Dating Violence, Childhood Maltreatment, and BMI From Adolescence to Young Adulthood

WHAT'S KNOWN ON THIS SUBJECT: Partner violence victimization is associated with mental and behavioral health effects linked to weight gain. Childhood maltreatment is directly linked to obesity and associated with neuroanatomic and psychosocial changes, which heighten vulnerability to subsequent stressors.

WHAT THIS STUDY ADDS: This study finds that dating violence victimization is associated with greater increases in BMI from adolescence to young adulthood among women. Women with previous exposure to childhood sexual abuse are especially vulnerable to dating violence–related increases in BMI.

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abstract

BACKGROUND AND OBJECTIVES: This study tested whether dating violence (DV) victimization is associated with increases in BMI across the transition from adolescence to young adulthood and whether gender and previous exposure to child maltreatment modify such increases.

METHODS: Data were from participants (N = 9295; 49.9% female) in the National Longitudinal Study of Adolescent Health. BMI was calculated from measured height and weight at waves 2, 3, and 4 of the study. DV victimization was measured at waves 2, 3, and 4 by using items from the revised Conflict Tactics Scales. Linear regression by using generalized estimating equations with robust SEs was used to test the association. Models were stratified according to gender and history of child maltreatment.

RESULTS: From baseline to wave 4, BMI increased on average 6.5 units (95% confidence interval [CI]: 6.2–6.7) and 6.8 units (95% CI: 6.5–7.1) among men and women, respectively, and nearly one-half (45.5% of men; 43.9% of women) reported DV at some point. In stratified models, DV victimization (β: 0.3 [95% CI: 0.0–0.6]) independently predicted BMI increase over time in women. Exposure to childhood sexual abuse magnified the increase in BMI associated with DV victimization (β: 1.3 [95% CI: 0.3–2.3]). No other types of childhood maltreatment were significant modifiers of the DV–BMI association. Violence victimization was not associated with BMI among men.

CONCLUSIONS: Screening and support for DV victims, especially women who have also experienced childhood maltreatment, may be warranted to reduce the likelihood of health consequences associated with victimization. *Pediatrics* 2014;134:678–685

Between 9% and 30%[1–3] of teenagers and young adults experience violence perpetrated by a dating partner (ie, dating violence [DV]). Despite growing evidence of the health effects of DV victimization,[4] little is known about the potential relationship between DV and measures of adiposity. The transition from adolescence to young adulthood is a period of high risk for the development and maintenance of obesity,[5] and DV has been associated with psychosocial and behavioral factors (eg, depressive symptoms,[6] binge eating,[7,8] unhealthy weight loss practices[9]) that have been linked to weight gain or obesity.[10,11] However, direct tests of the association are sparse.

To the best of our knowledge, no study has examined the relationship between DV victimization in adolescence and adiposity in young adulthood; however, studies of adults who experienced intimate partner violence (IPV) provide insight into the relationship. An analysis of Behavioral Risk Factor Surveillance System data found no association between lifetime physical or sexual IPV and BMI among men and women.[12] In contrast, IPV victimization was positively associated with obesity in a community-based study of reproductive age Egyptian women and with weight gain in a US sample of shelter residents.[13,14] A study using a broad composite measure of interpersonal violence demonstrated associations with weight gain and loss in middle-aged women.[15] Discrepancies in this body of knowledge are likely due to differences in study design, sample population, and definitions of violence victimization and adiposity. Common across all studies, however, is a lack of consideration of differences in the association according to history of childhood maltreatment, a potentially important effect modifier.

Adversities in childhood are associated with later obesity,[16–18] likely via complex pathways including alterations in neural regulation, inflammatory processes, and hypothalamic-pituitary-adrenal (HPA) axis and metabolic functioning.[17,19–21] For example, individuals who have experienced early-life adversity (eg, childhood maltreatment) develop depression in response to subsequent adversity, including IPV, at higher rates than unexposed individuals.[22–24] Dysregulation of the HPA axis and neuroanatomic changes in response to stress have been associated with increased vulnerability to the development of eating disorders and inhibited control of feeding behaviors.[21,25] C-reactive protein, which is associated with obesity in part through the increased expression of proinflammatory proteins in adipose tissue,[26] has been shown to be elevated among adults who experienced a harsh family environment.[27] Because these responses are likely mediators of the victimization–adiposity association (ie, depression, elevated C-reactive protein, and disordered eating are correlates of partner violence[7–9,28] and have been linked prospectively to obesity[10,11,29]), the impact of DV on adiposity is likely stronger among individuals with a history of child maltreatment. However, this synergistic effect has not yet been tested in relation to adiposity.

To address this gap, the present study examined the relationship between DV and BMI from adolescence to young adulthood among women and men with and without histories of childhood maltreatment by using a large, nationally representative data set.

METHODS

Sample

This study used data from participants interviewed in all 4 waves of Add Health (National Longitudinal Study of Adolescent Health),[30] a nationally representative sample of adolescents in grades 7 through 12 in the United States during the 1994–1995 school year. Using unequal probabilities of selection, a representative sample of schools from the United States (52 middle schools and 80 high schools) was selected with regard to the following: (1) racial/ethnic composition; (2) level of urbanization; (3) region of the country; and (4) school type and size. A total of 20 745 adolescents were selected to participate at wave 1 (79% response rate) and disabled and minority participants (black adolescents with ≥1 parent with a college degree, Puerto Rican, Chinese, and Cuban individuals) were oversampled. The study also interviewed a parent or guardian (17 670 of 20 745) at baseline. Wave 2 interviews (88.6% response rate) took place in 1996 with participants who were in grade 11 and lower at wave 1. Follow-up interviews for wave 3 (2001–2002; 77.4% response rate) and wave 4 (2008–2009; 80.3% response rate) were conducted with individuals who had participated in wave 1. The sample for the present study includes individuals who participated in all 4 waves of data collection, had nonmissing sampling weights, and reported at least 1 relationship for which DV was assessed (N = 9295).

Measures

Outcome

BMI was calculated at waves 2, 3, and 4 from measures of weight in kilograms divided by height in meters squared. Standardized approaches to height and weight measurements were used.[31]

Exposure

DV was measured in waves 2, 3, and 4 by using items from the revised Conflict Tactics Scales[32] (items listed in full in Supplemental Table 4). At wave 2, respondents were asked to report on their experiences of physical DV victimization in up to 3 relationships occurring in the previous 18 months. At wave 3, respondents reported on physical and sexual DV in relationships

that had occurred since the summer of 1995 and were considered important, defined by using factors such as marital status and recency and duration of the relationship.[33] At wave 4, respondents reported on physical and sexual victimization in a current relationship. Victimization was defined as present in a given wave if the participant gave an affirmative response to a victimization item at that wave of data collection.

Moderator

Frequency of parent/adult caregiver–perpetrated abuse and neglect that occurred before the sixth grade was retrospectively assessed at wave 3 by using modified versions of existing scales.[34–36] Maltreatment was defined as acts of omission (inadequate supervision, physical neglect) and acts of commission (physical or sexual abuse) in accordance with the definitions of the Centers for Disease Control and Prevention[37] (items listed in full in Supplemental Table 4). Similar to previous analyses of these data,[38] inadequate supervision and physical abuse were considered present if the participant reported ≥5 incidents of each type of victimization. Physical neglect and sexual abuse were considered present if the participant reported each type of victimization at least once.

Baseline Covariates

The model was adjusted for baseline BMI that was calculated based on self-reported height and weight to enable an assessment of BMI subsequent to exposure to DV. Family history of obesity, a major risk factor for obesity, was defined by whether the respondent's biological mother or father was obese as reported by the parental figure at baseline. Factors listed below were chosen for adjustment based on previous research associating them with both the exposure and outcome of

interest, making them potential confounders of the DV–adiposity relationship. A modified 20-item version of the Center for Epidemiologic Studies–Depression Scale[39] was used to measure baseline depressive symptoms. Previous research using Add Health data found that the modified scale had good internal consistency.[40] The original factor structure was replicated in the majority of the sample investigated (non-Hispanic white and Mexican American participants) and functioned similarly across Hispanic subgroups and non-Hispanic white participants.[40] Similar to the original Center for Epidemiologic Studies–Depression Scale scoring, a sum across all items was calculated after reverse-scoring the positive items. Sociodemographic variables included baseline age, race/ethnicity (Hispanic and non-Hispanic white, black, and other), and parental education level reported by the parental figure at baseline (ordinal variable ranging from less than high school to college graduate).

Analysis

Descriptive statistics were computed according to gender for study variables. Gender differences in study variables were examined by using χ^2 and t tests for categorical and continuous variables, respectively. Linear models relying on generalized estimating equations with robust SEs and an independence correlation structure were used to examine the relationship between the repeated measures of IPV victimization and BMI. Specifically, we estimated the extent to which victimization reported up to and including wave t predicts BMI reported at wave t by using data from waves 2 through 4 and controlling for baseline (wave 1) measures of age, race/ethnicity, parental education, family history of obesity, BMI, and depressive symptoms and retrospectively assessed (wave 3) measures of child maltreatment. DV–BMI models

were sequentially adjusted for each type of child maltreatment (model 1: inadequate supervision; model 2: physical neglect; model 3: physical abuse; and model 4: sexual abuse). Reported coefficients represent the difference in BMI units between those exposed and those not exposed. Multiplicative interaction terms between the measure of childhood maltreatment modeled and IPV were tested. Given strong evidence of different patterns of violence exposure and violence-associated health impacts,[1,12,34] all models were stratified according to gender. Observations at time points in which the respondent was pregnant (if female) or in which no relationship was assessed or all IPV items were designated as not applicable were excluded from the analysis.

Multiple imputation by using PROC MI in SAS version 9.3 (SAS Institute, Inc, Cary, NC) was performed to deal with missing data among those who participated in all 4 waves. Percent missing for all variables was between 0% and 4.8% except for inadequate supervision, parental education, and family history of obesity, which were 6.8%, 11.5%, and 11.7%, respectively. Twenty five data sets were generated. In addition to the study variables, auxiliary variables were included in the imputation process to improve power, reduce nonresponse bias, and improve the likelihood that the missing-at-random assumption underlying multiple imputation was not violated.[41]

Descriptive statistics and regression models were computed by using SUDAAN version 11.0 (Research Triangle Institute, Research Triangle Park, NC). All descriptive statistics incorporated survey design and unequal probability of selection per Add Health user guidance[42] and used the imputed data. Because accounting for the lack of independence of respondents' items across waves was not possible while also incorporating the study design

variables, only sampling weights could be correctly accounted for in the regression models. Variables representing how the schools were selected (region of the country, urban/rural location, and school type, size, and percentage of the study body that was white) were included as covariates in the model to adjust for the correlation that might arise due to the sampling design. Bivariate tests (t tests and χ^2 tests) were conducted to examine differences in baseline sociodemographic characteristics of individuals included compared with those excluded (ie, did not attend all waves/did not report a relationship). The participants not included in the analyses were slightly older, had parents with lower education, and were more likely to be non-white than individuals included in the analyses (all P values $<.01$).

RESULTS

At baseline, the sample was, on average, 15.0 years of age (95% confidence interval [CI]: 14.8 to 15.3) and 49.9% female (n = 5083). Sixty-eight percent were non-Hispanic white (n = 5236), 15.2% (n = 1909) were non-Hispanic black, 12.0% were Hispanic (n = 1435), and 5.0% (n = 715) were other race. From baseline to wave 4, BMI increased on average 6.5 units (95% CI: 6.2 to 6.7) and 6.8 units (95% CI: 6.5 to 7.1) among men and women, respectively; nearly one-half (45.5% of men; 43.9% of women) reported DV at some point. Men reported higher levels of parental education compared with women. Men and women did not differ in BMI except in adolescence when boys had slightly but significantly higher BMIs (Table 1). As adolescents, boys and girls did not differ significantly in their reports of victimization. By young adulthood (wave 3), more women than men reported partner violence victimization (women: 35.1%; men: 29.5%), but by later adulthood

TABLE 1 Participant Characteristics According to Gender (N = 9295)

Variable	Men (n = 4212)	Women (n = 5083)	P
Wave 1 age, mean (95% CI)	15.1 (14.9 to 15.3)	15.0 (14.7 to 15.2)	.001
Race/ethnicity			.21
Non-Hispanic white	2401 (67.6)	2835 (68.0)	
Non-Hispanic black	774 (14.7)	1135 (15.7)	
Hispanic	675 (12.2)	760 (11.9)	
Non-Hispanic other	362 (5.5)	353 (4.4)	
Parental education			.03
<High school/high school alternative	645 (15.2)	925 (17.1)	
High school graduate or GED test	1182 (30.2)	1489 (32.6)	
Vocational/some college	1272 (30.0)	1411 (27.7)	
College graduate	1113 (24.6)	1258 (22.6)	
Family history of obesity[a]			.96
No	3227 (76.6)	3906 (76.5)	
Yes	985 (23.4)	1177 (23.5)	
Depressive symptoms, mean (95% CI)	11.0 (10.7 to 11.3)	13.5 (13.0 to 13.9)	<.001
BMI, mean (95% CI)			
Wave 1	22.6 (22.3 to 22.8)	22.3 (22.0 to 22.5)	.04
Wave 2	23.2 (22.9 to 23.4)	22.8 (22.5 to 23.1)	.01
Wave 3	26.6 (26.2 to 26.9)	26.8 (26.4 to 27.1)	.28
Wave 4	29.0 (28.6 to 29.4)	29.1 (28.7 to 29.5)	.73
DV			
Wave 2			.58
No	2317 (88.5)	3119 (87.9)	
Yes	309 (11.5)	401 (12.1)	
Wave 3			<.001
No	2459 (70.5)	2826 (64.9)	
Yes	979 (29.5)	1487 (35.1)	
Wave 4			<.001
No	2960 (70.5)	3991 (80.5)	
Yes	1181 (29.5)	1018 (19.5)	
Childhood maltreatment			
Inadequate supervision			.31
No	3706 (88.6)	4554 (89.5)	
Yes	506 (11.4)	529 (10.5)	
Physical neglect			<.001
No	3621 (85.5)	4624 (90.8)	
Yes	591 (14.5)	459 (9.2)	
Physical abuse			.51
No	3822 (91.5)	4669 (92.0)	
Yes	390 (8.5)	414 (8.0)	
Sexual abuse			.45
No	4036 (95.7)	4834 (95.2)	
Yes	176 (4.3)	249 (4.8)	

Unless otherwise indicated, data are presented as n (%). GED, General Educational Development.
[a] Defined by whether the respondent's biological mother or father was obese as reported by the parental figure at baseline.

(wave 4), more men than women reported victimization (women: 19.5%; men: 29.5%). Adolescent boys were more likely to report childhood physical neglect, but no other gender differences were noted in exposure to child maltreatment.

On average, women exposed to DV had a 0.4 (95% CI: 0.1 to 0.7) higher BMI than women not exposed to DV (Table 2). In women, supervision neglect was associated with a 0.7 (95% CI: 0.2 to 1.1) higher BMI compared with those who

did not report supervision neglect. Exposure to childhood sexual abuse was associated with a 0.6 (95% CI: −0.1 to 1.3) higher BMI compared with women not sexually abused as children, although this effect was marginally significant (P = .07). Other forms of child maltreatment were not associated with women's BMI. Neither exposure to DV nor childhood maltreatment was associated with BMI in men.

Childhood sexual abuse compounded the impact of DV on BMI among women

TABLE 2 Independent Effect of Childhood Maltreatment and DV on BMI According to Gender (N = 9295)

Variable	Model 1[a]	Model 2[a]	Model 3[a]	Model 4[a]
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Women (n = 5083)				
DV				
No	Ref	Ref	Ref	Ref
Yes	0.4 (0.1 to 0.7)[b]	0.4 (0.1 to 0.7)[b]	0.4 (0.1 to 0.7)[b]	0.4 (0.1 to 0.7)[b]
Childhood maltreatment				
Inadequate supervision	0.7 (0.2 to 1.1)[b]	—	—	—
Physical neglect	—	−0.3 (−0.8 to 0.2)	—	—
Physical abuse	—	—	0.2 (−0.3 to 0.7)	—
Sexual abuse	—	—	—	0.6 (−0.1 to 1.3)[c]
Men (n = 4212)				
DV				
No	Ref	Ref	Ref	Ref
Yes	−0.2 (−0.4 to 0.1)	−0.2 (−0.4 to 0.1)	−0.2 (−0.4 to 0.1)	−0.2 (−0.4 to 0.1)
Childhood maltreatment				
Inadequate supervision	0.1 (−0.3 to 0.6)	—	—	—
Physical neglect	—	0.1 (−0.3 to 0.5)	—	—
Physical abuse	—	—	0.0 (−0.5 to 0.5)	—
Sexual abuse	—	—	—	0.3 (−0.4 to 1.0)

[a] Adjusted for baseline (wave 1) age, race/ethnicity, parental education, family history of obesity, BMI, and depressive symptoms. Each model (1–4) additionally incorporates 1 of the 4 forms of child maltreatment.
[b] $P < .05$.
[c] $P < .10$.

(interaction P value = .03) (Table 3). Women exposed to DV alone had a 0.3 (95% CI: 0.0 to 0.6) higher BMI compared with women not exposed to childhood sexual abuse and DV. However, women exposed to both forms of violence had a 1.3 (95% CI: 0.3 to 2.3) higher BMI compared with women not exposed to either form of violence. No other form of childhood maltreatment significantly altered the DV–BMI relationship in women (interaction P values ranged from .16 to .91). No synergistic effects between child maltreatment and DV were detected for men (interaction P values ranged from .54 to .96).

DISCUSSION

The findings of this prospective study suggest that DV is associated with higher BMI among women, and those individuals with previous exposure to childhood sexual abuse are especially vulnerable to DV-related BMI increases. These results extend understanding of the physical health consequences of DV at a time when obesity is a national epidemic, and nationally representative studies demonstrate high rates of DV in US adolescents and young adults. The significance of these findings is strengthened by the use of a nationally representative sample with objectively defined measures of BMI and behavioral markers of violence in childhood and in dating relationships, as well as our examination of differences according to gender. This study fills an important gap in the literature by examining the relationship of multiple forms of interpersonal violence in childhood and adolescence to adult health.

The lack of an association among men in this study is consistent with findings from the only previous study that investigated the relationship between IPV and a measure of adiposity in men.[12] Studies of the impacts of child maltreatment[17] and other interpersonal violence[43] on obesity have also found more substantial effects in women than in men. In the present study, depressive symptoms were higher among women compared with men, a finding consistent with the literature. Depression is a known health effect of exposure to childhood sexual abuse[44] and IPV[45] and

TABLE 3 Interaction Effect of Sexual Abuse and DV on BMI According to Gender (N = 9295)

	Women (n = 5083)	
	No Sexual Abuse (n = 4834)	Sexual Abuse (n = 249)
	β (95% CI)	β (95% CI)
DV		
No	Ref	Ref
Yes	0.3 (0.0 to 0.6)[a]	1.3 (0.3 to 2.3)[a]
	Men (n = 4212)	
	No Sexual Abuse (n = 4036)	Sexual Abuse (n = 176)
	β (95% CI)	β (95% CI)
DV		
No	Ref	Ref
Yes	−0.2 (−0.5 to 0.1)	0.2 (−1.0 to 1.4)

[a] $P < .05$.

an independent predictor of BMI increase and obesity,[10] with stronger evidence for the link in women compared with men.[46,47] Women's greater propensity to develop depression may be a key to understanding gender differences in the association between violence and measures of adiposity.

Childhood maltreatment was an independent predictor of BMI for women in this study. Previous research using Add Health data has found various forms of child maltreatment to be associated with being overweight in adolescence,[34] obesity in late adolescence and young adulthood,[48] and incident severe obesity.[49] In contrast, other Add Health studies found no evidence linking supervisory neglect[34] or sexual violence[48] to overweight and obesity in women during adolescence. However, adolescents exposed to sexual violence or neglect demonstrated greater BMI increases over time compared with unexposed adolescents in the Add Health literature.[50] Thus, dangerous weight trajectories may begin early in those exposed to childhood maltreatment and be evident later in life through measures of obesity and adiposity in adulthood.[17,43]

We are unaware of any previous study investigating the impact of both childhood maltreatment and DV victimization on measures of adiposity. This study's findings begin to fill this gap and highlight the synergistic effect of experiencing both forms of abuse on BMI. Findings are consistent with a diathesis–stress model: early exposure to childhood sexual abuse may have sensitized individuals to later challenges (ie, DV) due to long-term changes in the HPA axis.[51] This study did not examine specific aspects of HPA axis dysregulation or other potential pathways. Replicating study findings and identifying mediators and modifiers of the DV–BMI association will be essential to clinical and public health efforts to address the long-term health effects of victimization.

LIMITATIONS

Despite using a well-validated measure of DV, several factors potentially limit our ability to correctly classify an individual's violence experience. First, DV was self-reported because most violent incidents are not disclosed to verifiable sources.[52–54] Second, the current study measured violence by using items from subscales of the revised Conflict Tactics Scale but did not assess severe emotional violence, which independently predicts poor physical and mental health.[55] The items used to assess DV changed slightly over time, and violence was not assessed in all relationships at each wave. Furthermore, the time frame for reporting partners overlapped between waves 2 and 3, but both were retained because recall at each wave would be better for time periods closer to the actual interview. However, the prevalence of DV in waves 2, 3, and 4 is broadly similar to other large epidemiologic studies.[1,56,57] The baseline measure of BMI was self-reported. However, a validation study of Add Health data showed that 96% of self-reports correlated with obesity status in boys and girls, suggesting some concordance between self-report and measured BMI.[58] Also, the missing-at-random assumption underlying multiple imputation cannot be tested. The study included auxiliary variables in the imputation process to reduce the likelihood that the assumption is violated,[41] but some degree of violation may still exist. Importantly, although the models adjusted for relevant confounders, residual confounding cannot be ruled out. Finally, the sample included in this study was different from those not included in terms of several sociodemographic characteristics. Although sampling weights and study design were taken into consideration in the analyses, differential attrition and study design decisions may affect the generalizability of the findings.

CONCLUSIONS

Study findings have significant public health implications. Differences of as little as 1 BMI unit (the general effect size found in this study for individuals who had experienced both sexual abuse and DV) have been associated with significant increases in health care costs[59] and the risk of diabetes, even among those within the normal BMI range.[60] Furthermore, if BMI trajectories continue to diverge over time, differences may be more pronounced in mid- to later-life when risk of development of hypertension and type 2 diabetes is higher than in young adulthood. The American Academy of Pediatrics recommends a comprehensive approach to violence prevention including the provision of anticipatory guidance, screening, and counseling during routine health maintenance visits[61] and has guidelines on how to evaluate children when sexual abuse is suspected.[62] The present study highlights the importance of attending to the potential behavioral health correlates of violence to mitigate the long-term health effects of victimization.

P01-HD31921 for the present analysis. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. Dr Clark had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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