OVERWEIGHT ADOLESCENTS AND LIFE EVENTS IN CHILDHOOD

WHAT’S KNOWN ON THIS SUBJECT: Psychosocial stress in childhood has been associated with a greater risk of future overweight, although the associations have not always been consistent, the types of psychosocial stressors have often been somewhat extreme, and moderators of the association have rarely been examined.

WHAT THIS STUDY ADDS: Experiencing many negative life events in childhood, particularly with chronicity or events that are family health related, increases risk of overweight by age 15 years. Maternal obesity and greater delay of gratification for food each intensify this risk.

abstract

OBJECTIVES: To test the association of life events in childhood with overweight risk in adolescence; to examine the effects of chronicity, timing, intensity, valence, and type of life events; and to test potential moderators.

METHODS: Mothers of children enrolled in the Eunice Kennedy Shriver National Institute of Child Health and Human Development Study of Early Child Care and Youth Development responded to the Life Experiences Survey at ages 4, 9, and 11 years. Using logistic regression analysis, we tested the association of experiencing many negative life events with being overweight at age 15 years, controlling for child gender, race/ethnicity, maternal education, and maternal obesity. Child gender, maternal education, maternal obesity, child’s ability to delay gratification for food, and maternal sensitivity were tested as moderators.

RESULTS: Among the 848 study children (82% non-Hispanic white), experiencing many negative life events was associated with a higher risk of overweight (odds ratio: 1.47 [95% confidence interval: 1.04–2.10]). Greater chronicity and negative valence of the event were associated with greater overweight risk; timing of exposure and maternal reported impact of the event were not. The association was more robust for events related to family physical or mental health and among children of obese mothers and children who waited longer for food.

CONCLUSIONS: Children who experience many negative life events are at higher risk of being overweight by age 15 years. Future work should investigate mechanisms involved in this association, particularly those connected to appetitive drive and self-regulation; these mechanisms may hold promise for obesity prevention strategies. Pediatrics 2013;132:e1506–e1512

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KEY WORDS
adolescence, overweight, psychosocial, stress

ABBREVIATIONS
CI—confidence interval
OR—odds ratio

Dr Lumeng conceptualized and designed the study and drafted the initial manuscript; Drs Wendorf and Pesch assisted in conceptualizing and designing the study, contributed to drafting portions of the initial manuscript, and critically reviewed the manuscript; Ms Appugliese conducted statistical analyses and critically reviewed and revised the manuscript; Dr Kaciroti directed statistical analyses and critically reviewed and revised the manuscript; Dr Corwyn assisted in conceptualizing the study, assisted with data access and conceptualization of study variables, critically reviewed statistical analyses, and critically reviewed and revised the manuscript; Dr Bradley assisted in conceptualizing and designing the study, critically reviewed the statistical analyses, and critically reviewed and revised the manuscript, and all authors approved the final manuscript as submitted.

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Psychological and physiologic adaptation to chronic stress, or allostatic load, has important implications for health and disease. The association between psychosocial stressors and risk of childhood obesity has been documented in several studies, although reports have provided less robust support for the association than anticipated had null findings or shown evidence of moderation according to age, gender, or other factors. Improved understanding of the association between psychosocial stress and childhood obesity would inform interventions.

The definition of psychosocial stressors in previous studies has varied, with most studies combining various stressors into risk indices that include parental mental health, child violence exposure, socioeconomic stressors, and nonoptimal family structure and functioning. Another approach involves asking parents to report events that occurred and to rate their impact. A checklist of events allows the inclusion of common events, and the parent (as opposed to the researcher) assigns the event a negative, positive, or neutral valence. Only 3 studies have used this approach, and the association of life events with the child's obesity risk was inconsistent.

The current study had 3 objectives: (1) to test the association of life events at ages 4, 9, and 11 years with overweight at age 15 years among US children of diverse socioeconomic status; (2) to examine the effects of chronicity, timing, intensity, valence, and type of event on overweight; and (3) to test moderation by factors linked with increased appetitive drive (ie, the desire to eat) or diminished self-regulatory capacity (ie, the ability to restrict intake). We specifically hypothesized that the child being less able to delay gratification for food, or having an obese or less sensitive mother, represented biological and environmental factors that could intensify any effect of experiencing negative life events on overweight.

**METHODS**

**Sample**

We used data from the *Eunice Kennedy Shriver National Institute of Child Health and Human Development Study of Early Child Care and Youth Development*, a longitudinal cohort of 1364 families from 10 US sites commencing at the time of the child's birth in 1991 (https://secc.nichd.nih.gov). This study was approved by the institutional review boards of all participating institutions.

Anthropometric data at age 15 years were available for 864 children, of whom 863 had at least 1 life event measure, and 848 had complete data for gender, race/ethnicity, maternal education, and maternal weight status. The 848 participants (82% non-Hispanic white) included in the analyses, compared with the excluded, incomplete sample, were less likely to be male (49.5% vs 50.5%; *P* = .04) and had mothers with more education (14.43 years vs 13.91 years; *P* < .001). There was no difference in race/ethnicity.

**Main Predictor: Life Events**

Mothers completed an adapted version of the Life Experiences Survey when the child had a mean ± SD age of 4.7 ± 0.1, 9.0 ± 0.3, and 11.0 ± 0.3 years. Mothers reported whether each of 71 events had occurred in the last year, and if it occurred, rated the impact on a 7-point Likert scale, from −3 (extremely negative) to 0 (no impact) to 3 (extremely positive). Number of negative life events was defined as the sum of all events endorsed that were also rated as having a negative impact (−1 to −3). The number of negative life events at each age was then averaged across ages. We categorized mean number of negative life events as “many,” defined as the highest quartile (range: 4.5–17.3 mean number of negative life events across the 3 age points) versus “not,” defined as the lowest 3 quartiles (range: 0–4.3).

We created a chronicity variable, defined as the number of age points a child was in the top quartile: never (54.0%), once (27.2%), and at 2 (13.8%) or 3 (5.0%) years of age. We created a timing variable to reflect the ages at which the child was in the top quartile: early only (in the top quartile at only age 4 years or only ages 4 and 9 years; *n* = 102), late only (in the top quartile at only age 11 years or only ages 9 and 11 years; *n* = 147), and never (*n* = 458). Children in the top quartile at all 3 ages (*n* = 42) or intermittently (top quartile only at age 9 years, or top quartile at ages 4 and 11 years but not age 9 years; *n* = 99) were excluded from the timing analysis.

Impact ratings (−1 to −3) were reverse coded, summed at each age (range: 1–182 [age 4 years], 1–47 [age 9 years], and 1–45 [age 11 years]) and averaged across ages to create an impact of negative life events variable. Total number of life events, regardless of whether the impact rating was positive, negative, or neutral, was summed at each age and then averaged across ages, with the top quartile defined as “many life events.”

We created 4 categories of negative life events according to author consensus: parent or family physical or mental health and well-being (ie, family health; 15–18 items, depending on age [eg, “serious illness or injury of close family member,” “took prescription drugs for at least 1 month to help with mental problems”]; parental work, school, or financial stability (ie, family finances; 15 items [eg, “foreclosure on mortgage or loan,” “fired or laid off from job,” “return to work”]; emotional aspects of relationships (ie, family relationships; 14 items [eg, “trouble with in-laws,” “argument or conflict with husband/partner,” “divorce”]; and family structure, routine, and caregiving (10 items; eg, “birth or adoption of a child,” “child...
Outcome: Overweight at Age 15 Years

Height and weight were measured by using a standardized protocol at age 15 years. Overweight was defined as a BMI ≥85th percentile for age and gender based on the Centers for Disease Control and Prevention growth charts.17

Covariates

Child gender, race/ethnicity (non-Hispanic white versus not), and maternal education (continuous [in years]) were included as covariates. The data set includes only maternal BMI by self-report when the child is age 15 years. Mothers’ images on videotape at child ages 15, 24, and 36 months were assigned a weight status ranging from 1 (thinnest) to 9 (heaviest) by using a standard pictorial rating scale,18 an approach with demonstrated validity,19 and ratings were then averaged. The mean maternal weight status rating correlated with maternal BMI when the child was aged 15 years (r = 0.74).

Delay of gratification at age 4 years was assessed by using the Mischel and Ebbesen self-imposed waiting task.20 The child was told that the examiner was going to leave the room, and if the child could wait until the examiner returned, he or she would be allowed to eat a large quantity of a preferred food (candy, animal crackers, or pretzels). If the child could not wait, he or she would be allowed to eat only a small quantity. Children who waited were considered to have delayed gratification.

Parenting sensitivity was defined as the mean sensitivity z score coded from videotaped structured mother–child play interactions21,22 at ages 15, 24, and 36 months.

Statistical Analysis

Statistical analysis was conducted by using SAS version 9.2 (SAS Institute, Inc, Cary, NC). For the 9.7% of the sample that was missing the number of negative life events (total or in each category), impact rating score, or total number of life events at 1 or 2 of the 3 age points, these values were imputed. Descriptive statistics were used to characterize the sample, and χ² and t tests were used to evaluate the association of each covariate with overweight at age 15 years. We used multiple logistic regression analysis to evaluate the association of mean negative life events in childhood with being overweight at age 15 years, controlling for child race/ethnicity, child gender, maternal education, and maternal weight status. We next reran this model using as the predictor our created categorical variable “many negative life events.” Four new models were then retested, rerunning this fully adjusted model and replacing the many negative life events variable individually with each of the following variables: (1) chronicity of negative life events; (2) timing of negative life events; (3) impact of negative life events; and (4) many life events (of positive, negative, or neutral valence). To test the independent effect of each type of negative life event, we included the 4 different types of negative life events (family health, family finances, family relationships, and family structure, routine, and caregiving), each coded categorically as “many” versus “not” simultaneously in the model.

Four additional models were tested, individually including interactions of the categorical many negative life events variable with child gender, maternal education, maternal weight status, the child’s ability to delay gratification, and parenting sensitivity. Adjusted odds ratios (ORs) and their corresponding 95% confidence intervals (CIs) were calculated from all models.

RESULTS

Table 1 displays characteristics of the sample and bivariate associations with overweight. The main effect of each life event variable in the fully adjusted model is shown in Table 2. The mean number of negative life events experienced in childhood independently predicted a higher risk of overweight in adolescence (OR: 1.08 [95% CI: 1.01–1.14]). Experiencing many negative life events also independently predicted a higher risk of overweight (OR: 1.47 [95% CI: 1.04–2.10]).

Chronicity was important; experiencing many negative life events at ≥2 time points compared with never experiencing such events was associated with a higher risk of overweight (OR: 1.55 [95% CI: 1.03–2.34]); experiencing many negative life events just once was only marginally associated with a higher risk of overweight (OR: 1.37 [95% CI: 0.95–1.98]). Experiencing many negative life events at ≥2 time points was not associated with a higher risk of overweight than experiencing many life events at just 1 time point (OR: 1.14 [95% CI: 0.72–1.78]). With regard to timing of experiencing many negative life events, although there was a marginal effect of early only versus never, as well as late only versus never, there was no main effect of early only versus late only (OR: 1.11 [95% CI: 0.63–1.96]). The impact of the negative life events was not associated with risk of overweight (OR: 1.00 [95% CI: 0.99–1.02]). The total number of life events (positive, negative, or neutral impact) was not associated with a higher risk of overweight (OR: 1.38 [95% CI: 0.95–1.94]). When different types of negative life events were included simultaneously in the model, only family health remained a significant predictor of overweight (OR: 1.81 [95% CI: 1.21–2.72]).

The interactions of many negative life events with child gender and maternal education were not significant (P = .38
TABLE 1 Characteristics of the Sample According to Overweight Status at Age 15 Years

<table>
<thead>
<tr>
<th>Variable</th>
<th>Not Overweight (n = 588)</th>
<th>Overweight (n = 260)</th>
<th>Total (N = 848)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>45.8</td>
<td>57.7</td>
<td>49.4</td>
<td>.001</td>
</tr>
<tr>
<td>White race/ethnicity</td>
<td>84.5</td>
<td>75.4</td>
<td>81.7</td>
<td>.002</td>
</tr>
<tr>
<td>Mother’s education, y</td>
<td>14.74 ± 2.41</td>
<td>13.74 ± 2.23</td>
<td>14.43 ± 2.40</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Maternal weight status</td>
<td>4.27 ± 1.28</td>
<td>5.18 ± 1.50</td>
<td>4.55 ± 1.41</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>No. of negative life events</td>
<td>3.16 ± 2.50</td>
<td>3.60 ± 2.60</td>
<td>3.30 ± 2.54</td>
<td>.02</td>
</tr>
<tr>
<td>Many negative life events</td>
<td>22.1</td>
<td>30.4</td>
<td>24.7</td>
<td>.01</td>
</tr>
<tr>
<td>Chronicity of many negative life events</td>
<td>.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>57.0</td>
<td>47.3</td>
<td>54.0</td>
<td></td>
</tr>
<tr>
<td>At 1 age point</td>
<td>26.2</td>
<td>29.6</td>
<td>27.2</td>
<td></td>
</tr>
<tr>
<td>At ≥2 age points</td>
<td>16.8</td>
<td>23.1</td>
<td>18.8</td>
<td></td>
</tr>
<tr>
<td>Timing of many negative life events (n = 707)</td>
<td></td>
<td></td>
<td></td>
<td>.04</td>
</tr>
<tr>
<td>Early only</td>
<td>12.7</td>
<td>18.5</td>
<td>14.4</td>
<td></td>
</tr>
<tr>
<td>Late only</td>
<td>19.8</td>
<td>23.2</td>
<td>20.8</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>67.5</td>
<td>58.3</td>
<td>64.8</td>
<td></td>
</tr>
<tr>
<td>Impact of negative life events (n = 793)</td>
<td>6.29 ± 10.20</td>
<td>7.00 ± 4.89</td>
<td>6.51 ± 8.90</td>
<td>.19</td>
</tr>
<tr>
<td>Many total life events</td>
<td>21.1</td>
<td>30.4</td>
<td>23.9</td>
<td>.003</td>
</tr>
<tr>
<td>Types of negative life events (% in highest quartile)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family health</td>
<td>17.5</td>
<td>24.6</td>
<td>19.7</td>
<td>.02</td>
</tr>
<tr>
<td>Family finances</td>
<td>26.4</td>
<td>33.9</td>
<td>28.7</td>
<td>.03</td>
</tr>
<tr>
<td>Family relationships</td>
<td>20.8</td>
<td>22.3</td>
<td>21.2</td>
<td>.61</td>
</tr>
<tr>
<td>Family structure, routines, and caregiving</td>
<td>24.3</td>
<td>33.1</td>
<td>27.0</td>
<td>.01</td>
</tr>
<tr>
<td>Unable to delay gratification for food (n = 741)</td>
<td>41.7</td>
<td>56.9</td>
<td>46.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Maternal parenting sensitivity</td>
<td>0.13 ± 0.78</td>
<td>−0.20 ± 0.81</td>
<td>0.03 ± 0.79</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Data are presented as % or mean ± SD.

TABLE 2 Main Effects of Life Event Variables Predicting Overweight in Separate, Fully Adjusted Models (N = 848)

<table>
<thead>
<tr>
<th>Main Effect</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative life events</td>
<td>1.08 (1.01–1.14)</td>
</tr>
<tr>
<td>Many negative life events versus not</td>
<td>1.47 (1.04–2.16)</td>
</tr>
<tr>
<td>Chronicity of many negative life events</td>
<td>1.37 (0.95–1.98)</td>
</tr>
<tr>
<td>At 1 age point versus never</td>
<td>1.37 (0.95–1.98)</td>
</tr>
<tr>
<td>At ≥2 age points versus never</td>
<td>1.55 (1.03–2.34)</td>
</tr>
<tr>
<td>Timing of many negative life events (n = 707)</td>
<td></td>
</tr>
<tr>
<td>Early only versus never</td>
<td>1.61 (0.99–2.61)</td>
</tr>
<tr>
<td>Late only versus never</td>
<td>1.44 (0.94–2.22)</td>
</tr>
<tr>
<td>Impact of negative life events</td>
<td>1.00 (0.99–1.02)</td>
</tr>
<tr>
<td>Many total life events versus not</td>
<td>1.36 (0.95–1.94)</td>
</tr>
<tr>
<td>Types of negative life events</td>
<td></td>
</tr>
<tr>
<td>Many family health events versus not</td>
<td>1.81 (1.21–2.72)</td>
</tr>
<tr>
<td>Many family finances events versus not</td>
<td>1.35 (0.94–1.96)</td>
</tr>
<tr>
<td>Many family relationship events versus not</td>
<td>0.71 (0.46–1.09)</td>
</tr>
<tr>
<td>Many family structure, routines, and caregiving events versus not</td>
<td>1.35 (0.91–1.98)</td>
</tr>
</tbody>
</table>

Each life event variable main effect shown is adjusted for child gender, race/ethnicity, maternal education, and maternal weight status.

and P = .81, respectively). The interaction of maternal weight status with many negative life events was suggestive (P = .12). Among children of mothers with a figure rating ≥5 (a value sensitive and specific for obesity in previous work) (n = 309), the association of negative life events with overweight was not significant (OR: 1.15 [95% CI: 0.70–1.88]). The interaction of the child’s ability to delay gratification and negative life events was also suggestive (P = .07). Among children who delayed gratification (n = 399), the association of negative life events with overweight was significant (OR: 1.96 [95% CI: 1.14 – 3.31]). Among children who did not delay gratification, the association of negative life events with overweight was not significant (OR: 1.02 [95% CI: 0.59–1.76]). The interaction of parenting sensitivity with negative life events was not significant (P = .31).

DISCUSSION

Experiencing many negative life events during childhood increased the risk of overweight at age 15 years independent of child gender, race/ethnicity, maternal education, and mother’s weight status in these study subjects. The more chronic the exposure, the stronger the effect, although the timing of the exposure did not matter. Mother-reported intensity of negative impact was not associated with overweight risk. The valence of the life event mattered: events perceived as negative were associated with increased overweight risk, but total events were not. The type of negative event also mattered: events related to family health were most robustly associated with adolescent overweight, independent of whether there were also many life events related to family finances, relationships, structure, routines, and caregiving. The effect of negative life events was equally robust in both boys and girls and among children of mothers with varying levels of education. The association was more robust among children of mothers with a higher weight status as well as among children who waited for a larger amount of food at age 4 years.
Our finding that chronicity of negative life events is an important predictor of overweight risk requires replication, particularly because 2 previous studies have reported conflicting results, finding greater chronicity associated with both higher\(^5\) and lower\(^4\) overweight risk. Our finding that the association did not differ based on the timing of exposure to negative life events is similar to most\(^4,7,8\) (but not all\(^9,11\)) previous studies, suggesting that there does not seem to be a developmental window in childhood during which the association of negative life events or stressors with overweight is more robust. Our finding that the maternal-reported impact of negative life events was not associated with overweight risk may be consistent with a previous study demonstrating that the objective report of stressors in the home was predictive of child obesity, whereas the parent’s self-reported perceived stress was not.\(^6\) These results suggest that negative life events may have an impact on overweight risk even if they are not perceived as intensely stressful by the parent. This finding may occur either because the parent does not recognize the effect of the life events on the child or because the life events affect the child’s stress physiology but not the observable behavior.\(^23\) To our knowledge, our findings that the valence of events is important, and that some types of negative life events are more robustly associated with adolescent overweight, have not previously been reported.

We did not detect moderation according to gender; unlike 2 previous studies that examined moderation and found more robust associations in girls.\(^4,5\) Given that eating in response to stress is reported more commonly in women,\(^24,25\) potential gender differences deserve additional consideration. We did not detect moderation according to maternal education, consistent with the existing literature in which the association has been identified in samples of varying and diverse socioeconomic status.\(^3–8\)

The finding that the association of negative life events with overweight was more robust among children of obese mothers differs from the single previous study examining this question.\(^7\) Obese mothers may have more obesity-promoting home environments, which could potentiate the effect of negative life events. They may also share the same neurobiology with their child that promotes excessive eating in response to stressors (eg, hypothalamic-pituitary-adrenal axis functioning).\(^14\) Differences in neural circuitry related to food reward,\(^26\) genetic variants associated with eating behaviors (including both emotional eating and cognitive restraint)\(^27\).

The finding that the association was more robust among children who waited for a larger quantity of food was contrary to our expectations, as well as contrary to a recent study which found that the ability to delay gratification mediated the association of psychosocial risk with child BMI.\(^28\) We hypothesize that the child’s delay of gratification for food may reflect not just a general capacity for self-regulation but also how much the child desires the food or finds the food to be a motivator. Several studies have found that the reduced ability to delay gratification for food,\(^29–31\) as well as for nonfood items (toys),\(^29\) is associated with more rapid rates of weight gain and future obesity risk. This classic behavioral task using food may be tapping into more than just self-regulatory capacity but also interindividual differences in children’s motivation to attain a larger quantity of a palatable food or sensitivity to reward.\(^32\) The effect of negative life events on the development of overweight may occur through increased appetitive drive, as opposed to reduced self-regulatory capacity. In addition, not all children who experience significant stress respond with greater impulsivity; rather, some use more positive coping strategies.\(^33\)

Understanding these pathways should be a focus of future work.

There are several mechanisms through which negative life events may be associated with future overweight. Negative life events may lead to increased food consumption,\(^34–38\) particularly comfort foods, which contribute to relieving stress at a neurobiological level.\(^14\) Negative life events may also lead to poor sleep or disruption of household routines, which have been linked to increased obesity risk.\(^39,40\) Negative life events may also contribute to child behavioral or mental health problems, which have each been linked to childhood obesity.\(^41,42\) Previous work has also shown that under conditions of stress, the brain triggers changes in metabolism that can lead to excessive weight gain.\(^43\)

Strengths of our study include its relatively large, prospective, and socioeconomically and geographically diverse sample. Of the studies that measured negative life events as we did,\(^7,10,13\) our study included the most detailed measure. Limitations include that our sample was primarily white. Our study, like most previous work,\(^4,5,7–13\) asked mothers to describe events or stressors in the home but did not ask children directly about their experience of these events or stressors.

**CONCLUSIONS**

Early school-aged children experiencing many negative life events are at higher risk of being overweight by age 15 years. At present, clinicians might consider attending to the possibility of increases in overweight risk among children experiencing a substantial number of negative life events concurrently at any point in childhood, as well as children living in households in...
which adults or family members are experiencing own physical or mental health and well-being. As the mechanism becomes better understood, interventions could be developed to better target the mechanism of association to prevent obesity. Investment in parenting and early childhood education programs, which can mitigate early life adversity, may be a valuable focus for policies targeting childhood obesity.

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