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Original Contribution

Parental Incarceration and Gender-based Risks for Increased Body Mass Index: Evidence From the National Longitudinal Study of Adolescent Health in the United States

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Although recent studies suggest that 13% of young adults, including at least one-fourth of African Americans, experience parental incarceration, little research has examined links between parental incarceration and physical health. Using data from the National Longitudinal Study of Adolescent Health (1994–2008) and gender-based theories of stress, the authors examined whether parental incarceration is associated with increased body mass index among women but not men. Panel analysis spanning adolescence and adulthood, controlling for stressful life events, internalizing behaviors, and a range of individual, familial, and neighborhood characteristics, reveals that body mass index for women who have experienced parental incarceration is 0.49 units ($P < 0.004$) higher than that for women whose parents have never been incarcerated. This association is not evident among men. Similarly, in change score models between waves II and IV, women experiencing parental incarceration have a 0.92-unit increase in body mass index ($P < 0.026$) relative to women who did not have a parent undergo incarceration. In supplemental analysis examining if gender differences in incarceration stress response (externalizing vs. internalizing) explain these findings, the authors found that obesity status moderates the relation between depression and parental incarceration. Results suggest a stress internalization process that, for the first time, links parental incarceration with obesity among women.

body mass index; collateral consequences of incarceration; gender and stress internalization; internalizing/externalizing behaviors; parental incarceration; risk factors for obesity

Abbreviation: BMI, body mass index.

With the exponential rise in the US prison population, parental incarceration has become an increasingly common experience in US society. In 2007, 1.7 million children had a parent incarcerated in state or federal prison, while nearly 7.5 million children had a parent either incarcerated or on probation or parole (1, 2). Among young adults in the United States, 13% report that their biologic father has spent time in jail or prison, with mother/father incarceration becoming an increasingly common life experience, particularly for African-American children (3, 4). Wildeman (5) estimates that 1 in 4 African Americans born in 1990 have experienced a father's incarceration, compared with 1 in 25 whites. The racial disparities in adult incarceration are reflected among children: Black and Hispanic children are 7.5 and 2.5 times, respectively, more likely to have an incarcerated parent than are white children (1). With an incarceration rate that is 5–10 times higher than that in other industrialized nations, the United States is unique in its proportion of children experiencing a parent undergo incarceration (4).

As an increasingly common life-course event among children and young adults, parental incarceration has become the focus of a growing body of research (6–10). Parental incarceration is linked to a number of problem behaviors and poor outcomes, including aggression/misbehavior in early childhood (11, 12), antisocial behavior/delinquency (12–16), drug use (17, 18), mental health issues (17, 19–21), and poor educational performance/outcomes (9, 20). These associations result, in part, from additional risk factors that accompany

incarceration, including parental absence, lack of economic resources, family instability, and strained parental relationships; consequently, parental incarceration is considered a major and long-term stressor in the lives of children (9, 17, 22–24). Furthermore, male and female children may differentially express stress related to parental incarceration. General stress research suggests that boys and men typically externalize stressful life events like paternal incarceration through actions such as delinquent behavior; in contrast, girls and women generally internalize similar stressors through mechanisms such as anxiety or depression (25–27). Although most studies of parental incarceration do not separately analyze males and females (9), some findings are suggestive of this pattern. Using data from the Fragile Families and Child Wellbeing Study, Wildeman (11) found paternal incarceration to be associated with increased risk of aggression among young boys but with a decrease or ''protective effect'' for aggression among young girls. In an Australian sample, Kinner et al. (19) reported an association between paternal incarceration and internalizing behavior among adolescent girls but no association among boys.

The links among stress, internalizing behaviors, and subsequent health among adolescent and adult women (28–34) are well established. Thus, parental incarceration may, in turn, also be associated with such physical health issues, particularly among females, who internalize stress in lieu of the aggression/delinquency commonly observed among men. Recent work by Jackson et al. (33) and Mezuk et al. (34) suggests that poor physical health behaviors may also act as substitutes for mental health issues such as depression, similarly implicating obesity and other mental health issues as alternative adverse outcomes to aggression and delinquency.

Although stress theories and mental health outcomes have been studied among children of incarcerated parents (9), the lack of longitudinal studies examining long-term physical health outcomes, such as obesity, is notable. The internalization of stress, long-term association between parental incarceration and mental health issues reported by Murray and Farrington (9), and engagement in poor physical health behaviors make it a potentially highly significant issue among female children of incarcerated parents, both as an extension of current research on the effects of parental incarceration and in the context of high rates of parental incarceration within the US population. As a growing epidemic in the United States, an outcome frequently linked with internalization of stress, and a precursor to major health problems such as stroke, diabetes, hypertension, and coronary heart disease in later life, obesity represents a physical health measure with significant consequences with increasing age.

By examining the body mass index (BMI) of respondents over a 12-year period that extends from adolescence into adulthood, we examine how parental incarceration may result in increases in body size over this critical developmental period. We use a comprehensive set of statistical controls that are believed to mediate or confound the association between parental incarceration and BMI in a series of nested regression models that are designed to account for the hypothesized association. To test for robustness, we also compare how changes in parental incarceration status are associated with increased body mass for respondents interviewed at waves II–IV and, to further eliminate other sources of unobserved heterogeneity, we perform a comparable analysis on a subset of respondents reporting parental incarceration at some point during their lives. Finally, we explore the mechanism for this association by examining the influence of parental incarceration on changes in depressive symptoms among obese and nonobese women. If increased BMI is due to overeating as a means to cope with stress, then the influence of this stressful life event should be notably weaker among obese women than among nonobese women.

MATERIALS AND METHODS

Data

We used 4 waves of in-home data collection from the National Longitudinal Study of Adolescent Health (hereafter referred to as ''Add Health''). Information on how to obtain the Add Health data files is available on the Add Health website (http://www.cpc.unc.edu/addhealth).

The Add Health in-home sample consists of 20,700 respondents enrolled in grades 7–12 at wave I during 1994–1995. Follow-up interviews were conducted in 1996, 2001–2002, and 2007–2008, with approximately 14,700 (71%), 15,200 (73%), and 15,700 (75.5%) respondents completing interviews at waves II, III, and IV, respectively. Answers to sensitive questions in Add Health, including youth offending and arrest, were obtained by using audio-computer–assisted self-interviewing (known as ''audio-CASI'') technology to increase the reliability of self-reports (35).

For this study, we examined 15,558 individuals who had completed interviews for all waves of the study. In our sample, 1,205 males and 1,472 females reported that their biologic mother or father was incarcerated, including 242 male and 306 female respondents who reported that a parent was incarcerated between waves II and IV. Because of variation in BMI arising from pregnancy, we eliminated female respondents who reported being recently or currently pregnant. We used multiple-imputation techniques for missing values (36, 37) by use of the ''ice'' procedure in Stata software (38) across 50 imputed data sets to increase the reliability and statistical power of imputations (39). To make use of these imputed data, we used the Stata add-on ''mim'' in conjunction with regression analysis (40). To examine the reliability of our imputations, we compared the results presented below with results from the subset of observations with no missing data. Although we found that estimating the full sample yielded biased results, imputations that were restricted to the subsample of 1) observations with no missing internalizing/externalizing behaviors and 2) cases in which respondents completed interviews yielded reliable and consistent results. In our panel analysis, we use imputations from this subsample.

Because interactions can bias imputations (36) and to demonstrate robustness of findings, we present results for change models that include only cases with complete data for change score models presented in Tables 1 and 2. For change score models, we present results for all respondents. As a robustness check for unobserved heterogeneity, we

Table 1. Regression Results for the Effect of Parental Incarceration on Body Mass Index, National Longitudinal Study of Adolescent Health, 1994–2008[a]

	Full Sample			Males			Females		
	Estimate	95% CI	*P* Value	Estimate	95% CI	*P* Value	Estimate	95% CI	*P* Value
Model 1: baseline	0.358	0.147, 0.569	<0.001	0.038	–0.373, 0.250	<0.793	0.599	0.299, 0.900	<0.000
Model 2: alternative risks	0.382	0.149, 0.614	<0.001	0.160	–0.160, 0.482	<0.325	0.517	0.187, 0.849	<0.002
Model 3: stressful life events	0.383	0.151, 0.615	<0.001	0.171	–0.150, 0.491	<0.297	0.510	0.180, 0.840	<0.002
Model 4: full model	0.365	0.134, 0.597	<0.002	0.158	–0.162, 0.479	<0.332	0.490	0.161, 0.818	<0.004
Model 5: Δ BMI (wave II − wave IV)	0.178	–0.351, 0.709	<0.509	–0.621	–1.310, 0.066	<0.076	0.916	0.112, 1.720	<0.026

Abbreviations: BMI, body mass index; CI, confidence interval.

[a] All data come from waves I–IV of the National Longitudinal Study of Adolescent Health. Cell entries represent linear mixed-model parameter estimates for the average effect of parental incarceration on BMI across 4 waves of the study (models 1–4) and change (Δ) in BMI from wave II to wave IV (model 5). In all models, the unit of analysis for BMI is weight (kg)/height $(m)^2$.

also report results for the subpopulation of respondents who reported that their biologic father was incarcerated prior to wave IV.

Key measures

Tables 3 and 4 provide a description of constructed measures; Table 3 also presents means and standard deviations. In the following subsections, we discuss key variables used in the analyses.

Body mass index. BMI, derived from the respondent's weight (kg)/height $(m)^2$, is a metric used in research as an approximation of a respondent's body fat. Add Health collected self-reported weight and height at wave I but interviewer-assessed weight and height at waves II–IV. Although measured BMI is preferred in research, prior research examining BMI among Add Health respondents has shown that self-reported BMI at wave I yields results that are consistent with those at later waves (41). In Table 5, we differentiate between obese and nonobese women using a standard BMI threshold of 30 (42).

Parental incarceration. Parental incarceration is measured by the respondent's retrospective reports at wave IV. Reports at this wave are the first to provide the age at which the respondents recalled their mother and/or father being incarcerated. During interviews, respondents were first asked, ''Has your biological mother/father ever spent time in jail or prison?'' If respondents noted, ''yes,'' they were then asked, ''How old were you when your biological mother/father went to jail or prison (the first time)?'' Responses range from ''not yet born'' through ''31 years.'' Cases in which respondents either refused to answer these questions or indicated no knowledge of their mother's/father's incarceration are coded as missing. To adjust for the various methods used in analysis, we coded timing of parental incarceration in 2 ways. To investigate parental incarceration in panels, we used an indicator variable to denote whether either parent had undergone incarceration. Alternatively, for fixed-effect models, we investigated parental incarceration occurring between waves II and IV. We also report results from models for panel data that examine only respondents whose parents completed incarceration prior to wave I (these data are not shown).

Table 2. The Estimated Effect of Parental Incarceration on Depression for Men and Women and by Obesity Status: A Test of the Internalization Hypothesis, National Longitudinal Study of Adolescent Health, 1994–2008[a]

	Results, by Respondent's Gender		Results Among Women, by Obesity Status	
	All Men	All Women	Not Obese	Obese
Parental incarceration in waves II–IV	0.114 (0.184)	0.576* (0.211)	0.829* (0.275)	0.381 (0.344)
BMI in wave II	–0.004 (0.007)	0.032** (0.008)	0.011 (0.016)	0.032* (0.012)
Depression in wave II	–0.744** (0.014)	–0.739** (0.013)	–0.739** (0.017)	–0.737** (0.023)
Stressful life events in wave II	3.136** (0.498)	3.044** (0.735)	2.460* (0.948)	3.847* (1.201)
Stressful life events in waves II–IV	1.076** (0.082)	0.875** (0.094)	0.738** (0.110)	1.159** (0.180)
R squared	0.365	0.379	0.385	0.371

Abbreviation: BMI, body mass index.

* $P < 0.05$; ** $P < 0.01$.

[a] All data come from waves I–IV of the National Longitudinal Study of Adolescent Health. Cell entries represent estimated coefficients from ordinary least squares, with standard errors in parentheses. Models include controls for age and race/ethnicity. For all models, the unit of analysis is change (Δ) in depression score between waves II and IV, using the depression scale outlined in Table 4.

Table 3. Values for Measures Used in the Analysis and Behavioral/Lifestyle Variables, by Parental Incarceration Status ($n = 15{,}558$), National Longitudinal Study of Adolescent Health, 1994–2008[a,b]

Variable	Lifetime History of Parental Incarceration	
	With Parental Incarceration	Without Parental Incarceration
Measures used in analysis		
Male sex	0.44 (0.49)	0.47 (0.49)
Respondent's age at each interview wave, years		
Wave I	15.45 (1.71)	15.64 (1.73)
Wave II	16.37 (1.73)	16.56 (1.75)
Wave III	21.83 (1.74)	22.01 (1.75)
Wave IV	28.36 (1.77)	28.52 (1.78)
Self-reported race/ethnicity (wave I)		
White	0.46 (0.49)	0.54 (0.49)
Black	0.31 (0.46)	0.20 (0.40)
Hispanic	0.16 (0.36)	0.16 (0.36)
Asian	0.02 (0.14)	0.07 (0.25)
Native American	0.03 (0.16)	0.02 (0.12)
Other race	0.01 (0.09)	0.05 (0.20)
Ever arrested	0.43 (0.49)	0.25 (0.44)
Parental education (as reported by parents)		
Less than high school	0.35 (0.48)	0.27 (0.44)
High school graduate	0.35 (0.48)	0.34 (0.47)
College graduate	0.30 (0.46)	0.39 (0.49)
Wave I family structure		
Resides with both biologic parents	0.23 (0.42)	0.58 (0.49)
Two parents, one biologic	0.24 (0.43)	0.13 (0.35)
Single mother	0.36 (0.48)	0.21 (0.41)
Single father	0.05 (0.21)	0.03 (0.17)
Other family	0.13 (0.33)	0.05 (0.21)
Father unknown[c]	0.12 (0.33)	0.08 (0.27)
Father closeness scale[d]	3.29 (1.34)	3.88 (1.18)
Poverty rate[e]	0.11 (0.06)	0.11 (0.06)
Nonwhite county residents[f]	0.22 (0.16)	0.23 (0.16)
Urban density[g]	0.52 (1.37)	0.51 (1.32)
Repeated abuse by parent or caregiver[h]	0.16 (0.36)	0.07 (0.26)
Parental report of problems in child temperament[i]	0.35 (0 .48)	0.27 (0.44)
Stressful life events at each wave[j]		
Wave I	0.06 (0.09)	0.05 (0.08)
Wave II	0.04 (0.08)	0.03 (0.06)
Wave III	0.07 (0.09)	0.06 (0.08)
Wave IV	0.20 (0.17)	0.15 (0.14)
Internalizing/externalizing behaviors and unhealthy lifestyles		
Depression[k]		
Wave I	3.54 (2.95)	3.12 (2.78)
Wave II	3.57 (2.98)	3.05 (2.76)
Wave III	2.79 (2.94)	2.25 (2.65)
Wave IV	3.32 (3.08)	2.67 (2.73)
Suicidal thoughts[l]		
Wave I	0.17 (0.38)	0.13 (0.44)
Wave II	0.14 (0.34)	0.10 (0.30)
Wave III	0.09 (0.28)	0.06 (0.23)
Wave IV	0.10 (0.30)	0.06 (0.23)
Sedentary behaviors, hours/day[m]		
Wave I	3.66 (3.31)	3.14 (2.89)
Wave II	3.50 (3.30)	2.96 (2.81)
Wave III	3.58 (3.26)	3.11 (2.77)
Wave IV	3.46 (3.39)	3.12 (2.84)
Fast food consumption, days[n]	2.78 (2.94)	2.13 (2.05)
Soft drink consumption[o]	0.77 (0.42)	0.95 (0.20)
No. of respondents	2,677 (17.2)[p]	12,881 (82.8)[p]

[a] All data come from waves I–IV of the National Longitudinal Study of Adolescent Health.

[b] Cell entries represent means (standard deviations) for continuous variables and proportions for categorical variables.

[c] Biologic father not known by respondent at time of wave 1 interview.

[d] Respondent's wave I response to the question, "How close do you feel towards your biological father?" Coded 1 (not close at all) to 5 (fairly close). Used by K. M. Harris and S. Ryan in *Conceptionalizing and Measuring Father Involvement* (Mahwah, NJ: Lawrence Erlbaum Associates; 2003:293–319) (45).

[e] Proportion of families in the county living below the poverty level.

[f] Proportion of residents in the county who were not non-Hispanic Caucasians.

[g] Average number of residents in the county per square kilometer.

[h] Dichotomous variable indicating history of being slapped, kicked, or hit by a parent or caregiver more than 5 times before the age of 10 years. Coded 1 if the event occurred more than 5 times and 0 otherwise.

[i] Parent's response to the question, "Does your child have a temper?" Coded 1 if yes and 0 if no. Used as a measure of low self-control by Hagan and Foster (*Soc Forces.* 2003;82(1):53–86) (46).

[j] Proportion of stressful life events experienced at each wave, as discussed in Table 4.

[k] Five-item longitudinal measure of depression, as discussed in Table 4.

[l] Self-report of respondent's having suicidal thoughts or thinking about suicide in the 12 months prior to the interview, assessed at all 4 waves of interviews.

[m] Average number of hours per day that the respondent engaged in sedentary behaviors, as defined in Table 4.

[n] Number of days the respondent consumed fast food during the week prior to the interview.

[o] Any consumption of soft drinks during the week prior to the interview (yes).

[p] Number in parentheses, percentage.

Table continues

Table 4. Variables Capturing Potential Mechanisms for Internalizing/Externalizing Behaviors and Unhealthy Lifestyles That May Explain the Correlation Between Parental Incarceration and Body Mass Index/Obesity, National Longitudinal Study of Adolescent Health, 1994–2008

Measure	Description[a]	Mechanism
Stressful life events	Stressful life events experienced by the respondent in the 12 months prior to the interview. As a guideline, we used the stressful life events list found in the reports by Adkins et al. (47) and Boardman and Alexander (48) and identified the following occurrences of stress: ran away from home, was expelled from school, had an unwanted pregnancy, had an abortion, gave baby up for adoption, cohabitation ended, romantic relationship ended, marriage ended, nonromantic sexual relationship ended, diagnosed with STD, attempted suicide, threatened someone, shot or stabbed someone, injured someone in a fight, was discharged from the military, entered the military, was evicted from home, utility service was cut off, receiving welfare, involuntarily cut from welfare, juvenile conviction or detention, adult conviction, adult jail time, had a miscarriage, biologic father died, biologic mother died, parental figure died, romantic relationship partner died, spouse died, baby died, friend or family member committed suicide, baby had medical problems, relationship abuse (threatening, insulting, swearing, throwing things, pushing), was jumped, saw violence, was shot or stabbed, had sex for money, was threatened, mother or father is on public assistance, was raped, was injured in a fight, skipped needed health care.	As recent ethnographic work suggests, parental incarceration is associated with a number of long-term stressful life events, and parental incarceration may act as a "marker" for experiencing many stressful life events, which would explain the association between parental incarceration and obesity/BMI.
Depression	Five-item depression scale based on that of Perreira et al. (49) for Add Health measures found to be reliable and consistent across racial/ethnic groups. The questions assess the respondent's frequency of particular emotions during the past week, including being happy/satisfied with life,[b] feeling depressed, being unable to shake off the blues, being happy, and feeling sad. The adjusted Cronbach's alpha was 0.80 at wave I, 0.79 at wave II, 0.85 at wave III, and 0.84 at wave IV. Psychiatric diagnoses are not available in Add Health.	With the strong correlation between depression and obesity/BMI among women, depression may be higher among females who have experienced parental incarceration.
Suicidal thoughts	Self-report at each wave indicating whether the respondent considered suicide or had suicidal thoughts in the 12 months prior to the interviews.	Suicidal thoughts are used as a measure of internalizing behaviors.
Average no. of sedentary behaviors per day	Average number of hours per day that the respondent was engaged in sedentary behaviors. At waves I–III, these behaviors were the sum of hours spent watching television, playing computer or video games, and watching videos. At wave IV, these measures were the number of hours spent watching television, playing video or computer games, and time spent at a computer.	Measures whether increased BMI associated with parental incarceration may result from increased sedentary behaviors.
Fast food consumption	Average number of days per week that the respondent ate fast food at wave IV interviews.	Measure capturing whether children of incarcerated parents may cope with stressors through unhealthy dietary patterns.
Consumption of soft drinks	Indicator variable for whether the respondent had consumed soft drinks in the week prior to the interview at wave IV.	Measure capturing whether children of incarcerated parents may cope with stressors through unhealthy dietary patterns.

Abbreviations: BMI, body mass index; STD, sexually transmitted disease.

[a] Reference 47: Adkins et al. (*Soc Forces*. 2009;88(1):31–60); reference 48: Boardman and Alexander (*Soc Sci Med*. 2011;72(10):1659–1666); reference 49: Perreira et al. (*Soc Forces*. 2005;83(4):1567–1601).

[b] At waves I, III, and IV, respondents were asked how happy about life they were during the last 7 days. Unfortunately, this item was not queried at wave II, so we substituted a similar measure that asked how satisfied respondents felt about their lives. The mean and standard deviation of this substituted variable are similar to those for the "happy" items used at the other 3 waves and yielded results that are comparable to those from other waves in cross-sectional analyses.

Internalizing/externalizing and unhealthy behaviors. To determine the extent to which associations between parental incarceration and obesity may be explained by internalizing/externalizing behaviors, stress, and unhealthy behaviors/lifestyles, we also added several additional measures listed in Table 4. In longitudinal analysis, our measures include 1) the proportion of all stressful life events a respondent experienced at each wave, 2) 4-wave measures of depression and suicidal thoughts to assess internalization, and 3) 4-wave measures of sedentary behavior, fast food consumption, and soft drink consumption to capture maladaptive behaviors that may substitute for internalization. In change score models, we examined onset of arrest, increase in depression, increase in suicidal thoughts, and an increase in stressful life events to explore potential internalizing/externalizing pathways.

Methods

To model a respondent's BMI over time, we estimated the random intercept model described in equation 1 that adjusts for repeated individual measures:

$$\mathrm{BMI}_{it} = \beta_0 + \boldsymbol{\beta} \boldsymbol{X}_{it} + v_i + e_{it}. \quad (1)$$

Here, BMI for individual i at time t is estimated by the intercept β_0 and the row vector $\boldsymbol{\beta X}_{it}$ consisting of age, parental history of incarceration, demographic controls, potential alternative explanatory variables related to family structure and processes, neighborhood and individual characteristics, stressful life events, and alternative predictors. Error is measured by the individual-level random effect v_i and the random

Table 5. Means and Standard Deviations for Body Mass Index by Parental Incarceration, Wave, and Sex, National Longitudinal Study of Adolescent Health, 1994–2008[a,b]

	Wave I		Wave II		Wave III		Wave IV		All Waves	
	Mean (SD)	*P* Value	Mean (SD)	*P* Value	Mean (SD)	*P* Value	Mean (SD)	*P* Value	Mean (SD)	*P* Value
All respondents		<0.0003		<0.0019		<0.0003		<0.0003		<0.0001
Any parent incarcerated ($n = 2,677$)	22.98 (4.70)		23.59 (5.23)		27.24 (6.72)		29.69 (8.07)		25.87 (6.89)	
No parent incarcerated ($n = 12,881$)	22.62 (4.53)		23.26 (4.97)		26.75 (6.27)		29.10 (7.57)		25.43 (6.51)	
Male respondents		<0.7107		<0.7913		<0.5003		<0.2682		<0.1934
Any parent incarcerated ($n = 1,205$)	22.86 (4.61)		23.42 (5.09)		26.68 (5.88)		28.93 (6.80)		25.57 (6.17)	
No parent incarcerated ($n = 6,079$)	22.87 (4.54)		23.38 (4.80)		26.80 (5.70)		28.93 (6.93)		25.55 (6.14)	
Female respondents		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001
Any parent incarcerated ($n = 1,472$)	23.08 (4.77)		23.72 (5.35)		27.70 (7.31)		30.30 (8.93)		26.20 (7.41)	
No parent incarcerated ($n = 6,802$)	22.40 (4.50)		23.14 (5.12)		26.71 (6.74)		29.03 (8.10)		25.32 (6.83)	

Abbreviation: SD, standard deviation.

[a] All data come from waves I–IV of the National Longitudinal Study of Adolescent Health.

[b] The *P* values indicate the statistical significance for the difference between children of incarcerated parents and non-incarcerated parents within each wave.

disturbance term e_{it}, where $v_i \sim N(0,\sigma_i^2)$ and $e_{it} \sim N(0,\sigma^2)$ (43). These models are presented in models 1–4 of Table 1. To examine whether the experience of parental incarceration is associated with a change in BMI, we estimated a basic change model, modeling change in BMI from waves II and IV, as described in equation 2:

$$\mathrm{BMI}_{i,\mathrm{II-IV}} = \beta_0 + \beta_1 \mathrm{BMI}_{i,\mathrm{II}} + \boldsymbol{\beta}\mathbf{X}_{it} + e_i. \qquad (2)$$

Here, $\mathrm{BMI}_{i,\mathrm{II-IV}}$ is individual i's change in BMI between waves II and IV; β_0 is the estimated intercept; $\beta_1\mathrm{BMI}_{i,\mathrm{II}}$ is initial BMI at wave II; the row vector $\boldsymbol{\beta}\mathbf{X}_{it}$ represents age, parental incarceration, and internalizing/externalizing behaviors occurring between waves II and IV, as well as demographic controls; and e_i is the random disturbance term. Regression results are presented in model 5 of Table 1. In Table 2, we present results for the main effects for parental incarceration and internalizing/externalizing behaviors.

All analyses were conducted by using Stata, version 11.1, statistical software (StataCorp LP, College Station, Texas).

RESULTS

Table 5 contains the mean BMI by gender and parental incarceration status for all 4 waves of the Add Health Study. As indicated in this table, the average effect of incarceration is 0.44 BMI units across all waves, and parental incarceration is positively associated with higher BMI for each of the 4 waves of the study. Importantly, the effects are evident among women only. At wave I, we show an average difference of ~0.75 BMI units for women who have had a parent go to jail, compared with those who have not. For a woman 170 cm tall and weighing 68 kg, this translates to a 2.3-kg weight increase. By wave IV, the average BMI difference is ~1.3 BMI units. For the same 170-cm woman, this translates to a 4.1-kg increase, compared with those who have not had a parent incarcerated. On average, we observed an unadjusted difference of 0.88 BMI units for women whose parents had been incarcerated compared with those whose parents had never been incarcerated.

Random-intercept models

Table 1 presents a series of nested regression models that add successive blocks of mediating variables to examine the social and behavioral mechanisms that may account for the patterns observed in Table 5. For parsimony, we provide only the effect of parental incarceration on BMI; for full results for models 1–5, refer to Web Tables 1–3, respectively, for all respondents, males, and females, posted on the *Journal*'s website (http://aje.oxfordjournals.org/). The first 4 models are random-intercept models in which 4 observations are nested within individuals. For both the full sample and women, the inclusion of basic sociodemographic controls (model 1) significantly attenuated the association observed in Table 5, but parental incarceration remains a highly significant predictor of BMI; sociodemographic factors account for roughly 32% of the association between parental incarceration and BMI. Similarly, as shown in models 2–4, statistical controls

for alternative risks, stressful life events, and differential health lifestyles account for only a small amount of the remaining association (~18%). After we adjusted for these factors, parental incarceration was associated with a ~0.49-unit increase ($P < 0.004$) in BMI for women (model 4). As a robustness check, in comparing those who experienced parental incarceration prior to wave I with those never experiencing parental incarceration, we found nearly identical results; for example, we observed a 0.43-unit increase in BMI for women experiencing parental incarceration prior to wave I ($P < 0.003$) using model 4 of Table 1.

In supplemental analyses (available on request), we also estimated the relation between parental incarceration and respondents' meeting official classifications for obesity, using comparable longitudinal models presented in models 1–4 of Table 1. In the baseline model, parental incarceration is associated with a 29.6% and 40.9% increase in the risk of obesity for all respondents and women, respectively; there is no significant association between parental incarceration and obesity among males.

Change score models

To derive more refined estimates of the influence of parental incarceration on BMI, we examined change in BMI from wave II to wave IV (in which measured BMI is available and provides a large-enough window to assess change) as a function of parental incarceration during that same period. This model includes the full set of controls, changes in the control variables, and a control for BMI at wave II (model 5 of Table 1). According to this model, women whose parents were incarcerated between waves II and IV ($n = 194$) saw BMI increases that were 0.92 units higher than those of women whose parents were not arrested during this period. As a final check of robustness to rule out other sources of unobserved heterogeneity, we also reran model 5, comparing respondents whose father was arrested during the wave II–IV period with respondents whose father was arrested prior to wave II; the results were substantively identical ($b = 1.25$) and statistically significant ($P < 0.05$, 1-tailed test). In other words, this association does not appear to be due to unobserved characteristics that affect both the risk of parental incarceration and the risk of BMI.

In Table 2, to examine the mechanism responsible for the observed association between parental incarceration and BMI and the notable gender differences in this association, we considered the gendered process of internalizing stress by estimating the effect of parental incarceration on change in depression levels from wave II to wave IV. Our models control for stressful life events and changes in them from wave II to wave IV that may confound the association between parental incarceration and mental health. The first model examines this association among men. As the gendered-internalization perspective anticipates, parental incarceration does not significantly influence the mental health of men ($b = 0.114$; not significant). However, this same model indicates a fairly robust and deleterious influence of parental incarceration on the mental health of women ($b = 0.576$; $P < 0.01$). Results from interaction models suggest that the gender difference is statistically significant ($P < 0.05$, one-tailed test). We then examined this association among women as a function of wave IV obesity status and showed a stronger effect among nonobese women ($b = 0.829$; $P < 0.01$) and a nonsignificant effect among obese women ($b = 0.381$; not significant). That is, obesity appears to mute the mental health consequences of parental incarceration for women and remains an alternative coping mechanism that may help to explain the mechanism by which parental incarceration influences BMI levels for young women.

Sensitivity analyses

To evaluate the robustness of findings, we conducted sensitivity analysis on the models and methods used in the analyses (data not shown). For parental incarceration, we found no substantive variation by parent's sex (i.e., mother's and father's incarceration), age of respondent (e.g., parental incarceration before age 10), or incarceration prior to wave I. In alternative methods, we found that parental incarceration significantly predicted increased BMI using multilevel models that controlled for school clustering and cross-sectional analysis that made use of Add Health's multistage weights. In interaction models, we found that the effect of parental incarceration did not vary significantly by race/ethnicity, age, or parental education.

DISCUSSION

In this study, we linked parental incarceration to increases in body mass among a national sample of American youth. By controlling for a comprehensive array of stressful life events, detailed information about family structure and socioeconomic status, father closeness, neighborhood poverty, respondent low self-control, and internalizing/externalizing behaviors, we are able to demonstrate a significant, independent influence of parental incarceration on the BMI and obesity for young women. Additionally, our results from change models support research suggesting that parental incarceration leads to increased BMI through internalizing/externalizing behaviors. Parental incarceration is associated with increased depression among women who are not obese, but it is nonsignificantly associated with depression among all men and among women who are obese. The gender differences that we observe are in line with gender-based theories of internalizing/externalizing behaviors in the general health literature (25–27), research linking internalization with obesity (28–32), and research on the effects of parental incarceration (11, 19). Thus, we find parental incarceration to be a risk factor for increased obesity among women and a potential alternative to internalizing behaviors such as depression.

Given the gender and internalizing/externalizing differences observed in our research, links between parental incarceration and long-term physical health outcomes, such as obesity, should be a focus of increased research. Instead of simply being added risk factors, obesity and elevated BMI are consistently observed among women who do not display internalizing behaviors. Given the many risks associated with parental incarceration and recent research suggesting that children of incarcerated parents suffer adversity

in adolescence and young adulthood (17), our research suggests the need to consider how individuals may differentially respond to the stresses of incarceration and related disadvantages.

We believe that this association is particularly important for African-American women, who are more likely than non-Hispanic white women to express this internalization through high caloric intake and sedentary lifestyles (33, 34). According to recent estimates, the median BMI for non-Hispanic white women aged 20–39 years is 24.5, compared with 29.4 for African-American women aged 20–39 years (44). Thus, the 0.9-unit increase in BMI for women who have had a parent incarcerated is equivalent to 18.4% of the existing disparity (4.9 BMI units). Because at least one-fourth of African-American children entering adulthood are raised in families in which the father has spent time in prison (4), this stressful life event may uniquely contribute to obesity disparities between black women and white women. Similarly, given the characterization of the exponential increase in obesity among black women as rooted in a stress-coping process (33, 34), future research examining how women respond to the stresses of parental incarceration may yield insights into racial disparities in obesity.

Several limitations should be considered in the interpretation of the results of our study. First, we have fairly limited information about the specific timing of incarceration, the duration of incarceration, and parental criminality that may clarify the links between parental incarceration and BMI. Future research should explore these associations as a function of the type of crime committed, the occurrence of the event within the criminal history of the parent, and the specific developmental periods of the child's life in which a parent was absent because of incarceration. Second, we emphasized gender differences in the association between parental incarceration and BMI, but age, race/ethnicity, socioeconomic status, religiosity, and other important sociodemographic factors may also moderate the effects of stress on body mass. Future research should explore these possibilities. Finally, we emphasize one particular health outcome when, in fact, parental incarceration is linked to behavioral problems (11–16) and health behavior problems such as drug use (17, 18). An important next step would be to characterize the influence of parental incarceration on the comorbidity of health, risky behaviors, and education (20). If parental incarceration affects this broad range of outcomes in unique yet predictable ways, then interventions should be developed to provide this specific at-risk population with effective mechanisms to reduce the deleterious health influences of parental incarceration.

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