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## Maternal Childhood Adversity, Prepregnancy Obesity, and Gestational Weight Gain

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### Abstract

**Introduction**—Growing evidence suggests that exposure to childhood adversity may influence obesity across the life course. High maternal weight complicates pregnancy and increases the risk of child obesity. This study examined the association between maternal childhood adversity and pregnancy-related weight in a large U.S. sample.

**Methods**—Data on 6,199 pregnancies from 2,873 women followed from 1979 to 2012 by the National Longitudinal Survey of Youth 1979 were analyzed in 2014. Associations between three adversity exposures before age 18 years (history of physical abuse, alcohol problems, or mental illness in the household) and two maternal weight outcomes (prepregnancy obesity and excessive gestational weight gain) were modeled separately using survey-adjusted log-binomial models.

**Results**—After adjusting for race/ethnicity and early life socioeconomic factors, childhood physical abuse was associated with a 60% increase in the risk of prepregnancy obesity (adjusted risk ratio [RR]=1.6, 95% CI=1.1, 2.2). Household alcohol abuse was associated with a 30% increase in prepregnancy obesity (RR=1.3, 95% CI=1.0, 1.7), as was household mental illness (RR=1.3, 95% CI=0.8, 1.9), but the mental illness exposure was not significant. Physical abuse and household alcohol abuse were associated with a significant 20% increase in the risk of excessive gestational weight gain; mental illness was not.

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**Conclusions**—Adversity in early life may affect maternal weight before and during pregnancy. Screening and treating women of reproductive age for childhood adversity and its negative effects could significantly reduce obesity-related health outcomes for women and their children.

## Introduction

Maternal prepregnancy obesity and excessive gestational weight gain (GWG) increase pregnancy complications, long-term maternal obesity, and obesity in the next generation.<sup>1,2</sup> One third of U.S. women are obese,<sup>3</sup> 8% are extremely obese,<sup>3</sup> and at least 40% gain excessive weight during pregnancy.<sup>4</sup> As the childbearing years may represent a critical window in which to address obesity prevention for women, identifying high-risk women is imperative. However, there is a scant evidence base for preconceptional weight interventions, and lifestyle intervention trials to prevent excessive GWG have yielded inconsistent results.<sup>5,6</sup> Prevention and treatment of obesity is challenging, and new research is needed to identify biological, psychological, and social risk factors for obesity across the life course, including during pregnancy.<sup>7</sup>

There is growing evidence that a history of exposure to physical, emotional or sexual abuse, or neglect or household dysfunction before age 18 years (adverse childhood experiences [ACEs]) is both common<sup>8</sup> and a risk factor for obesity and many chronic diseases in adults.<sup>9</sup> However, only two small studies in select populations have investigated the association between ACEs and pregnancy-related weight.<sup>10,11</sup>

This study investigated associations between three specific self-reported ACE exposures (physical abuse, alcohol abuse in the household, and mental illness in the household) and two measures of pregnancy-related weight (pregnancy obesity and excessive GWG) in a large U.S. sample overall and within subgroups.

## Methods

### Study Sample

The National Longitudinal Survey of Youth 1979 (NLSY79) is a longitudinal study of 12,686 women and men aged 14–22 years enrolled in 1979 with an oversampling of black and Hispanic participants, which has been previously described in detail.<sup>12</sup> Participants were surveyed every year through 1994 and every 2 years from 1996 to 2012. Beginning in 1986, data on women's pregnancies were collected in the NLSY79 Children and Young Adult Survey.<sup>12</sup> Data were collected retrospectively for pregnancies prior to 1986. The eligible sample (6,849 pregnancies from 3,097 mothers) included non-Hispanic white, non-Hispanic black, and Hispanic women with at least one singleton birth with complete information to calculate prepregnancy BMI and GWG, as well as complete information for ACE exposures. The complete case sample included 6,199 pregnancies from 2,873 mothers.

### Measures

In the most recent survey year (2012), three questions selected from the ACE module from the U.S. Behavioral Risk Factor Surveillance System survey were added to the NLSY79 survey.<sup>13</sup> NLSY79 participants were asked to recall their exposure to physical abuse,

household alcohol abuse, and household mental illness before age 18 years using the following questions:

1. How often did a parent or adult in your home ever hit, beat, kick or physically harm you in any way? Do not include spanking. Would you say never, once, or more than once?
2. Did you live with anyone who was a problem drinker or alcoholic?
3. Did you live with anyone who was depressed, mentally ill, or suicidal?

Ninety-nine percent of the respondents answered the ACE questions. Household alcohol abuse and household mental illness responses were used as collected (*yes/no*) and responses to the question about history of physical abuse, originally collected in three categories (*never, once, or more than once*), were dichotomized as *yes/no* (*yes* if reporting abuse two or more times; *no* otherwise) to capture recurrent/chronic physical abuse.

Women recalled their prepregnancy and delivery weights for pregnancies through 1986 and self-reported their weights at the first survey after each pregnancy for pregnancies after 1986. Prepregnancy BMI (weight [kg]/height [m<sup>2</sup>]) was calculated using the height reported closest to the pregnancy and recalled prepregnancy weight; obesity was categorized as BMI  $\geq 30$ .<sup>14</sup> The self-reported height data were regression-calibrated using error data from the National Health and Nutrition Examination Survey.<sup>15</sup> Measurement error in the recalled prepregnancy weight was assessed by comparing this measure to the BMI reported at the closest previous survey prior to that pregnancy. Because they were similar, the recalled prepregnancy BMI data were utilized in the statistical models. Weight gain for each pregnancy was calculated as the difference between recalled prepregnancy weight and weight at delivery and then categorized as inadequate gain, adequate gain, or excessive gain according to the 2009 IOM guidelines.<sup>4</sup>

Potential confounding variables were selected a priori and included race/ethnicity (white, black, Hispanic), the participant's childhood SES as measured by her mother's education level (less than high school, high school, more than high school), having lived in an urban location as a child, and foreign birth. All covariates were self-reported in 1979.

### Statistical Analysis

Bivariate analyses examined the distribution of maternal characteristics and pregnancy-related variables by the three ACE exposures: physical abuse, household alcohol abuse, and household mental illness. Log-binomial models were utilized to estimate adjusted risk ratios of the associations between each measure of childhood adversity and prepregnancy obesity and excessive GWG separately, adjusting for the covariates listed above. Interaction terms were included to test whether race/ethnicity, childhood SES, or parity (primiparous/multiparous) modified the observed associations; these were considered significant and retained in final models if  $p < 0.1$ . In accordance with the complex survey design, all models included custom sampling weights to make the results nationally representative and accounted for clustering by primary sampling units. Identical models using generalized estimating equations were also run to account for multiple pregnancies per woman. Because the point estimates from both sets of models were similar, the results from the survey-

adjusted models are presented because these models explained more variance and are nationally representative.

Several sensitivity analyses were conducted to test the robustness of the observed associations. Physical abuse was analyzed as collected (zero, one, or two or more exposures). Models adjusting for all three adversity exposures were also run to assess the impact of co-occurrence of ACEs. Models with BMI  $\geq 25$  (overweight and obese) and BMI  $\geq 35$  (severe obesity) as secondary outcomes were also examined. Additional GWG models were adjusted for prepregnancy BMI. The IOM GWG guidelines are for term births.<sup>4,16</sup> As 12% of the sample delivered before 37 weeks, the GWG analyses were also conducted in the sample restricted to full-term births.

Finally, missing data were addressed by multiple imputation of missing covariate data (0.3%–6.3%) to assess their impact on observed associations. Ten data sets with imputed values for relevant covariates were created using the chained imputation program in Stata,<sup>17,18</sup> accounting for complex survey design using custom sampling weights and for clustering within primary sampling units at the estimation stage. Because the results did not differ by using multiple imputation, complete case analyses are presented.

All analyses were conducted in 2014 using Stata, version 13 and all reported *p*-values are twosided. This study was approved by the University of California Berkeley's Committee for the Protection of Human Subjects.

## Results

After excluding observations with missing data on childhood adversity exposures, prepregnancy BMI, GWG, and relevant covariates, 6,199 pregnancies from 2,873 women were available for analyses. The majority of the analytic sample was white (78%), 15% were black, and 7% were Hispanic (Table 1). Nine percent of the cohort was obese and 38% gained excessive weight during pregnancy.

Comparison of BMI based on reported weight at the closest interview preceding the pregnancy with the recalled prepregnancy BMI measure suggested a significant difference in mean BMI by paired *t*-test (0.34 kg/m<sup>2</sup>); however, the correlation between the two measures was 0.9. Based on the two measures, the proportion of obese women was similar (9.8% vs 9.2%) and 85% of those categorized as obese using the previous reported weight were similarly categorized using the prepregnancy recalled weight, indicating high agreement between the measures.

Table 1 shows that ACE exposure was more often reported by white women and less often by black women and more often reported by women with prepregnancy obesity and excessive GWG. Physical abuse in childhood was more common in women born outside the U.S. Women whose mothers had at least a high school education reported higher prevalence of household mental illness.

Thirteen percent of participants reported being physically abused prior to age 18 years, about a quarter reported household alcohol abuse, and 11% reported household mental

illness. Two thirds of participants reported no history of these childhood adversities and only 3% reported exposure to all three types of adversity. Table 2 also displays the co-occurrence of the three adversities.

Table 3 shows results of separate models for each of the three exposures (compared with women without the same exposure) with maternal obesity or excessive GWG outcomes. Reported exposure to at least two events of childhood physical abuse was associated with a 60% increase in the risk of prepregnancy obesity; one episode of physical abuse was not associated with maternal obesity (data not shown). Both household alcohol abuse and household mental illness were associated with a 30% increase in risk of maternal obesity; however, the increase associated with household mental illness was not statistically significant. None of the exposures were associated with maternal obesity when maternal weight was defined as BMI  $\geq 25$  or BMI  $\geq 35$ .

Table 3 also shows that both exposure to physical abuse and household alcohol abuse were independently associated with a 20% increase in the risk of excessive GWG, whereas household mental illness exposure was not. Excluding preterm births and additionally adjusting for prepregnancy BMI yielded similar results. Physical abuse experienced once was not related to excessive GWG.

Results were consistent when simultaneously adjusted for all three types of childhood adversity. There was no evidence of effect measure modification by race/ethnicity, childhood SES, or first pregnancy.

## Discussion

In this racially diverse, nationally representative sample, a history of physical abuse or household alcohol abuse in childhood was associated with prepregnancy obesity and excessive GWG. This was independent of race/ethnicity and childhood SES, and did not vary by these factors or by parity. The prevalences of childhood exposure to physical abuse at least twice (13%) and alcohol abuse at home (23%) reported by NLSY79 women are similar to those recalled by women in a 2009 Behavioral Risk Factor Surveillance System study of ACEs in five states collected by CDC, which estimated a prevalence of 15% for physical abuse and 31% for household substance abuse (data on alcohol problems alone were not reported).<sup>19</sup> NLSY79 women reported half the prevalence of childhood exposure to household mental illness as compared with the Behavioral Risk Factor Surveillance System sample (11% vs 22%); perhaps this lower prevalence and its reduced power explains the lack of significant associations between household mental illness and either maternal weight outcome. Nonetheless, two of the three childhood adversity questions assessed were associated with increased risk of prepregnancy obesity and excessive GWG. Though additional studies are needed to better understand whether household mental illness increases maternal weight, the results of this study suggest that ACEs may be an important risk factor for both prepregnancy obesity and excessive GWG.

A recent meta-analysis of 41 studies, including almost 200,000 participants, concluded that childhood maltreatment was associated with a 30% increase in the odds of developing

obesity in adulthood.<sup>20</sup> However, a review of the literature identified only two previous studies that examined history childhood adversity and adult weight specifically in childbearing women.<sup>10,11</sup> These studies utilize the Childhood Trauma Questionnaire, which comprehensively assesses recalled intensity of childhood physical, emotional, and sexual abuse, and physical and emotional neglect. In one study, moderate to severe emotional and physical abuse were associated with greater than twice the odds of prepregnancy obesity,<sup>10</sup> whereas in the second, a higher Childhood Trauma Questionnaire score was associated with an elevated risk of both prepregnancy obesity and excessive GWG only among women with elevated anxiety or depression during pregnancy.<sup>11</sup> Both studies were conducted in small, select groups of high-risk women attending prenatal clinics and neither adjusted for early life maternal social factors. The current study extends their findings to a large, diverse, national sample and suggests that associations between childhood adversity and maternal weight are independent of several other early life maternal factors.

Mechanisms that explain the relationship between ACE exposure and obesity are not yet well understood. Chronic stressors in early life may result in overactivation of the hypothalamic–pituitary axis, which may lead to appetite dysregulation and accumulation of visceral fat or decreased impulse control and compulsive eating.<sup>21</sup> A recent study reported that ACEs were associated with food addiction in adult women.<sup>22</sup> Using food in response to stress<sup>23</sup> and eating comfort foods<sup>21</sup> are types of coping strategies that individuals who have experienced childhood adversity may use to ease emotional discomfort. These behaviors may explain why some women begin pregnancy obese, and why the extra stresses of pregnancy might make some women susceptible to gaining excessive weight. There is also evidence that childhood maltreatment affects patterns of DNA methylation in children, which may cause epigenetic changes in physiology and behavior that persist across the life course.<sup>24</sup>

## Implications

These findings that early life adversity increases risk of maternal obesity suggest that identifying women during or ideally before pregnancy may offer an important new pathway for promoting healthy weight. Primary care physicians, obstetrician–gynecologists, and pediatricians are well positioned to identify exposure to childhood adversity in women of childbearing age as part of their delivery of care, with the goal of preventing unhealthy weight gain and promoting health for women and their children.<sup>31–33</sup> Though a recent study suggests that tools are available to make prenatal screening for psychosocial risks achievable,<sup>34</sup> less than one third of physicians screen female patients for childhood abuse.<sup>31</sup> This suggests that additional awareness, training, and support are needed to help providers to engage with their patients on this sensitive issue.<sup>31</sup>

Development of appropriate interventions to address ACEs is critical. A recent paper proposes a framework and strategies for trauma-informed primary care.<sup>35</sup> For women who have experienced traumatic childhood events, traditional weight control approaches limited to nutritional and physical activity counseling, without addressing trauma, will likely fall short. This may explain why intervention trials to prevent excessive GWG often meet with limited success.<sup>5,6</sup> There is preliminary evidence to suggest that targeted psychoeducational

intervention for pregnant women with post-traumatic stress disorder improves labor and delivery outcomes and postpartum mental health.<sup>36</sup> Future studies should investigate whether such targeted strategies could be extended to women who do not necessarily meet criteria for post-traumatic stress disorder but who experienced maltreatment or other adverse family events in early life.

### Limitations

This study has several limitations. NLSY79 participants recalled exposure to childhood adversity as mid-life adults, and their self-reports cannot be validated, which is a limitation of all ACE studies, though responses to ACE questions have been reported to be reproducible.<sup>25</sup> It is notable that the prevalence of both recalled physical abuse and household alcohol abuse in NLSY79 are consistent with national estimates.<sup>8</sup> There is evidence that self-reports of ACEs may be under-reported,<sup>26</sup> suggesting that these results may be conservative. Because NLSY79 participants recalled ACE exposure in mid-life, long after they reported their pregnancy weight data, recall bias may be reduced. Owing to time constraints, the NLSY79 survey included only three measures of childhood adversity and did not assess severity of abuse; therefore, this study could not capture and assess the entire range and intensity of ACE exposures or assess cumulative exposure using an ACE score.<sup>26</sup> However, these results are similar to the two previous studies that collected measures that address severity as well as a greater range of exposures.<sup>10,11</sup> Furthermore, negative childhood experiences may occur together, and the three investigated here may be proxies for other adversities not studied.<sup>27</sup>

Like previous studies,<sup>10,11</sup> data on maternal prepregnancy obesity and GWG were self-reported. Self-reported prepregnancy weight and delivery weight are highly correlated with measured weight from medical records, though some women may be misclassified with respect to obesity and excessive GWG.<sup>28,29</sup> No measured data were available to validate these weights, but an assessment of the reliability of recalled prepregnancy weight using self-reported measures at the wave just 1–2 years prior to pregnancy suggested reasonable agreement. In this sample, where almost 90% of births were after 37 weeks, a relationship between child adversity and excessive GWG was found overall and when restricted to term births, but the authors did not have a valid measure of GWG (e.g., z-scores<sup>30</sup> from an appropriate reference base for NLSY79) to allow differentiation of excessive GWG by length of pregnancy. This GWG finding therefore requires future confirmation in samples that both include the full range of gestational ages at birth and a gestational age-specific measure of GWG to ensure that the association with child adversity found here holds in both preterm and term births. Finally, data on possible biological markers of early stress exposure, treatments received, current mental health and lifestyle behaviors were not available.

The limitations of this study highlight several future research directions to fully understand the role of childhood adversity in pregnancy-related weight outcomes. Future studies should:

1. use measured weights;
2. collect data on a range of possible early life maternal socioeconomic and behavioral factors;



3. investigate important pathways, including mediation by maternal lifestyle and psychosocial factors; and
4. include data on both individual ACE exposures as studied here as well as the full range of childhood adversities to identify the most important early life risk factors for pregnancy-related obesity and weight gain.

## Conclusions

Though the focus of this study was promoting healthy weight, screening and treating women before and during pregnancy for issues related to childhood adversity would likely extend benefits to ensuring an optimal environment for their children's emotional, social, and physical development. Although the most obvious way to prevent negative effects of childhood adversity is to ensure that no child is harmed or neglected, childhood maltreatment has been shown to be transgenerational,<sup>37</sup> with children of abused parents more likely to be abused themselves. Screening for and treating ACEs in pregnancy could offer an important way to break this cycle by promoting a healthy pregnancy and improving mothers' mental health during pregnancy or when their children are infants. There is an urgent need for research aimed at considering stress in early life as well as across the life course. An important next step is the design and testing of efficient, short-term, and cost-effective programs and policies to improve maternal health during prenatal and primary care.

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## References

1. Leddy MA, Power ML, Schulkin J. The impact of maternal obesity on maternal and fetal health. *Rev Obstet Gynecol.* 2008; 1(4):170–178. [PubMed: 19173021]
2. Gaillard R, Durmu B, Hofman A, Mackenbach JP, Steegers EaP, Jaddoe VWV. Risk factors and outcomes of maternal obesity and excessive weight gain during pregnancy. *Obesity (Silver Spring).* 2013; 21(5):1046–1055. <http://dx.doi.org/10.1002/oby.20088>. [PubMed: 23784909]
3. American College of Obstetricians and Gynecologists. Obesity in pregnancy. Committee Opinion No. 549. *Obstet Gynecol.* 2013; 121:213–217. [PubMed: 23262963]
4. Yaktine, AL.; Rasmussen, KM. *Weight Gain During Pregnancy: Reexamining the Guidelines.* National Academies Press; 2009.
5. Gardner B, Wardle J, Poston L, Croker H. Changing diet and physical activity to reduce gestational weight gain: a meta-analysis. *Obes Rev.* 2011; 12.7:e602–e620. <http://dx.doi.org/10.1111/j.1467-789X.2011.00884.x>. [PubMed: 21521451]

6. Thangaratinam S, Rogozi ska E, Jolly K, et al. Effects of interventions in pregnancy on maternal weight and obstetric outcomes: meta-analysis of randomised evidence. *BMJ*. 2012; 344:e2088. <http://dx.doi.org/10.1136/bmj.e2088>. [PubMed: 22596383]
7. U.S. DHHS. NIH. [Accessed December 1, 2014] Strategic Plan for NIH Obesity Research. [http://obesityresearch.nih.gov/about/StrategicPlanforNIH\\_Obesity\\_Research\\_Full-Report\\_2011.pdf](http://obesityresearch.nih.gov/about/StrategicPlanforNIH_Obesity_Research_Full-Report_2011.pdf). Published March 2011.
8. Gilbert LK, Breiding MJ, Merrick MT, et al. Childhood Adversity and Adult Chronic Disease: An Update from Ten States and the District of Columbia, 2010. *Am J Prev Med*. 2015; 48(3):345–349. <http://dx.doi.org/10.1016/j.amepre.2014.09.006>. [PubMed: 25300735]
9. Felitti VJ, Anda RF, Nordenberg D, et al. Household Dysfunction to Many of the Leading Causes of Death in Adults The Adverse Childhood Experiences (ACE) Study. *Am J Prev Med*. 1998; 14(4): 245–258. [http://dx.doi.org/10.1016/S0749-3797\(98\)00017-8](http://dx.doi.org/10.1016/S0749-3797(98)00017-8). [PubMed: 9635069]
10. Hollingsworth K, Callaway L, Duhig M, Matheson S, Scott J. The association between maltreatment in childhood and pre-pregnancy obesity in women attending an antenatal clinic in Australia. *PLoS One*. 2012; 7(12):e51868. <http://dx.doi.org/10.1371/journal.pone.0051868>. [PubMed: 23300572]
11. Diesel JC, Bodnar LM, Day NL, Larkby CA. Childhood maltreatment and the risk of pre-pregnancy obesity and excessive gestational weight gain. *Matern Child Nutr*. 2014:1–11. <http://dx.doi.org/10.1111/mcn.12147>.
12. National Longitudinal Survey of Youth. Washington, DC: U.S. Department of Labor; 1979. Bureau Of Labor Statistics.
13. CDC. [Accessed August 18, 2015] Behavioral Risk Factor Surveillance System Questionnaire. 2010. [www.cdc.gov/brfss/questionnaires/pdf-ques/2010brfss.pdf](http://www.cdc.gov/brfss/questionnaires/pdf-ques/2010brfss.pdf).
14. WHO. [Accessed December 1, 2014] Obesity and Overweight Fact Sheet. 2014. [www.who.int/mediacentre/factsheets/fs311/en/](http://www.who.int/mediacentre/factsheets/fs311/en/).
15. Burkhauser RV, Cawley J. Beyond BMI: The Value of More Accurate Measures of Fatness and Obesity in Social Science Research. *J Heal Econ*. 2008; 27(2):519–529. <http://dx.doi.org/10.1016/j.jhealeco.2007.05.005>.
16. IOM. Nutrition during Pregnancy: Part I. Weight Gain. Washington, DC: National Academy Press; 1990.
17. StataCorp. Stata Multiple-Imputation Reference Manual. College Station, TX: StataCorp LP; 2013.
18. Rubin, D. Multiple Imputation for Nonresponse in Surveys. New York: John Wiley and Sons Inc; 1987. <http://dx.doi.org/10.1002/9780470316696>.
19. CDC. Adverse Childhood Experiences Reported by Adults — Five States, 2009. *Morb Mortal Wkly Rep*. 2010; 59(49):1609–1613. <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5949a1.htm>. Published December 17, 2010.
20. Danese A, Tan M. Childhood maltreatment and obesity: systematic review and meta-analysis. *Mol Psychiatry*. 2014; 19(5):544–554. <http://dx.doi.org/10.1038/mp.2013.54>. [PubMed: 23689533]
21. Dallman MF. Stress-induced obesity and the emotional nervous system. "Trends in Endocrinology & Metabolism. *Trends Endocrinol Metab*. 2010; 21(3):159–165. <http://dx.doi.org/10.1016/j.tem.2009.10.004>. [PubMed: 19926299]
22. Mason SM, Flint AJ, Field AE, Austin SB, Rich-Edwards JW. Abuse victimization in childhood or adolescence and risk of food addiction in adult women. *Obesity (Silver Spring)*. 2013; 21(12):E775–E781. <http://dx.doi.org/10.1002/oby.20500>. [PubMed: 23637085]
23. Greenfield EA, Marks NF. Violence from parents in childhood and obesity in adulthood: using food in response to stress as a mediator of risk. *Soc Sci Med*. 2009; 68(5):791–798. <http://dx.doi.org/10.1016/j.socscimed.2008.12.004>. [PubMed: 19185965]
24. Yang B-Z, Zhang H, Ge W, et al. Child abuse and epigenetic mechanisms of disease risk. *Am J Prev Med*. 2013; 44(2):101–107. <http://dx.doi.org/10.1016/j.amepre.2012.10.012>. [PubMed: 23332324]
25. Dube S, Williamson D, Thompson T, Felitti V, Anda R. Assessing the reliability of retrospective reports of adverse childhood experiences among adult HMO members attending a primary care clinic. *Child Abuse Negl*. 2004; 28(7):729–737. <http://dx.doi.org/10.1016/j.chiabu.2003.08.009>. [PubMed: 15261468]

26. Hardt J, Rutter M. Validity of adult retrospective reports of adverse childhood experiences: Review of the evidence. *J Child Psychol Psychiatry Allied Discip.* 2004; 45(2):260–273. <http://dx.doi.org/10.1111/j.1469-7610.2004.00218.x>.
27. Scott J, Varghese D, McGrath J. As the twig is bent, the tree inclines: Adult mental health consequences of child adversity. *Arch Gen Psychiatry.* 2010; 67(2):111–112. <http://dx.doi.org/10.1001/archgenpsychiatry.2009.188>. [PubMed: 20124110]
28. McClure C, Bodnar L, Ness R, Catov J. Accuracy of maternal recall of gestational weight gain 4 to 12 years after delivery. *Obesity.* 2011; 19(5):1047–1053. <http://dx.doi.org/10.1038/oby.2010.300>. [PubMed: 21164507]
29. Bodnar L, Abrams B, Bertolet M, et al. Validity of Birth Certificate-Derived Maternal Weight Data. *Paediatr Perinat Epidemiol.* 2014; 28(3):203–212. <http://dx.doi.org/10.1111/ppe.12120>. [PubMed: 24673550]
30. Bodnar L, Hutcheon J, Parisi S, Pugh S, Abrams B. Comparison of gestational weight gain z-scores and traditional weight gain measures in relation to perinatal outcomes. *Paediatr Perinat Epidemiol.* 2015; 29(1):11–21. <http://dx.doi.org/10.1111/ppe.12168>. [PubMed: 25492396]
31. Weinreb L, Savageau J, Hargraves J. Screening for Childhood Trauma in Adult Primary Care Patients: A Cross-Sectional Survey. *Prim Care Companion J Clin Psychiatry.* 2010; 12(6):e1–e10. <http://dx.doi.org/10.4088/PCC.10m00950blu>.
32. American College of Obstetricians and Gynecologists. Adult manifestations of childhood sexual abuse. Committee Opinion No. 498. *Obstet Gynecol.* 2011; 118:392–395. <http://dx.doi.org/10.1097/AOG.0b013e31822c994d>. [PubMed: 21775872]
33. American Association of Pediatrics. Addressing Adverse Childhood Experiences and Other Types of Trauma in the Primary Care Setting. [https://www.aap.org/en-us/Documents/ttb\\_addressing\\_aces.pdf](https://www.aap.org/en-us/Documents/ttb_addressing_aces.pdf). Published 2014.
34. Spyridou A, Schauer M, Ruf-Leuschner M. Obstetric care providers are able to assess psychosocial risks, identify and refer high-risk pregnant women: validation of a short assessment tool – the KINDEX Greek version. *BMC Pregnancy Childbirth.* 2015; 15:1–17. <http://dx.doi.org/10.1186/s12884-015-0462-y>. [PubMed: 25591791]
35. Machtinger E, Cuca Y, Khanna N, Rose C, Kinberg L. From treatment to healing: the promise of Trauma-informed Primary Care. *Womens Heal Issues.* 2015; 25(3):1093–1197. <http://dx.doi.org/10.1016/j.whi.2015.03.008>.
36. Rowe H, Sperlich M, Cameron H, Seng J. A Quasi-experimental outcomes analysis of a psychoeducation intervention for pregnant women with abuse-related posttraumatic stress. *J Obstet Gynecol Neonatal Nurs.* 2014; 43(3):282–293. <http://dx.doi.org/10.1111/1552-6909.12312>.
37. Newcomb MD, Locke TF. Intergenerational cycle of maltreatment: A popular concept obscured by methodological limitations. *Child Abuse Negl.* 2001; 25(9):1219–1240. [http://dx.doi.org/10.1016/S0145-2134\(01\)00267-8](http://dx.doi.org/10.1016/S0145-2134(01)00267-8). [PubMed: 11700694]

**Table 1**

Distribution of Individual-Level and Pregnancy Characteristics by Adverse Childhood Experiences

	Total	Physical abuse (%)		Alcohol abuse (%)		Mental illness (%)	
		No	Yes	No	Yes	No	Yes
<b>Individual characteristics (N=2,873)</b>							
Race/ethnicity							
White	78	77	80	76	82	76	87
Black	15	16	10	17	11	17	8
Hispanic	7	6	10	7	7	7	5
Maternal mother's education							
Less than high school	37	36	42	36	38	37	31
High school	44	45	43	44	46	45	43
More than high school	19	19	15	20	16	18	26
Urban environment as a child	78	78	76	71	77	77	79
Foreign born	4	3	9	4	5	4	5
Parity							
1	12	12	12	12	10	12	10
2	31	33	20	32	29	31	28
3	26	26	28	27	25	26	25
4+	30	29	40	29	36	29	36
<b>Pregnancy characteristics (N=6,199)</b>							
Pre-pregnancy BMI							
Underweight (<18.5)	9	8	11	8	10	9	11
Normal (18.5–24.9)	66	67	61	67	63	66	63
Overweight (25–29.9)	16	17	13	16	16	16	15
Obese (≥ 30)	9	8	13	9	11	9	11
Gestational weight gain (GWG)							
Inadequate	31	32	27	32	27	31	29
Adequate	31	31	27	31	30	31	29
Excessive	38	37	46	37	43	38	42
Full term births (gestational age ≥ 37 weeks)	89	88	90	88	89	88	90

**Table 2**

## Description of Co-Occurrence of ACEs

	<b>Total sample (N=6,199)</b>
No ACE (%)	65
One ACE (%)	
Physical abuse	7
Mental illness	4
Alcoholism	12
Two ACEs (%)	
Physical abuse + Mental illness	2
Physical abuse + alcoholism	6
Mental illness + alcoholism	2
All Three ACEs (%)	3

ACE, Adverse childhood experience

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**Table 3**

RRs and 95% CIs Estimating the Association Between ACE and Prepregnancy Obesity and Excessive GWG<sup>a,b</sup>

	Prepregnancy obesity (BMI ≥ 30)	Excessive GWG
Physical abuse		
No	Ref	Ref
Yes	<b>1.6 (1.1, 2.2)</b>	<b>1.2 (1.1, 1.4)</b>
Household alcohol abuse		
No	Ref	Ref
Yes	1.3 (1.0, 1.7)	<b>1.2 (1.1, 1.3)</b>
Household mental illness		
No	Ref	Ref
Yes	1.3 (0.8, 1.9)	1.1 (0.9, 1.2)

<sup>a</sup> Adjusted for race, maternal mother's education, urban environment as a child, and foreign born

<sup>b</sup> Boldface indicates statistical significance ( $p < 0.05$ ).

GWG, Gestational weight gain; RR, Risk ratio.