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Maternal correlates of body mass index in American Indian/Alaska Native and White adolescents: Differences between mother/son and mother/daughter pairs

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Abstract

INTRODUCTION—Obesity rates for American Indian and Alaska Native (AI/AN) adolescents are among the highest in the US. However, little is known about the influence of maternal correlates on adolescent body mass index (BMI), and the extent to which the size and significance of these correlates vary by adolescent sex and race.

METHODS—We conducted a cross-sectional analysis with a sample of 531 AI/AN and 8,896 White mother/adolescent pairs from Wave 1 of the National Longitudinal Study of Adolescent to Adult Health. We used generalized estimating equations to measure the association of maternal educational attainment, marital status, employment status, obesity status, and adolescent BMI of AI/AN and White adolescents, while controlling for adolescents' demographic and behavioral covariates. We sought to determine whether the size and statistical significance of maternal correlates differed by race, and between mother/son and mother/daughter pairs.

RESULTS—The strength and statistical significance of maternal correlates varied between mother/son and mother/daughter pairs in both races. However, we did not find effect modification by race.

Maternal obesity showed the strongest effect on adolescent BMI in all mother/adolescent pairs.

CONCLUSION—Our findings suggest that maternal factors are critical in the transmission of obesogenic behaviors from one generation to the next, and their effects vary between mother/son and mother/daughter pairs, and are similar for AI/ANs and Whites. We encourage future work aimed at preventing adolescent obesity to investigate causal pathways between maternal correlates and adolescent BMI.

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Keywords

obesity; adolescents; American Indian/Alaska Native; body mass index

1. INTRODUCTION

Adolescent obesity is a pressing public health concern, especially for minority populations. Compared to other racial and ethnic groups, American Indian and Alaska Native (AI/AN) adolescents exhibit a worrisome prevalence of obesity. Twenty percent of AI/ANs aged 10-17 years are obese, compared to 12% of non-Hispanic Whites in the same age range (1). Adolescent obesity is a multifactorial disorder (2), and parental factors have been found to play a critical role in adolescent obesity outcomes (3, 4). Given parents' role in establishing dietary habits (5-7), sedentary behaviors (8-11), and distorted perceptions of body mass index (BMI) (5, 12, 13), interventions to prevent obesity in AI/ANs have often included parents (7, 14, 15). However, previous studies examining parental factors associated with adolescent BMI in AI/ANs have used primarily regional samples with limited generalizability. Only two studies have investigated these factors in large, nationally-representative samples. Both found statistically significant associations between parental obesity, household composition, parental education, and adolescent BMI (16, 17). Other studies found that parental employment and marriage were protective factors against adolescent obesity (18, 19), but AI/ANs were not included in the study samples.

Previous studies have used sex concordance between parents and their adolescent children to explain health outcomes ranging from mental health conditions (20) to alcohol consumption (21). Research on obesity outcomes, however, has returned mixed results. Some studies found that obesity is transmitted from mothers to daughters and from fathers to sons (22). Another study found that an intervention targeting weight loss in overweight parents and their children was more effective in sex discordant parent/child pairs than in sex concordant ones (23). Given the lack of consensus, the prevalence of adolescent obesity in AI/ANs, and the likely role of parental factors in children's BMI, clarifying the role of sex concordance in the intergenerational transmission of obesogenic behaviors should be a high priority.

The present study contributes to the field by estimating the role of maternal correlates in the BMI of 531 AI/AN and 8,896 White participants in Wave 1 of the National Longitudinal Study of Adolescent to Adult Health (Add Health). We measured the associations between maternal educational attainment, marital status, employment status, obesity status, and adolescent BMI, and estimated whether the strength and statistical significance of these coefficients differed by adolescent sex and race. Specifically, we aimed to test the following hypotheses:

- H1. Adjusting for age, sex, and race, maternal correlates of body mass index will be stronger for daughters than for sons.
- H2. Adjusting for age, sex, and race, maternal correlates of body mass index will be different for AI/ANs and Whites.

2. METHODS

We performed a cross-sectional analysis of data from Add Health, a national survey conducted by the Carolina Population Center at the University of North Carolina-Chapel Hill. Add Health collects data on a nationally representative sample of adolescents and young adults recruited from public schools across the country and followed for four waves (1994-2008). Details of the survey's recruitment and sampling strategy have been published elsewhere (24). The present analysis relied on data from Wave I (1994), the only wave that included both an adolescent and a parental questionnaire. Add Health requested mothers to complete the parental questionnaire, when possible. Thus, over 90% of the parental questionnaires were completed by mothers. Our work was determined to be exempt from approval by the Institutional Review Board at the University of Washington because we used de-identified data.

2.1 Inclusion criteria

We included adolescent respondents who met the following criteria: a) self-identified as either AI/AN or White, independent of ethnicity; b) their mother completed the parental questionnaire; and c) had data on height and weight available to calculate BMI. Of the original 20,745 Add Health respondents, 531 AI/ANs and 8,896 Whites met our inclusion criteria (N = 9,427 mother/adolescent pairs).

2.2 Measures

2.2.1 Outcome—We estimated adolescent BMI by assessing self-reported height and weight, and used BMI as a continuous variable in our statistical models. In our descriptive analysis, we also included the percentages of adolescents above the 85th and the 95th percentiles, based on CDC growth charts (25).

2.2.2. Exposures—We measured maternal educational attainment, marital status, employment status, and obesity status by self-report. Educational attainment was categorized as a) less than high school, b) high school graduate, or c) college graduate. Marital status was categorized as a) never married, b) married, or c) previously married (separated, divorced, or widowed). Employment status was measured with a dichotomous variable (employed/unemployed). Maternal obesity was collected by self-report, and coded categorically (obese/non-obese).

2.2.3 Covariates—For adolescents, we included demographic covariates for age, sex, and AI/AN race, as well as behavioral covariates for watching television 10 hours per week or more, and weekly frequency of playing an active sport (baseball, softball, basketball, soccer, swimming, or football).

2.3 Statistical analysis

We used descriptive statistics to present the demographic, behavioral, parental, and BMI characteristics of the two racial samples. We used generalized estimating equations to estimate the association between maternal correlates and adolescent BMI, controlling for other demographic and behavioral covariates. We compared the coefficients for mother/son

and mother/daughter pairs for each racial group separately. We performed a test of modification to measure differences in the effects of maternal correlates by race. Our results are reported with β coefficients, 95% confidence intervals (CI), and p-values (p). All significance testing was performed with an α -level of 0.05. All analyses were conducted with R 3.1.2 (26).

3. RESULTS

3.1 Sociodemographic characteristics

We described our study sample using proportions, means, and standard deviations (Table 1). We decided not to include p-values in Table 1, as per the recommendations of a recent publication (27). We observed important racial differences in adolescent weight, maternal educational attainment, marital status, employment status, and prevalence of obesity. The average BMI for AI/AN (23.3; standard deviation (SD) 5.1) and White (22.2; SD 4.2) adolescents was very similar. However, the prevalence of adolescent overweight and obesity was substantially higher in AI/ANs (35% and 18%, respectively) than in Whites (27% and 11%, respectively). AI/AN mothers typically had lower educational attainment than Whites, with 24% of AI/AN mothers reporting less than a high school education, compared to 14% of Whites. AI/AN mothers were also more likely to be never married (8% versus 2%) or previously married (27% versus 21%) than their White counterparts. Finally, AI/AN mothers had higher rates of obesity (24%) than Whites (18%; see Table 1).

3.2 Differences between mother/son and mother/daughter pairs

Maternal obesity was the most important risk factor for higher-than-average BMI in sons and daughters of both races. Maternal obesity increased the average BMI of adolescent AI/AN daughters by 3.57 (CI 2.26, 4.87; $p < 0.001$), and less than high school education increased the average BMI by 1.54, relative to adolescents with high school graduate mothers (CI 0.19, 2.89; $p = 0.025$). Maternal obesity also increased the average BMI of adolescent sons by 3.73 (CI 1.88, 5.57; $p < 0.001$). Mothers who had been previously married had sons with an average BMI 1.72 points higher than those of their married counterparts (CI 0.02, 3.43; $p = 0.048$). All other maternal correlates were not statistically significant. Additionally, daughters and sons who watched TV more than 10h per week had an average BMI 1.56 (CI 0.57, 2.56; $p = 0.002$) and 1.59 (CI 0.33, 2.86; $p = 0.014$) points higher, respectively, than their counterparts who watched less TV (Table 2).

Maternal obesity increase the average BMI of White daughters by 2.52 points (CI 2.14, 2.89; $p < 0.001$). Mothers who had less than high school education were expected to have daughters with an average 0.89 point higher BMI than their high school graduate counterparts (CI 0.51, 1.27; $p < 0.001$), and college graduates had daughters with a BMI 0.30 lower than high school graduates ($-0.56, -0.04$; $p = 0.023$). Mothers who were previously married were expected to have daughters with a BMI 0.59 point higher than their married peers (CI 0.30, 0.89; $p < 0.001$). Sons of obese mothers had, on average, a BMI 2.27 points higher than those of non-obese mothers (CI 1.88, 2.67; $p < 0.001$). Sons of college graduates had an average BMI 0.47 point lower than sons of high school graduates (CI $-0.76, -0.18$; $p = 0.001$). All other maternal correlates were not significant. Sedentary habits, identified

with watching TV 10h per week or more, increased average BMI for daughters and sons by 0.50 (CI 0.27, 0.72) and 0.62 (0.37, 0.87) point respectively. Weekly frequency of playing sports was associated with a BMI 0.14 points less in daughters (CI -0.24, -0.03; $p=0.011$), not in sons (Table 3).

3.3 Effect modification by race

We ran our model for both races combined and found consistent results. Less than high school education, previously married mothers, and maternal obesity were risk factors for higher-than-average adolescent BMI, while high levels of maternal education was a protective factor. We tested for effect modification by AI/AN race for four maternal variables: educational attainment, marital status, employment status, and maternal obesity. None of these interaction terms were significant (Table 4; supplementary file).

4. DISCUSSION

For a long time, researchers on health disparities have realized that parental factors are associated with adolescent BMI, and have tried to understand the relative importance of specific factors in these associations (1, 15, 28-32). Interventions aimed at preventing weight gain have also recognized the importance of including parents in their efforts (7, 14, 33-35). Yet the significance of maternal correlates in the BMI of their adolescent children remains unclear. We used data from Add Health to examine the association of maternal correlates with adolescent BMI in AI/ANs, one of the most understudied US minority groups. AI/AN race was associated with increasing BMI, on average, but the interaction effects between AI/AN race and maternal correlates were not significant. While AI/AN race increases the likelihood of having a higher BMI, the effects of maternal correlates on adolescent BMI are similar in both races. We measured the associations of maternal obesity, education, marital status, and employment, with adolescent BMI, and we compared the strength of these associations for mother/son and mother/daughter pairs. We found that maternal obesity was the most important risk factor for adolescent obesity, and that the effects of parental education and marital status varied significantly by adolescent sex.

Our results are consistent with previous findings that maternal obesity is a risk factor for adolescent obesity (16), while educational attainment is a protective factor (17, 36). A previous study using Add Health data found that parental obesity was the most important predictor of overweight in adulthood (16). Another study based on data from the 2007 National Survey of Children's Health observed that parental education was inversely related to adolescent overweight across all racial groups (36). A third study based on the 2003 California Health Interview Survey found that low parental education was associated with a higher risk of overweight across all racial and ethnic groups (37). The present analysis adds to these findings by showing the extent to which maternal correlates of adolescent BMI vary by sex, but not by race.

Further research is needed to clarify the causal pathways between maternal correlates and adolescent BMI. Maternal education might protect against obesity by increasing adolescents' knowledge of nutrition or by facilitating the purchase of healthy, low-calorie foods, as previous research has shown (38). Similarly, multiple causal pathways might link

maternal marital status with adolescent BMI. Both never married and previously married mothers are likely to have less time than married ones to cook at home or buy fresh groceries, as previous research suggests (39). Further research is expected to help us understand how maternal and paternal factors influence adolescent BMI, and contribute to obesity prevention efforts.

This study has important limitations. First, our data were collected more than two decades ago. We were constrained to use data from 1994 because that was the only wave of Add Health to include both a parental and an adolescent questionnaire. To our knowledge, these are the most recent nationally representative survey data of relevance to our research question. Second, we examined AI/ANs and Whites as homogeneous groups, although we are aware of substantial within-group heterogeneity (40). Moreover, our AI/AN sample was not truly nationally representative, because Add Health did not oversample racial and ethnic minorities. Third, our cross-sectional analysis did not allow us to assess causality by tracking the effects of parental factors on BMI over time. Fourth, all BMI data in our analyses were based on self-report, so that social desirability bias might underrepresent the extent to which respondents were overweight or obese (41). Fifth, our study focused on maternal correlates because more than 90% of Add Health parent respondents were mothers. Our data did not allow us to estimate paternal correlates, which are expected to also play an important role in the transmission of obesogenic behaviors. Finally, we did not have adequate indicators to estimate the extent to which dietary practices at the household level might interact with parental and adolescent variables and contribute to BMI.

Despite these limitations, we believe that our research adds to the literature on adolescent BMI by showing the importance of maternal correlates. Our results show that the strength and statistical significance of maternal correlates vary between mother/son and mother/daughter pairs, but they are similar in AI/ANs and Whites. Interventions aimed at preventing adolescent obesity should consider the role of maternal correlates, and the variability of their effects by adolescent sex. Future studies are needed to clarify the causal pathways between maternal correlates and adolescent BMI across all racial and ethnic groups. In the meantime, we encourage public health investigators to consider adolescent sex in the design of inter-generational interventions to reduce adolescent obesity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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HIGHLIGHTS

- Maternal correlates are associated with adolescent BMI.
- American Indians and Alaska Natives have not been included in previous studies.
- The variability of maternal correlates by adolescent sex and race is unclear.
- Maternal correlates of adolescent BMI were found to vary by sex, not by race.
- Maternal correlates were stronger for daughters than for sons.

Table 1Adolescent and maternal characteristics^(a)

Adolescent variables	AI/AN (n=531)	White (n=8,896)
<i>Demographic variables</i>		
Age, mean (SD)	15 (1.7)	15 (1.7)
Female adolescent, n (%)	291 (54.8)	4,655 (52.3)
<i>Weight variables</i>		
BMI, mean (SD)	23.3 (5.1)	22.2 (4.2)
Overweight (85 th percentile), n (%)	185 (35.0)	2,411 (27.0)
Obese (95 th percentile), n (%)	95 (18.0)	985 (11.0)
<i>Behavioral variables, n (%)</i>		
TV watching more than 10 h/wk	322 (60.6)	5,038 (56.6)
Playing sports: Never	131 (30.3)	2,406 (27.0)
Playing sports: 1 or 2 times per week	145 (27.3)	2,522 (28.3)
Playing sports: 3 or 4 times per week	103 (19.4)	1,714 (19.3)
Playing sports: 5 or more times per week	121 (22.8)	2,254 (25.3)
Maternal variables		
<i>Educational attainment, n (%)</i>		
Less than high school	125 (23.5)	1,267 (14.2)
High school graduate	315 (59.3)	5,551 (62.4)
College graduate	91 (17.1)	2,073 (23.3)
<i>Marital status, n (%)</i>		
Never married	38 (7.2)	166 (1.9)
Married	354 (66.7)	6,961 (78.2)
Previously married	139 (26.2)	1,766 (19.9)
<i>Employment status, n (%)</i>		
Employed	341 (64.2)	6,486 (72.9)
Unemployed	190 (35.8)	2,410 (27.1)
<i>Obesity status, n (%)</i>		
Obese mother	135 (25.4)	1,602 (18.0)

Source: National Longitudinal Study of Adolescent to Adults Health, 1994.

Notes:

^(a)Totals and percentages might not add to 100%, because of missing cases.

Table 2

Maternal correlates of adolescent body mass index in American Indian and Alaska Natives, 1994

	Mother/daughter (N=287)			Mother/son (N=236)		
	β	95% CI	p-value	β	95% CI	p-value
Adolescent variables						
Age	0.18	-0.12, 0.47	0.247	0.51	0.13, 0.88	0.008
Frequency of playing sports	-0.10	-0.54, 0.34	0.646	0.30	-0.24, 0.83	0.276
Watches TV more than 10h/w	1.56	0.57, 2.56	0.002	1.59	0.33, 2.86	0.014
Maternal variables						
Age	0.05	-0.04, 0.13	0.252	-0.10	-0.21, 0.00	0.055
<i>Educational attainment</i>						
Less than high school	1.54	0.19, 2.89	0.025	1.65	-0.54, 3.83	0.140
High school graduate (ref.)						
College graduate	-0.49	-1.66, 0.68	0.411	-0.14	-2.15, 1.86	0.889
<i>Marital status</i>						
Never married	1.60	-0.28, 3.46	0.095	-0.94	-3.94, 2.05	0.537
Married (ref.)						
Previously married	0.59	-0.60, 1.77	0.335	1.72	0.02, 3.43	0.048
<i>Employment status</i>						
Unemployed (ref.)						
Employed	-0.49	-1.58, 0.60	0.380	-0.77	-2.10, 0.57	0.261
<i>Obesity status</i>						
Mother is obese	3.57	2.26, 4.87	<0.001	3.73	1.88, 5.57	<0.001

Note: β = β coefficient, CI = confidence interval.

Source: National Longitudinal Study of Adolescent to Adults Health, 1994.

Table 3

Maternal correlates of adolescent body mass index in Whites, 1994

	Mother/daughter (N=4,606)			Mother/son (N=4,207)		
	β	95% CI	p-value	β	95% CI	p-value
Adolescent variables						
Age	0.34	0.26, 0.41	<0.001	0.53	0.45, 0.61	<0.001
Frequency of playing sports	-0.14	-0.24, -0.03	0.011	-0.07	-0.18, 0.05	0.246
Watches TV more than 10h/w	0.50	0.27, 0.72	<0.001	0.62	0.37, 0.87	<0.001
Maternal variables						
Age	-0.01	-0.03, 0.01	0.278	0.01	-0.01, 0.04	0.327
<i>Educational attainment</i>						
Less than high school	0.89	0.51, 1.27	<0.001	0.32	-0.10, 0.74	0.139
High school graduate (ref.)						
College graduate	-0.30	-0.56, -0.04	0.023	-0.47	-0.76, -0.18	0.001
<i>Marital status</i>						
Never married	0.48	-0.39, 1.35	0.282	-0.20	-1.20, 0.80	0.697
Married (ref.)						
Previously married	0.59	0.30, 0.89	<0.001	-0.17	-0.48, 0.15	0.308
<i>Employment status</i>						
Unemployed (ref.)						
Employed	-0.06	-0.33, 0.21	0.680	0.08	-0.22, 0.37	0.621
<i>Obesity status</i>						
Mother is obese	2.52	2.14, 2.89	<0.001	2.27	1.88, 2.67	<0.001

Note: β = β coefficient, CI = confidence interval.

Source: National Longitudinal Study of Adolescent to Adults Health, 1994.