Original Paper

Inter- and Intra-Ethnic Group Comparison of Metabolic Syndrome Components Among Morbidly Obese Adolescents

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This study explored inter- (between) and intra- (within) ethnic group differences in metabolic syndrome components among a clinical sample of morbidly obese (body mass index [BMI] ≥97th percentile for age and sex) 12- to 18-year-olds originating from Latin America and the Caribbean Basin and a matched (age/ethnicity/sex/BMI percentile) national sample (N=208, both samples) of Mexican American and non-Hispanic blacks from the 1999 to 2006 National Health and Nutrition Examination Survey (NHANES). Mexican American and non-Hispanic black boys from the NHANES/national sample had significantly higher mean fasting glucose levels compared with Latin and Caribbean blacks (98.50 vs 85.42 mg/dL, 97.34 vs 86.44 mg/dL, respectively, (P<.001 for both comparisons). Conversely, both diastolic/systolic blood pressure was consistently higher among Latin/Caribbean adolescents vs Mexican American and non-Hispanic blacks for all age/sex/ethnic groups. These results indicate that morbidly obese adolescents from both major ethnic groups and subgroups within these groups show health-related comorbidities in both clinic- and population-based settings. J Clin Hypertens (Greenwich). *2010;12:645–652.* ©*2010 Wiley Periodicals, Inc.*

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Currently, more than 17% of children in the Unites States aged 2 to 19 are obese (≥95th percentile for body mass index [BMI] for age and sex), and another 34% are at-risk for becoming obese (≥85th percentile for BMI for age and sex).[1] Data consistently show that non-Hispanic blacks and Hispanics have higher obesity prevalence rates compared with their non-Hispanic white counterparts.[1–3] A secular trend analysis of US national data showed that non-Hispanic black children and adolescents experienced the largest increase in the prevalence of obesity (12.2%) compared with non-Hispanic white (8.0%) and Mexican Americans (4.9%) during the past 20 years.[4] Moreover, national prevalence estimates from 1999 to 2002 show that extreme obesity (>99th percentile for BMI) approached 6% to 7% among non-Hispanic black girls and Mexican American boys.[2]

Recent studies have reported an association between childhood obesity and the subsequent development of a constellation of cardiometabolic risk factors characterized by insulin resistance, dyslipidemia, and hypertension, which some have termed the metabolic syndrome (MetS).[5–8] In turn, this clustering is associated with type 2 diabetes and long-term vascular complications in both childhood and adulthood.[9–11] Previous population-based studies have shown that ethnic minorities have higher rates of MetS compared with their white counterparts.[12–16] Because components of the MetS are relatively stable characteristics that tend to track from childhood into adulthood,[5,6,17–20] the identification of adolescents with these risk factors is of great clinical and public health interest.

Few studies have addressed the prevalence of morbid obesity and health-related consequences among subgroups of non-Hispanic black and non-Mexican Hispanic adolescents residing in the United States, such as those originating from Latin America and the Caribbean region.[21] Little is known about how these groups compare with their national ethnic group counterparts in the prevalence and severity of individual MetS components. Therefore, this analysis sought to compare the prevalence of individual MetS components among a multiethnic sample of morbidly obese adolescents from Central and South America (Latin) and the Caribbean region (Caribbean/West Indian black) with the National Health and Nutrition Examination Survey (NHANES), a population-based sample that included predominantly Mexican American and non-Hispanic black children *not* from Central/South American (with the exception of Mexico) and the Caribbean.

METHODS

Miami Sample

A cross-sectional sample of convenience of morbidly obese (≥97th percentile BMI for age and sex) adolescents aged 12 to 18 years (N=208) was analyzed. Data were abstracted from medical charts of adolescents who attended the Pediatric Endocrinology Clinic at the University of Miami Miller School of Medicine between November 2006 and November 2007. For this analysis, however, we included only the first visit so we would have two cross-sectional groups (Miami and NHANES) that would be as comparable as possible. By including adolescents' first visit data only, we reduce selection bias for those patients who may be more likely to return for multiple visits due to MetS diagnosis or other related health issues. Adolescents classified as Latin self-identified as originating from South and Central America (no adolescent identified as Mexican), Cuba, Dominican Republic, and/or Puerto Rico and those classified as Caribbean black self-identified as originating from the West Indies (including Haiti). The Miami sample will be referred to as Latin and Caribbean black from this point forward as such. All adolescents were referred from general pediatric or adolescent medicine clinics within the university or community pediatric clinics due to concerns of obesity and possible health-related issues. This study had University of Miami institutional review board approval.

National Sample

The NHANES cross-sectional surveys used a stratified, multistage probability design to capture a representative sample of the civilian noninstitutionalized US population.[22] To produce estimates with greater statistical reliability for demographic subdomains and rare events, combining two or more 2-year cycles of the continuous NHANES is encouraged and strongly recommended. Therefore, we chose to combine 1999 through the most available dataset that included the variables of interest, which was 2006.

NHANES-selected persons were invited to take part in the survey by being interviewed in their homes. Household interview data were collected with computer-assisted personal interviewing procedures and included demographic, socioeconomic, dietary, and health-related information. After the interview, participants were asked to undergo a physical examination at a medical examination center.

Data Collection

We selected all Mexican American and non-Hispanic black boys and girls aged 12 to 18 years from the combined 1999 to 2006 NHANES data who had a BMI percentile for age and sex ≥97th percentile. We excluded all those who identified their race/ethnicity as "other." The NHANES sample will be referred to as Mexican American and non-Hispanic black from this point forward as such to distinguish them from the Miami Latin/Caribbean black sample. Two groups, younger (aged 12 to 14 years) and older (aged 15 to 18 years) adolescents were formed for the analysis of variance. We dichotomized the age groups because we did not have Tanner stage information available and therefore were unable to control for pubertal stage. These two age groups were chosen based on previous studies that show that by age 15 a majority of adolescents have reached puberty.[23,24] We selected

only patients who had the following variables available for analysis: BMI, high-density lipoprotein (HDL) cholesterol, systolic and diastolic blood pressure (BP), fasting glucose, and triglycerides.

Adolescents were excluded from the NHANES sample if they were known to have diabetes (n=26) or used medications that altered BP, lipid metabolism, or blood glucose such as insulin, androgens, anabolic steroids, or corticosteroids (n=30). No adolescents were pregnant. The final NHANES sample size after exclusions was 208 (non-Hispanic black=55, Mexican American=153).

Methods for Collecting MetS Components in Clinical and National Samples

For the Miami Latin/Caribbean black clinical sample, prevalence estimates of MetS components were calculated from medical chart information and specifically included: (1) anthropometric measurements (height, weight, BMI with clothing); (2) metabolic measurements (fasting blood sugar); (3) systolic and diastolic BP; (4) lipid profiles (HDL cholesterol and triglycerides); (5) family health history; (6) medication history; and (7) self-identified ethnicity and country of birth. Familial information obtained during the initial clinic visit includes an exhaustive medical history to assess for familial obesity, type 2 diabetes mellitus (or gestational diabetes), dyslipidemia, hypertension, or early cardiovascular disease.

All measures (anthropometric, medical history, clinical, and laboratory) analyzed are standard procedure during a routine pediatric endocrinology clinic visit and are not considered experimental. Specific standard clinical protocol follows that of the NHANES procedure described below. No patients in this sample had type 2 diabetes, polycystic ovary syndrome (confirmed via ultrasound), familial dyslipidemia, human immunodeficiency virus infection, history of intrauterine growth restriction, or renal or liver disease. No patients used medications that altered BP, lipid metabolism, or blood glucose such as insulin, androgens, anabolic steroids, or corticosteroids at the time the data were collected and analyzed for this study.

The same MetS component variables described above were analyzed from the NHANES sample. All laboratory methods used at the Medical Examination Center are reported in detail in the *NHANES Laboratory/Medical Technologists Procedures Manual*.[25] Briefly, the standardized anthropometric measures consisted of barefoot standing height (with a stadiometer) and weight with minimal clothing (on a digital, electronic scale). Heights and weights were recorded to the nearest 0.1 cm.

All blood samples were collected, processed, stored at −20°C, and shipped to the respective laboratory for analysis.[25] HDL cholesterol was measured in supernatants after precipitation of apolipoprotein B–containing lipoproteins with heparin-manganese chloride and removal of excess manganese by precipitation with sodium bicarbonate.[26] Triglycerides were analyzed enzymatically with the use of commercially available reagents. Fasting plasma glucose was measured by a modified hexokinase enzymatic method.[27]

Statistical Methods

The NHANES sample was matched with the Miami sample on race/ethnicity (Mexican American and Latin; non-Hispanic black and Caribbean black, respectively), age, sex, and BMI percentile (±1%) to achieve comparable groups. The outcome data are continuous and reported as means and standard errors. A *t* test was used to compare MetS components between the two samples for sex-race/ethnic groups and then each race/ethnic-sex group was analyzed separately with a general linear model. The model fit a 2×2 factorial design that included group (NHANES, Miami) and age group (aged 12 to 14 years [N=121] and 15 to 18 years [N=87]). Contrasts were used to test for significant differences between NHANES and Miami for each age group and between age groups for the samples. Statistical tests resulting in a probability of $\leq .05$ were considered statistically significant. SAS 9.2 (SAS Institute Inc, Cary, NC) was used for all statistical analyses.

RESULTS

More than half of the Miami sample was female (55%), while 74% were identified as Latin and 26% as Caribbean black (Table I). The majority of the sample (83%) had parents who were born in countries in the Caribbean Basin (Cuba, Dominican Republic, Puerto Rico, Haiti, Jamaica, Bahamas, and US Virgin Islands), Central America (Honduras, Nicaragua, and Costa Rica), and South America (Ecuador, Argentina, Columbia, Peru, and Guyana) (data not shown in Tables). Conversely, the NHANES Hispanic sample was comprised of all Mexican Americans and the NHANES black sample consisted of all non-Hispanic blacks not originating from the Caribbean/West Indies (eg, self-identified as "African American").

Intergroup Comparison of MetS Components Among Boys

In general, black boys had higher mean systolic BP than their Hispanic counterparts for both the

Table I. Ethnic Group Comparison of Metabolic Syndrome Components by Sex for NHANES (1999–2006) (n=208) and Miami (n=208) Samples

	Male							Female						
	National (n=98)			Miami (n=98)				National (n=110)			Miami (n=110)			
	No.	Mean	SD	No.	Mean	SD	*P* Value	No.	Mean	SD	No.	Mean	SD	*P* Value
Non-Hispanic black[a]														
Age, y	20	14.15	2.08	20	14.15	2.08	1.000	35	14.57	2.02	35	14.57	2.02	1.000
PBMI	20	99.65	0.75	20	99.80	0.70	.515	35	99.51	0.56	35	99.83	0.45	.012
SBP, mm Hg	17	120.71	9.84	13	132.31	12.98	.009	24	111.54	10.24	22	124.46	13.74	.001
DBP, mm Hg	17	66.71	12.48	13	76.85	7.61	.015	24	65.13	7.95	22	73.68	9.92	.002
Glucose, mg/dL	15	97.34	8.93	16	86.44	8.05	.001	26	91.17	9.65	32	93.19	42.01	.793
HDL, mg/dL	19	44.42	9.64	12	49.83	8.85	.127	35	48.26	10.14	31	46.13	11.02	.416
Triglycerides, mg/dL	15	109.93	58.87	12	93.92	56.08	.480	26	81.77	36.86	33	112.36	87.20	.075
Hispanic[b]														
Age, y	78	13.77	1.71	78	13.77	1.71	1.000	75	14.69	1.80	75	14.69	1.80	1.000
PBMI	78	98.72	1.15	78	99.28	1.27	.004	75	98.55	1.41	75	99.17	1.60	.012
SBP, mm Hg	70	116.76	10.47	58	126.95	13.49	<.001	64	113.55	8.72	51	119.77	13.02	.004
DBP, mm Hg	69	60.25	11.27	58	73.60	9.79	<.001	64	62.14	9.03	51	74.16	9.22	<.001
Glucose, mg/dL	42	98.50	8.01	57	85.42	10.89	<.001	43	91.72	7.25	67	84.94	11.35	<.001
HDL, mg/dL	73	42.43	9.26	57	40.46	8.92	.224	72	42.97	8.76	57	42.68	8.34	.850
Triglycerides, mg/dL	41	144.37	89.00	57	145.60	81.67	.944	43	139.81	102.53	57	113.53	62.74	.142

Abbreviations: DBP, diastolic blood pressure; HDL, high-density lipoprotein cholesterol; PBMI, body mass index percentile; SBP, systolic blood pressure. [a]National (National Health and Nutrition Examination Survey [NHANES]) sample non-Hispanic black=African American/not of Caribbean decent; Miami sample non-Hispanic black=self-identified Caribbean black. [b]National (NHANES) sample Hispanic=Mexican American, Miami sample Hispanic=self-identified Latin, of South or Central American origin, or Cuban, Puerto Rican, or Dominican.

national (120.71 mm Hg vs 116.76 mm Hg) and Miami (132.31 mm Hg vs 126.95 mm Hg) samples. This pattern was also true for diastolic BP (66.71 mm Hg vs 60.25 mm Hg and 76.85 mm Hg vs 73.60 mm Hg, respectively). Intergroup comparisons showed that mean systolic BP was significantly higher among Latins compared with Mexican Americans (126.95 vs 116.76 mm Hg, $P<.001$) and among Caribbean blacks compared with non-Hispanic blacks (132.21 mm Hg vs 120.71 mm Hg, $P=.009$). This pattern was consistent for diastolic BP as well (73.60 mm Hg vs 60.25 mm Hg, $P<.001$; 76.85 mm Hg vs 66.71 mm Hg, $P=.015$, respectively).

Intergroup comparisons showed that fasting glucose was significantly higher in Mexican Americans vs Latins (98.50 mg/dL vs 85.42 mg/dL, $P<.001$) and non-Hispanic blacks vs Caribbean blacks (97.34 mg/dL vs 86.44 mg/dL, $P=.001$). Specifically, among Mexican American and non-Hispanic black boys, mean values (98.50 mg/dL and 97.34 mg/dL, respectively) were close to the American Diabetes Association cut-off value of 100 mg/dL for diagnosis of impaired fasting glucose/prediabetes.[27]

While not statistically significant, non-Hispanic black boys in the national sample had lower HDL cholesterol (44.42 mg/dL vs 49.83 mg/dL, $P=.127$) and higher triglyceride levels (109.93 mg/dL vs 93.92 mg/dL, $P=.480$) vs their Caribbean black counterparts.

Intergroup Comparison of MetS Components Among Girls

Conversely, among girls, Hispanics had higher systolic BP compared with blacks in the national sample (113.55 mm Hg vs 111.54 mm Hg). However, the Miami sample of Caribbean blacks had higher mean systolic BP compared with the non-Hispanic blacks (124.46 mm Hg vs 119.77 mm Hg). This pattern was reversed for diastolic BP: non-Hispanic blacks from the NHANES sample had higher diastolic BP compared with Mexican Americans (65.13 vs 62.14 mm Hg) but slightly lower means values were found in the Miami sample of Latins compared with Caribbean blacks (73.68 mm Hg vs 74.16 mm Hg).

Intergroup comparisons showed that mean systolic BP was significantly higher among Latins compared with Mexican Americans (124.46 mm Hg vs 111.54 mm Hg, $P=.001$) and among Caribbean blacks compared with non-Hispanic blacks (119.77 mm Hg vs 113.55 mm Hg, $P=.004$). Diastolic BP

intergroup comparisons showed that Latins were significantly more likely than Mexican Americans (74.16 mm Hg vs 62.14 mm Hg, $P<.001$) and Caribbean blacks were significantly more likely than non-Hispanic blacks (73.68 mm Hg vs 65.13 mm Hg, $P=.002$) to have elevated levels.

In general, non-Hispanic black and Mexican American girls from the national sample showed roughly the same fasting glucose levels (91.17 mg/dL and 91.72 mg/dL, respectively) but Caribbean blacks had markedly higher fasting glucose compared with Latins (93.19 mg/dL vs 84.94 mg/dL). Intergroup comparisons showed that fasting glucose was significantly higher in Mexican American girls vs their Latin counterparts (91.72 mg/dL vs 84.94 mg/dL, $P<.001$, respectively) while there were no significant differences among non-Hispanic blacks vs Caribbean blacks.

Intragroup Comparison of MetS Components Among Boys

When intragroup analysis was conducted among younger (12 to 14 years) and older (15 to 18 years) age groups, many of the significant interethnic group differences remained across all ages for both boys and girls (Table II).

Specifically among boys, systolic BP was significantly higher in younger Caribbean black boys (130.00 mm Hg vs 116.46 mm Hg, $P=.014$) vs their non-Hispanic black counterparts, but was not significantly higher in the older age group.

Fasting glucose was significantly higher in younger Mexican Americans vs Latins (98.47 mg/dL vs 84.84 mg/dL, $P<.001$) and non-Hispanic blacks vs their Caribbean black counterparts (96.46 mg/dL vs 87.73 mg/dL, $P=.039$) as well as older age groups (98.55 mg/dL vs 87.00 mg/dL, $P=.002$, 98.34 mg/dL vs 83.60 mg/dL, $P=.007$, respectively). Conversely, diastolic BP was significantly more elevated in both younger (71.69 mm Hg vs 58.89 mm Hg, $P<.001$) and older (76.73 mm Hg vs 62.79 mm Hg, $P<.001$) Latin vs Mexican Americans. This pattern was consistent for systolic BP as well; for both age groups, Latin boys had significant elevation vs their Mexican American counterparts.

Intragroup Comparison of MetS Components Among Girls

Systolic BP was significantly higher in younger Caribbean black girls (124.33 mm Hg vs 107.67 mm Hg, $P=.001$) vs their non-Hispanic black counterparts. Similarly, diastolic BP was significantly higher in both younger (70.33 mm Hg vs 63.17 mm Hg, $P=.048$) and older (77.70 mm Hg vs 67.08 mm Hg, $P=.006$) Caribbean black girls vs their non-Hispanic black counterparts.

With the exception of triglycerides among 12- to 14-year-old black females (79.23 mg/dL in non-Hispanic blacks vs 131.24 mg/dL among Caribbean blacks, $P=.047$), no significant differences in lipids were seen for all age/ethnic groups.

DISCUSSION

To the author's knowledge, this is one of the first cross-sectional inter-ethnic and intra-ethnic group comparisons of mean differences of MetS components among a sample of morbidly obese adolescents originating from Latin America and other Caribbean countries and a US-representative sample of Mexican American and non-Hispanic blacks. Our results show that the nonclinical US representative sample of Mexican American and non-Hispanic black boys had significantly higher mean fasting glucose levels compared with the Miami Latin sample. Fasting glucose values for both of these groups as well as for older non-Hispanic black females in the clinical sample was just below the American Diabetes cut-off value for prediabetes.[28]

Race and ethnicity have been shown to be independently associated with cardiometabolic disease risk in childhood and adolescence in other reports.[16,29] The prevalence of MetS has been reported to be highest among Mexican Americans (8%–14%) and lowest among non-Hispanic black adolescents (3%–7%), with white adolescents in between (5%–9%) in other NHANES analyses[7,13,20,30,31] as well as in smaller clinical samples.[19] Our findings here are consistent with this distribution, particularly in context to the high glucose values found in Mexican Americans but not consistent in reference to non-Hispanic blacks, and boys in particular. With the exception of BP, non-Hispanic black boys from the national sample had significantly higher fasting glucose levels as well as lower HDL cholesterol and elevated triglycerides compared with the male clinical sample, indicating that this subclinical group may in fact be at the highest risk for childhood-onset MetS compared with other groups.

Our analysis showed that regardless of ethnicity, adolescents seen in the clinical setting had higher mean systolic and diastolic BP than the population-based sample, and in the case of both ethnic/sex groups, the difference was highly statistically significant. This finding is most likely due to these patients being referred to a

Table II. Ethnic Group Comparisons of Metabolic Syndrome Components Among NHANES and Miami Samples Stratified by Younger and Older Age Group

	NHANES (N=208)					Miami (N=208)					Sample Comparisons by Age Group	
	12–14 y (n=121)		15–18 y (n=87)			12–14 y (n=121)		15–18 y (n=87)				
	Mean	SEM	Mean	SEM	*P* Value	Mean	SEM	Mean	SEM	*P* Value	12–14 y *P* Value	15–18 y *P* Value
Black[a] male	n=13		n=7			n=13		n=7				
PBMI	99.46	0.20	100.00	0.27	.113	99.69	0.27	100.00	0.2673	.359	.411	1.000
SBP, mm Hg	116.46	3.20	128.50	4.33	.034	130.00	4.33	135.00	4.3325	.405	.014	.299
DBP, mm Hg	66.36	3.32	67.33	4.50	.864	75.43	4.50	78.50	4.4958	.620	.101	.091
Glucose, mg/dL	96.46	3.06	98.34	3.27	.678	87.73	3.87	83.60	3.8657	.384	.039	.007
HDL, mg/dL	46.33	2.55	41.14	3.34	.227	54.14	3.95	43.80	3.947	.056	.074	.611
Triglycerides, mg/dL	110.00	20.12	109.86	21.51	.996	116.57	25.45	62.20	25.452	.116	.825	.166
Black[a] female	n=18		n=17			n=18		n=17				
PBMI	99.67	0.12	99.35	0.12	.070	99.89	0.12	99.77	0.1221	.468	.190	.020
SBP, mm Hg	107.67	3.45	115.42	3.45	.120	124.33	3.78	124.60	3.7836	.959	.001	.080
DBP, mm Hg	63.17	2.49	67.08	2.49	.273	70.33	2.73	77.70	2.7314	.053	.048	.006
Glucose, mg/dL	92.65	8.92	89.69	8.92	.815	87.53	8.30	99.60	8.3011	.294	.667	.419
HDL, mg/dL	47.83	2.49	48.71	2.56	.808	43.63	2.73	48.79	2.7288	.179	.251	.981
Triglycerides, mg/dL	79.23	19.24	84.31	19.24	.853	131.24	17.34	92.31	17.341	.113	.047	.758
Hispanic[b] male	n=53		n=25			n=53		n=25				
PBMI	98.53	0.17	99.12	0.24	.044	99.30	0.24	99.24	0.2404	.832	.001	.725
SBP, mm Hg	114.72	1.65	120.67	2.29	.037	122.61	2.39	134.05	2.39	.000	.002	<.001
DBP, mm Hg	58.89	1.56	62.79	2.14	.143	71.69	2.23	76.73	2.2346	.078	<.001	<.001
Glucose, mg/dL	98.47	1.86	98.55	2.63	.981	84.86	2.54	87.00	2.5434	.471	<.001	.002
HDL, mg/dL	41.45	1.30	44.42	1.86	.194	40.26	2.36	40.99	2.3551	.791	.538	.256
Triglycerides, mg/dL	123.56	16.08	184.50	22.33	.029	146.02	21.57	144.40	21.5706	.949	.278	.200
Hispanic[b] female	n=37		n=38			n=37		n=38				
PBMI	98.57	0.25	98.53	0.24	.906	98.92	0.24	99.42	0.2441	.151	.317	.011
SBP, mm Hg	112.53	1.83	114.70	1.94	.417	116.61	2.22	123.61	2.2194	.021	.136	.003
DBP, mm Hg	61.41	1.55	62.97	1.65	.493	72.00	1.88	76.78	1.8833	.063	<.001	<.001
Glucose, mg/dL	92.32	1.89	90.61	2.59	.596	84.00	1.67	85.75	1.6688	.477	.002	.117
HDL, mg/dL	42.66	1.46	43.27	1.42	.764	42.46	1.50	42.85	1.5047	.867	.931	.839
Triglycerides, mg/dL	145.11	15.65	129.93	21.39	.568	118.24	14.64	109.84	14.6432	.705	.241	.440

Abbreviations: DBP, diastolic blood pressure; HDL, high-density lipoprotein cholesterol; PBMI, body mass index percentile; SBP, systolic blood pressure. [a]National (National Health and Nutrition Examination Survey [NHANES]) sample non-Hispanic black=African American/not of Caribbean decent; Miami sample non-Hispanic black=self-identified Caribbean black. [b]National (NHANES) sample Hispanic=Mexican American, Miami sample Hispanic=self-identified Latin, of South or Central American origin, or Cuban, Puerto Rican, or Dominican.

specialty/endocrinology clinic for obesity and an elevated BP reading at their general pediatrician's office. Population-based studies have also shown that non-Hispanic blacks have higher baseline systolic BP than their Hispanic and non-Hispanic white counterparts,[7,13] but this is one of the first analyses to examine intra-ethnic group differences. Our findings suggest that not all morbidly obese Hispanics and not all blacks are equal in terms of their risk for elevated BP. Moreover, our findings suggest that subgroups of major ethnic groups who are extremely overweight may be at an elevated risk for cardiovascular disease compared with their Mexican and non-Hispanic black counterparts.

There are very few studies that have examined the etiology of morbid obesity in immigrant children and adolescents, and obesity-prone behaviors and environments in particular. Adult studies have reported less favorable dietary patterns among various ethnic groups born in the United States compared with those who were foreign-born.[32–34] Specifically, previous studies among Mexican adults have shown that those who speak English (a proxy

for acculturation to the United States) ate less fresh produce and whole grains and more fat than Mexican American adults who were born in Mexico.[34] Similarly, another adult study found that Caribbean blacks living in New York City had more healthful diets than US-born blacks[35] as well as lower mortality from coronary heart disease, hypertension, and stroke.[36]

Of those pediatric studies that have examined ethnic differences in obesity-etiology, it has been reported that ethnic minority children and adolescents consume more daily fast food than their white counterparts[37] and are less likely to participate in organized physical activities in a given week.[38] Recent immigrant children and their families are also more likely to be faced with socioeconomic challenges, which are also a risk factor for obesity. Specifically, studies report that children who live in economically depressed communities are less likely to have access to fresh fruits and vegetables,[39,40] and food insecurity among low-income families is associated with increased risk of child obesity.[41,42] Furthermore, studies have shown that residents of impoverished, unsafe neighborhoods are less likely to be physically active and are two BMI units heavier than those living in safer neighborhoods.[38] Certainly, these are all issues that our clinic-based sample could potentially be faced with in Miami that may contribute to childhood-onset obesity. Due to our study design (cross-sectional), however, we are unable to make any causal inferences from the current analysis.

LIMITATIONS

The main limitation of this analysis was not having waist circumference data available from the clinical sample. However, because this study included only morbidly obese persons, it is likely that all had abnormal values. The adult definition of the MetS includes waist circumference instead of BMI because BMI is not always an accurate measure of obesity in pediatric populations. Moreover, several studies report that BMI is an equally strong predictor (as waist circumference) of metabolic risk in children and adolescents.[42,43] Additionally, we did not have nutrition and physical activity data available from the Miami clinical sample to compare with the national sample. Finally, because both samples are cross-sectional, no causal inferences or statements about etiology can be made from the analysis conducted.

CONCLUSIONS

There are concerns that childhood overweight will contribute to an earlier onset of overall morbidity and mortality in adulthood, making early intervention of crucial importance.[1–3] Because cardiometabolic risk factors are relatively stable characteristics that tend to track from childhood into adulthood,[9,10] the identification of children and adolescents with components of the MetS is of great interest from both clinical and public health standpoints. Our results indicate that morbidly obese adolescents from both major ethnic group categories as well as subgroups of these categories show health-related comorbidities regardless of where they are seen (ie, in a clinic or population-based sample). Morbidly obese minority adolescents should be closely monitored for potential onset of cardiometabolic disease.

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