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Intergenerational Educational Attainment and Cardiometabolic Health in Latinos Living in the United States

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Abstract

Objective: Estimate the association between cycles of poverty, measured by intergenerational educational attainment (IEA), and the burden of obesity and metabolic dysfunction among Hispanics/Latinos in the United States.

Methods: This is a cross-sectional study utilizing data from 392 adults linked to 286 biologic parents from the Niños Lifestyle and Diabetes Study and Sacramento Area Latino Study on Aging. We dichotomized educational attainment of parents and offspring to categorize IEA. Outcomes included obesity and metabolic syndrome (MetS). We used model-based standardization with population weights to compare obesity and MetS across generations, and Poisson regression to estimate prevalence ratios by IEA.

Results: We observed a higher prevalence of obesity and MetS in offspring, 54% and 69%, compared to their parents, 48% and 42%. Compared to stable-low IEA, any category with high offspring education was associated with lower obesity and MetS prevalence. The upwardly mobile group saw the greatest benefit; they were 38% (95% CI: 10%, 57%) and 46% (95% CI: 21%, 63%) less likely to have obesity or MetS.

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Conclusions: IEA strongly patterns cardiometabolic health among Hispanics/Latinos living in the US, suggesting that promotion of higher education is associated with reductions in obesity and MetS, potentially benefitting future generations of this population.

Keywords

Metabolic Syndrome; Obesity; Education; Epidemiology; Hispanics

Introduction

The obesity epidemic continues to be a top public health priority for the United States, particularly among the adult Hispanic/Latino population, of whom 44.8% were classified as obese in 2017–2018, compared to 42.4% of total adult US population (1). The disproportionately high burden of obesity and metabolic dysregulation confers excess morbidity and mortality. Between 1999 and 2015, Hispanics/Latinos experienced an excess 9.9 deaths per 100,000 people due to type 2 diabetes relative to non-Hispanic or Latino whites and have one of the highest rates of metabolic syndrome (MetS) of any ethnic group in the US (2–7). Obesity, particularly abdominal obesity, has been shown to have a multifaceted effect on cardiovascular and metabolic health by promoting insulin resistance, inflammation, and atherosclerosis (8). The International Diabetes Federation (IDF) has defined metabolic syndrome (MetS) as a constellation of cardiovascular disease (CVD) risk factors, which can be seen as an additional level of metabolic disturbance beyond obesity alone. Individuals with MetS have been found to be at twice the risk of CVD and 5 times the risk of type 2 diabetes than their metabolically healthy peers (9,10). MetS has also been found to be predictive of mortality in normal-weight individuals, underlining the importance of looking at both obesity and MetS (11).

In addition to having a higher risk of metabolic dysregulation compared to the US as a whole, there are a disproportionately high number of Hispanics/Latinos living below the poverty line in the US, 19.4% compared to 8.8% of non-Hispanic whites in 2016 according to the US Census Bureau. There is a well-established association between low socioeconomic status (SES) and poor cardiometabolic health (10,12–28), and a number of studies have illuminated the relationship between cycles of intergenerational low educational attainment and cardiometabolic outcomes, many of which demonstrate worsening of obesity prevalence across generations (13,14,18,26–31). However, the relationship between intergenerational socioeconomic mobility and the burden of obesity and MetS has not been clearly demonstrated for Hispanic/Latino communities (15,17,25), and there may be a stronger association for women, though few studies have examined this in a Hispanic/Latino population (13,15,16,19,26,28). While SES is often measured by income, educational attainment is a more stable measure of SES across the life course, particularly for young adults and retirees, and is often a more effective marker in immigrant populations, whose earning potential may be limited in their new country due to language barriers and lack of recognition for training or degrees earned in their home country (32,34). Education is also associated with health behaviors, such as smoking and access to healthy foods, as well as access to preventative medical care and health literacy (34,35). By examining SES during childhood, through the parents' SES, and in adulthood, we are able to see a fuller picture of SES across the life course.

This study uses data from the community-based Sacramento Area Latino Study on Aging (SALSA) and the Niños Lifestyle and Diabetes Study (NLDS) of their adult offspring. Together, these studies represent two generations of Sacramento Area Hispanic/Latino families (parents and adult biologic offspring) of predominantly Mexican origin, allowing us to assess IEA and its effect on obesity and MetS. Given the gaps of research in IEA and cardiometabolic health among Hispanics/Latinos, this study is the first to our knowledge to both examine the relationship between IEA and obesity and MetS in a contemporary Hispanic/Latino population and to compare the age- and gender-standardized prevalence of these outcomes across generations to assess changes in the public health burden of obesity and MetS over time in this high-risk population. Additionally, we investigate the estimated association between IEA and continuous measures of specific subcomponents of MetS, and examine the evidence for gender-specific associations of IEA with cardiometabolic health in this population.

Methods

Study Population

SALSA, a longitudinal community-representative cohort study of 1,789 older Latinos (aged 60+ in 1998), the majority of whom are of Mexican-origin, and NLDS, an assessment of their biologic children living in the Sacramento area (aged 18+ in 2013), are cohorts which have been described elsewhere (33,36). Both cohorts included at-home anthropometric measurements (height (nearest quarter inch), weight (nearest 0.2 pounds), waist circumference (nearest quarter inch), blood pressure), fasting blood tests (glucose and triglycerides) and a medication inventory. Of the 670 NLDS participants who completed a baseline phone interview, 410 completed the additional in-home examination for anthropometric measurements. Of these participants, 392 could be linked to a biologic parent in either SALSA or NLDS (n = 286 unique parents; n = 261 from SALSA and n = 17 from NLDS) and had information available on both generations' educational attainment as well as the adult offspring's height, weight, age, and gender, collected at study baseline, 1998 for SALSA and 2013 for NLDS. Therefore, this cross-sectional study represents parent-offspring dyads of predominantly Mexican origin.

Measures

Cardiometabolic Outcomes—Our cardiometabolic outcomes of interest were obesity, defined as having a body mass index (BMI) greater than 30 kg/m^2, and MetS. We used the definition of MetS created by the IDF, which considers individuals to have MetS if they have abdominal obesity (waist circumference (WC) ≥ 94 cm for males or ≥ 80 cm for females) and at least two additional cardiometabolic disturbances (triglycerides ≥ 150 mg/dl, high density lipoprotein (HDL) cholesterol < 40 mg/dl for males and < 50 mg/dl for females, high blood pressure measured by either systolic blood pressure (SBP) ≥ 130 mm Hg or diastolic blood pressure (DBP) ≥ 85 mm Hg, and fasting plasma glucose (FG) ≥ 100 mg/dl). If an individual was taking antihypertensive, antidyslipidemic, or antidiabetic medications, those factors were considered elevated. Using this definition, MetS can be seen as a further disruption to cardiometabolic health than obesity alone. Cardiometabolic health measures were reported as continuous measures and dichotomized for the purpose of defining MetS. The method of measuring WC in SALSA and NLDS has been described previously (25). Information on 16 participants' waist circumferences was unavailable, so obesity defined by BMI was substituted for central obesity per IDF recommendation.

Intergenerational Educational Mobility—Our exposure of interest was IEA, a measure of socioeconomic mobility across generations and a robust measure of SES in studies such as this, which include a wide range of participant ages and immigration statuses (32). Educational attainment was classified as being high or low based on nativity status, country of birth, for SALSA and NLDS separately to account for nativity and study cohort-related differences in the distributions of educational attainment. This also allowed us to better describe individuals' educational attainment compared to their study cohort and nativity-specific peers (37).

The study-specific median of each distribution was used as the threshold value for high/low classifications. SALSA participants' educational attainment was considered "high" if they had at least 4 years of formal education and were foreign-born (some primary education), or at least 10 years if they were US-born (some high school education). NLDS participants' educational attainment was considered "high" if they had at least 12 years of education if they were foreign-born (completed high school education), and at least 14 years if they were US-born (some higher education). For individuals with educational data for both parents, the parent with the highest educational attainment was used to determine IEA. Using these two generations of linked educational attainment data, adult offspring were classified as having a stable-high IEA (high parental and adult offspring educational attainment), upwardly mobile (low parental and high adult offspring educational attainment), downwardly mobile (high parental and low adult offspring educational attainment), or stable-low (low parental and adult offspring educational attainment, the referent category).

Location of Education—An individual's location of education was determined by previous work to be an important covariate in this population and a potential confounder (36), as it corresponds closely with nativity and time spent in the US and could influence both IEA and the health of the adult offspring in our sample. Though correlated with IEA and nativity, it is also an important marker of an individual's geographically distinct exposures and behaviors acquired during their youth, which may not be fully described by nativity or other proxy measures of acculturation, especially if an individual immigrated at a young age. Location of education for both generations was determined based on the individual's nativity and age at immigration to the US, if applicable. If a participant received some of their education outside of the US, they were considered foreign-educated for the purposes of this analysis.

Age and Sex—Age and gender were determined *a priori* to be potential confounders based on the literature (7,8,13,14,16,22,23,30,31,38) and previous work with these studies (25), as metabolic disturbances tend to develop with age and in a sex-dependent manner (6,16,30).

Statistical Analyses

The distributions of demographic factors, IEA exposures, and outcome measures were summarized with descriptive analyses. We used a model-based age- and gender-standardization to compare the prevalence of obesity and MetS between the two cohorts (39). Age and gender population weights were obtained from the 2010 U.S. Census of Sacramento County. We restricted our sample to individuals aged 60–80 years at the time of measurement for this portion of the analysis, as this was the age range with the greatest overlap between the SALSA and NLDS, covering 52% of the parents and adult offspring.

Prevalence ratios (PR) and 95% confidence intervals (CIs) for the outcomes of interest across IEA categories were estimated for the adult offspring using a robust Poisson general estimating equation to account for clustering of adult offspring within families (40). Two regression models were created: Model 1 adjusted for gender, age, and age^2; Model 2 adjusted additionally for the adult offspring and parent's location of education. Due to missing location of education for 13 participants, the sample sizes for these analyses differ from Model 1. We later stratified by gender to assess possible effect measure modification and, as a sensitivity analysis, examined the models with an interaction term between gender and IEA.

As an exploratory analysis, we modeled the relationship between IEA and the continuous measures of the subcomponents of MetS by conducting a series of general estimating equations after transforming each subcomponent to the natural log scale. The first model adjusted for age and gender, the second adjusted additionally for location of education for parents and the adult offspring. The regression estimates were used to calculate the percent change of the subcomponent for each IEA category as compared to the stable-low referent, allowing for ease of comparison of IEA effects across the subcomponents' various units of measure.

All statistical analyses were done in SAS 9.4 (SAS Institute, Inc., Cary, NC). This study was approved by the University of North Carolina at Chapel Hill Institutional Review Board, and informed consent was given by each participant.

Results

Characteristics of the Study Population

Table 1 describes the baseline characteristics of the study population. The parents had an average age of 68.9 ± 7.8 years, and 63.6% were female, while the average age of the adult offspring was 53.1 ± 11.8 years and 63% were female. Seventy-six percent of the adult offspring were US-born and 20.9% were born in Mexico, compared to 53.5% and 41.6% for their parents, respectively. The adult offspring were more educated than their parents on average, as two-thirds of the adult offspring had more than a high school education or its equivalency, while only 24.1% of their parents did. Similarly, adult offspring whose parents were US-educated tended to be more educated than their peers whose parents were foreign-educated. More than 70% of the adult offspring of US-educated parents had some higher education, compared to 60% of their peers whose parents were foreign-educated (Table S1). Of the adult offspring, 26.8% had stable-high IEA, 16.6% had upwardly mobile

IEA, 27.8% had downwardly mobile IEA, and 28.8% had stable-low IEA (Table 1). The SALSA parents included in this sample were very similar to the entire SALSA sample (Table S2).

Obesity and MetS were related but not equivalent in both generations: 73.6% of the adult offspring who were classified as having MetS were also classified as having obesity, and 77.1% of the adult offspring with obesity were classified as having MetS (Table 1). However, adult offspring with greater metabolic disturbance (≥ 2 elevated subcomponents) were more likely to have abdominal obesity than elevated BMI (Table S2).

Standardized Prevalences of Obesity and MetS

After age- and gender-standardization (Table 2), there was a significantly higher burden of obesity and MetS among adult offspring 60 to 80 years old compared to the obesity and MetS burden of their parents in the same age range when assessed 15 years earlier. The standardized prevalence of obesity and MetS among the adult offspring were 54% (95% CI: 50, 58) and 69% (95% CI: 65, 72) respectively, compared to 42% (95% CI: 39, 44) and 48% (95% CI: 45, 51) for the parents. The standardized prevalence for obesity and MetS increased across generations of Hispanic/Latino adults in our sample, independent of age and gender differences.

The Association Between IEA and the Prevalence of Obesity and MetS

Results from Model 1, adjusting for age, age^2, and gender, show that, in comparison to the participants with a stable-low IEA, greater IEA was associated with a reduced prevalence of obesity and MetS (Table 3). Adult offspring who were upwardly mobile experienced the greatest benefit, having only 0.55 times the prevalence of MetS (95% CI: 0.38, 0.80) and 0.64 times the prevalence of obesity (95% CI: 0.44, 0.93). Stable-high participants also experienced a significant benefit with respect to obesity, having 0.74 times the prevalence of obesity compared to the stable-low group (95% CI: 0.55, 0.98). Prevalence ratios remained similar after adjusting additionally for the location of education of the parents and adult offspring.

Stratification by gender showed that there may be a stronger association between upward mobility and the prevalence of obesity and MetS for women than men, indicating possible effect measure modification of IEA by gender (Table 4). However, the estimates were imprecise and the 95% CIs for men and women overlapped. Women who were upwardly mobile experienced a significant benefit in obesity and MetS prevalence compared to their stable-low peers (Obesity PR = 0.56, 95% CI: 0.32–0.98; MetS PR = 0.48, 95% CI: 0.27–0.86). Despite the smaller sample size of male adult offspring, higher levels of education for men still seemed to be protective against obesity and MetS, although only upward mobility was significant in Model 1 on MetS (PR = 0.66, 95% CI: 0.44, 0.98). This finding was no longer statistically significant in the fully adjusted model. The relationship between greater education and cardiometabolic health was consistent when effect measure modification was examined with an interaction term between gender and IEA.

Quantitative Analysis of the Subcomponents of MetS

After observing the inverse association between greater IEA and MetS prevalence, we investigated the association between IEA and the individual continuous measures of the subcomponents of MetS (Table S4). The results from the fully adjusted model show that greater IEA tends to be associated with a better outcome for each subcomponent of MetS. Specifically, upward mobility had the strongest association with several subcomponents, significantly improving BMI, WC, SBP and DBP, and HDL cholesterol profiles by between 4.4% and 13.6% compared to adult offspring with stable-low IEA. FG and triglycerides were not significantly associated with IEA in the full sample, but they had a similar direction of effect as the other subcomponents. As observed with our modeling of obesity and MetS prevalence, effect sizes were generally stronger and more precise for women than men, though the 95% CIs for women and men did overlap. In both models, compared to the stable-low referent, the downwardly mobile category had worse outcomes for men and women in DBP, HDL cholesterol, and FG, though these results were not statistically significant.

Discussion

Our findings demonstrate that there is an increased burden of obesity and MetS for younger generations of Hispanic/Latino families living in the Sacramento area which is beyond what could be explained by differences in the distribution of age and gender at the time of their respective examinations. Additionally, our study supports the relevance of both personal and parental education on cardiometabolic health for Hispanic/Latino populations. In our sample, any greater level of educational attainment across generations was protective against obesity and MetS compared to the stable-low group, and upward mobility was particularly impactful. Participants who were upwardly mobile experienced 0.64 times the prevalence of obesity and 0.55 times the prevalence of MetS compared to the stable-low referent. This is consistent with the literature, as previous studies have also found that higher educational attainment is associated with a decreased risk of negative cardiometabolic outcomes, such as obesity and MetS (13,16,19,25,28). In a sensitivity analysis, these results were robust to adjusting for an indicator of birth cohort (defined by 15 year ranges), indicating that this relationship is consistent across birth cohorts for the adult offspring.

The observed intergenerational rise of cardiometabolic risk could be due to differences in early life exposures or birth cohort effects between parents and offspring. Indeed, a higher percentage of the adult offspring in our study were US-born or US-educated when compared to their parents, indicating that there may be geographically distinct exposures or behaviors acquired in early childhood that impact their lifestyles and cardiometabolic outcomes later in life, such as nutrition and exercise habits. Yet, behavioral factors alone likely do not account for this generational difference; previous studies have also implicated the importance of psychosocial factors experienced across the life course on the hypothalamic-pituitary-adrenal axis due to its response to stressors and associated cardiometabolic changes (41,42). Alternatively, this generational trend could also be reflective of rising rates of obesity in more contemporary populations overall, which is supported in the literature on the global obesity epidemic (43). Given the protective benefit the adult offspring's higher educational attainment should have conferred on their socioeconomic standing, health insurance rates, or health literacy compared to their parents (3,44,45), their higher burden of obesity and MetS warrants further scrutiny.

Among the adult offspring, the protective association between greater educational attainment and obesity and MetS compared to the stable-low referent suggests an accumulation of risk model for the effect of IEA on obesity and MetS for those with a stable-low IEA. This implies that there is an interaction between parental and personal educational attainment for the adult offspring which explains their risk of obesity and MetS beyond what either can explain alone, especially for individuals with intergenerational low educational attainment. However, the strength of associations of stable-high and upwardly mobile IEA as compared to the stable-low versus the weaker association seen for the downwardly mobile category suggests that the effect of IEA on the risk of obesity and MetS may also be impacted by a social mobility model of risk. Together, this provides evidence that exposures during both childhood and adulthood affect the development of obesity and cardiometabolic risk factors, though exposures during adulthood may be more proximate and impactful to cardiometabolic health than early life exposures. Though we did not see statistically significant differences between the associations of IEA for men and women, our findings support previous work indicating that there may be a differential effect of IEA by gender and that women may be more strongly affected by IEA (13,16,22,28).

Our study also adds to the literature a more nuanced look into the association between IEA and continuous measures of the individual subcomponents of MetS, and thus, the bio-social drivers of metabolic dysfunction in this population. The relatively large percent change in WC and HDL cholesterol when comparing the upwardly mobile IEA to the stable-low category indicates that the effect of education on abdominal obesity and dyslipidemia could be driving the differences we see with MetS. The 9.93% change in abdominal obesity for women and the 1.99% change for men correspond to a 9.69 cm and 2.11 cm reduction in WC compared to the mean WC for stable-low women and men, respectively. Similarly, the 13.36% change in HDL cholesterol for women and 4.67% change for men correspond to a 6.8 mg/dl and 2.0 mg/dl increase, respectively, in HDL cholesterol from the mean for stable-low for women and men. This could help clinicians prioritize interventions that target abdominal obesity and dyslipidemia as key drivers of MetS in this population because both are strongly related to the social determinants of MetS. That IEA has a stronger association with these subcomponents in women indicates a further need to understand the etiology of MetS for women and the importance of the potential differences from the etiology for men, suggesting differences in best practice for lifestyle interventions in women compared to men.

Our study should be interpreted with several limitations noted. First, not all of the participants consented to allow an in home exam. Secondly, the adult offspring have a wide range of ages, 18 to 84 years. Given that educational standards and educational expectations in the labor market have changed both in the US and abroad over time, the value of a higher education may have shifted. However, by adjusting for age and using thresholds to define educational attainment categories which were tied to each cohort's median years of education, we incorporated these societal trends in our models. Additionally, our results on the impact of IEA on obesity and MetS were robust to a sensitivity analysis that included 15-year birth cohorts. Lastly, as the findings are cross-sectional, temporality is impossible to confirm; however, these findings utilize data that follows a temporal sequence because the parent's educational attainment occurred before their offspring's.

Despite these limitations, the strengths of our study include the use of standardized prevalence estimates to compare the burden of obesity and MetS across generations, focus on a contemporary cohort of Hispanics/Latinos, use of stratification by gender to assess effect modification, and analysis of continuous measures of the subcomponents of MetS. MetS may confer greater risk for type 2 diabetes and other cardiometabolic conditions than an assessment of its individual subcomponents, including obesity; thus, examining the subcomponents of MetS quantitatively provides us a greater understanding of how each subcomponent is affected by IEA. Additionally, the use of location of education as a covariate rather than nativity was a strength in our analysis as it conferred information on both nativity and the exposures a participant would have experienced in their youth. For participants who migrated to the US at a very young age, their early life experiences would likely be more similar to someone who was born in the US than someone who was lived abroad until they had finished their education. Given that the origins of obesity and MetS may occur throughout the life course, these life course exposures are more informative than nativity alone. Furthermore, educational attainment is a widely-used, robust marker of SES, especially for studies of populations where income may not accurately reflect an individual's earning capacity or past SES (17,25,28,32). Finally, similar trends in the protective impact of education on WC, SBP, and FG have been found in this population in the context of CVD risk, but failed to include effect modification for gender or account for different distributions of educational attainment for parents and offspring of different nativities (21).

In conclusion, our study addresses a key gap in the literature on the burden of obesity and MetS across generations of Hispanics/Latinos, as well as the impact of IEA on these outcomes in a contemporary cohort. Our results indicate a need to further investigate the causes of worsening cardiometabolic health across generations in Hispanic/Latino populations and also motivate a multi-generational view of cardiometabolic health. Sustained investments in educational attainment could help to buffer Hispanic/Latino individuals from worsening cardiometabolic health due to changes in lifestyles or societal factors and to help to break cycles of poverty experienced by many Hispanic/Latino families in the US today.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Study Importance Questions

What is already known?

- Hispanic/Latino populations experience a disproportionate health burden due to obesity and metabolic dysregulation, such as type 2 diabetes and metabolic syndrome, compared to the rest of the United States.
- There is limited research on the importance of intergenerational educational attainment to cardiometabolic health for Hispanics/Latinos living in the United States.

What are the new findings in this manuscript?

- Younger generations of Hispanics/Latinos in the United States have a higher standardized prevalence of obesity and metabolic syndrome compared to their parents, and intergenerational educational attainment strongly patterns cardiometabolic health in this population.
- This study uses data from two generations of biologically related parent-offspring dyads in a population of predominantly Mexican origin, providing a clearer picture of the intergenerational influence of poverty in this population.

How might these results change the direction of research?

- This study highlights the importance of using intergenerational data and measures of socioeconomic status that are robust across the life course.

Table 1.

Descriptive Characteristics of Parents from SALSA and NLDS (N=286) and Their Non-Pregnant Adult Offspring in NLDS (N=392) with Metabolic Syndrome and Obesity Information

		Adult Offspring		Parents	
		N	Mean ± SD or %	N	Mean ± SD or %
Covariates	Age (years)	392	53.1±11.8	286	68.9±7.8
	Gender	392		286	
	Male		37.0		36.4
	Female		63.0		63.6
	Country of Birth	392		286	
	United States		76.3		53.5
	Mexico		20.9		41.6
	Other		2.8		4.9
	Location of Education	387		286	
	United States		80.4		59.6
	Both/uncertain		10.1		2.9
	Mexico		9.6		37.6
	Education by Nativity	387		286	
	US-Born				
	US Educated, Foreign Educated		100, 0		100, 0
	Foreign-Born				
	US Educated, Foreign Educated		13.6, 86.4		9.7, 90.3
Socioeconomic Position	Educational Attainment (years)	392		286	
	≤ 4		2.0		24.1
	5–10		9.7		34.6
	11–12		21.9		17.1
	13–14		28.8		12.2
	≥15		37.5		11.9
	Intergenerational Educational Mobility	392			
	Stable High		26.8		
	Upwardly Mobile		16.6		
	Downwardly Mobile		27.8		
	Stable Low		28.8		
Health Outcome	Metabolic Syndrome	392		271	
	MetS *		51.3		48.0
	Abdominal Obesity and 0–1 Elevated Subcomponents †		32.1		31.7
	Not Abdominally Obese		16.6		20.3

	Adult Offspring		Parents	
	N	**Mean ± SD or %**	**N**	**Mean ± SD or %**
Obesity (BMI ≥ 30)	392		245	
Obese		51.8		43.8
Not Obese		48.2		56.2
Elevated Subcomponents[†]	392		286	
Low HDL-Cholesterol	366	58.5	265	46.8
High Blood Pressure	390	57.2	271	67.2
High Fasting Plasma Glucose	352	44.6	267	50.2
High Triglycerides	354	36.2	264	50.0
MetS and Obesity	371		242	
Of Those with MetS, % Obese		73.6		48.3
Of Those Obese, % with MetS		77.1		54.5

[*] MetS defined by the IDF as having abdominal obesity and at least two elevated subcomponents

[†] Elevated per the IDF definition of MetS

Table 2.

Age- and Gender-Standardized Prevalence and 95% Confidence Intervals of Metabolic Syndrome and Obesity (BMI ≥ 30 kg/m^2) for All Adult Offspring and Parents, and Both Generations Restricted to Individuals Aged 60 – 80 Years.

Population	Metabolic Syndrome (%)	Obesity
All Ages *		
Adult Offspring	0.406 (0.394, 0.417)	0.453 (0.440, 0.467)
Parents	0.522 (0.502, 0.542)	0.519 (0.490, 0.548)
Individuals Aged 60 – 80 †		
Both Generations	0.531 (0.509, 0.552)	0.447 (0.426, 0.469)
Adult Offspring	0.688 (0.654, 0.722)	0.539 (0.504, 0.575)
Parents	0.479 (0.452, 0.505)	0.414 (0.388, 0.440)

*All ages: adult offspring, N = 392; parents, N = 286.

†Individuals aged 60 – 80: adult offspring, N = 105; parents, N = 245.

Table 3.

Prevalence Ratios and 95% Confidence Intervals for Metabolic Syndrome and Obesity (BMI ≥ 30 kg/m^2) in up to 392 NLDS Participants

Intergenerational Educational Mobility	Model 1*	Model 2†
	Metabolic Syndrome	
	N = 371	**N = 358**
Stable High	0.84 (0.66, 1.05)	0.82 (0.65, 1.04)
Upwardly Mobile	**0.55 (0.38, 0.80)**	**0.54 (0.37, 0.79)**
Downwardly Mobile	0.91 (0.73, 1.14)	0.92 (0.73, 1.16)
Stable Low	1 (ref)	1 (ref)
	Obesity	
	N = 392	**N = 379**
Stable High	**0.74 (0.55, 0.98)**	**0.70 (0.52, 0.93)**
Upwardly Mobile	**0.64 (0.44, 0.93)**	**0.62 (0.43, 0.90)**
Downwardly Mobile	0.94 (0.74, 1.20)	0.92 (0.73, 1.16)
Stable Low	1 (ref)	1 (ref)

*Adjusted for age, age^2, and gender

†Adjusted for age, age^2, gender, and the location of education of parents and adult offspring

PR and 95% CIs in bold indicates statistical significant ($p < 0.05$)

Table 4.

Prevalence Ratios and 95% Confidence Intervals for Metabolic Syndrome and Obesity in up to 392 NLDS Participants by Intergenerational Educational Mobility, Stratified by Gender

Intergenerational Educational Mobility	**Model 1***		**Model 2†**	
	Women	**Men**	**Women**	**Men**
	Metabolic Syndrome			
	N = 234	**N = 137**	**N = 226**	**N = 132**
Stable High	0.87 (0.63, 1.18)	1.01 (0.81, 1.25)	0.90 (0.65, 1.24)	0.88 (0.68, 1.13)
Upwardly Mobile	**0.48 (0.27, 0.86)**	**0.66 (0.44, 0.98)**	**0.49 (0.28, 0.88)**	0.66 (0.42, 1.03)
Downwardly Mobile	0.96 (0.70, 1.30)	0.89 (0.67, 1.19)	1.00 (0.72, 1.39)	0.89 (0.67, 1.18)
Stable Low	1 (ref)	1 (ref)	1 (ref)	1 (ref)
	Obesity			
	N = 247	**N = 145**	**N = 239**	**N = 140**
Stable High	0.72 (0.50, 1.03)	0.77 (0.50, 1.19)	0.73 (0.50, 1.04)	0.67 (0.44, 1.03)
Upwardly Mobile	**0.56 (0.32, 0.98)**	0.75 (0.46, 1.21)	**0.55 (0.31, 0.97)**	0.75 (0.47, 1.21)
Downwardly Mobile	0.97 (0.71, 1.31)	0.92 (0.64, 1.33)	0.98 (0.72, 1.34)	0.87 (0.62, 1.22)
Stable Low	1 (ref)	1 (ref)	1 (ref)	1 (ref)

*Adjusted for age, age^2, and stratified by gender

†Adjusted for age, age^2, and the location of education of parents and adult offspring, and stratified by gender

PR and 95% CIs in bold indicates statistical significance ($p < 0.05$)