

**Risk factors for type 2 diabetes in a 6th grade multi-racial cohort: the
HEALTHY study**

The HEALTHY Study Group*

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Objective: HEALTHY is a 3-year middle school intervention program designed to reduce risk factors for type 2 diabetes. The prevalence of diabetes risk factors at baseline in a cohort of 6358 sixth grade students is reported.

Research Design and Methods: 42 schools at 7 US sites were randomly assigned to intervention or control. Students participated in baseline data collection during fall 2006.

Results: Overall, 49.3% of children had BMI \geq 85th percentile, 16.0% had fasting blood glucose \geq 100 mg/dL (< 1% had fasting blood glucose \geq 126 mg/dL), and 6.8% had fasting insulin \geq 30 μ U/mL. Hispanic youth were likelier to have BMI, glucose, and insulin levels above these thresholds compared to Blacks and Whites.

Conclusions: Sixth grade students in schools with large minority populations have high levels of risk factors for type 2 diabetes. The HEALTHY intervention was designed to modify these risk factors to reduce diabetes incidence.

The HEALTHY study is determining the effectiveness of a 3-year intervention that changes the school environment with regard to nutrition, physical activity, and health messaging, and facilitates student and parent behavior change to reduce risk factors for type 2 diabetes (BMI \geq 85th percentile, fasting glucose \geq 100 mg/dL, and fasting insulin \geq 30 μ U/mL). A pilot study in 8th grade students found a high prevalence of diabetes risk factors, but almost no diabetes [1]. We report baseline data in 6th graders prior to beginning the HEALTHY intervention.

RESEARCH DESIGN AND METHODS

Design: Forty-two middle schools with at least 50% of students eligible for free or reduced-price lunch or belonging to a minority group, with an annual student attrition rate \leq 25%, and with a guarantee of at least 225 minutes of physical education every 10 days were recruited by 7 centers (see appendix). All 6th grade students were invited to participate and offered a \$50 incentive for data collection. This study was approved by Institutional Review Boards, and informed parental consent and child assent were obtained.

Data Collection: Methods for data collection were described previously [1]. Ethnicity and race were collected by student self report: anyone checking 'Hispanic or Latino' ethnicity was classified as Hispanic; non-Hispanics choosing only 'Black or African American' race were classified as Black; non-Hispanics choosing only 'White' race were White; all other response categories were combined into 'Other'. Students underwent a fasting blood draw; those with known diabetes or unable to participate in PE classes were not eligible.

Statistical Methods: BMI percentile by age and sex was calculated using the SAS program provided by the CDC referencing

year 2000 [2-3]. The 'Other' racial/ethnic group was too heterogeneous to interpret and was not included in the analysis. P-values are given from analyses of generalized linear mixed models (SAS Proc GLIMMIX) that included a random effect for school. If the overall effect was significant ($p < .05$), then pair-wise comparisons were performed.

RESULTS

A total of 6358 6th grade students had complete and valid data. Overall, 57.6% of the 6th grade students were recruited to participate (range 44.4%-87.0%). The mean number of participants per school was 151 (range 73-229).

The table presents student characteristics. Tests for the effect of race/ethnicity on percent at risk for each factor were conducted and all were statistically significant ($p < .0001$): 52.4% of Hispanics, 47.9% of Blacks, and 43.6% of Whites had BMI \geq 85th percentile; 19.3% of Hispanics, 10.4% of Blacks, and 13.9% of Whites had fasting glucose \geq 100 mg/dL; and 8.3% of Hispanics, 5.2% of Blacks, and 3.5% of Whites had fasting insulin \geq 30 μ U/mL. The distribution of fasting glucose and fasting insulin across three BMI percentile categories (< 85 , 85-94, ≥ 95) showed that for fasting glucose \geq 100 mg/dL, pair-wise tests were significant for 85-94 versus ≥ 95 and for < 85 versus ≥ 95 ; for fasting insulin \geq 30 μ U/mL, all three pair-wise comparisons were significant.

When analyzing the combined effects of race/ethnicity and BMI percentile on the glycemic risk factors, Hispanics had the highest percent with fasting glucose \geq 100 mg/dL across all three BMI categories (Hispanics 16.9%, 19.3%, 23.0%; Blacks 7.5%, 6.2%, 18.1%; Whites 11.7%, 15.7%, 17.7%). Percent with fasting insulin \geq 30 μ U/mL rose dramatically across all three BMI categories, and again Hispanics had the highest percent at risk (Hispanics 0.7%, 3.6%,

22.5%; Blacks 1.0%, 2.2%, 14.5%; Whites 0.6%, 2.2%, 11.8%).

The proportion of the total sample with all three risk factors for diabetes was 2.3%. In contrast, 43.7% of students had all three factors below the risk cutoffs. There was no difference by sex. Among those with a family history of diabetes, 4.6% had all three risk factors. Risk varied minimally by race/ethnicity, with 2.9% of Hispanic, 2.0% of Black, and 1.3% of White youth having all three risk factors.

CONCLUSIONS

The percent of overweight youth in our cohort was higher than reported for NHANES in a representative sample of the US children [4], but similar to rates reported in other predominantly minority cohorts [5-6], including our 2003 pilot study of 8th grade students [1]. Hispanics had the greatest percent of overweight/obesity, followed by Blacks, similar to NHANES [4].

The mean glucose was higher than reported in overweight Mexican Americans of comparable age (78-81 mg/dL) [7], similar to reports in high-risk Mexican American youth with a family history of diabetes (91.5 mg/dL) [6, 8] and American Indians in this age range (91.8 mg/dL) [9], and lower than our 8th grade pilot cohort (98.2 mg/dL) [1]. The percent of students with IFG was higher than teens from NHANES [10-12] and from a community sample of teens in Cincinnati [13]. However, it was notably lower than the IFG rate of 40.5% in our 8th grade pilot study [1]. There was virtually no undiagnosed diabetes, indicating that the rate of conversion from IFG to diabetes in youth was very low, or children who developed diabetes were symptomatic and sought medical care early, or both. With regard to race/ethnicity, IFG was most common in Hispanics, intermediate in Blacks, and least common in Whites, similar to NHANES [10].

Previous reports have shown an effect of race/ethnicity on insulin levels and IFG in youth. Insulin levels have been previously reported to be affected by pubertal stage and race/ethnicity, with Black girls having highest values [14-15]. In our cohort, more Hispanics had insulin ≥ 30 mU/mL than Blacks and Whites, who were not statistically different. Hyperinsulinism varied across the BMI percentile categories. Hispanics had the greatest percent with IFG in all BMI percentile groups. Blacks showed the greatest effect of increasing BMI on IFG. A relatively small percent of students (2.3%) had all three diabetes risk factors; this was increased two-fold in those with a family history of diabetes.

Our results confirm high rates of overweight/obesity in 6th graders, similar to our 8th grade pilot [1], but with lower rates of metabolic abnormalities. This justifies research, such as the HEALTHY trial, to evaluate interventions to reduce diabetes risk in middle-school students.

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The HEALTHY Study Group is listed in the on-line appendix.

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Table 1. 6th Grade Student Characteristics (N=6358)

Age (years)	Mean (SD)	11.8 (0.6)	
	Min-Max	9-15	
Gender	Male	47.6%	
Race/Ethnicity	Hispanic	53.1%	
	Black	19.7%	
	White	18.8%	
	Other	8.4%	
Self-report 1st degree family history of diabetes	Positive	16.4%	
Tanner stage (self-report Pubertal Development Scale)	Male	1	15.5%
		2	38.6%
		3	38.1%
		4	6.5%
		5	0.3%
	Female	1	5.8%
		2	13.0%
		3	42.7%
		4	34.9%
		5	3.6%
BMI (kg/m²)	Mean (SD)	22.3 (5.5)	
	Male	22.4 (5.5)	
	Female	22.2 (5.5)	
BMI percentile (categorical, adjusted for age and gender)	< 85	50.7%	
	85-94	19.7%	
	≥ 95	29.6%	
Fasting glucose (mg/dL)	Mean (SD)	93.4 (6.7)	
Fasting glucose (categorical)	< 100	84.0%	
	100-109	14.7%	
	110-125	1.2%	
	≥ 126	0.1%*	
Fasting insulin (μU/mL)	Mean (SD)	13.3 (11.6)	
Fasting insulin (categorical)	≥ 30	6.8%	

* 6 subjects had fasting glucose ≥ 126 mg/dL at screening; only 1 was confirmed on follow-up clinical testing