Published in final edited form as:
Obes Rev. 2011 May ; 12(5): e159–e172. doi:10.1111/j.1467-789X.2010.00823.x.

Interpersonal violence in childhood as a risk factor for obesity: a systematic review of the literature and proposed pathways

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Summary

We examined the associations between exposure to interpersonal violence in childhood and risk for obesity and central adiposity. Interpersonal violence is defined as behaviour that threatens, attempts or causes physical harm. In addition, we evaluated the evidence for three mechanisms that may connect interpersonal violence to obesity: negative affect, disordered eating and physical inactivity. Based on a literature search of Medline and PsycInfo databases, 36 separate studies were evaluated and ranked based on quality. Approximately 81% of the studies reported a significant positive association between some type of childhood interpersonal violence and obesity, although 83% of the studies were cross-sectional. Associations were consistent for caregiver physical and sexual abuse and peer bullying, and there was mixed evidence for community violence. Although few studies explored mechanisms, early evidence suggests that negative affect and disordered eating may be involved. More prospective studies are needed, as well as studies that examine the mechanisms connecting early childhood victimization to obesity and central adiposity.

Keywords

Abuse; bullying; childhood; obesity

Introduction

Recent evidence has suggested that childhood abuse has the same magnitude of risk for negative physical health outcomes as it does for negative psychological outcomes (1). Most literature examining childhood abuse and health outcomes has focused on one specific traumatic experience, sexual abuse. Other types of abusive incidents in childhood may also be important, particularly experiences involving interpersonal violence. Interpersonal violence is defined as behaviour that threatens, attempts or causes physical harm. Children who are victims of interpersonal violence are often repeat victims, in part because of the chronic nature of these forms of interpersonal violence. Additionally, there are correlations between types of experiences. Studies reporting on various types of childhood victimization suggest that the risk for a new victimization is typically 3–6 times higher for a child who has been previously victimized (2,3).

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Conflict of Interest Statement
No conflict of interest was declared.

Interpersonal violence may be related to negative physical health outcomes in part by its association with obesity and central adiposity. Obesity, measured by body mass index (BMI), predicts all-cause mortality, as well as cardiovascular disease, diabetes, hypertension and some types of cancer (see review by (4)). Central adiposity, measured by waist circumference (WC) or waist-to-hip ratio, predicts mortality in adults (5) and morbidity in adults and children (6–8), independent of BMI.

Two reviews recently examined the evidence linking childhood abuse to obesity. One meta-analysis assessed the associations between sexual abuse and lifetime diagnosis of somatic disorders (9). Only two articles on obesity were included and the pooled odds ratio was non-significant. The second paper reviewed the effects of childhood abuse (physical, sexual, emotional and neglect) on medical outcomes in adulthood (1). Eight articles tested the association between childhood abuse and metabolic disorders and obtained a significant mean effect size of $d = 0.37$. Of these eight studies, only one study reported on a specific relationship between childhood abuse (sexual) and obesity. Thus, on the basis of only three studies, the evidence for childhood abuse and obesity and central adiposity is equivocal.

The purpose of this paper is to systematically review several types of childhood interpersonal violence in addition to sexual abuse, in relation to obesity and central adiposity. Three pathways are considered as mechanisms connecting childhood interpersonal violence to obesity: negative affect, disordered eating and physical activity. These pathways may distinguish specific phenotypes of obesity, or may identify ways in which interpersonal violence leads to increased caloric intake and reduced caloric expenditure.

Method

Definition and measurement of interpersonal violence

For the purpose of this review, interpersonal violence in childhood is operationalized as any threat of or actual physical harm inflicted on the child from other people. Childhood is defined as birth to age 18. Types of interpersonal violence included for review are: physical abuse, sexual abuse, witnessing domestic violence, peer bullying and neighbourhood crime and safety. Violence because of war and violence from the media are excluded. Other instances of interpersonal violence in childhood (e.g. assault with weapons, teen rape, cyber bullying, assault of property, sibling abuse) are also excluded because of the absence of empirical studies examining a link with obesity. All methods of measuring interpersonal violence in childhood are included even though there is significant variability.

Definition and measurement of obesity

Studies included in this review measure obesity or overweight using BMI and central adiposity using WC or waist-to-hip ratio. Obesity may be indicated by categorical cut-points of BMI (e.g. BMI ≥ 30 kg m^{-2}) or by a continuous scale of BMI. BMI is measured by self-report or in the lab. For studies of children and adolescents, overweight and obesity reflects ≥85th and 95th percentiles of BMI based on age and sex.

Criteria for inclusion

To identify articles for inclusion in this review, a literature search was performed in Medline and PsycInfo databases. Based on the previously explained definitions, the following subject headings were included and exploded: violence, child abuse, sexual abuse, physical abuse, bullying, domestic violence, teasing, crime victims, harassment, violent crime, obesity, morbid obesity, body size, BMI, WC, waist-hip-ratio, overweight and bariatric surgery. The following keywords were also entered: battered child syndrome, victimization, stalking,

neighbourhood, sexual harassment, adiposity, abdominal fat, adipose tissue, subcutaneous fat and visceral fat. Reference lists were screened to identify additional relevant articles. A total of 321 articles were initially identified.

To be included in the review, articles needed to examine at least one measure of interpersonal violence occurring before the age of 18 and at least one measure of obesity or central adiposity. Articles included in earlier reviews were excluded. Sample sizes less than 100 participants would have limited statistical power to find an effect; thus, two studies were excluded from the review. Additionally, one study (and three analyses within studies) was excluded because of exceptionally low prevalence of violence (<5%), compared to the 15–30% national prevalence rates based on self-report data (10–12). Low prevalence rates would increase the likelihood of a false negative. The present review is based on 36 studies containing 55 separate analyses that fit the criteria.

A formal meta-analysis of the relevant literature was not completed for several reasons. First, there was a wide range of covariates among the studies, and univariate results were often missing. Second, obesity outcomes varied across studies; outcomes included BMI as a continuous measure, overweight and obesity (BMI ≥ 25), obesity (BMI ≥ 30), or morbid obesity (BMI ≥ 35). Third, measures of the interpersonal violence were markedly different across studies, both in psychometric properties and the severity of violence assessed, making it difficult to make comparisons across studies. Consequently, a qualitative review describes the patterns in the literature and a range of effect sizes is reported when available.

To assess the strength of the evidence, we rated five components of each study's method: sample size, measure of interpersonal violence, measure of obesity, study design and covariates. For sample size: $n > 500$ was rated 1 and $n = 100–500$ was rated 0. For measures of interpersonal violence: objective measurement was rated 2, standardized self-report measure (or portion of) or structured interview was rated 1, and a single-item or unstandardized questionnaire or interview was rated 0. For measure of obesity: lab or clinic measured BMI was rated 2 and self-reported BMI (or method not reported) was rated 0. For study design: longitudinal or prospective design (defined by following individuals over time or evaluating events that happen in the future) was rated 2 and cross-sectional or retrospective design (defined by subjects assessed in relation to a current event or subjects evaluating events that happened in the past) was rated 0. For covariates: inclusion of age, sex, race and major confounders (e.g. socioeconomic status [SES], health behaviours) was rated 2, inclusion of age and/or sex and/or race was rated 1, and no covariates was rated 0. The range of ratings for the studies included in this review was 1–8, and 'higher-quality' studies were defined as those that earned a score of 4 or greater.

Results

In the 36 studies reviewed here, there was wide variability in measurement of childhood interpersonal violence, ranging from a single item to court-substantiated cases. Most studies (83%) employed cross-sectional study designs. Across all studies, 138 746 (61% female, 39% male) participants were involved, with 6–34% of the participants reporting some form of interpersonal violence in childhood. Twenty-nine (81%) studies reported positive associations between at least one type of childhood interpersonal violence and obesity, in contrast to seven (19%) studies that reported null relationships. Twenty-one studies (58%) were classified as higher-quality based on a quality score ranging 4–8. Of the higher-quality studies, 18 studies (86%) reported positive associations and 3 (14%) reported non-significant findings. In sum, the majority of studies report positive associations between childhood interpersonal violence and obesity.

Below we review the specific studies according to the source of the violence. Childhood interpersonal violence from caregivers is reviewed first, targeting childhood sexual abuse, physical abuse, and witnessing domestic violence (18 studies; see Table 1). Interpersonal violence from peers, specifically bullying, is reviewed second (12 studies; see Table 2). Finally, interpersonal violence from the community is reviewed third, focusing on neighbourhood crime and safety (six studies; see Table 3). Tables display sample size, study design, interpersonal violence measure, obesity measure, covariates, results, and study rating. Summaries of the literature focus primarily on the higher-quality studies because of the strength of the methodology. Patterns and discrepancies between the higher- and lower-quality studies are described briefly. Studies that examine central adiposity are reviewed separately because of central adiposity's association to morbidity and mortality, independent of overall obesity.

Childhood interpersonal violence from caregivers

There have been two prospective studies (13,14) following children with documented histories of physical and sexual abuse into adulthood and were among the studies to receive the highest quality ratings. Noll *et al*. (14) found that penetrative sexual abuse predicted higher BMI in young adult women, 42% of sexually abused women were obese and 28% of matched controls were obese. Bentley and Widom (13) reported that physical abuse, but not sexual abuse, was related to BMI in midlife men and women, $\beta = 0.14$, $p < 0.05$. These prospective, longitudinal studies concur in their findings that individuals with documented histories of childhood abuse have greater BMI in adulthood. The discrepancy between the two studies regarding sexual abuse may have been a result of methodological differences. For instance, Noll *et al*. (14) used strict criteria for identifying substantiated cases with severe sexual abuse, perhaps indicating that more severe forms of sexual abuse are associated with BMI.

Among the 16 cross-sectional studies examining interpersonal violence from caregivers and obesity, 7 were deemed higher quality and generally reported positive associations between sexual abuse and BMI (15–18) and physical abuse and BMI (16,18–21). Only one study examined witnessing domestic violence and reported a positive association with BMI in adulthood (21). Results suggested that individuals experiencing interpersonal violence from caregivers had odds ratios ranging from 1.26–2.85 for obesity and odds ratios ranging from 1.16–1.85 for overweight. Non-significant results were reported between physical abuse and BMI in one study (15); however, the sample was notably healthy with only 13% of the participants being obese, suggesting possible sampling bias.

Of the lower-quality studies, approximately half reported positive findings between physical and sexual abuse and obesity in women (22–26). The other half of the lower-quality studies (each with quality score of 1) examined bariatric and binge eating disorder patients and reported null results (27–30). It should be noted that rates of abuse in these patient samples were much higher than in normative samples, which may itself suggest a relationship between childhood violence and obesity. However, no significance tests were performed. Null findings may have been because of little variation in BMI in the morbidly obese participants.

Two higher-quality studies investigated the relationship between interpersonal violence in childhood and central adiposity. Midei and colleagues (18) examined cross-sectional and longitudinal associations between abuse and WC. Midlife women with histories of physical or sexual abuse had higher mean WC at baseline than women without histories of abuse. Moreover, normal weight and overweight abused women (BMI ≥ 30 kg m^{-2}) showed greater increases in WC over 9 years compared to non-abused normal weight and overweight women, whereas abused obese women (BMI ≥ 30 kg m^{-2}) showed decreases in

BMI over 9 years compared to non-abused obese women. A second cross-sectional study of men and women showed that childhood physical abuse or witnessing abuse significantly predicted greater WC in adulthood (21). In summary, child abuse from caregivers predicts higher obesity and central adiposity in longitudinal studies and higher-quality cross-sectional studies.

Childhood interpersonal violence from peers

Two longitudinal studies received higher-quality ratings and reported that peer bullying predicted increases in BMI during adolescence. Sweeting *et al*. (31) compared children who became obese over 4 years to continually non-obese children and found that peer bullying at age 11 doubled the odds of becoming obese by age 15, controlling for baseline BMI. The second study by Adams and Bukowski (32) found that obese females who reported being bullied by peers at age 12–13 had significant increases in BMI by age 16–17. Obese males showed the opposite relationship, bullying at age 12–13 was associated with decreases in BMI. Peer bullying was not related to changes in BMI for normal weight adolescents. A third study by Lumeng and colleagues (33) showed a significant cross-sectional relationship between obesity and being bullied; however, being bullied at age 8 did not predict change scores in BMI at age 12 (controlling for baseline BMI, gender, SES, social skills, and academic achievement). Lumeng *et al*.'s sample was younger than the previously described studies, which may suggest an age effect in the relationship between bullying and increases in BMI. Alternatively, bullying may be associated with increases in BMI only in subgroups of children, as suggested by Adams and Bukowski (32).

Eleven studies reported on the cross-sectional relationship between peer bullying and obesity, and the majority of studies utilized samples of children and adolescents. All of the higher-quality studies (31,33–36), as well as the lower-quality studies (37–42), reported a positive association between peer bullying and obesity. Studies that provided an effect size suggested that individuals experiencing interpersonal violence from peers had odds ratios ranging from 1.52–2.67 for obesity.

Researchers have considered the possibility that types of bullying experiences may vary by gender. It is possible that boys more often experience verbally or physically aggressive bullying, termed overt bullying, and that girls experience social harm inflicted by friendship status, termed relational bullying (43). Three studies explored gender differences (36,38,41). In general, both overt and relational bullying predicted obesity, and associations were not gender specific.

Childhood interpersonal violence from the community

All six of the studies examining childhood interpersonal violence from the community and obesity received higher-quality scores. Studies investigating associations between interpersonal violence from the community and obesity were conducted in children or adolescents and were cross-sectional in design. Findings were mixed, such that three studies reported a positive association between neighbourhood crime/safety and obesity (44–46) and three studies reported null findings (47–49). Neighbourhoods identified as being unsafe were associated with a 1.2–4.43 odds ratio of being obese (44,46), and violent crime predicted 6.7% of the variance in childhood and adolescent obesity (45). Most studies controlled for family SES, while some studies further controlled for neighbourhood SES or neighbourhood social cohesiveness. There were no consistent patterns of results based on objective vs. subjective measures of community violence or parent vs. child reporter of community violence. Studies conducted in children less than 10 years of age tended to find non-significant results between neighbourhood crime/safety and obesity (47–49). Taken

together, the evidence is inconsistent for an association between neighbourhood violence and obesity.

Moderators

There are several moderators to consider in the overall relationship between childhood interpersonal violence and obesity and central adiposity, including severity of abuse, obesity status, race, age, gender and SES. There were few formal tests of moderation or effect size for covariates in analyses. With regard to trauma severity, some higher-quality studies suggested that only the most severe forms of physical or sexual abuse were associated with BMI (17,19), whereas some studies found a dose–response relationship between increasing severity or frequency and BMI (16,35,41).

Patterns show that childhood interpersonal violence may be better at predicting obesity than overweight (31–33,36–38,41,42), although other studies found a similar risk profile for overweight individuals or BMI measured continuously (13,16–18,20,26,34,35,39,50). Several of the studies on children found that interpersonal violence was associated with BMI, but only for obese kids (32,33,36–38,41). Obese children appear to be particularly vulnerable to the association between violence and weight.

Prevalence data within these higher-quality studies suggested that more black women and more adolescents who self-identified as multiracial reported histories of physical abuse (18,20). However, only one study tested whether the relationship between interpersonal violence and obesity varied by race (22); interactions were not significant.

Childhood interpersonal violence was more consistently associated with obesity earlier in the life span (i.e. adolescence and young adulthood) than in later adulthood (14,17,25). This may be because 66% of Americans are overweight or obese in adulthood (51) and childhood interpersonal violence may account for less of the variance in obesity as adults move through the life course and gain more weight.

With regard to gender, significant relationships were more consistent in samples limited to females (16,18,22,24) compared to samples with both males and females (15,27,29). Moreover, three studies found significant relationships in only females but not males (17,32,42). Finally, previous literature shows that SES is associated with interpersonal violence in childhood and obesity (52–54). In total, 25% of the studies controlled for childhood SES and 25% of the studies controlled for adulthood SES, but there was no change in significant associations. In sum, although some studies suggest that moderators such as trauma severity or obesity categories might matter, the most consistent patterns indicate that the relationship between interpersonal violence and obesity is stronger in females and younger adults.

Mechanisms

Interpersonal violence, negative affect and obesity—About one-quarter of the studies showing a positive relationship between interpersonal violence and obesity incorporated a measure of negative affect. Emotional difficulties were frequently reported symptoms and analyses showed positive correlations with either childhood interpersonal violence (20,39) or obesity status (16,34,35,37). These findings were consistent among various measures of negative affect, which ranged from one-item to standardized questionnaires.

Three studies tested whether negative affect mediated the relationship between childhood interpersonal violence and obesity, although measures of negative affect varied across studies. For example, Midei *et al*. (18) reported that anger partially mediated cross-sectional

relationships between childhood abuse and BMI and WC, but depression, anxiety and cynicism did not mediate. In a study by Alvarez and colleagues (24), perceived stress partially mediated the relationship between childhood abuse and obesity. Finally, Sweeting *et al*. (31) reported cross-sectional and longitudinal relationships between peer bullying and obesity in adolescents and measured depressed mood. Cross-sectional analyses at age 11 showed that obese males had more negative mood than non-obese males, which was partly explained by concurrent bullying, suggesting that obese boys had both depression symptoms and were more frequently bullied. Longitudinal analyses showed that frequent peer bullying at age 11 predicted becoming obese by age 15; however, these same individuals reported smaller increases in depression symptoms compared to continually non-obese adolescents (31). In summary, there is preliminary evidence to suggest that negative affect may be a significant pathway in the relationship between childhood interpersonal violence and obesity.

Interpersonal violence, disordered eating and obesity—Among the studies that found a significant positive relationship between interpersonal violence and obesity, only three studies included a measure of disordered eating. One study by Gibson and colleagues (35) reported that eating disorder psychopathology was related to obesity in children ages 8–13, but made no connection with interpersonal violence. Two studies statistically tested the pathway of interpersonal violence to obesity through disordered eating. Rhode *et al*. (22) assessed binge eating by measuring loss of control when eating, consumption of objectively large quantities of food, and a binge frequency of 2–3 times per week. Childhood physical or sexual abuse predicted binge eating and binge eating significantly predicted obesity. The final model showed that inclusion of binge eating appeared to partially mediate the association between childhood physical abuse and obesity, although there was no test of significance for mediation (i.e. Sobel test). Greenfield and Marks (19) measured disordered eating by responses to an item measuring the use of food in response to stress. In mediation models, greater use of food in response to stress partially mediated the relationship between childhood abuse and obesity, reducing the relationship to a trend. These two studies provide preliminary support for disordered eating as a mechanism linking childhood interpersonal violence and obesity.

Interpersonal violence, physical inactivity and obesity—Among the studies that reported a positive association between interpersonal violence and obesity, six studies measured physical activity. Two studies suggested that interpersonal violence were associated with lower physical activity (26,44), whereas one study reported a non-significant relationship between abuse and physical activity (15). Thomas *et al*. and Alvarez *et al*. (21,24) included physical activity in statistical models and found that adjusting for physical activity had little effect on the positive associations between violence and obesity. Midei and colleagues (18) provided the only study that statistically tested whether physical activity mediated the relationship between childhood abuse and adiposity in midlife women, and results showed no significant mediation. In summary, these few studies suggest that physical activity may not be a primary mechanism linking childhood interpersonal violence to obesity.

Discussion

The current literature provides strong support for an association between interpersonal violence in childhood and obesity, with physical abuse, sexual abuse, and peer bullying garnering the most empirical evidence. A review of only the higher-quality studies also shows consistent positive associations between interpersonal violence from caregivers and peers and obesity. Studies measuring the outcome of central adiposity were few in number,

but the early evidence suggests a positive association with interpersonal violence from caregivers and WC.

There is mixed support for the association between neighbourhood crime/safety and obesity, suggesting that interpersonal violence from the community may be experienced in a qualitatively different manner than childhood maltreatment or peer bullying. Alternatively, age of participants may have negatively influenced the direction of findings. Two out of the three studies that found non-significant associations included boys and girls between the ages of 3 and 5. This period of the life course may be too early to detect the onset of an obesity trajectory in relation to the burden of childhood interpersonal violence. It is also probable that the immediate family plays a more important role in childhood, while the influence of neighbourhood and peers increases in adolescence. Finally, measures of childhood interpersonal violence from the community did not identify whether individuals were targets of the neighbourhood crime, which may be more comparable to violence from caregivers or peers.

The literature largely relies on cross-sectional associations, although the few prospective and longitudinal studies (13,14,31,32) suggest that childhood interpersonal violence from caregivers and peers predicts greater increases in obesity compared to controls. Moreover, longitudinal research demonstrated a significant relationship between childhood interpersonal violence and increases in central adiposity (18). It should be noted that this review covered 36 studies assessing childhood interpersonal violence, published between 1999 and 2010, and found a consistent positive association with obesity, as well as for central adiposity. Prior mixed results were based on only three studies (1,9).

It is likely that some bidirectional relationships exist between interpersonal violence and obesity. For instance, the stigma of obesity may contribute to being bullied. Studies showed that pictures of obese children were rated as least liked by boys and girls, in comparison to pictures of children with physical handicaps (crutches, wheelchair, missing hand, facial disfigurement) and a healthy child (55–57). There may be a cyclical interplay between interpersonal violence and obesity, such that that interpersonal violence increases risk for obesity, and obesity increases risk for interpersonal violence. For example, the study by Adams *et al*. (32) showed that peer bullying predicted increases in BMI over 3 years, but only for obese girls, not normal weight girls. Obese girls were bullied more, and bullying was associated with increases in body mass. Only one study statistically tested bidirectional relationships between interpersonal violence and obesity. Sweeting *et al*. (31) found that peer bullying at age 11 was associated with becoming obese by age 15; however, becoming obese was not associated with greater peer victimization at age 15. These mixed findings suggest that future research should focus on the possible cyclical interplay between interpersonal violence and obesity.

This comprehensive review showed that approximately 81% of the literature found positive associations between childhood interpersonal violence and obesity. Of primary importance is the consideration of *how* interpersonal violence in childhood may change the trajectory of health to increase risk for obesity. Only 4 out of the 36 studies examined mechanisms. Three main pathways were reviewed as potential mechanisms linking interpersonal violence to obesity: negative affect, disordered eating, and physical inactivity. Among the limited evidence that tested for mediation, studies showed that negative affect, specifically anger, perceived stress, and depressive symptoms, partially mediate relationships between interpersonal violence and obesity. Previous literature has shown that children who experienced interpersonal violence had increases in anger, fear, and aggression when with peers and adults (58–60). Other types of negative affect, such as depression, sadness, and loneliness, are also increased in victims of childhood interpersonal violence (61,62). Victims

of interpersonal violence may overeat in order to redirect, control or modulate negative emotions. For instance, one study reported that overweight/obese individuals with high negative affect ate more in response to a negative mood induction than the overweight/obese group with low negative affect or the normal weight group (63). Depression, anger, hostility and anxiety are associated with both BMI (64–66) and measures of central adiposity (67,68).

Another mechanism examined in the present review was disordered eating or binge eating, which partially mediated the relationship between childhood interpersonal violence and obesity. Childhood interpersonal violence has been associated with binge eating and disordered eating in prior literature (69–73), and binge eating is associated with obesity (74). Disordered eating may be related to obesity through sensitized neural-reward pathways. Studies using functional neuroimaging methods reported that obese individuals with binge eating behaviours had increased neural reactivity in response to high-caloric food cues, suggesting a heightened motivation and reward for eating (75,76).

Preliminary empirical evidence did not support physical inactivity as a pathway, although only one study did a purposeful testing of mediation. In summary, results suggest that positive associations between childhood violence and obesity may in part be because of negative affect and disordered eating. Furthermore, partial mediations indicate that other mechanisms are important to consider in understanding how childhood interpersonal violence influences adiposity.

One limitation of the literature reviewed in this paper is the lack of adiposity measures other than BMI, except for two studies on central adiposity. High waist-to-hip ratio is a strong predictor of death from ischemic heart disease in men (77) and coronary heart disease in women (50), even after adjusting for BMI and other coronary risk factors. Furthermore, central adiposity in childhood is associated with concurrent high plasma triglycerides, high plasma insulin, and unhealthy lipid profiles, controlling for weight, height and age (6). A link between childhood interpersonal violence and central adiposity may identify a specific phenotype of obesity.

A second limitation is that no studies examined violence exposure, obesity/central adiposity and potential biological mediators, such as hypothalamic-pituitary-adrenal (HPA) axis dysregulation. Hypersecretion of cortisol has been documented in samples of sexually and physically abused children and adolescents (78–80), as well as in boys who were victims of occasional verbal bullying (81). Moreover, heightened cortisol levels and cortisol reactivity have been associated with central adiposity in observational and laboratory studies (82–84). These findings suggest that studies of HPA regulation would be useful to understand the connections between exposure to interpersonal violence in childhood and the development of excess body fat.

A third limitation of the studies included in this review is the wide variability in measures of childhood interpersonal violence. To examine childhood maltreatment, some studies use an item with the broad labelling term of ‘sexual abuse’ without behavioural markers. This type of question encourages high false negatives (85), particularly for men (86,87). Stronger methodological studies utilized the Childhood Trauma Questionnaire, which shows measurement invariance, strong test–retest reliability, and convergent validity with clinical interview and therapist ratings (88–90). Objective measures of childhood maltreatment (e.g. court-substantiated cases) eliminate the bias associated with recall and increase external validity. On the other hand, cases reaching social services reflect a small portion of the population who are victims of interpersonal violence (88–91), and this subgroup may be qualitatively different than children who never receive intervention (92).

Finally, the current qualitative review is limited because a range of effect sizes as opposed to average effect sizes was presented. As mentioned previously, the range of methodologies used to examine the relationship between interpersonal violence and obesity rendered an overall effect size less meaningful. To encourage the use of meta-analytic techniques, future studies should utilize independent variables with strong psychometric properties, and report effect sizes for univariate analyses and multivariate analyses, and the influence of potential moderators.

When examining interpersonal violence from peers, it is important to distinguish bullying from normative playful teasing. An accepted definition of peer bullying, developed by Olweus (87), suggests that bullying occurs when a child or adolescent is exposed to the negative actions of peers and has three important criteria: the negative action is intended to inflict harm or to disturb, the behaviors are repeated over time, and there is an imbalance of power or strength. Most of the bullying measures included in the present review overlap with this definition by using behavioural markers for bullying (e.g. 'Have you been hit, kicked, pushed, shoved around or locked indoors?') and by assessing the frequency of bullying (e.g. '≥2–3 times per month'). However, the measures ranged from a single-item to standardized questionnaires. Finally, studies on community crime and safety used both objective and subject measures to assess neighbourhoods, with inconsistent results. Future studies should consider examining whether objective measures of crime/violence (e.g. serious crimes reported to the police) is moderated by perceptions of violence (e.g. feelings of threat and vigilance).

An important direction for future research is poly-victimization, or the experience of multiple violence exposures. An example would be that a child physically abused at home is more likely to be bullied at school. The Adverse Childhood Experiences study surveyed a large sample of health maintenance organization patients and found that exposures to abuse and household dysfunction were positively correlated; for a person reporting a single exposure, the probability of reporting a second exposure was on average 80%, and the probability of reporting two or greater additional adverse experiences was on average 56% (93). The co-occurrence of different types of violence may partly explain the similar obesity outcomes across different types of violence. Only one study examined the relationship between poly-victimization and obesity, and this study was included in a previous review (94). The authors found a dose–response relationship between the number of exposures to adverse experiences and severe obesity (93).

There are several implications of this comprehensive review. Children and adolescents are the most likely to be victimized compared to adults of any age, and they are also the least likely to report exposure to violence (2). Prevention is the first priority for this high-risk population and has been shown to be effective. Schools initiating anti-bullying practices reported decreases in peer victimization and aggression (95), and programmes teaching parenting skills reduce physical abuse at home (96). The second priority is identifying children experiencing interpersonal violence to minimize the number of undetected cases. Programmes educating children and adults regarding the seriousness of interpersonal violence can increase awareness and reporting. Schools and police can take a larger role in encouraging victims to report, improving interactions with the criminal justice system, and providing referrals to help victims.

Another priority in addressing childhood interpersonal violence is to improve intervention and treatment programmes. Interpersonal violence in childhood (specifically physical and sexual abuse) has long been recognized as a risk factor for mental health, but only recently has interpersonal violence been considered as a precursor to physical health problems, such as obesity and overweight. Clinicians and clinical-researchers have the opportunity to

improve the trajectory of mental and physical health outcomes for victims of interpersonal violence. One school-based intervention for children exposed to violence used cognitive-behavioural therapy to increase healthy coping strategies (97). After 10 sessions, the intervention group showed decreases in post-traumatic stress symptoms, depression, psychosocial dysfunction and classroom problem behaviours. It is possible that a similar intervention would also prevent excessive weight gain.

Finally, analysing and clarifying the relationship between interpersonal violence in childhood and obesity may increase our understanding of the pathogenesis of obesity. The list of childhood psychosocial stressors predicting obesity, such as poor social support and clinical depression (64,68), may now include interpersonal violence.

Acknowledgments

This research was supported by T32 HL007560 and HL25767.

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Table 1

Interpersonal violence from caregivers and obesity

Reference	Sample	Study design	Interpersonal violence measure	Obesity measure	Covariates	Quality rating/comments	Results
Aaron & Hughes (23)	*n* = 416 F Age 18–83 Lesbians	C	CSA – 1 item by interview	Self-reported BMI ≥ 30	Age, race, education	2	CSA+
Allison *et al*. (27)	*n* = 273 M + F Age ~40–50 BED and NES patients, obese controls	C	CPA – CTQ CSA – CTQ	Self-reported BMI		1	CPA 0 CSA 0
Alvarez *et al* (24)	*n* = 11 115 F Age 18–65+	C	CPA – 1 item by phone survey CSA – 1 item by phone survey	Self-reported BMI ≥ 30	Age, race, education, food insecurity, inadequate fruit and vegetable consumption, physical inactivity, perceived stress	3	CPA+ CSA+
Bentley & Widom (13)	*n* = 410 abused B + G; 303 controls Age 41	L	CPA – official records CSA – official records between age 0–11	Lab-measured BMI	Age, race, sex, cigarette smoking, alcohol consumption	8	CPA+ CSA 0
Chartier *et al*. (15)	*n* = 8 116 M + F Age 15–64	C	CPA – 7 items, modified Conflict Tactics Scale CSA – 4 items from National Population Survey of Canada	Self-reported BMI ≥ 30	Age at interview, gender, high school education, marital status	4	CPA 0 CSA+
Greenfield & Marks (19)	*n* = 1 650 M + F Age 33–84	C	CPA – 8 items, modified Conflict Tactics Scale	Self-reported BMI ≥ 30	Living with parents during childhood, welfare during childhood, parental education, participant's education, income, marital status, race, gender, age	4 CPA was only significant with psychological abuse	CPA+
Grilo & Masheb (28)	*n* = 145 M + F Age 23–61 BED patients	C	CPA – CTQ CSA – CTQ	BMI – method not reported		1	CPA 0 CSA 0
Grilo *et al*. (29)	*n* = 340 M + F Age mean = 43 candidates for bariatric surgery	C	CPA – CTQ CSA – CTQ	BMI – method not reported		1	CPA 0 CSA 0
Gustafson *et al*. (30)	*n* = 556 M + F Age mean = 43 Candidates for bariatric surgery	C	CSA – 1 item	Self-reported BMI		1	CSA 0
Hussey *et al*. (20)	*n* = 10 828 M + F Age 18–26	C	CPA – 1 item (occurred before the sixth grade)	Lab-measured BMI ≥ 85th %	Gender, age, race/ethnicity, parent's education, family income, immigrant generation, US region	5	CPA+

Reference	Sample	Study design	Interpersonal violence measure	Obesity measure	Covariates	Quality rating/comments	Results
Jia *et al*. (16)	*n* = 239 F Age 18–70 Gastrointestinal patients	C	CPA – structured interview CSA – structured interview	Lab-measured BMI ≥ 25	Race, age, education, smoking, stress-affected health, health perception, psychiatric in-patient GI diagnosis, coping	5	CPA+ CSA+
Mamun *et al*. (17)	*n* = 2 461 M + F Age 21	C	CSA – 5 items	Lab-measured BMI ≥ 25	Age, maternal age at birth, maternal education, income, maternal depression, maternal smoking, marital status, behaviour problems	5	CSA + (penetrative only, F only)
Midei *et al*. (18)	*n* = 311 F Age mean = 45.7 Baseline plus 8 follow-up visits	C/L	CPA – CTQ CSA – CTQ	Lab-measured BMI/WC	Age at baseline, menopausal status at baseline, adulthood SES, race	7	BMI/WC = CPA+, CSA+ Δ WC = CPA+, CSA+ (When BMI 3 30) Δ BMI = CPA 0, CSA 0
Noll *et al*. (14)	*n* = 84 abused G, 89 controls Age 6–16 Time 1 Age 18–27 Time 2	L	CSA – (penetrative) referred by Child Protective Services	Lab-measured BMI z-score of ≥ 95th % or BMI ≥ 30	Race and parity	7 BMI increased at steeper rate for CSA	CSA + (by young adulthood) Δ BMI = CSA+
Pinhas-Hamiel *et al*. (25)	*n* = 145 G Age mean= 10.4 Obese treatment-seeking girls	C	CSA – interview; penetrative intercourse	Lab-measured BMI		3	CSA+
Rohde *et al*. (22)	*n* = 4 641 F Age 40–65	C	CSA – 1 item by phone survey CPA – 1 item by phone survey	Self-reported BMI ≥ 30	Age and race	2 No interactions with race	CPA+ CSA+
Thomas *et al*. (21)	*n* = 9 310 M + F Age 45	C	CPA – 1 item Witnessing abuse – 1 item	Lab-measured BMI ≥ 30 WC ≥ 102 cm (M), 88 cm (F)	Gender, birth weight, childhood SES, cognitive ability, school SES, housing, # of persons per room, adult SES, smoking, alcohol, diet, physical activity, watching TV	5	CPA+ Witnessing abuse+
Walker *et al*. (26)	*n* = 1 225 F Age mean = 42	C	CSA – CTQ	Self-reported BMI ≥ 27	Martial status, education	3	CSA+

B, boys; BED, binge eating disorder; BMI, body mass index; C, cross-sectional; CPA, childhood physical abuse; CSA, childhood sexual abuse; CTQ, Child Trauma Questionnaire; F, females; G, girls; GI, gastrointestinal; L, longitudinal; M, males; NES, night eating syndrome; SES, socioeconomic status; WC, waist circumference; Δ, change; %, percentile.

Table 2

Interpersonal violence from peers and obesity

Reference	Sample	Study design	Interpersonal violence measure	Obesity measure	Covariates	Quality rating/comments	Results
Adams & Bukowski (32)	*n* = 1 287 B + G Three waves of assessment Age 12–13 Time 1	L	Peer victimization – 3 items	Self-reported BMI ≥ 95th % BMI ≥ 85th %	Self-concept for physical appearance	4	Δ BMI = Bully + (obese G) Δ BMI = Bully - (obese B)
Bell *et al*. (34)	*n* = 177 B + G Age 6–13 some obese treatment seeking	C	Bullying/teasing – structured interview	Lab-measured BMI z-score	SES, parent's ages, parent's physical complaints, age, sex	5	Bully+
Berg *et al.* (37)	*n* = 989 B Age 15	C	Bullying – 2 items	Self-reported BMI ≥ 95th % BMI ≥ 85th %		1	Bully + (obese B only)
Gibson *et al.* (35)	*n* = 262 B + G Age 8–13	C	Bullying – Bullying Questionnaire for Children	Lab-measured BMI z-score	Family-level clustering, gender, age group	4	Bully+
Griffiths *et al.* (36)	*n* = 8 210 B + G Age 7.5	C	Bullying – standardized questionnaire, 2 types overt, relational	Lab-measured BMI ≥ 95th % BMI ≥ 85th %	Parental social class	6	Overt Bully + (obese B, G) Relational Bully + (obese B only)
Gunstad *et al*. (40)	*n* = 696 M + F Age 18–82	C	Bullying/rejection – 1 item	Self-reported BMI ≥ 30 BMI ≥ 25	Age	3	Bully + (men only)
Janssen *et al.* (41)	*n* = 5 749 B + G Age 11–16	C	Bullying – 1 item per type of bullying, verbal, physical, relational	Self-reported BMI	Age	2	Verbal Bully + (obese B, G) Physical Bully + (obese G only) Relational Bully + (obese B, G)
Kestila *et al*. (42)	*n* = 1 158 M + F Age 18–29	C	Bullying – 1 item	Self-reported BMI ≥ 95th % BMI ≥ 85th %	Parental education, # of parents, child neighbourhood, self-reported childhood adversities, subject education, job type, adulthood neighbourhood, having children, leisure-time physical activity, vegetables intake	3	Bully + (obese women only)
Lumeng *et al*. (33)	*n* = 821 B + G Age ~8, Time 1 Age ~11, Time 2 Age ~12, Time 3	C/L	Bullying – 4 items, child response; 7 items, teacher and parent response	Lab-measured BMI ≥ 95th % BMI ≥ 85th %	Gender, race, income to needs ratio, % in school with free lunch, % in school who were non-	8	Bully + (obese only) Δ BMI = Bully 0

Reference	Sample	Study design	Interpersonal violence measure	Obesity measure	Covariates	Quality rating/comments	Results
					white, grade, BMI status at Time 1		
Pearce *et al*. (38)	*n* = 416 B + G Age ~14–18	C	Bullying – modified Peer Experiences scale	Self-reported BMI ≥ 95th % BMI ≥ 85th %		1	Overt Bully + (obese B only) Relational Bully + (obese G only)
Srabstein *et al*. (39)	*n* = 15 686 B + G Age ~11–16	C	Bullying – 1 item	Self-reported BMI ≥ 85th %		1	Bully+
Sweeting *et al*. (31)	*n* = 2 127 B + G Age 11, Time 1 Age 15, Time 2	C/L	Peer victimization – 2 items	Lab-measured BMI ≥ 95th %		5	Bully+ Δ BMI, Bully+

B, boys; BMI, body mass index; C, cross-sectional; F, females; G, girls; L, longitudinal; M, males; %, percentile.

Table 3

Interpersonal violence from the community and obesity

Reference	Sample	Study design	Interpersonal violence measure	Obesity measure	Covariates	Quality rating/comments	Results
Burdette & Whitaker (48)	*n* = 7020 B + G Age 3–5 Low-income children	C	Crime – objective measure; serious crimes and 911 calls	Lab-measured BMI ≥ 95th % BMI ≥ 85th %		7	Crime 0
Burdette & Whitaker (49)	*n* = 3141 B + G Age 3	C	Safety – 8 items from Environment for Children Rating Scales, parent response	Lab-measured BMI ≥ 95th %		6	Safety 0
Evenson *et al.* (44)	*n* = 1554 G Age M = 11.8	C	Safety – 10 items from the TAAG study, child response	Lab-measured BMI ≥ 95th % BMI ≥ 85th %	School, site, physical activity, neighbourhood SES, percentage of free lunch, race	6	Safety+
Lumeng *et al.* (46)	*n* = 768 B + G Age 7	C	Safety – 5 items from the Neighbourhood Questionnaire, parent response	Lab-measured BMI ≥ 95th %	Safety reporter, sex, BMI z-score at age 4.5, maternal marital status, maternal education, maternal depression, race, after-school activities, quality of home environment, neighbourhood cohesiveness	6	Safety+
Romero *et al.* (47)	*n* = 796 B + G Age ~9	C	Safety – 8 items from the Hazards Scale, child response	Lab-measured BMI		4	Safety 0
Singh *et al.* (45)	*n* = 46 707 B + G Age = 10–17	C	Crime – objective measure of state-level violent crime	Self-reported BMI ≥ 95th %	Age, gender, race/ethnicity, household composition, place of residence, language use, household poverty status, neighbourhood safety, social capital, television viewing, recreational computer use, physical activity, sports participation	5	Crime+

B, boys; BMI, body mass index; C, cross-sectional; G, girls; M, mean; SES, socioeconomic status; TAGG, Trial of Activity in Adolescent Girls; %, percentile.