Macronutrients	Boys ($n = 9$)		Girls ($n = 17$)	
	Pre Mean ± SD (Range)	Post Mean ± SD (Range)	Pre Mean ± SD (Range)	Post Mean ± SD (Range)
Calcium, mg	886.9 ± 351.1 (375–1384)	585.6 ± 268.6 (201–1031)	710.9 ± 325.8 (295–1550)	714.0 ± 364.2 (231–1464)
Fiber, g	13.94 ± 7.4 (5.8–31)	11.9 ± 5.7 (6–23)	13.9 ± 4.4 (6.6–23)	14.5 ± 4.7 (7.8–24)
Folate, mcg	333.8 ± 247.5 (114–775)	205.4 ± 168.8 (21–545)	281.2 ± 149.6 (135 –762)	275.7 ± 145.0 (118–644)
Iron, mg	14.1 ± 9.1 (7.3–34)	10.9 ± 6.7 (5.5–28)	11.8 ± 4.5 (6.9–25)	11.5 ± 4.7 (3.6–25)
Protein, g	69.6 ± 26.5 (38–127)	60.2 ± 19.0 (33–88)	72.1 ± 24.1 (35–118)	75.3 ± 29.4 (22–139)
Saturated fat, g	25.4 ± 5.9 (15–35)	18.9 ± 6.3 (12–28)	25.3 ± 10.4 (8.5–49)	24.9 ± 9.2 (12–41.5)
Sodium, mg	3205.1 ± 849.4 (1786–4614)	2852.4 ± 1010.9 (1431–4502)	3368.5 ± 1342.1 (908–6789)	2843.6 ± 795.2 (1187–4453)
Total calories, kcal	1943.6 ± 436.4 (1189–2655)	1498.7 ± 431.6 (966–2075)	1923.9 ± 560.1 (816–3077)	1899.7 ± 568.2 (1055–2920)
Total fat, g	96.1 ± 52.7 (49–229)	58.8 ± 18.1 (36–87.5)	78.6 ± 27.6 (26–138)	74.0 ± 25.1 (46–115)
Vitamin A, re	453.2 ± 256.5 (85–897)	505 ± 448.9 (130–1527)	445.2 ± 235.5 (234–1039)	536.7 ± 361.2 (131–1531.7)
Vitamin B12, mcg	4.6 ± 2.0 (2–8.2)	2.5 ± 2.0 (0.3–7)	3.7 ± 1.6 (1.2–7.4)	3.6 ± 2.1 (0.9–7.9)
Vitamin C, mg	64.3 ± 30.9 (29–114)	53.6 ± 47.9 (10–149)	83.9 ± 67.3 (9.9–293)	105.9 ± 103.3 (12.7–370)
Vitamin D, mcg	5.0 ± 3.1 (0.3–9)	2.6 ± 3.1 (0.03–8.4)	3.3 ± 2.1 (0.3–7.1)	3.6 ± 3.5 (0.6–12.9)
Vitamin E, mg	0.7 ± 1.2 (0.02–3.8)	0.4 ± 0.6 (0–1.7)	2.9 ± 5.9 (0–25)	0.9 ± 0.9 (0.03–2.8)

mcg, microgram; re, 1 mcg of all-trans retinol.

total fat consumption continued beyond this timeframe. Research has shown that behavioral lifestyle interventions for children exceeding 52 contact hours produced a higher effective change in body weight and cardiometabolic risk factors (24).

While at camp, the youths participate in our program for 50 h. The food items served at camp follow Choose MyPlate (25) and recipes are developed by our camp registered dieticians and meet DGA recommendations. The foods are served in single serving sizes and seconds are not allowed. The recipes are low fat, sugar, and salt. An open salad bar is available at both lunch and dinner and snacks are provided before breakfast, midmorning, midafternoon, and after dinner. Only water is served for the entirety of camp. We have not conducted recalls during the week at camp and recognize that we do need to assess what foods are being consumed. Over three-quarters (79.5%) of the youths rated the meals as great on the camp evaluation and said "My experience at camp so far is cool because we eat healthy food," "I enjoy the food and I learned that food can be good and healthy," and "…I learned how we have to eat so we don't get diabetes."

There are several limitations to our study. First, we recognize and understand that the low adherence to dietary guidelines represent larger issues of access, barriers, inequities, and disparity that need to be included in studies such as ours. We are working to acquire additional funding to expand our program to include parents, follow-up of youths and expanded protocols to include more complete postcamp recalls, parent nutrition education, home food inventories, measures of food insecurity and food access. Second, our sample size is small, limited to 3 Arizona tribes, and does not show substantial long-term changes in dietary habits over time. FCG assumed camp directorship in 2013 and in 2016, the first 24-h recalls were collected – the data described in this article. We are in the process of collecting additional diet information among youths attending subsequent camps to assess changes over time. Third, dietary recalls provide at best an estimate of the usual dietary patterns of a participant. It is possible that the youths over- or underreported the intake of certain foods. Fourth, we used standardized nutrition software and selected food choices within the database that most closely matched the reported food items. However, it could be that our choices introduced some bias because not all food items in the database were exact, particularly relating to native foods.

In conclusion, diet is a modifiable risk factor for obesity and chronic diseases such as type 2 diabetes and needs to be an integral part of any healthy lifestyle intervention. The AI Youth Wellness Camp based nutrition education did have a positive effect on the youths, as observed through the total fat intake decreasing after camp. However, because

TABLE 4 Percent of youths meeting Dietary Guidelines Recommendations, precamp recalls

Food group	Servings per day	Girls ($n = 17$)	Boys ($n = 9$)	Total ($n = 26$)
Fruit (g)	>1.5 servings	24%	0%	15%
Vegetables (g)	>2.5 cup-equivalents	41%	22%	35%
Grains (g)	>6 oz-equivalents	50%	22%	40%
Protein foods (g)	>5 oz-equivalents	9%	17%	12%
Dairy (mg)	>3 cup-equivalents	68%	44%	60%
Limit on empty calories	170 (9% of total calories)	0%	0%	0%

TABLE 5 Comparison of Healthy People 2020 Targets to American-Indian Wellness Camp Youth for nutrition and weight status, precamp recalls

	Healthy people 2020 target	American-Indian youth wellness camp youth ($n = 26$)
BMI ≥95th percentile, %	14.5	59.3
Food and nutrient consumption		
Vegetables, equivalent per 1000 calories	1.16 cup	0.59 cup
Fruits, equivalent per 1000 calories	0.93 cup	0.69 cup
Empty calories, % of total calories	25.5%	41%
Saturated fat, % of total calories	9.9%	12%
Sodium, mg per day	2300	3079
Calcium, mg per day	1384	720

there was no substantial time effect in the other 3 nutrition categories (total calories, saturated fat, and protein), nutrition education needs to be reinforced. Future nutrition education should involve parents and caregivers, be delivered beyond the week at camp, and be encompassing of social determinants of health and access to healthy foods.

Low adherence by AI youths to federal dietary guidelines is consistent with reports of the quality of foods available on tribal reservations. Limited access to fruits and vegetables and easier access to foods high in empty calories likely contributed to the dietary patterns reported by the youths. The diet quality observed in the AI youths can suggest areas of focus for nutrition education programs, including traditional foods, longer sustained follow-up, and programming to include parents.

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