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Ethnic Group Differences in Cardiometabolic Disease Risk Factors Independent of Body Mass Index among American Youth

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Abstract

Objective—The purpose of this analysis was to identify any ethnic group differences in the prevalence of cardiometabolic disease risk factors independent of body mass index (BMI) in United States youth.

Design and Methods—Data on 3,510 boys and girls ages 8-to-11 years old from the 1999–2008 National Health and Nutrition Examination Surveys were analyzed to determine the prevalence of one or 3 cardiometabolic disease risk factors: abnormal waist circumference and systolic (SBP) and diastolic blood pressure (DBP), increased concentrations of fasting triglyceride and decreased concentrations of high density lipoprotein (HDL) cholesterol before and after adjusting for BMI.

Results—Abnormal waist circumference and HDL-cholesterol significantly differed by ethnic group before and after adjusting for BMI ($P < 0.01$). Non-Hispanic blacks were significantly less likely to have abnormal HDL cholesterol concentrations than were Hispanics and non-Hispanic whites, but non-Hispanic whites were significantly more likely to have elevated triglycerides and three or more abnormal cardiometabolic risk factors than non-Hispanic blacks.

Conclusions—These findings point to ethnic group disparities not related to BMI alone, even in children as young as 8-to-11 years old. Programs to prevent and treat eventual cardiometabolic disease in children could be tailored for specific ethnic backgrounds as a result.

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INTRODUCTION

The current prevalence of obesity among United States youth is important, given the associations between childhood-onset obesity and cardiometabolic risk factors including increased waist circumference, dyslipidemia and hypertension.(1,2) These cardiometabolic disease risk factors are associated with type 2 diabetes and vascular complications in childhood and adulthood.(3,4)

Analysis of the National Nutrition and Health Examination Survey (NHANES) III indicates that the prevalence of at least 3 cardiometabolic disease risk factors was highest among Hispanic (6% to 13%) and lowest among black older adolescents (2% to 3%), with white adolescents in between (5% to 11%).(5) Smaller clinical studies estimate the overall prevalence of a clustering of at least 3 cardiometabolic disease risk factors is between 4% and 9% in adolescents with a higher prevalence in minorities than in whites.(6,7) Only one study examined differences in the prevalence of at least 3 cardiometabolic disease risk factors by ethnicity in children younger than 12 years old.

Although rates of overweight and obesity vary by ethnicity, it is currently unclear whether obesity alone is driving the differences in the prevalence of these cardiometabolic disease risk factors. Ethnic group-specific genotype and phenotype variations may be partially responsible for some of the disparity. If the prevalence of individual cardiometabolic disease risk factors varies by ethnicity and are independent of obesity then these findings could, in turn, be used to refine prevention and treatment programs. The objective of this analysis is to identify ethnic differences in the prevalence of individual and clustering of at least 3 cardiometabolic disease risk factors while controlling for age, sex, and body mass index (BMI) in youth between 8 and 11 years old. This analysis focused on younger children because studies consistently show adverse health effects from obesity at increasingly younger ages.(1–8) We controlled for BMI because it is a powerful predictor of cardiometabolic risk and is highly correlated with waist circumference (WC).

METHODS

The NHANES 1999–2008 surveys used a stratified, multistage probability design to capture a representative sample of the civilian, non-institutionalized US population. NHANES design allows two or more “cycles” to be combined to increase the sample size and analytic options.

Eligibility Criteria for Analysis

Data from all Hispanic, non-Hispanic white, and non-Hispanic black youth aged 8-to-11 years from the combined 1999–2008 NHANES data were analyzed. Children identified as “other” ethnicity were excluded. We analyzed all youth with complete BMI and WC data; fasting triglyceride and high-density lipoprotein (HDL) cholesterol concentrations; and systolic and diastolic blood pressure.

Diagnostic Criteria for Normal and Abnormal Cardiometabolic Disease Risk Factors

Systolic and Diastolic Blood Pressures—Abnormal blood pressure was defined if either systolic or diastolic values were above the 90th percentile, adjusted for age, sex and height.(9)

Triglyceride Concentration—Empirical 90th percentile cut offs adjusted for age and sex were used as the threshold values. Only subjects who fasted at least 4 hours were analyzed (71% of sample). Additionally, it should be noted that triglyceride concentrations were only measured in a subsample (~15%) of the population.

High-Density Lipoprotein Cholesterol—Abnormal HDL-cholesterol was defined as those below the 10th percentile, adjusted for age and sex from the NHANES III data.(10)

Waist Circumference—Abnormal waist circumference was defined as above the 90th percentile of the NHANES III prevalence estimates adjusted for age, sex and ethnicity.(11)

Measures and Data Collection

All laboratory methods are described in detail in *The NHANES Laboratory/Medical Technologists Procedures Manual*.(12)

Statistical Methods

The estimated mean and prevalence of each cardiometabolic disease risk factor is presented with 95% CIs for each ethnic group. Logistic regression was used to determine the significance of ethnic group differences. Survey year was included in all logistic regression models to adjust for trends over the 10 survey years. The national prevalence of children with a clustering of three or more cardiometabolic disease risk factors was calculated, and appropriate weights were applied to generate national population estimates.

All cardiometabolic disease risk factors adjusting for BMI percentiles for age-and sex were also examined. P-values for the three pair-wise comparisons among ethnicities were Bonferroni adjusted. SAS version 9.2 survey procedures were used for all analyses to apply the appropriate sample weights and to adjust for the complex sample design of the NHANES surveys.

RESULTS

Of 3,864 youths represented in the combined surveys, the following groups were excluded: those who did not complete a medical exam (n =135), those who identified as “other” ethnicity (n=179), diagnosed diabetic (n = 13) or were taking medications that altered blood pressure, lipid metabolism, or blood glucose such as insulin, androgens, anabolic steroids, or corticosteroids (n = 27). After excluding these cases, data from 3,510 youths were available for analysis.

Among males, 28% of Hispanics, 22% of non-Hispanic blacks and 17% of non-Hispanic whites were obese (BMI ≥95th percentile for age and sex) (P=0.001). An additional 17% of all three ethnic groups were overweight (BMI ≥85th – <95th percentile for age and sex).

Among females, 20% of Hispanics, 26% of non-Hispanic blacks and 17% of non-Hispanic whites were obese ($P=0.02$). An additional 20% of Hispanics, 16% of non-Hispanic blacks and 17% of non-Hispanic whites were overweight.

Ethnic group comparisons of mean values of all cardiometabolic disease risk factors are presented in Table 1 by gender and by ethnic group. Among males, Hispanics were more likely to have an elevated WC than other groups. Among both males and females, Hispanics were more likely to have lower HDL-cholesterol versus non-Hispanic blacks.

Overall significant ethnic group differences in the prevalence of abnormal WC and HDL-cholesterol were found both before and after adjusting for BMI (Table 2). Before adjusting for BMI, the prevalence elevated WC was higher in Hispanics than in non-Hispanic whites and blacks. Non-Hispanic whites were also more likely to have an elevated WC than were non-Hispanic blacks after adjusting for BMI.

Non-Hispanic blacks were also less likely to have abnormal HDL-cholesterol than were Hispanics and non-Hispanic whites, but non-Hispanic whites were more likely to have elevated triglycerides and three or more abnormal cardiometabolic risk factors than non-Hispanic blacks.

There was an overall significant difference between ethnic groups in the prevalence of 3 cardiometabolic disease risk factors. The most common combination of abnormal factors was WC, HDL-cholesterol and triglycerides (64%), followed by the combination of WC, HDL-cholesterol and systolic blood pressure (19%). Five percent of the sample had 4 risk factors (WC, HDL-cholesterol, triglyceride, and systolic blood pressure).

DISCUSSION

We estimated the national prevalence of individual and a clustering of three or more cardiometabolic disease risk factors among 8-to-11 year olds in the US, by ethnic group unadjusted and adjusted for BMI. Overall and pairwise ethnic group differences for WC and HDL-cholesterol are consistent after controlling for BMI, suggesting that these differences are not driven by obesity alone and are present from a young age. With the exception of diastolic blood pressure, the prevalence of all cardiometabolic disease risk factors was lowest in non-Hispanic blacks.

A recent American Heart Association scientific statement calls for research to determine racial and ethnic differences in the overall prevalence, mechanisms and pathways to the prevalence of three or more cardiometabolic disease risk factors (termed “metabolic syndrome”) in children and adolescents.(13) This approach should eventually help guide pediatric clinical practice by clarifying the predictive value of an ethnic-specific definition or a “one definition for all.” Non-Hispanic blacks and Mexican Americans typically have higher rates of obesity, insulin-resistance syndrome, and high blood pressure versus non-Hispanic whites.(3,5–7) Within minority groups, there are differences as well; Hispanics and Mexican Americans have higher rates of diabetes than do non-Hispanic blacks, but non-Hispanic blacks have higher rates of hypertension. Our results are consistent with the literature that reports non-Hispanic black adults with a lower prevalence of abnormal HDL-

cholesterol and triglycerides than both Mexican American and non-Hispanic whites.(14) Our results in a younger age group are consistent with studies(3, 5) that show that non-Hispanic blacks have lower rates of 3 cardiometabolic disease risk factors than non-Hispanic whites and Mexican Americans/Hispanics.

Other estimates of ethnic group differences indicate that although individual within-population differences account for about 95% of genetic variation, ethnic group differences account for only 5%.(15) The population-based differences in disease risk we found here suggest further investigations on the genetic, biologic and non-biologic factors underlying phenotypic variation at the individual and population level.(16) For example, environmental influences couched in lifestyle patterns may become more prevalent once children enter early adolescence. Other studies show that energy intake among 9-to-14 year old girls is directly related to BMI over 1 year (17), whereas physical activity is inversely associated BMI.(18) A greater availability of genetic information will increase our understanding of ethnic differences in disease risk and may help develop targeted prevention and treatment strategies to overcome health-related disparities.

Strengths and Limitations of the Study

NHANES surveys are cross-sectional, thus no causal inferences can be made. We could not assess the effect of puberty because Tanner stage was not available. This subject warrants further investigation. Fasting lipid concentration data were available for only 71% of 8-to-11 year olds and of this proportion a subsample representing only 15% of the sample had triglyceride concentrations available for analysis. This created significant differences in sample sizes among the various risk factors. We were able to estimate the 90th percentile cut-off values, estimates that have been unavailable in this age group and another potential strength of the study. We found a previously established crude cut-off of 110 mg/dL for triglycerides did not correspond to the 90th percentile in our study, potentially causing a type 2 error in the prevalence of abnormal triglyceride concentrations in this age group.

Conclusions

American adolescents in all ethnic groups often have one or more risk factors for cardiometabolic disease. Ethnic group differences were found for WC and HDL-cholesterol after adjusting for BMI, indicating disparities not related to BMI alone. These findings suggest that ethnic-specific pediatric prevention and treatment models for future onset of cardiometabolic disease should be developed.

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Table 1

Mean Values of Cardiometabolic Disease Risk Factors Among 8-to-11-Year-Olds Males and Females, by Ethnicity and by Ethnic Group Contrasts, 1999–2008 NHANES Data.

Cardiometabolic Disease Risk Factor	Male			Female			Male versus Female
	Mean ± SE	Hispanic	NHB	Mean ± SE	Hispanic	NHB	
BMI percentile^d							
Hispanic	68.8 ± 1.7			67.8 ± 1.6			0.69
NHB	66.5 ± 1.4	0.33		67.9 ± 1.4	0.98		0.51
NHW	63.3 ± 1.6	0.02	0.12	61.2 ± 1.6	<0.01	<0.01	0.31
Waist Circumference, cm							
Hispanic	70.1 ± 0.7			69.7 ± 0.6			0.66
NHB	65.6 ± 0.5	<0.001		68.2 ± 0.5	0.04		<0.01
NHW	67.6 ± 0.6	<0.01	<0.01	68.5 ± 0.6	0.13	0.758	0.23
Systolic Blood Pressure, mm Hg							
Hispanic	102.9 ± 0.4			101.3 ± 0.6			<0.01
NHB	102.9 ± 0.4	0.93		102.5 ± 0.4	0.06		0.47
NHW	102.7 ± 0.4	0.62	0.75	101.9 ± 0.5	0.40	0.34	0.23
Diastolic Blood Pressure, mm Hg							
Hispanic	54.7 ± 0.7			53.8 ± 0.7			0.35
NHB	54.6 ± 0.7	0.89		54.5 ± 0.7	0.489		0.93
NHW	53.7 ± 0.7	0.30	0.33	54.9 ± 0.7	0.285	0.714	0.16
HDL Cholesterol, mg/dL							
Hispanic	53.4 ± 0.6			51.6 ± 0.9			0.08
NHB	59.6 ± 0.8	<0.001		56.2 ± 0.7	<0.001		0.001
NHW	52.9 ± 0.7	0.63	<0.001	51.4 ± 0.6	0.888	<0.001	0.11
Triglyceride, mg/dL							
Hispanic	90.9 ± 6.2			101.9 ± 4.9			0.09
NHB	75.0 ± 3.8	0.05		83.5 ± 6.1	0.03		0.23

Cardiometabolic Disease Risk Factor	Male			Female			Male versus Female
	Mean ± SE	Hispanic	NHB	Mean ± SE	Hispanic	NHB	
NHW	88.2 ± 4.4	0.74	0.02	100.3 ± 3.8	0.79	0.03	0.03

NHW = non Hispanic white, NHB = non Hispanic black

^a adjusted for age and sex¹

Table 2

Percentage of 8-to-11-Year-Olds with Cardiometabolic Disease Risk Factors Adjusted for Age, Sex, or Age, Sex and Body Mass Index, by Ethnicity and by Ethnic Group Contrasts, 1999–2008 NHANES Data.

Cardiometabolic Disease Risk Factor ^a	Group	n	Frequency	Abnormal		Ethnic Group Comparisons	
				%, 95% Confidence Interval	Group Contrasts	P, Adjusted for Age, Sex, and Yearly Trend	P, Adjusted for Age, Sex, BMI, and Yearly Trend
Waist Circumference (90 th Percentile)	Total	3,423	845	23.4 (21.2, 25.5)	Overall	<0.01	<0.001
	Hispanic	1,334	389	28.4 (25.1, 31.7)	Hispanic vs. NHB	<0.01	<0.001
	NHB	1,130	240	21.6 (19.1, 24.0)	Hispanic vs. NHW	0.01	0.13
	NHW	959	216	22.2 (19.0, 25.5)	NHB vs. NHW	0.77	<0.001
Systolic Blood Pressure (90 th Percentile)	Total	3358	267	7.8 (6.2, 9.3)	Overall	1.00	1.00
	Hispanic	1307	115	8.6 (6.1, 11.0)	Hispanic vs. NHB	1.00	1.00
	NHB	1100	80	7.3 (5.3, 9.3)	Hispanic vs. NHW	1.00	1.00
	NHW	951	72	7.6 (5.6, 9.7)	NHB vs. NHW	1.00	1.00
Diastolic Blood Pressure (90 th Percentile)	Total	3358	94	3.0 (2.2, 3.7)	Overall	1.00	1.00
	Hispanic	1307	33	2.5 (1.4, 3.7)	Hispanic vs. NHB	1.00	1.00
	NHB	1100	31	2.8 (1.8, 3.7)	Hispanic vs. NHW	1.00	0.95
	NHW	951	30	3.2 (2.1, 4.2)	NHB vs. NHW	1.00	1.00
High Density Lipoprotein (HDL) Cholesterol (10 th Percentile)	Total	2967	301	11.0 (9.2, 12.8)	Overall	<0.001	<0.001
	Hispanic	1171	158	12.6 (10.2, 15.0)	Hispanic vs. NHB	<0.001	<0.001
	NHB	975	47	4.8 (3.5, 6.0)	Hispanic vs. NHW	1.00	1.00
	NHW	821	96	12.1 (9.4, 14.9)	NHB vs. NHW	<0.001	<0.001
Triglyceride (90 th Percentile)	Total	518	53	11.0 (7.6, 14.5)	Overall	0.50	0.08
	Hispanic	209	28	11.8 (6.6, 17.0)	Hispanic vs. NHB	0.29	0.21
	NHB	203	12	6.3 (2.3, 10.3) ^b	Hispanic vs. NHW	1.00	0.86
	NHW	106	13	12.6 (7.0, 18.2)	NHB vs. NHW	0.25	0.03
(3 Risk Factors Present)	Total	500	20	3.7 (1.3, 6.1) ^b	Overall	0.58	0.04
	Hispanic	202	11	4.1 (1.5, 6.7) ^b	Hispanic vs. NHB	0.29	0.24

Cardiometabolic Disease Risk Factor ^d	Abnormal				Ethnic Group Comparisons		
	Group	n	Frequency	%, 95% Confidence Interval	Group Contrasts	P, Adjusted for Age, Sex, and Yearly Trend	P, Adjusted for Age, Sex, and BMI, and Yearly Trend
	NHB	194	5	2.5 (0.1, 4.9) ^b	Hispanic vs. NHW	0.93	0.06
	NHW	104	4	4.1 (0.1, 8.1) ^b	NHB vs. NHW	0.41	0.01

NHW = non Hispanic white, NHB = non Hispanic black

^a Adjusted threshold values were: (1) waist circumference = 90th percentile adjusted for age and sex, NHANES III²⁰; (2) systolic and diastolic blood pressure = 90th percentile adjusted for age, sex, and height National High Blood Pressure Education Program¹⁸; (3) HDL cholesterol = 10th percentile adjusted for age and sex, NHANES III¹⁹; and (4) triglycerides = empirical 90th percentile adjusted for age and sex, NHANES III¹⁹

^b Relative standard errors >30%; data may not be reliable¹⁹