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A Prospective Study of Weight and Metabolic Syndrome in Young Hispanic Children

Anna Maria Patiño-Fernández, PhD, Alan M. Delamater, PhD, Lee Sanders, MD, MPH, Arturo Brito, MD, MPH, and Ronald Goldberg, MD

University of Miami Miller School of Medicine, Miami, FL USA 33136

Abstract

Objective—Examine weight in young Hispanic children over a two-year period; investigate the relationships among overweight, physical activity, caloric intake, and family history in the development of the metabolic syndrome (MS).

Methods—Forty-seven children (ages 5–8) from diverse Hispanic backgrounds recruited from elementary schools were evaluated. Laboratory analyses, anthropometric data, and measures of physical activity and caloric intake were included.

Results—The majority of the children were overweight at baseline (66%) and at follow-up (72%). Children who were overweight at baseline were more likely to exhibit MS at follow-up than were those who were not overweight at baseline.

Conclusions—Overweight appears to be an independent predictor of MS among Hispanic children.

Keywords

overweight; physical activity; caloric intake; children; metabolic syndrome

The rise in childhood overweight is a significant national health problem. Overweight in children has been defined as a body mass index (BMI) $\geq 95^{\text{th}}$ percentile and at-risk for overweight as a BMI $\geq 85^{\text{th}}$ percentile and $< 95^{\text{th}}$ percentile (Center for Disease Control [CDC], 2006). Ethnic minorities are particularly at risk. In 2000, the prevalence of overweight among children between the ages of 6 and 11 years was 19.5% among African American children and 23.7% among Mexican American children (Ogden, Flegal, Carroll, Johnson, & 2002). Additionally, from 1986 to 1998 overweight prevalence had increased by more than 120% among African Americans and Hispanics and by more than 50% among Caucasians (Strauss & Pollack, 2001). The economic burden of childhood overweight is also increasing, with overweight-associated annual hospital costs for youths rising from \$35 million during 1979–1981 to \$127 million from 1997 to 1999 (Wang & Dietz, 2002).

In adults, the clustering of four health risk factors, obesity, hyperinsulinemia, high blood pressure, and dyslipidemia, has been referred to as syndrome X, insulin resistance syndrome, and/or metabolic syndrome (Reaven, 1988). These risk factors manifest in childhood and have a major impact on the development of medical problems throughout the life course. Although the clustering of these risk factors is not well understood in children, children who are

overweight are more likely to have hyperlipidemia, elevated blood pressures, and elevated insulin levels (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003; Williams, Strobino, Bollella, & Brotanek, 2004). The need to explore the trajectory of the metabolic syndrome (MS) during childhood has become a priority because of evidence that hyperinsulinemia and insulin resistance are precursors to the development of type 2 diabetes (McCance, Pettit, Hanson, Jacobson, Bennett, & Knowler, 1994). A decrease in insulin sensitivity is one of the first manifestations of the MS in youth (Arslanian & Suprasongsin, 1996) and insulin levels in children are positively associated with levels of triglycerides, blood pressure, and body mass index, and negatively associated with high-density lipoprotein cholesterol (Batey et al., 1997).

Two child health behaviors believed to contribute to the development and maintenance of overweight are physical activity and dietary intake (Gordon-Larsen, Adair, & Popkin, 2002; Klesges, Klesges, Eck, & Shelton, 1997). These behaviors in childhood are independently associated with adult risk of obesity, MS, cardiovascular disease, and type 2 diabetes (Webber, Srinivasan, Wattigney, & Berenson, 1991).

Limitations of previous studies of childhood overweight and the MS are their cross-sectional nature and the lack of ethnic diversity among the children studied. Only three studies to date have included Hispanic children (Batey et al., 1997; Cook et al., 2003; Cruz, Weigensberg, Huang, Ball, Shaibi, & Goran, 2004), but few have investigated the roles of overweight and health behaviors in the development of medical risk factors in young children. This is unfortunate, given that ethnic minority children, particularly Hispanic children, have experienced the greatest burden of type 2 diabetes (Dabelea Pettitt, Jone, & Arslanian, 1999), overweight (Ogden et al., 2002), decreased physical activity (Wolf et al., 1993), and increased clustering of MS risk factors (Batey et al., 1997; Cruz et al., 2004). Furthermore, studies of Hispanic children have primarily included those of Mexican heritage, despite the fact that overweight is also increasing disproportionately among non-Mexican, Hispanic youth (Mirza, et al., 2004).

Findings from examinations with Mexican Americans cannot necessarily be generalized to all Hispanics. One reason for this is that unlike other Hispanics, Mexican-origin Hispanics have a long history in the United States due to shared borders between the two countries, such that Mexican Americans tend to have lived in the United States for many more generations than other Hispanic Americans (Umana-Taylor & Fine, 2001). Although ethnicity persists beyond generations and pertains to cultural traditions and norms, Mexican Americans may be more “Westernized” than Hispanics from other Latin American countries. The elements considered possible risk factors for diabetes in a westernized environment include increased consumption of calories, fat, and refined sugars, decreased consumption of carbohydrates and fiber, and decreased physical activity (Stern, 1991). Studies of populations that have migrated from a traditional to a more modern or westernized environment have revealed that a “Westernized” lifestyle is associated with increased frequency of type 2 diabetes (see Stern et al., 1992).

These gaps in our understanding underscore the need to prospectively examine the interrelationships among weight, physical activity, caloric intake, and MS risk factors for diverse Hispanic children from various Latin-American countries. The direction of the relationship between weight and MS has not yet been studied in young Hispanic children; therefore, our overall goals were to promote a greater understanding of the development of MS and to increase knowledge regarding the factors placing school-aged Hispanic youth at risk for future illness. First we hypothesized that body mass index (BMI) would predict the MS and MS risk factors at 2-year follow-up. Second, we predicted that both caloric intake and physical activity at baseline would be related to BMI at baseline and the MS at follow-up. Finally, we hypothesized that family history of health risks would moderate these relationships.

Methods

Sampling Procedure at Baseline

Following Institutional Review Board approval, self identified Hispanic families with children in kindergarten through the third grade (aged 5 to 9 years) in three Miami-Dade County elementary schools were invited to participate. Letters were sent home with children inviting them and their parents to participate in The Hispanic Child Health Project, described as a program evaluating children's weight and "children's risk of developing later health problems, such as diabetes..." Families were telephoned until 120 families agreed to participate. Exclusion criteria were that only one child per family could participate and the child could not have a pre-existing medical condition (i.e. diabetes) that would affect the variables of interest.

Baseline Procedure

Interested families were contacted by telephone and informed that, if they chose to participate, their child would receive a free medical examination and a blood draw at their elementary school by a physician and nurse and that an identical follow-up evaluation would be conducted in approximately two years. Parents were instructed that their child must be in a fasting state the morning of the study. Once informed consent and assent were obtained, the child received a physical examination and had blood drawn. Trained bilingual (English and Spanish language) graduate students assisted the family in the completion of the questionnaires, which were made available in Spanish and English. Demographic information and physical activity recall were obtained during an interview with the parent and child. The family received a \$20 gift card for their participation. There is complete data on 112 families, due to children with needle phobia and incomplete questionnaires.

Follow-up Procedure

Approximately two years after initial participation, families were scheduled for a follow-up medical examination and fasting blood glucose analysis. Families provided updated information regarding medical history and were asked to complete the same two measures of physical activity and dietary intake and received a \$20 gift card for their participation.

Participants

Of the 112 families who participated at baseline, only 47 participated at the time of follow-up. Reasons for nonparticipation at follow-up are: changes in the residence and unavailable contact information ($n = 37$), families no longer interested ($n = 20$), and scheduling difficulties ($n = 8$). Examination of differences at baseline between children who participated at follow-up and those who did not revealed no significant differences on the variables of interest (demographic variables, total PA, familial history of health risk, z BMI, total kilocalories consumed, and metabolic outcomes).

At follow-up, children were between 7.5 and 12.5 years of age ($M = 9.9$ years). The sample was comprised of children (46.8% girls, $N = 22$) born primarily in the United States (72.3%), Nicaragua (10.6%), and Colombia (6.4%). Although 93% of the parents immigrated to the United States from a Latin American country, the majority of the families (53.2%) spoke both English and Spanish. More than half of the sample reported a family history of diabetes (55.3%) and cardiovascular disease (54.3%). Because maternal education was slightly higher and more complete than paternal education, mother's highest grade served as a proxy for socioeconomic status (SES). No site and/or SES differences were noted, indicating a relatively homogenous sample with regard to neighborhood and SES.

Measures

Physical Activity—*Seven Day Physical Activity Recall* (Sallis, Haskell, & Wood, 1985) is a 9-item interview that inquires about the child's sleep habits and level of physical activity (PA) in the past 7 days. Hours spent in various activities are grouped based on their energy requirements to determine level of PA. The Seven-day Physical Activity Recall has been found to have adequate test-retest reliability ($r = .77$) and validity ($r = .53$; Sallis, Buono, Roby, Micale, & Nelson, 1993). This measure has also been validated with behavioral observation of children, and indicates 97.5% accuracy in recall of PA (Wallace McKenzie, & Nader, 1985). For purposes of the present study, children's level of physical activity was analyzed by calculating total kilocalories of energy expenditure per day and per kilogram of body weight (KKDAY), as recommended (Sallis et al., 1985).

Caloric Intake—*The Harvard-Willett Food Frequency Questionnaire (FFQ)* (Willett et al., 1985) is a self administered, paper and pencil questionnaire, filled out by the parent, with the help of the child. This questionnaire measures the frequency of consumption (nine possible responses, ranging from never to six or more times a day) of an extensive list of foods over the past three months. Given that the sample was Hispanic, various ethnic foods were added to the questionnaire in order to obtain a representative sample of food consumed by the children. The FFQ estimates the intake of 62 nutrients based on 116 different foods and their serving sizes. The FFQ has been validated in previous studies (Willett et al., 1985), correlating with one-week diet records over three-month intervals (r ranges between .45 and .70). Based on the available literature regarding the relationship between nutrient intake and overweight, insulin levels, high blood pressure, and elevated cholesterol, nutrient intake scores for kilocalories (kcal) consumed (i.e. caloric intake) was used in the analyses.

Physical Examination—Physical examination, conducted by a physician, included measurement of child's height with a tape measure (to the nearest 0.1cm), weight with the Tanita TBF-551 Body Fat Monitor/Scale (to the nearest 0.1kg), and pubertal development assessment according to the criteria of Tanner (1981). Additionally, parents reported family history of type 2 diabetes and/or cardiovascular disease, with either considered indicative of family health risk for the child.

Anthropometrics—Standardized percentile curves of children's body mass index (BMI), from the Centers for Disease Control and Prevention Growth Charts (CDC, 2000), were used to determine at-risk for overweight and overweight status. BMI scores were z transformed based on age and gender norms provided by the CDC. For later analysis, all children $\geq 85\%$ ile were categorized as "overweight" due to a small number ($n = 5$) of at-risk for overweight children.

Blood pressure (BP)—After approximately a ten-minute rest period, resting blood pressure (BP) was measured from the right arm with the child sitting, by means of the Dinamap model 9300 automatic blood pressure measuring instrument. After selecting the appropriate cuff, three consecutive measurements of systolic and diastolic BP were taken at 1-minute intervals. The mean of the second and third systolic pressure readings were used as the measure of BP. High systolic blood pressure (SBP) was determined by the guidelines set forth by the National High Blood Pressure Education Program (1996) in which BP percentiles are based on height, sex, and age. According to the report, and for purposes of the current study, high SBP was defined as a child's systolic blood pressure $> 90^{\text{th}}$ percentile.

Metabolic risk—Blood samples were drawn for plasma glucose, insulin, triglyceride, and HDL-C levels after a 12-hour fast. All laboratory analyses were conducted at the Clinical Chemical Laboratories at the Diabetes Research Institute.

Distributions from the Lipid Research Clinic Prevalence study (1992) were used to determine elevated serum lipid levels. High triglyceride level was determined by the cutoff values for the 90th percentile for age and sex, whereas a low level of HDL-C was determined by the cutoff values for the 10th percentile for age and sex. The Expert Committee on the diagnosis and classification of diabetes mellitus (2003) has provided guidelines to classify individuals whose glucose levels are higher than normal (impaired fasting glucose; IFG), but do not meet criteria for diabetes. This group of individuals with IFG has fasting plasma glucose (FPG) levels ≥ 100 mg/dl but < 126 mg/dl. Insulin sensitivity was estimated using the Homeostasis Model Assessment (HOMA). HOMA, a simple, inexpensive, and valid method of assessment of insulin sensitivity, has been proposed as an alternative to the glucose clamp technique, which is considered the reference method for an accurate assessment of insulin resistance (Bonora et al., 2000). HOMA yields an estimate of insulin sensitivity based on FPG and insulin concentrations ($[\mu\text{U/ml} \times \text{mmol/l}] / 22.5$). No established guidelines for elevated HOMA scores exist; therefore, the cutoff for a high score was based on the distribution of the sample. A HOMA score was considered elevated if it exceeded the 50th percentile of the levels for the present sample, corresponding to a HOMA score of 2.46. Previous studies with nondiabetic adults have reported HOMA mean scores of 2.06 (SD = .14), placing the mean HOMA scores of the present sample at two standard deviations above the mean previously reported in the Bonora et al. study (2000).

Definition of the Metabolic Syndrome—The metabolic syndrome (MS) in adults has been defined in the literature by various organizations, including the National Cholesterol Education Program Expert Panel (2001), although a standard definition does not exist in either the adult or child literature. Recently, these definitions have been modified for the examination of the MS in children (Cook et al., 2000; Cruz et al., 2004). For purposes of the present study, MS is defined as previously set forth by Cruz and colleagues (2004) and includes the presence of at least three of the following abnormalities: overweight, hypertension, hypertriglyceridemia, low HDL cholesterol, and impaired glucose tolerance. Given that body proportions change during development and the longitudinal nature of this study, we defined overweight on the basis of BMI rather than waist circumference.

Overview of Statistical Analyses

Various outcome variables were created to reflect the objectives previously set forth. The metabolic syndrome (MS) factors and HOMA scores were categorized as below or above established clinical guidelines. BMI, HDL-C, triglycerides, IFG, and SBP were evaluated to determine if they exceeded clinical guidelines. If children had three or more MS risk factors exceeding clinical guidelines, they were categorized as positive for the MS.

Chi-square analyses and Student's t-tests were examined to determine whether differences existed at baseline between children who participated at follow-up and those who did not. Point biserial correlations were conducted to examine if maternal education, child age, and Tanner Stage were associated with the MS risk factors and the MS. Pearson product moment correlations were conducted to examine a) the association between maternal education, child age, Tanner Stage, physical activity, and caloric intake; b) the clustering of MS risk factors and their relationship to zBMI and HOMA scores; and c) the relationship between zBMI and PA and caloric intake. Chi-square analyses examined the distribution of gender among the MS factors. One-way analysis of variances (ANOVA) were conducted to examine relationships between PA and caloric intake (at baseline) and the MS, as well as mean differences on all the variables of interest between children with and without the MS. Logistic regression analyses, controlling for elapsed time and MS diagnosis at time 1, were conducted to establish predictive relationship between zBMI and the MS, the MS factors, and the role of family history of health

risk. All analyses were performed using SPSS version 13.0 (SPSS Inc., Chicago, IL) with an alpha set at $p < .05$.

Results

Descriptive Data

Maternal education was not associated with the variables of interest and no significant relationships were found between age and the variables of interest. With regard to gender, boys and girls were evenly distributed among the risk factor categories and no gender differences were noted for PA or caloric intake. Gender differences in Tanner Stage ($\chi^2(3) = 8.22, p = .042$) were noted at follow-up, with more males (70%) in Tanner I and more females (71%) in Tanner II. However, no relationship between the predictor or outcome variables and Tanner Stages were found. Those with and without MS at follow-up did not differ with respect to age, gender, or Tanner Stage.

Seventeen percent ($n = 8$) of the sample met criteria for the MS at baseline and at follow-up 19% ($n = 9$) of the sample met criteria for the MS (see Figure 1). All of these children also met criteria for overweight; thus, the MS was present in 26.5% of overweight children at follow-up. Table 1 demonstrates the mean values for the variables of interest by presence/absence of the MS. Descriptive statistics and the main features of the sample are presented in Table 2 and Figure 1. As shown in Table 2, the mean zBMI at baseline was substantially high (2.09, $SD = 2.21$) and increased slightly at follow-up to 2.11 ($SD = 1.68$). The majority of the sample was overweight at baseline ($n = 31, 66\%$) and there were more children overweight at follow-up ($n = 34, 72\%$). Notably, 93% of the children who were overweight at baseline remained so at follow-up. As shown in Figure 1, 46% of the sample ($n = 21$) had elevated triglycerides, 15% ($n = 7$) had a low HDL-C level, 2% ($n = 1$) had IFG and 28% ($n = 13$) had high SBP at baseline. At follow-up, more children had low HDL-C ($n = 8, 17\%$) and high SBP ($n = 16, 34\%$), while fewer children had high triglyceride levels ($n = 17, 36\%$) and IFG remained the same. In addition, 49% of the sample ($n = 22$) exhibited a high HOMA score at baseline and 51% ($n = 23$) had high HOMA scores at follow up.

Although a substantial portion of the sample reported not engaging in moderate to very hard levels of physical activity (15–36%), 32–54% reported participating in more than three hours/week of at least moderate physical activity (e.g., brisk walking, mowing the lawn, calisthenics). The mean caloric intake was 3,576 kcal ($SD = 2252$ kcal) at baseline and 2,983 kcal ($SD = 1,623$ kcal) at follow-up. Due to outlier data (kilocalories $\sim 10,000$), one subject's dietary intake data was dropped from the analyses.

Analyses of Clinical Data

zBMI and the MS—The relationship between zBMI and the MS risk factors was of primary interest. zBMI at baseline was correlated with baseline SBP ($r = .34, p < .02$) levels, and follow up SBP ($r = .34, p < .02$). At baseline, zBMI was also related to baseline HOMA ($r = .41, p = .005$) and follow-up HOMA ($r = .60, p < .001$). In addition, zBMI at baseline was highly correlated with zBMI at follow-up ($r = .91, p < .001$).

Of interest was the clustering and tracking of the MS risk factors from baseline to follow-up (Table 3). The relationship between HOMA and these risk factors was also explored. At baseline, HDL-C was inversely correlated with triglycerides and overweight and SBP was positively correlated with overweight and fasting glucose. Additionally, HOMA was positively correlated to SBP and fasting glucose. At follow-up, HDL-C and triglycerides, as well as SBP and overweight continued to be significantly related. In addition, HOMA was positively correlated with HDL-C and overweight. In examining the tracking of factors, analyses

indicated a relation between baseline and follow-up HDL-C levels, triglyceride levels, SBP, and HOMA scores.

As expected, logistic regression analysis (controlling for elapsed time and the presence of the MS at baseline) revealed that z BMI was a strong predictor of MS at follow-up ($\beta = .86, p < .01$), and that with every one-unit increment in z BMI the odds ratio of exhibiting MS was 2.4 (95% CI: 1.21–4.63). Secondary analyses examined the individual MS risk factors at follow-up and HOMA scores as outcome variables. z BMI at baseline was found to significantly predict HOMA scores ($\beta = .73, p < .006$), with an OR = 2.1 (95% CI: 1.24–3.45). z BMI was also found to predict SBP ($\beta = .35, p < .03$), with an OR = 1.4 (95% CI: 1.04–1.94).

Physical Activity and Caloric Intake—Analyses revealed no relationship between baseline and follow-up PA ($r = .08, p < .59$) and no significant relationships with PA and z BMI at baseline ($r = -.22, p < .14$) or follow-up ($r = -.15, p < .32$). Additionally, no significant differences were found in total PA at baseline or follow-up between those with and without the MS at follow-up ($F = .04, p < .83$; $F = .60, p < .44$). Caloric intake at baseline and follow-up were not related ($r = .01, p < .99$); nor was caloric intake and z BMI at baseline ($r = -.22, p < .13$) or follow-up ($r = .14, p < .34$). Additionally, analyses conducted to investigate if caloric intake differed for those classified as exhibiting or not exhibiting MS at follow-up revealed no significant mean differences in caloric intake at baseline ($F = .271, p = .605$) and follow-up ($F = .495, p = .485$).

Family History—Family history was expected to moderate the relationship between z BMI at baseline and the presence of the MS at follow-up. Logistic regression revealed family history did not serve as a moderator (Interaction: $\beta = -.62; p < .40$).

Discussion

This study extends previous work by addressing several research questions through prospective data analyses. This two-year longitudinal study addressed the inter-relationships among weight status, physical activity, diet, and the MS risk factors in school-aged Hispanic children. In addition, we assessed the moderating influence of family history of health risk on these relationships. Several important findings emerged.

Metabolic Syndrome

At baseline, 17% of the children met criteria for the MS and at follow-up 19% met criteria. Few studies have clearly defined the MS and examined MS risk factor clustering in children. Those studies that have, report the prevalence of MS in overweight white, black, and Mexican American children as 28.7% (Cook et al., 2000) and 30% (Young-Hyman, Schlundt, Herman, DeLuca, & Counts, 2001), which is similar, albeit greater, to our finding of the presence of MS in 26.5% of overweight Hispanic youth.

In the present study, cross sectional analyses revealed clustering of the MS variables, consistent with previous studies (Young-Hyman et al., 2001). Furthermore, strong correlations were found among the MS risk factors and HOMA scores, both at baseline and follow-up. At baseline, the factors most important in distinguishing children with and without the MS were SBP, HDL-C and z BMI. At follow-up, all of the MS risk factors, except fasting glucose, and HOMA score were significantly different for the children with and without MS. These findings support the concept that the MS risk factors cluster together and track across time, even in young children.

Also consistent with previous studies was our finding that HDL-C and HOMA scores were the two most robustly clustered MS risk factors. Notably, the mean HOMA scores in our sample

were two standard deviations above that from a national sample of adults (Bonora et al., 2000). These two factors appeared to cluster together across time in certain individuals. Previous investigations have also shown tracking of triglycerides and HDL-C over a three-year (Freedman, Shear, Srinivasan, Webber, & Berenson, 1985) and twelve-year (Weber et al., 1991) period. Given the relationship between HOMA scores and the MS risk factors, the significant difference of HOMA scores between those children with and without MS, and the fact that IFG was only associated with SBP and did not differentiate between the two groups of children, it seems worthwhile to include HOMA scores in future research investigating the MS factors in children.

Weight Status

Most children in the sample were overweight at baseline (66%) and at follow-up (72%). The association between overweight and MS risk factors has been documented in Mexican American, Caucasian, and African American samples (Batey et al., 1997; Morrison, Barton, Biro, Daniels, & Sprecher, 1999; Young-Hyman et al., 2001). In our study of Hispanic children, z BMI at baseline was correlated with MS risk factors at baseline and independently predicted MS risk factors at follow-up. These findings suggest that overweight is a predictive risk factor for the other MS factors among Hispanic children, with increasing weight placing children at greater risk for the MS. Similarly, z BMI predicted elevated HOMA scores and high SBP. Taken together, these relationships lend support to the notion that the origin of the MS is obesity, which also links the different dimensions of the syndrome (Maison, Byrne, Hales, Day, & Wareham, 2001).

Physical Activity (PA)

A negative relationship between PA and BMI is documented in the literature (Hernandez et al., 1999). Contrary to study hypothesis, no relationships emerged between PA and either overweight or the presence of the MS. However, the fact that one-fifth to one-third of the present sample reported not engaging in at least moderate levels of physical activity may help explain why these associations were not evident. Another factor that may explain this “non-finding” is the mean age of the children in the sample (7.7 yrs. at baseline, 9.9 yrs. at follow-up), which was considerably lower than the mean age of children in studies where PA (also assessed via self report) is reportedly related to BMI (e.g., mean age 12.4 years; Hernandez et al., 1999).

Another explanation for our discrepant findings includes possible inadequate sensitivity of the measurement tool, since PA was assessed via self and parent report and not through more objective means. Although the present study did not find the expected relationships, further study with larger samples may find low levels of PA are associated with high BMI and/or adverse health outcomes in young Hispanics.

Caloric Intake

The mean kilocalories reportedly consumed by the children in the present sample was alarmingly high at baseline and follow-up, compared to the US Department of Agriculture (2000) recommendations that children between 2 and 6 years of age consume approximately 1600 calories and children over 6 years of age consume approximately 2200 calories. Nevertheless, we found no significant relationship between caloric intake at baseline and either overweight or the MS at follow-up. However, the frequency of overweight and the unusually high caloric intake of most children in this study may have obscured such relationships. The literature regarding the relationship between adiposity and dietary intake is mixed. For example, in a study of 9–14 year olds, a rise in caloric intake was associated with increases in BMI (Berkey et al., 2000), whereas, a study of 7–12 year old children revealed no clear relationship between BMI and fat or carbohydrate intake (Rolland-Cachera & Bellisle, 1986),

but did find that energy intake and overweight were greater in the lower socioeconomic groups, such as those represented in this study.

Family History

Among the nine children in our sample with findings indicating MS at follow-up, seven had a family history of health problems. Nonetheless, family history was not found to be a statistically significant moderating factor in any of the multivariate models tested. The fact that family history was not associated with zBMI and/or MS was especially surprising; however, the small sample size most likely contributed to these nonsignificant findings.

These findings are subject to several limitations. A lack of significant associations may be attributable to the small sample size, resulting from the inability to include more of the families from baseline. We also failed to measure several important confounding factors, including parents' weight status and child sedentary behavior, which have been shown in previous studies to contribute to adverse health outcomes. A potential limitation was the use of maternal education as a proxy for SES. Given the benefits of the study to participants (free medical evaluation and analysis of health risk factors), it is possible that selection bias existed, which would limit the generalizability of our findings. Although the self-report measures utilized in this study have been used in the past with adequate reliability and validity, their use is often subject to response and recall biases. A final limitation may have been the definition of MS used in this study. Although no consensus exists in the literature for defining pediatric MS, it is possible that other combinations of risk factors may have yielded different results.

Implications for Practice

This investigation extends previous work with its prospective study of modifiable behavioral and metabolic risk factors for health risks associated with overweight among a high-risk group of low-income, young Hispanic children. Our findings suggest that, among a diverse group of Hispanic youth, weight status is an important independent predictor of the development of metabolic risk factors over a two-year period. Our findings support current clinical guidelines recommending that weight status should be closely monitored for all children, not just those suspected to be overweight. These findings support suggestions that modifying weight status early in childhood may help decrease risk for the development of type 2 diabetes and cardiovascular disease risk factors during childhood. Furthermore, the present findings highlight the need for interventions to begin at an early age, as adverse health outcomes are already present in school-age children, even before they enter puberty, a period of naturally increased insulin resistance.

Early screening to identify weight related health issues is particularly essential for young Hispanic children and identifying these risk factors could be useful in designing and implementing future prevention programs. Future studies examining the effectiveness of early screening are warranted. Future research may also identify the partnerships among primary care physicians, public school staff, pediatric psychologists and community-based organizations that can most effectively accomplish the early screening and behavior-management counseling necessary to reduce the disease burden of overweight for Hispanic youth. The implication for more aggressively treating younger children who are overweight, with both behavioral interventions and medical follow-up is evident from the findings. Teaching healthier behaviors to parents and children early on may be more effective than reversing already established unhealthy behaviors.

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Figure 1.
Percent of sample meeting criteria for MS risk factors at baseline and follow-up

Figure 2.
Number of MS risk factors at baseline and follow-up

Table 1

Means (SD) for the MS risk factors, PA and caloric intake by presence/absence of the MS at follow-up

Variable	No metabolic syndrome (n=38)	Metabolic syndrome (n=9)
SBP baseline **	102.6 (9.8)	115.7 (12.0)
SBP follow-up *	108.4 (9.7)	118.0 (11.7)
Triglyceride baseline	87.4 (29.2)	140.6 (74.3)
Triglyceride follow-up **	82.0 (28.2)	124.2 (42.8)
HDL-C baseline *	64.5 (16.6)	50.3 (17.5)
HDL – C follow up **	53.1 (10.4)	42.0 (10.3)
Fasting glucose baseline (mg/dl)	80.2 (8.3)	87.1 (14.5)
Fasting glucose follow-up (mg/dl)	83.6 (9.8)	85.4 (9.8)
zBMI baseline **	1.6 (1.9)	4.3 (2.1)
zBMI follow-up **	1.7 (1.5)	3.7 (1.4)
HOMA baseline	3.0 (2.8)	7.3 (7.6)
HOMA follow-up *	2.8 (2.0)	4.3 (2.2)
PA baseline (kcal)	319.2 (197.6)	334.9 (327.6)
PA follow-up (kcal)	347.9 (272.2)	422.1 (176.6)
Calories baseline (kcal)	3695.3 (2465.0)	3101.2 (998.8)
Calories follow-up (kcal)	2921.1 (1369.6)	3237.6 (2506.1)

Significant difference between the two groups

*
p< .05;**
p< .01

Kkcal = kilocalories per kilogram per day

Table 2

Descriptive Characteristics of the Sample (N = 47)

	Mean (SD)	
	Baseline	Follow-up
Age (yrs)	7.69 (1.23)	9.87 (1.20)
zBMI	2.09 (2.21)	2.11 (1.68)
Time Elapsed to follow-up (months)		24.77 (9.89)
Mother's Highest Grade	12.39 (3.29)	
Father's Highest Grade	11.71 (4.74)	
Dietary Intake: Total calories (kcal)	3576.43 (2252.2)	2983.01 (1622.76)
Physical Activity Recall (KKDAY)	369.35 (298.73)	362.12 (256.67)
	Frequency	Percentage
Mother's Country of Origin ^a		
Nicaragua	15	32.6
Cuba	7	15.2
Colombia	5	10.9
Peru	3	6.5
Honduras	3	6.5
United States	3	6.5
Mexico	2	4.3

^a Other countries represented (n = 1, 2.1%): Panamá, Venezuela, Ecuador, Argentina, Guatemala, El Salvador, and Uruguay.

Table 3
Pearson product moment correlation coefficients for MS risk factors at baseline and follow-up

MS risk factors	1	2	3	4	5	6	7	8	9	10	11	12
1. HOMA baseline		.36*	.41**	.24	.06	.12	.04	.12	.48***	.46***	.58**	-.05
2. HOMA follow-up			-.03	.24	.12	.25	-.32*	-.37*	.60***	.53***	.15	.18
3. SBP baseline				.33*	.10	.03	-.07	.06	.65***	.64***	.43**	.02
4. SBP follow-up					.09	.03	.06	.10	.49***	.51***	.13	-.02
5. Triglyceride baseline						.50**	-.34*	-.37*	.13	.09	-.11	-.01
6. Triglyceride follow-up							-.38*	-.45**	.25	.27	.10	.03
7. HDL-C baseline								.68***	-.29*	-.26	-.13	.20
8. HDL-C follow-up									-.30*	-.33*	.04	.06
9. zBMI baseline										.91***	.37*	.04
10. zBMI follow-up											.36*	.04
11. Fasting Glucose baseline												.09
12. Fasting Glucose follow-up												

* p < .05,

** p ≤ .01,

*** p ≤ .001