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The Role of Prenatal Violence Exposure in the Development of Disparities in Children's Adiposity from Birth to Middle Childhood

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Abstract

Objective—The current study examined whether women's exposure to multiple types of violence during childhood and pregnancy was associated with children's BMI trajectories and whether parenting quality moderated those associations.

Method—A cohort of 1,288 women who gave birth between 2006–2011 self-reported their exposure to childhood traumatic events (CTE), intimate partner violence (IPV), and residential address (linked to geocoded index of violent crime) during pregnancy. Children's length/height and weight at birth and 1, 2, 3, 4–6, and 8-years were converted to BMI z-scores. Observed mother-child interactions were behaviorally coded during a dyadic teaching task.

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Results—Covariate-adjusted Growth Mixture Models identified three trajectories of children's BMI from birth to 8-years-old: Low-Stable (17%), Moderate-Stable (59%), High-Rising (22%). Children whose mothers experienced more types of IPV during pregnancy were more likely to be in the High-Rising than the Low-Stable (*OR*=2.62 CI=1.27, 5.41) trajectory. Children whose mothers lived in higher crime neighborhoods were more likely to be in the High-Rising than Low-Stable (*OR*=1.11 CI=1.03, 1.17) or Moderate-Stable trajectories (*OR*=1.08 CI=1.03, 1.13). Main effects of CTE and moderation by parenting were not detected.

Conclusions—Maternal experiences of violence during pregnancy increase children's risk for developing overweight, highlighting intergenerational transmission of social adversity in children's health.

Keywords

Childhood trauma; Interpersonal violence; Neighborhood crime; BMI; Overweight; Childhood Obesity

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Effective promotion of positive child health and wellness requires early identification of risk factors for poor health to generate precision intervention targets. Such efforts should also attend to the inequitable distribution of these risks in order to promote health for *all* children. Specifically, efforts to foster child health should consider the incidence of obesity within child populations, which is estimated to affect 18.5% of children in the United States and has gained attention as a significant public health concern.[1] At a broad level, obesity (or adiposity) arises when energy intake exceeds energy expenditure. However, this relationship is nonlinear, and the development of obesity is multifaceted, with individual variation in children's propensity to amass excess adipose tissue.[2] Although most research to date has focused on diet and exercise, a growing body of research suggests that early life obesity and metabolic dysfunction may be linked to prenatal social and environmental exposures that influence child development.[3] For example, developmental origins of health and disease and prenatal programming hypotheses suggest that women's experiences of adversity during pregnancy can alter endocrine, adipocyte, and immune processes. These alterations pass between mother and fetus via their placental connection and play a crucial role in both fetal development and subsequent child health.[2,4,5] A newer line of research suggests that effects of trauma may be intergenerationally transmitted such that a woman's own early childhood traumatic experiences may alter her biology in lasting ways, which may additionally influence her and her offspring's health[6]-through both pre- and postnatal pathways. Beyond the biological mechanisms, experiencing major traumatic events (both in childhood and pregnancy) may also indirectly influence the dyad through impacts on women's social and health behaviors. In sum, there are strong theoretical rationales for both biological and social mechanisms of the associations between women's history of trauma and children's outcomes, with increasing evidence for neurodevelopmental outcomes. However, there are limited empirical examinations on the lasting effects of women's trauma on children's adiposity.[6,7]

A small body of existing studies have explored the intergenerational associations between women's stress exposure and child physical growth. These studies have found that higher levels of maternal stress in pregnancy predict lower infant birthweight,[8,9] rapid infant weight

gain across the first 6 months of life,[10] and higher child weight at 5-years-old.[11] To our knowledge, there is one study of women's childhood traumatic events and child weight outcomes, which found positive associations with low birthweight.[12] Though the emerging evidence is compelling, existing studies are limited by their use of singular types and timepoints of maternal stress exposure. In addition, most prior work has focused on single outcome timepoints, preventing understanding of whether effects on child growth endure longitudinally.[13] Considering multiple types of violence exposure in both immediate and broader environmental contexts (e.g., interpersonal and community violence) and across multiple key periods in the woman's life (e.g., early childhood and pregnancy) more comprehensively accounts for the intergenerational impact of her history of traumatic experiences on her child's adiposity. Specifically, intimate partner violence (IPV, i.e., experience of violence from a current or former partner) is an unfortunately common experience among women during pregnancy and is associated with increased rates of morbidity and mortality[14,15] As a measure of community violence, living in neighborhoods characterized by high levels of violent crime can produce prolonged periods of stress which have negative impacts on health in the moment and across time.[16] Combined, accounting for experiences of IPV and neighborhood violent crime during pregnancy may capture a range of violent exposures that transmit risk to children's obesity development. As with examining multiple types of violence exposures, studies mapping growth in individuals across time will increase our understanding of the development of pediatric obesity across important periods in physical development to identify early risk patterns.[3,13,17]

In addition to the need to understand the intergenerational associations of trauma and childhood adiposity, there has also been a recent emphasis on examining factors that protect individuals from the health risks associated with violence exposure.[18] As a particularly relevant factor for children, parenting is an interactive system established through reciprocal behaviors in which a parent and child influence one another. In this bi-directional process, interactions rely on the parent's capacity to respond and interpret the child's cues, behaviors, and competence that contribute to the quality of their interaction.[19] The quality of these parenting interactions have been shown to support adaptive regulatory abilities in children which have, in turn, been associated with weight related attitudes, exercise behaviors, and eating habits.[20] Specifically, multiple studies have documented associations between parenting characterized by reciprocal and warm interactions and lower risk of adverse weight-related outcomes.[21,22] Therefore, postnatal parenting quality may be a particularly relevant modifier of the impact of perinatal stress on growth trajectories. To our knowledge, there are no empirical evaluations of these connections.

To build upon prior research, the present study investigated the independent contributions of maternal violence exposure in childhood (childhood traumatic events; CTE) and pregnancy (intimate partner violence; IPV and neighborhood crime) on children's BMI growth trajectories from birth to 8-years-old, while rigorously adjusting for a wide range of potential covariates. We employed growth modeling techniques to identify distinct trajectories of children's growth and evaluate the intergenerational impact of multiple types of maternal violence exposures. We hypothesized that: 1) there would be three distinct trajectories of growth from birth to age eight in the current sample (i.e., low-stable, moderate-stable, high-rising trajectories), consistent with previous findings in this

cohort from birth to age four;[3] 2) maternal CTE, IPV and neighborhood crime would be independently associated with differing trajectories of children's growth from birth to 8-years-old, supporting the additive utility of examining multiple measures of violence exposure; 3) children whose mothers were exposed to higher levels and/or more types of violence in childhood and pregnancy would be at increased risk for being in the group characterized by increased obesity risk (e.g., excessive catch-up growth, high adiposity gaining trajectories). In secondary analyses, we explored postnatal parenting quality as a modifying factor and hypothesized that higher quality parenting would buffer children from the deleterious effects of violence exposure across multiple levels. Given the composition of our sample (>50% Black) and historic divestment and oppression of the Black community, in the United States, we also compared rates of violence exposures by self-identified race, to enhance understanding of disparities in exposure-related risk.

Methods

Participants and Procedures

The Conditions Affecting Neurocognitive Development and Learning in Early Childhood (CANDLE) study is a prospective cohort of mother-child dyads in Shelby County, Tennessee, United States. Detailed description of the study and participants has been reported elsewhere.[3] The CANDLE study recruited women aged 16–40 years old who were in the second trimester of a singleton pregnancy between 2006 and 2011. Exclusion criteria included existing chronic disease requiring medication, known pregnancy complications (i.e., gestational diabetes, pre-eclampsia, or hypertension), and plans to deliver at a nonparticipating hospital. Following visits during the second trimester, third trimester, and live birth of their infants, mothers completed questionnaires, and physical exams were conducted at the research clinic when children were 1, 2, 3, 4–6, and 8-years-old. All postnatal assessments included anthropometric measurements and evaluations of demographics. Women reported on their histories of violence exposure during their pregnancy assessments, and parenting was directly observed and scored at 1, 2, and 3-year assessments. The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of The University of Tennessee Health Sciences Center.

Measures

Maternal Childhood Traumatic Events (CTE).—At their second trimester study visit, women reported their history of violence exposure in childhood using three items from the Traumatic Life Events Questionnaire[23] that assessed experiences of physical abuse before age 18, sexual abuse before age 13, and witnessing family violence 'while growing up'. A count of the number of traumatic events experienced was created (coded 0–3), with a higher value reflecting exposure to more types of traumatic events in childhood.

Intimate Partner Violence (IPV).—During the third trimester, women reported on their experiences of IPV via the short-form of the revised Conflict Tactics Scale.[24] Participants' indicated (yes/no) whether they had experienced any of four forms of aggression (physical,

sexual, psychological, and injury) perpetrated by their partner in the past year. Responses were summed to create a total count ranging from 0–4.

Neighborhood Crime.—During the prenatal assessments, participants reported their residential address, which was used to evaluate neighborhood violent crime (i.e., homicide, rape, armed robbery and aggravated assault) rate per 1000 residents using an objective, geocoded index of neighborhood violent crime derived from a national register of crime data obtained from Neighborhood Scout.[25,26] Uniform crime rates are provided annually to the FBI by a broad range of local law enforcement agencies and are considered a valid measure of criminal behavior. For each participant, we utilized the violent crime rate statistic for the census tract and month of residence closest to their child's year of birth. For those that moved during pregnancy, we calculated a duration-weighted average for level of neighborhood violence.

Child Physical Growth.—Newborn birth weight and length were abstracted from birth records. Children's length/height and weight were measured at each postnatal timepoint by a trained clinical data collection team.[3] Measurements were used to derive age- and sex- specific weight and BMI z-scores according to the World Health Organization (WHO) growth charts for children under age two years,[27] and Center for Disease Control (CDC) guidelines for children two years and over. The BMI z-scores place weight and length/height from WHO growth charts and CDC guidelines on the same scale, which aids in comparison with international and national averages for their age, respectively. Utilizing standardized z-scores aids in generalizability beyond the current sample and examines how the individual's BMI ranking changes in the population over time which may be more relevant for a pediatric population. A BMI z-score of zero reflects a child who has a BMI at the national average, while a z-score of 1 or −1 reflects a child with one standard deviation above and below the national average BMI, respectively.

Observed Parenting Quality.—The NCAST Parent-Child Interaction Teaching Scale is a 50-item yes/no observational measure designed to assess parent-child interaction during a brief teaching episode that produces minor stress on the dyad.[28] Coding was conducted during study visits by extensively trained coders who were required to maintain reliability of 85% or higher and were reassessed every 6-months to ensure reliability. The NCAST utilizes four parenting behavior subscales: sensitivity to cues, response to distress, social-emotional growth fostering, and cognitive growth fostering. Parents demonstrate sensitivity through recognizing and responding to the child's behaviors and cues. They respond to and alleviate their child's distress as they recognize the child's cue as distress (i.e., sensitivity to cues), know the action that will alleviate distress (i.e., response to distress), and can use this knowledge to engage in behavior that meets their child's needs. Growth fostering occurs as parents understand the importance of social-emotional and cognitive stimulation for the child, their child's level of functioning, and how to support and facilitate the child's development at that level. Parents must be emotionally and physically available to provide experiences and stimulation to facilitate the child's growth and development. Dichotomous parenting scores were summed across all 50-items, at each timepoint, with high scores

reflecting more positive parenting practices.[29] An overall early childhood parenting quality score was created by averaging observed scores across age 1, 2, and 3-years-old.

Covariates.—To reduce bias, analyses included potential covariates of the association between maternal violence exposure and children's BMI. During the prenatal visits, women self-reported their nutritional intake during pregnancy (kCal)[30] as well as their total household income, race,[a] and whether they smoked during pregnancy. Maternal age at birth, pre-pregnancy BMI, gestational age at birth, maternal pregnancy complications (gestational hypertension, preeclampsia, or gestational diabetes at any time during pregnancy), gestational weight gain, number of previous live births (i.e., parity), and child sex were extracted from the obstetric record. In an attempt to isolate associations of violent crime from those of socioeconomic deprivation, we also included a U.S. Census-derived measure of neighborhood-level social deprivation based on the women's neighborhood of residence during pregnancy.[31] In postnatal follow-up visits, mothers reported on whether they breastfed their children, using the Infant Feeding Practices Questionnaire, and their child's total daily nutritional intake (kCal) using the Food Frequency Questionaire.[32] At age 4–6 and 8-year-old assessments, women reported on their child's physical activity (average weekly activity), their own perceived stress and highest level of educational achievement.

Analytic Plan

All analyses were performed in MPLUS version 8. Chi-squared and t-test analyses were used to investigate sample characteristics. To identify distinct patterns of growth (hypothesis 1), regarding variation in children's growth, we utilized Latent Class Growth Mixture Models (LCGMM), a person-centered technique that groups individuals with similar growth patterns and captures the heterogeneity in BMI development from birth to 8-years-old in a set number of classes ranging from one to five. First, we fit linear LCGMM successively increasing the number of classes allowed within the model, and evaluated each model using fit indices (e.g., Bayesian Information Criterion, BIC and entropy) to determine the best fitting model.[33] Specifically, the best fitting model was identified as that with the lowest BIC and highest entropy, as well as the solution that did not have a trajectory made up of less than 5% of the total sample. Following the selection of this model, to test hypotheses 2 and 3 evaluating whether maternal violence exposure was associated children's growth, we added mother's CTE, as well as experiences of IPV and neighborhood crime during pregnancy into the singular LCGMM to evaluate associations with these trajectories. Given that some of the covariates included in this investigation may in fact operate as mediators, this model was evaluated in steps. First, we evaluated an unadjusted model with no covariates included in our LCGM analysis. Second, we evaluated a model with only the essential covariates included (i.e., race, maternal age, child sex) before finally evaluating a fully adjusted model that included all prenatal and postnatal covariates, including ones that may be conceptualized as mediators. These three models were compared to evaluate whether the inclusion of our robust covariate set influenced the direction and strength of the associations between violence exposure and BMI trajectories. Given no substantive differences in these

[a]Race is a political and social construct that often serves as a proxy for the impact of racist practices and structural inequality (including disproportionate exposure to violence), it is not a biological variable and thus is examined in the current paper with this premise in mind

models, we moved forward with the fully adjusted model only. This single model yielded multinomial logistic regression tests of each type of violence exposure's association with trajectory membership. Secondary analyses (hypothesis 4) built upon prior models by including an interaction term between postnatal parenting and each prenatal exposure to evaluate moderation. Missing data was handled using full information maximum likelihood (FIML) estimation.

Results

The full CANDLE sample include 1300 mother-child dyads who participated in the longitudinal cohort design. However, for the purpose of this study, only participants with a valid birthweight measurement and at least 2 postnatal height and weight measurements were included. Rates of missing data for BMI z-score varied across time (birth = 11.3%, 1-year = 13%, 2-years = 17%, 3-years = 19.1%, 4–6-years = 17.7%, 8-years = 20.9%). In evaluations of patterns of missingness, there were no associations between children's BMI missingness at single timepoints and other variables within our study (*p*s > .05). The analytic sample included 1288 mother–child dyads, and mothers predominantly identified as Black (62.9%) or White (29.2%), which is representative of the larger Memphis area. Women also reported an average income of $20,348 a year and were 26.98 years old at the time of delivery; see Table 1 for full demographics. In the current sample, 39.1% of women experienced at least one type of CTE, 67.1% experienced at least one type of IPV, and 20.6% of women lived in a neighborhood with a crime rate above the average in the Memphis, TN area (see supplemental Table S4 for exposure comparisons by race). Rates of children having a BMI z-score above 1.67 (cutoff for obesity at 2-years and older) varied by age; 9.3% at 2-years, 8.9% at 3-years, 12.1% at 4–6-years, 13.6% at 8-years.

BMI Trajectory Characterizations

Evaluation of model fit indices found that a three-class solution was the best fitting model in the trajectory analysis (Figure 1; supplemental table S5 for all model fit comparisons). Most children (59.8%) were classified in a trajectory characterized by average size at birth (a BMI z-score close to zero) followed by a moderate BMI z-score gain across the first year of life and a subsequent, relatively stable, z-score ranging from 0 to .6 through age eight. Given this pattern, and in line with the previous BMI trajectory study in this sample,[3] we termed this group the Moderate-Stable BMI trajectory. The next trajectory group (22.7% of children) started at a moderate size at birth, had rapid BMI gain during the first year and high stable BMI z-score that ranged from 1.55 to 1.95. Therefore, we termed this group the High-Rising BMI trajectory. The third and final trajectory (17.4% of children) was characterized by relatively small size at birth, moderate gains in the first year of life and then relatively stable low BMI z-score that ranged from −.25 to −.9. Notably, although these patterns were the lowest within the sample, they did not reach levels of clinical underweight. Given this pattern, and in line with previously identified trajectories, we termed this group the Low-Stable trajectory.

Maternal Violence Associations with BMI Trajectory

In covariate-adjusted models including all types of violence exposure in a single model, IPV and neighborhood crime were independently associated with trajectory membership (Table 2). Given that only the High-Rising BMI trajectory reached clinical thresholds for weight-related risk, we evaluated comparisons between this trajectory and both other variations in growth. For every additional type of IPV mothers experienced during pregnancy (range 0 – 4), their children were 2.62 times more likely to be in the High-Rising than the Low-Stable trajectory (*OR*=2.62, CI=1.27, 5.41) and 1.81 times more likely to be in the Moderate-Stable than the Low-Stable trajectory (*OR*=1.81, CI=1.07, 3.04). For every one standard deviation (10.88 crimes per 100,000) increase in rate of neighborhood violent crime during pregnancy, children were 1.08 and 1.11 times more likely to be in the High-Rising than the Moderate-Stable (*OR*=1.08, CI=1.03, 1.13), and the Low-Stable trajectory (*OR*=1.11, CI=1.03, 1.17), respectively. Maternal CTE was not associated with trajectory group. Full model outputs, including the covariate associations with trajectory membership, are shown in supplemental Tables S1–S3. In the secondary analysis evaluating whether parenting behaviors operated as a protective factor, we found no interaction between any violence exposure variable and parenting quality in associations with children's growth trajectories (see Tables S6–S8).

Discussion

Worldwide, overweight and obesity account for millions of deaths each year, leading to widespread call for understanding the development of these problems and plans for mitigation.[34] Leveraging a large sociodemographically diverse prospective pregnancy cohort, we identified three distinct trajectories of BMI from birth to 8-years-old. We found that mothers who experienced more types of IPV and lived in higher crime neighborhoods during pregnancy were more likely to have children in the High-Rising trajectory (representing moderate weight at birth followed by high postnatal weight gain). Notably, both interpersonal and community-level violence exposure were independently associated with children's adiposity across early childhood, including well-established predictors of child BMI (e.g., neighborhood poverty, child energy intake, activity level). To our knowledge, this is the first evidence to suggest the intergenerational impact of women's violence exposures, across multiple contexts during pregnancy, on children's physical growth. Findings suggest risk for developing obesity in childhood may originate, in part, during pregnancy.

During pregnancy, the placental connection between a mother and her developing fetus creates a pathway by which her experiences, and their corresponding biological responses, can transmit risk across generations. The prenatal period is marked by rapid fetal development across both brain and body. Elevations in mother's endocrine and inflammatory biomarkers in response to stressors (such as exposure to violence) may disrupt typical fetal developmental trajectories that ultimately place children at risk of developing obesity.[5] By accounting for violence exposure across multiple contexts (i.e., interpersonal and neighborhood), the current study provides support for different levels of violence exposure as unique and independent factors for children's physical health outcomes. Ultimately, the independent associations suggest the importance of evaluating multiple aspects of

women's experience and indicate that interventions focused on only one type of pregnancy exposure may not fully address the risk of intergeneration violence exposures. Rather, interventions focused on multiple points of exposure across contexts may be more effective in reducing obesity rates in children. Importantly, the current findings suggest a specific influence of perinatal violence exposure above and beyond that of family and neighborhood socioeconomic factors, in line with recent evidence from the mental health field that exposure to threat and experiences of deprivation may operate differently to confer risk for individuals,[35] with our findings suggesting independent effects that cross generations.

In the current sample, we identified three distinct trajectories of children's growth across childhood. Two trajectories emerged that characterized BMI z-scores in non-clinical ranges, the Moderate-Stable trajectory, and the Low-Stable trajectory. The Moderate-Stable group characterized children who maintained BMI around national averages across childhood, and although the Low-stable group was the lowest BMI group, their averages did not reach clinical significance for underweight. However, the High-Rising BMI trajectory did reach clinical thresholds for overweight and obesity. About 22% of children fell into this category, which is consistent with the rates of children with obesity in Tennessee as a whole. Tennessee, along with six other states in the U.S. have the highest rates of children with obesity in the country, so the prevalence of children within this High-Rising trajectory may vary in states with lower obesity rates. In evaluating the influence of violence exposure for different growth trajectories, the current study identified significant differences between the High-rising BMI trajectory as compared to both the Moderate-Stable and the Low-Stable trajectories. Given the non-clinical nature of these two groups, our findings show that both IPV and living in high crime neighborhood during pregnancy are associated with increased risk of being on a High-Rising trajectory as compared to both an average BMI across childhood and a slightly lower than average BMI trajectory. Although this is the first study to examine the associations longitudinally, findings map onto single timepoint studies which identify links between maternal stress exposure and child birthweight and weight at 5-years-old.[8–10]

Contrary to our hypothesis, maternal CTE was not independently associated with BMI trajectory membership despite research suggesting that women's early childhood experiences may program her biology in ways that may impact her future offspring.[36] Notably, two robust pregnancy violence measures were simultaneously included in the model, which may have better accounted for the association between maternal exposure and child growth and occluded a potentially weaker association between CTE and BMI trajectories. Moreover, the CTE measure available in this cohort included only three types of traumatic exposures and did not include the full range of experiences that may have occurred in a women's childhood that might be impactful for the intergenerational transmission of her childhood stress. To gauge these findings, future studies should evaluate these questions with a more comprehensive measurement of maternal CTE.

Similarly, there was no evidence for parenting quality moderating the association between maternal history of violence exposure and children's BMI trajectories. Although parenting quality supports adaptive regulatory abilities in children that may influence weight-related attitudes, exercise behaviors, and eating habits,[20] it may not be strong enough to combat the

deleterious impacts of violence exposure. This null finding suggests that community-level efforts to prevent violence in homes and communities, and to support families through health-promoting resources and services, are needed to promote child health and buffer children from risks.

Findings from this study suggest that those who are disproportionately exposed to different types of violence may merit prioritization of support and targeted prevention efforts that reduce disparities in pregnant people's exposure which may ultimately promote children's health.[37,38] Reflecting on the differences in violence exposure by race in this sample, Black mothers were more likely to live in high crime neighborhoods, experience IPV, and be exposed to CTE than White mothers (see supplemental Table S4). These differential rates of exposure to violence likely reflect the history of structural practices that uphold racial segregation and disparate neighborhood contexts.[37] Findings from the present study should be considered when evaluating solutions to poor health for racially marginalized children.

Strengths and Limitations

Strengths of the current study include a large, socioeconomically and racially diverse sample, modeling growth at six measurement timepoints across childhood, robust covariate adjustment, and evaluations of the intergenerational transmission of violence exposure utilizing multiple measures of women's violence exposure across contexts and periods in her life. However, this study used a 3-item measure of CTE that did not assess the full range of potential childhood traumatic experiences, although it captured some of the most pernicious types of violence exposure. Thus, we cannot rule out whether a broader assessment of maternal stressful childhood experiences would have contributed to offspring weight/growth. Also, about 30% of participants moved during pregnancy, so, although a duration-weighted average was used to capture moves, we cannot evaluate these questions in a multilevel analysis to assess the impact of shared neighborhood environments. In addition, although the phenomena of intergenerational transmission should be universal across human development, effects found here may not generalize to geographies with social and health policies that vary substantially from those found in the U.S. region the sample was drawn from. Similarly, although our fully-adjusted models include maternal report of stress at her child's 8-year visit as a covariate to capture some postnatal stress exposure, it is possible that unmeasured aspects of children's own direct exposure to stressors postnatally may be important for the associations documented here—either as covariates or additional mediators of maternal risk. Future work should evaluate these longitudinal associations and impacts of different types of violence exposure within and beyond the intergenerational framework discussed here. Finally, some covariates included in the analysis may operate as mediators; therefore, the associations found here may be underestimated.

Conclusion

In a large, socioeconomically and racially diverse, prospective longitudinal U.S. cohort utilizing well-adjusted LCGMM models, we identified independent associations between women's experiences of IPV and neighborhood violent crime during pregnancy with children's risk for being in a high BMI trajectory. These findings provide foundational evidence for the likelihood of intergenerational transmission of social adversity in the

etiology of children's health. Interventions focused on preventing and mitigating family- and community-level exposure to violence for pregnant people may support two generations and help address child obesity rates.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Study Importance:

What is already known about this subject?

- Many factors contribute to the development of childhood obesity, and there are individual differences in trajectories of adiposity
- Prenatal environments may program postnatal health, with most research focusing on prenatal nutrition
- Although maternal stress in pregnancy has been linked to fetal development, its role in childhood obesity trajectories has not been examined

What are the new findings in your manuscript?

- Mothers' exposure to interpersonal violence during pregnancy (i.e., intimate partner violence) is associated with their children's adiposity trajectories
- Mothers' exposure to violence in the broader environment during pregnancy (i.e., neighborhood crime rates) is also associated with children's adiposity trajectories

How might your results change the direction of research or the focus of clinical practice?

- Our work highlights the importance of considering the influence of prenatal psychosocial factors in child physical health outcomes
- Findings suggest it is important to consider multiple potential sources of prenatal stress to understand the development of child obesity
- Family- and community-level interventions focused on preventing and/or mitigating exposure to violence for pregnant people may be one avenue to help to address child obesity rates

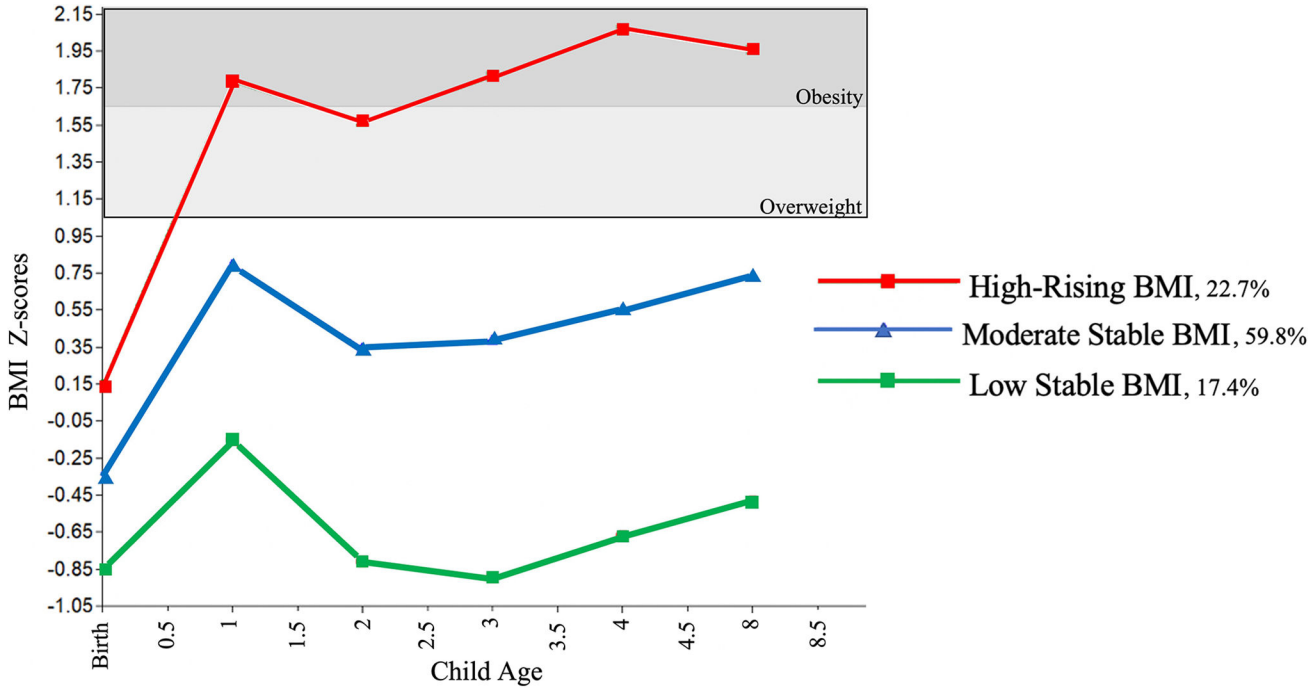

Figure 1.

BMI z-score trajectories from birth to age 8 in the CANDLE sample.

Note: A BMI z-score of zero represents a BMI score that is the same as the national averages of BMI for that age. The grey sections of the graph represent the CDC cutoff for classifying overweight (z-score above 1.06) and obese (z-score above 1.654). No trajectory in the current samples reached the CDC benchmark of underweight (z-score = −1.645).

Table 1.

Demographics for the full analytic sample (N = 1,288)

Categorical Variables	N	%
Child Sex (female)	640	49.7
Race (Black)	810	62.8
Ever Breastfed (yes)	769	59.7
Previous live births		
0	532	41.3
1	390	30.5
2	212	16.5
3+	154	12
Maternal Education at age 4		
Less than High School	41	4.5
High School Diploma or GED	151	16.6
Vocational or Technical School	62	6.8
Some College or Associates Degree	298	32.8
Baccalaureate degree	190	20.9
Master's Degree	137	15.1
Doctorate Degree	30	3.3
Smoking during pregnancy (yes)	119	9.2

Continuous Variables	M	SD	Range
Maternal age at delivery (years)	26.98	5.48	16.39 – 41.24
Gestational age (days)	272.59	12.20	181 – 293
Gestational weight gain (kg)	14.62	7.35	−19 – 55
Pre-pregnancy BMI (kg/m2)	27.62	7.61	14 – 54
Adjusted household income ($)	20,348.35	17,482.70	510.20 – 79,473.45
Prenatal nutrition (Nutritious intake score)	60.91	12.74	20.12 – 87.66
Prenatal neighborhood deprivation	0.35	0.86	−1.22 – 3.08
Observed parenting quality, postnatal average	39.80	5.31	18 – 50
Child daily energy intake, postnatal average (kcal)	2506.75	1456.49	421.86 – 11828.68
Child physical activity, postnatal average (days)	4.77	2.21	0 – 7
Maternal Perceived Stress (Age 8)	1.34	0.74	0 – 3.5
Mother's CTE	0.52	0.78	0 – 3
Mother's IPV	1.10	0.86	0 – 4
Neighborhood Crime (rate per 1,000)	13.87	10.86	0.13 – 50.89
BMI z-score at birth	−0.38	1.06	−4.32 – 2.92
BMI z-score at age 1	0.76	1.13	−5.03 – 5.79
BMI z-score at age 2	0.30	1.23	−9.29 – 5.49
BMI z-score at age 3	0.34	1.27	−7.66 – 6.30
BMI z-score at age 4	0.54	1.11	−2.99 – 5.24
BMI z-score at age 8	0.68	1.08	−2.69 – 2.94

Note: IPV = Intimate partner violence, CTE = childhood traumatic events.

A crime rate of 13.76 per 1,000 residents corresponds to a 1 in 72 chance of being a victim of violent crime.

Table 2.

Class-specific means of the maternal psychosocial stress predictors and odds ratio comparisons by z-score trajectory profile.

Profile	Predictor Variable	Mean (SD)	OR	95% CI	Reference Group
High-Rising BMI Trajectory	CTE	0.60 (0.81)	0.72	0.38, 1.34	Moderate-Stable BMI trajectory
			0.70	0.36, 1.36	Low-Stable BMI trajectory
	IPV	1.10 (0.94)	1.45	0.75, 2.80	Moderate-Stable BMI trajectory
			2.62	1.27, 5.41	Low-Stable BMI trajectory
	Neighborhood Crime	15.61 (10.96)	1.08	1.03, 1.13	Moderate-Stable BMI trajectory
			1.11	1.03, 1.17	Low-Stable BMI trajectory
Moderate-Stable BMI Trajectory	CTE	0.53 (0.78)	0.98	0.62, 1.56	Low-Stable BMI trajectory
	IPV	1.10 (0.80)	1.81	1.07, 3.04	Low-Stable BMI trajectory
	Neighborhood Crime	13.39 (11.03)	1.02	0.96, 1.08	Low-Stable BMI trajectory
Low-Stable BMI Trajectory	CTE	0.45 (0.76)	---	---	---
	IPV	1.04 (0.80)	---	---	---
	Neighborhood Crime	13.44 (10.79)	---	---	---

Note: CTE = childhood traumatic events, IPV = Intimate partner violence. The rate of neighborhood crime for the Low-Stable and Moderate-Stable BMI trajectories are similar to the sample average of a 1 in 72 risk of being a victim of violent crime. For the High-Rising BMI trajectory, that risk increases to 1 in 64. Covariates include maternal age, adjusted household income, maternal education, gestational age, gestational weight gain, pregnancy risk, parity, prenatal nutrition, pre-pregnancy BMI, smoking during pregnancy, prenatal neighborhood deprivation, child race, child sex, breastfeeding, child postnatal diet, child physical activity, maternal postnatal perceived stress, postnatal parenting quality.