Diabetes Risk Factors in Low-Income Mexican-American Children

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OBJECTIVE — To learn if Mexican-American children from low-income neighborhoods have excess diabetes risk factors.

RESEARCH DESIGN AND METHODS — The study involved 173 Mexican-American children aged 9 years. This is the age before type 2 diabetes usually develops in youths and where the disparity in body fat between Mexican-American and non-Hispanic white children is evident. The study also targets poor children because diabetes and being overweight are more common in Mexican-American adults from a lower than from a higher socioeconomic status. The diabetes risk factors measured were percent body fat, dietary fat intake, daily fruit and vegetable intake, and physical fitness. Body fat was measured by bioelectric impedance, dietary intake was measured by three 24-h dietary recalls, and physical fitness was measured by a modified Harvard step test.

RESULTS — According to self-reported dietary recalls, Mexican-American children ate higher than recommended fat servings and had higher percent energy from fat and saturated fat. On the other hand, their reported daily fruit and vegetable intake was half of that recommended by national dietary guidelines. A large percentage of these children were at unacceptable physical fitness levels. Percent body fat was higher in these Mexican-American children than that reported for non-Hispanic white children. Finally, 60% of the children had a first- or second-degree relative with diabetes.

CONCLUSIONS — Because diabetes is highly prevalent in Mexican-American adults, type 2 diabetes is increasing in Mexican-American youths, and diabetes risk factors are more common in Mexican-American children, a prudent measure would be to explore early-age diabetes risk factor prevention programs in this population.

Diabetes Care 22:202–207, 1999

Historically, type 2 diabetes has been considered to be a disease of adults, therefore, epidemiological studies on type 2 diabetes have largely excluded children. The medical records of diabetic Mexican-American youths were reviewed at the Pediatric Endocrinology service in Ventura, California (1). The findings of Neufeld et al. (1) showed that type 2 diabetes accounted for 45% of the newly diagnosed cases of diabetes and for 31% of all diabetic youths. Furthermore, early development of complications was observed in these youths. Neufeld et al.'s (1) findings suggest type 2 diabetes may be quite common in Mexican-American youths from low-income families and often remains undiagnosed. Their study highlights the expanding health problem of type 2 diabetes in Mexican-Americans. Type 2 diabetes increases with age; it is increasing in prevalence and incidence in Mexican-American adults (2,3), however, and now it is occurring in Mexican-American children.

Because lifestyle interventions at an early age may prove to be more effective (4,5) than interventions at adulthood (6), identifying diabetes risk factors in nondiabetic children may be useful in designing and evaluating prevention programs. Type 2 diabetes is associated with modifiable (body weight, exercise, diet) and nonmodifiable (heredity, aging) risk factors. Modifiable risk factors reported to be associated with type 2 diabetes are being overweight (6–10), low physical activity (11–13), high dietary fat intake (14–17), and low fiber intake (18,19).

In the present study, body fat, physical fitness, reported dietary fat, reported daily fruit and vegetable intake, and family history of diabetes were examined to learn if Mexican-American children in the fourth grade and residing in public housing have excess diabetes risk factors. The study targets Mexican-American children at age 9 years because that is the age before type 2 diabetes usually develops in the young (1) and where the disparity in body fat between Mexican-American and non-Hispanic white children is evident (20). The study also targets low-income children because diabetes and being overweight are more common in Mexican-American adults from a lower than from a higher socioeconomic status (21,22).

RESEARCH DESIGN AND METHODS

Study population

The study involved 173 Mexican-American students in the fourth grade from two public schools in San Antonio, Texas. Students from both elementary schools reside in nearby public housing and were from welfare-recipient families. Students were participating in the Bienestar health program, a diabetes risk factor prevention program, during the 1997–1998 school year (23). The diabetes risk factors collected were part of Bienestar's baseline evaluation. The two participating elementary schools had a total of 188 fourth graders, and the present study included 173 fourth graders whose parents had signed the consent (92% response rate).

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Received for publication 5 May 1998 and accepted in revised form 7 October 1998.

Abbreviations: CATCH, Child and Adolescent Trial for Cardiovascular Health; FGP, food guide pyramid; HHANES, Hispanic Health and Nutrition Examination Survey; MVPA, moderate-to-vigorous physical activity; NHANES, National Health and Nutrition Examination Survey; PFS, physical fitness score; SCT, Social Cognitive Theory.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Parental consent was obtained for all students who agreed to participate.

A parent's demographics, according to social systems theory, are attributes for children's health behaviors (i.e., children from low-income families may have more unhealthy behaviors) (24,25). In the present study, parent demographics were collected from mothers because single-parent households headed by mothers were common, mothers were more willing to participate, and mothers usually exert the most influence on children's eating behaviors. All mothers were asked to participate in the parent survey, and of those, 89 answered the survey (51.4%). Regarding their annual income question, only 51 (29.4%) of the mothers responded. Nonetheless, income values may be representative of extreme poverty levels since all mothers and their children participating in the present study reside in public housing and average income of public housing residents in the targeted area is $4,300 per household (San Antonio Housing Authority personnel, personal communication, 1998).

Measurement of diabetes risk factors

Diabetes risk factors examined in this study were self-reported dietary intake, body fat, physical fitness, and family history of diabetes. Dietary intake was measured by three 24-h dietary recalls (2 weekdays and 1 weekend day). Studies have found dietary recalls to be reliable and valid in children of this age-group (27,28). Five full-time Social and Health Research Center staff members conducted all interviews in English, during school hours. The staff training outlined two procedures for collecting dietary information. One was the interviewing procedure, which consisted of a script for dialog, prompting methods and recording methods. The other was the measuring methodology, which consisted of using food models and measuring utensils. Time of day and type of food/beverage consumed, and amount consumed measured in fluid ounces, cups, and/or portion sizes were collected for the day (24 h) before the interview.

Dietary information was analyzed using Nutrition IV software for Windows (The Hearst Corporation, San Bruno, CA). These analyses provide specific macronutrient and micronutrient content of foods. Number of servings of fat and fruits and vegetables were quantified manually using an adapted U.S. Department of Agriculture's Food Guide Pyramid (FGP) method (29). This method applies specific conversion factors as serving quantities (C.C. Mobley, K. Hattaway, unpublished observations).

Body fat was measured by BMI and bioelectric impedance analysis (Tanita Corporation of America, Skokie, IL). BMI (kg/m^2) was calculated from weight and height. Overweight prevalence was calculated from the reference data for BMI for children obtained from the first National Health and Nutrition Examination Survey (NHANES I) (31,32). Bioelectric impedance analysis was used to measure percent body fat because in children, body fatness has been shown to relate closely to atherogenic and diabetogenic risk factors (33) and because BMI may not represent their true body fatness (34). Also, bioelectric impedance analysis is an expeditious method for group studies and has shown close correlation with dual energy X ray absorptiometry, skinfold-thickness, and underwater body density measurements in non-Hispanic white children (35,36). Mexican-American students in the present study showed a positive and significant correlation ($r = 0.89$; $P < 0.001$) between percent body fat measured by bioelectric impedance analysis and BMI measured by a Detecto scale.

The bioelectric impedance analysis instrument consists of a computer laptop and a metal electrode box. The children, wearing indoor clothing, were asked to remove their shoes and socks and step on the metal electrode box. Within 30 s the instrument printed out percent body fat and fat mass in grams. Students, wearing indoor clothing and barefooted, had their body weight and height measured by trained personnel, using standardized methods on a Detecto scale. Height and weight were collected in a nonfasting state in the morning hours.

Physical fitness was measured by a modified Harvard step test (37). Physical fitness instead of physical activity was used in the present study. While physical activity (recalls) measures an individual's perception of their frequency and intensity of activity, physical fitness measures an individual's cardiovascular physiological (heart rates, maximum O_2 consumption) response to a standardized exercise test (cycle ergometer, walk/run protocol, step test). Physical fitness has consistently shown a stronger correlation with cardiovascular risk factors than has physical activity (38–40). The step test consists of connecting a heart rate sensing unit (Polar Vantage XL, Polar Electric Company, Port Washington, NY) with a transmitter to the student's lower chest and a receiver monitor to the wrist. A baseline heart rate is recorded, then the student is asked to step up and down (both feet) on a stool 30-cm high, 42-cm wide, and 38-cm deep for 5 min. The student is paced at 30 cycles/min. Immediately after the student either completes the exercise or stops the exercise prematurely, heart rate is recorded at 0, 1, and 2 min postexercise. Physical fitness score (PFS) is calculated by dividing the total time of exercise in minutes by the sum of three heart rate values measured at 0, 1, and 2 min postexercise (37).

$$PFS = \frac{\text{Duration of exercise in seconds} \times 100}{\text{Sum of three heart rates postexercise}}$$

Previous studies indicate that PFS is considered poor if <55, low average if between 55 and 64, high average if between 65 and 79, good if between 80 and 89, and excellent if >90 (37). Using these previously established PFS values, we chose the medium (65–79) as a cutoff point to separate the students between an upper and a lower PFS tertile. This measure provided the analysis to determine if students were more physically fit than not, or vice versa.

Family history of diabetes was examined since susceptibility to diabetes is strongly influenced by degree of relatedness to the diabetic proband. On the parent questionnaire, in four separate items, parents were asked if a physician diagnosed them, their siblings, their mother, or their father with diabetes.

Data analysis

Since this study presented mostly descriptive data, means ± SDs were calculated. For most variables, comparisons for statistically significant differences between boys and girls were obtained by using Student's *t* test for independent samples. Cross-tabulations with χ^2 tests were performed on levels of physical fitness and family history of diabetes by sex. In addition, correlation coefficients were calculated comparing bioelectric impedance analysis with BMI, as well as percent body fat with PFS.

RESULTS

Characterization of households

Mothers who responded to the survey were poor, unemployed, had a low educational attainment, and perceived themselves to have a fair or poor health status (Table 1).

Among the mothers who responded, annual income per household was $9,000. Under the Texas welfare system, a single parent with two children can receive no more than $9,828 a year in cash and benefits from the state. The high number of people living per household (U.S. average is 2.6 [41]) made financial matters worse since the annual income decreased from $9,000 per household to $1,900 per capita. The latter figure is lower than the $3,081.09 income per capita cited in the 1989 U.S. Census for the same census tracts as those targeted by the present study (41). The U.S. Census data confirms the extreme poverty levels found in the study.

Among the mothers that responded, the rate of unemployment was high (68 versus 3.6% overall in the San Antonio, Texas, area), and in two-parent households, nearly one-fourth of the fathers were unemployed (42). Of the mothers that responded, 43% had not completed high school and none had a college or technical school degree. The majority of these mothers perceived themselves to be in fair or poor health status.

Diabetes risk factors

Mexican-American students in the present study reported eating higher than recommended percent energy from fat and percent energy from saturated fat (29) (Table 2). On the other hand, their reported daily fruit and vegetable intake was half of that recommended by national dietary guidelines. There were almost three times as many students with unacceptable PFS as with acceptable scores (37.8 and 12.8%, respectively) (Table 3).

With respect to body weight, percent body fat was higher in these Mexican-American students than that reported by non-Hispanic white and African-American children (36,43). The prevalence of being overweight was higher for boys (20.9%) and girls (18.1%) in the present study than that reported by the NHANES III for U.S. boys (10.8%) and girls (10.7%) (44). Percent body fat was the only diabetes risk factor that was significantly different between boys and girls. The differences in body fat by sex are well established (31,32,45). Because hours of TV viewing has been associated with overweight in U.S. youths (46), the average hours a day (weekday and weekend) of TV viewing was examined. These Mexican-American fourth graders averaged 3.25 h of TV viewing per day.

Family history of diabetes, an indicator of genetic predisposition, was also high. Of a student's first-degree (parents, siblings) and second-degree (aunts, uncles, grandparents) relatives, 60% were diagnosed with diabetes by a physician.

CONCLUSIONS — Mexican-American fourth graders from San Antonio, Texas, residing in public housing, are at risk of developing type 2 diabetes in the near future. With type 2 diabetes now occurring

Table 1—*Socioeconomic characteristics of mothers participating in the Bienestar Health Program, 1997–1998*

Characteristics	Values
Age	34.9 ± 8.3
Single-parent households (%)	49.4
Persons per household (mean)	4.7
Annual income per household* (U.S. dollars)	9,020 ± 9,488
Annual income per capita (U.S. dollars)	1,876 ± 1,564
Unemployed (%)	68.5
Education (%)	
Less than high school	42.5
High school	37.9
More than high school	19.5
Mother's perception of her health status (%)	
Very good health	10.1
Good health	34.8
Fair health	46.1
Poor health	9.0

Data are means, %, or means ± SD. n = 89; 51.4% response rate. *Thirty-eight mothers refused to answer the income question.

Table 2—*Mean daily dietary intake of Mexican-American children participating in the Bienestar Health Program, 1997–1998*

Variable	Recommended dietary allowances*	Boys	Girls	Total
n	—	90	83	173
Macronutrients				
Total energy (kcal)	Maintain ideal body weight	1,961.8 ± 665.2	1,882.7 ± 675.8	1,923.8 ± 669.6
Energy from				
Protein (%)	10	15 ± 3	15 ± 2	15 ± 3
Carbohydrates (%)	60	54 ± 7	53 ± 7	53 ± 7
Fat (%)	30	33 ± 5	34 ± 5	34 ± 5
Saturated fat (%)	10	13 ± 2	13 ± 3	13 ± 2
Cholesterol (mg)	300	274.6 ± 129.9	269.8 ± 150.2	272.3 ± 139.7
Fiber (g/day)	14	11.8 ± 4.8	11.38 ± 5.31	11.6 ± 5.1
Servings				
Fat	Sparingly	7.2 ± 3.9	7.2 ± 4.1	7.2 ± 4.0
Meat	2–3	2.4 ± 1.5	2.6 ± 1.5	2.5 ± 1.5
Milk	2–3	2.1 ± 1.0	2.1 ± 1.3	2.1 ± 1.1
Sugar	NA	2.3 ± 1.3	2.2 ± 1.0	2.2 ± 1.2
Bread	4–6	5.8 ± 2.4	5.7 ± 2.6	5.8 ± 2.5
Fruits and vegetables	5/day	1.2 ± 1.1	1.3 ± 0.9	1.2 ± 1.0
Micronutrients				
Sodium (mg)	2,400	3,154.9 ± 1,302.9	2,839.8 ± 1,298.3	3,002.8 ± 1,306.5
Potassium (mg)	3,500	2,269.6 ± 839.8	2,162.2 ± 824.8	2,216.8 ± 831.7
Calcium (mg)	1,000	914.3 ± 427.0	865.9 ± 360.7	891.0 ± 396.0
Magnesium (mg)	2.0	210.5 ± 77.1	227.6 ± 176.7	218.9 ± 135.4
Phosphorus (mg)	1,000	1,192.8 ± 445.0	1,090.6 ± 376.9	1,142.6 ± 414.9
Chromium (mg)	120	0.08 ± 0.24	0.05 ± 0.03	0.06 ± 0.18
Vitamin A (IU)	5,000	702.7 ± 504.2	693.6 ± 514.2	698.3 ± 507.6
Vitamin D (IU)	400	5.3 ± 3.0	4.5 ± 2.0	5.0 ± 2.6

Data are n, %, or means ± SD. *From the Center for Nutrition Policy and Promotion (29), Murphy et al. (51), and Pennington and Hubbard (59).

Table 3—*Diabetes risk factors (biological) of Mexican-American children participating in the Bienestar Health Program, 1997–1998*

Variable	Recommended*	Boys	Girls	Total
n (%)	—	90 (52)	83 (48)	173
Age	—	9.4 ± 0.6	9.3 ± 0.5	9.4 ± 0.5
Physical fitness scores				
Unacceptable (%)	—	37	39	38
Marginally acceptable (%)	—	51	47	49
Acceptable (%)	—	12	14	13
Anthropometric				
% Body fat (mean)	Boys <14 Girls <20	22.4 ± 11.2	27.1 ± 8.9	24.7 ± 10.4†
Prevalence of overweight (%)	—	21	18	20
Family history of diabetes (*n*)	—	45	44	89
First- or second-degree relative (%)	—	56	64	60

Data are *n*, %, or means ± SD. *From the American Academy of Pediatrics (43) and Troiano et al. (44). †$P = 0.003$.

in Mexican-American children as young as age 10 years, it is important to identify and modify diabetes risk factors at a younger age. Identifying diabetes risk factors may be helpful in designing and evaluating diabetes prevention programs since risk factor values can be used as behavior endpoints for learning activities, as performance measures for program evaluation, and as identifiers for selecting high-risk youth populations. In addition, with the child's social context impinging on diabetes risk factors, the Social Cognitive Theory (SCT) (47) should be considered as a theoretical framework when analyzing descriptive studies and when developing intervention programs. The basic tenet of SCT is the notion of reciprocal determinism, where personal factors (cognitive, affective) and social systems (family, schools, communities) are all interrelated and dynamic in developing and modifying health-related behaviors.

A limitation of this study is the lack of reference values for percent body fat and physical fitness levels in Mexican-American children. In the present study, dietary reference values are consistent with the dietary guidelines for Americans (48), and prevalence of being overweight is based on reference values for children from national data sets (31,32,45). On the other hand, percent body fat and physical fitness reference values were based on studies done with non-Hispanic white children (37,43). In this study, a correlation coefficient was computed to examine the relationship between PFS and percent body fat. PFS had a significant ($r = -0.43$, $P < 0.001$) negative correlation with percent body fat. Although reference values for PFS in Mexican-American children do not exist, the present physical fitness measure did demonstrate appropriate criterion validity.

In the present study, girls had higher percent body fat than boys, but boys had higher prevalence of being overweight than girls. Although it is well established that girls have higher body fat than boys (49,35), other investigators have also reported higher mean BMI and higher prevalence of being overweight (based on BMI) in boys compared with girls in this age-group (44,50). During prepuberty, body proportions, bone mass, and lean-to-fat ratio differ by sex, thereby changing the relationship between body fat and total body mass (34). Therefore, BMI may not be an appropriate tool for measuring body fat in this age-group.

Mexican-American students in the present study show anthropometric, dietary, and physical activity risk factor levels similar to those reported in Mexican-American children from other U.S. sites. Although the present study included children from low-income neighborhoods, socioeconomic status was not factored into the analysis of the following studies cited. The Hispanic Health and Nutrition Examination Survey (HHANES) investigators reported that the percentile levels for BMI in Mexican-American youths (1–18 years) were higher than those for non-Hispanic white youths in the NHANES II at almost all ages in each sex (45). In the Child and Adolescent Trial for Cardiovascular Health (CATCH) study, investigators noted in children (mean 8.73 years) that Latinos had a significantly greater BMI (18.2 kg/m^2) than African-American (17.8 kg/m^2) and non-Hispanic white (17.4 kg/m^2) children (50).

Investigators from HHANES using a food frequency questionnaire reported that 97% of Mexican-American children (6–11 years) ate less than the recommended servings of fruits and vegetables and 79% ate more than the recommended servings of meat (51). The U.S. Department of Agriculture's Continuing Survey of Food Intakes by Individuals, using a 24-h dietary recall and 2 days of food records, reported that Latino children ate 3.3 servings of fruits and vegetables, compared with 3.6 in non-Hispanic white and 3.7 in African-American children (52). In the CATCH study, using a 24-h dietary recall, Latino children (8–10 years) tended to eat more percent energy from fat and saturated fat and less percent energy from carbohydrates than non-Hispanic whites and African-American children (50).

The major difference between the studies described and ours is the method of measuring dietary intake. Whereas the above studies used either one food frequency questionnaire or one 24-h dietary recall, the present study used three 24-h dietary recalls.

The following studies analyzed the levels of physical activity in children of different racial/ethnic background. Latinos and non-Hispanic white children (4.4 years) had physical activity measured by direct observation technique (53). At home, non-Hispanic white children spent significantly more time walking, being very active and engaging in moderate-to-vigorous physical activity (MVPA) than Mexican-American children. Mexican-American children at home spent significantly more time lying down and being indoors in the company of adults and had less access to active toys. There was a trend for Mexican-American children to spend more time watching television than non-Hispanic white children (13 vs. 10 percent of time; $P < 0.07$). During recess, non-Hispanic white children significantly spent more time walking, more time engaging in MVPA, and less time sitting than Latino children. As in the home, Mexican-American children had significantly fewer active toys at recess but spent more time in the company of other children and adults. In another study using the Godin-Shepard Physical Activity Survey, investigators showed that Latino schoolgirls (8–9 years of age) self-reported fewer physical activity units (frequency of exercise levels) than did African-American and non-Hispanic white schoolgirls the same age (54). Thus, modifiable diabetes risk factors are more common in Mexican-American children than in other U.S. children.

Because the majority of students had a first- or second-degree relative with type 2 diabetes, genetic predisposition may also contribute to the new finding of type 2 diabetes in Mexican-American children. Familial clustering of type 2 diabetes is often used as a proxy for genetic predisposition (55). A shortcoming with this method is that it does not consider the transmission of cultural practices (56). Cultural traits also may be transmitted from generation to generation along family lines (57). Nonetheless, despite a higher genetic predisposition, a study in Mexican-Americans reported that environmental factors appear to override genetic factors in their expression of type 2 diabetes (58).

In the present study, body fat, physical fitness, reported dietary fat, reported daily fruit and vegetable intake, and family history of diabetes were examined in low-income Mexican-American children in the fourth grade. Because of high diabetes risk factor levels and increasing occurrence of type 2 diabetes in Mexican-American children, early-age screening should be encouraged and early-age diabetes prevention programs should be explored further.

Acknowledgments— This research was funded by the Texas Department of Health/Texas Diabetes Council and Southwest General Hospital of San Antonio.

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