

**HHS PUBLIC ACCESS**

Author manuscript

*J Sch Health*. Author manuscript; available in PMC 2019 April 01.

Published in final edited form as:

*J Sch Health*. 2018 April ; 88(4): 296–305. doi:10.1111/josh.12609.

## Crime Prevention Through Environmental Design (CPTED) Characteristics Associated With Violence and Safety in Middle Schools

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### Abstract

**BACKGROUND**—This study used a new Crime Prevention Through Environmental Design (CPTED) assessment tool to test the associations between physical attributes of schools and violence-related behaviors and perceptions of students.

**METHODS**—Data were collected from 4717 students from 50 middle schools. Student perceptions of risk and safety, and violence were assessed. Evaluators used the CPTED School Assessment (CSA) to quantify how well the physical elements of each school correspond to ideal CPTED principles. Generalized linear mixed models were used to adjust for school- and student-level characteristics.

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### SUPPORTING INFORMATION

The following Supporting Information is available for this article:

Additional Supporting Information may be found in the online version of this article.

**RESULTS**—Higher CSA scores were generally associated with higher perceptions of safety and lower levels of violence perpetration and perceived risk in unadjusted models. Higher CSA scores were also associated with lower odds of missing school because of safety concerns in most adjusted models, with significant adjusted odds ratios (AORs) ranging from 0.32 to 0.63. CSA scores for parking and bus loading areas also remained associated with higher perceived safety (AORs = 1.28 and 1.32, respectively) and lower perceived risk (AORs = 0.73 and 0.66, respectively) in adjusted models.

**CONCLUSIONS**—The CSA is useful for assessing school environments that are associated with violence-related behaviors and perceptions. The CSA might help guide school environmental modifications to reduce violence.

### Keywords

school violence; violence perceptions; crime prevention through environmental design; school environment; school safety; school risk perception

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School-based youth violence prevention strategies often focus on changing attitudes, beliefs, and norms about violence and enhancing youths' skills to effectively resolve disputes.<sup>1</sup> One goal of these approaches is to change the social climate within the school to reduce aggression and fear. However, the *physical* environment of schools may also contribute to risk for violence and cause daily challenges to students and teachers. For example, inadequate lighting, hiding places, gang or hate-related graffiti, inadequate supervision of corridors, and poor maintenance can provide opportunities for conflict and foster feelings that the school and students are not cared for and that aggressive behavior is tolerated or even necessary to stay safe.

### Crime Prevention Through Environmental Design (CPTED)

Interventions based on the principles of CPTED attempt to reduce the occurrence of crime and violence and promote positive interactions with design and judicious use of the built environment.<sup>2</sup> The principles of CPTED rely on 3 basic overlapping strategies: controlling access, increasing opportunities for casual surveillance, and promoting a sense of ownership.<sup>3</sup> The effects of these strategies can extend beyond reducing opportunities for crime to enhance positive social interactions and create a sense that people care what happens and that problems will be addressed. Environmental strategies designed to reduce crime and improve quality of life have been applied in diverse settings, including communities,<sup>4,5</sup> industrial areas,<sup>6</sup> public transportation,<sup>7</sup> and businesses.<sup>8</sup>

### CPTED and Schools

Despite these examples of environmental strategies, relatively limited research has been conducted to test the effectiveness of the CPTED principles. In addition, few studies have been conducted to test the association between CPTED constructs and violent behaviors, particularly in schools. Historically, there were only a few notable examples of CPTED evaluations conducted in schools, including the CPTED school demonstration project involving 4 suburban high schools in Broward County, Florida,<sup>9</sup> and research in Michigan

elementary and middle schools.<sup>10,11</sup> These studies demonstrated that certain areas of the school, where adults are typically not present, were more likely than others to be associated with increased violence and fear among students. Similar studies conclude the areas most susceptible to violence and crime in schools are parking areas, locker rooms, restrooms, classrooms, and hallways.<sup>12</sup>

Millions of dollars are being spent adding high-tech security equipment (eg, video surveillance, weapon detection) to schools despite limitations<sup>13</sup> such as cost effectiveness and inconsistent evidence of effectiveness.<sup>14</sup> Some types of security, such as metal detectors, have been associated with a greater likelihood a student will be worried about crime.<sup>15</sup> Alternatively, CPTED may be a more effective, cost-efficient, and socially positive way to enhance safety in schools.

CPTED is useful for creating strategies to promote safe, orderly, and comfortable schools. In addition, these strategies can enhance a school's aesthetic quality and bolster pride for students, staff, and the community, which in turn may promote prosocial behaviors.<sup>16,17</sup> To understand the potential for CPTED principles to enhance safety and decrease violence in schools, the US Centers for Disease Control and Prevention (CDC) developed a new, standardized assessment tool, referred to as the CPTED School Assessment<sup>18</sup> (CSA) to assess the extent to which schools adhere to CPTED principles. A critical next step was to empirically test the associations of scores on this tool with students' perceptions of risk and safety and experiences with violence.

## School CPTED Principles

School CPTED principles are based upon a combination of existing research results, field experience, and inquiries of students and school personnel. When asked what *attributes of the environment* create feelings of apprehension or fear, most people respond with examples such as isolation, dim or dark areas, lack of authority, disorderly behavior or illegal activities, and signs of vandalism.<sup>19</sup> Conversely, environmental conditions and behavior associated with comfort and a sense of security include good lighting, actively used buildings, well-maintained areas, secured entrances and exits, the presence of authority figures, access to assistance, and signs of caring (art, murals, gardens).<sup>19,20</sup>

The 5 school CPTED principles from the current study can be summarized as (1) natural surveillance, (2) access management, (3) territoriality, (4) physical maintenance, and (5) order maintenance. These principles form the basis of the CSA statements (Figure 1).

## Current Study

We examined the potential usefulness of the CSA for guiding changes to the design and use of physical attributes in schools to enhance safety. Therefore, the purpose of the study was to determine whether the 5 CPTED principles as measured by the CSA were associated with student perceptions of risk and safety, as well as violence victimization and perpetration on school property. The main outcomes of interest for the current analysis were bullying victimization, verbal abuse victimization and perpetration, physical abuse victimization and perpetration, student perceived safety, student perceived risk of inappropriate or violent

behavior, and missing school out of concern for safety. Based on past research, we hypothesized that in schools with higher (ie, better) CSA scores students would report fewer incidents of violence, less feelings of risk, and greater feelings of safety than students in schools with lower CSA scores. Further, we anticipated that the link between CSA scores and student outcomes (eg, feelings of risk or safety) would vary by specific locations throughout the school grounds (eg, hallways, bathrooms, classrooms) so we tested location-specific associations.

## METHODS

### Participants

A purposive sampling design was conducted to select schools in the greater metro-Atlanta area that would reflect variability in environmental factors potentially related to feelings of risk and safety, as well as violence victimization and perpetration and include diverse student populations (ie, socioeconomic status [SES], race/ethnic mix). Using public records, the sampling frame organized schools into sampling strata that reflected 3 variable dimensions: a school SES indicator, urbanicity, and school facility age. Class and student selection within school site was designed to be representative of each school's student population. We sought a minimum of 25 students per grade from each school. For a given school, classes were selected in advance of data collection from a list provided by the school. Depending on the classroom sizes at each school, 1 or 2 classes (that all students must take) per grade level were selected to meet the minimum sample size per grade level. A total of 213 classrooms in grades 6–8 within 50 schools with 5375 enrolled students were recruited into the CPTED School Study. Institutional review board and Office of Management and Budget approval were acquired, and permission was obtained from the participating school districts, schools, students, and parents of the students.

One of the initial school districts declined the invitation to participate. The schools in this district were replaced with schools in other participating districts from within the same sampling strata. The CPTED School Study had a student response rate of 88% of the planned sample in the participating schools (4717 students participated out of an eligible 5375 enrolled students).

### Instruments

The CPTED School Study included 3 newly created data collection instruments: The CSA, the CPTED Student Survey, and the CPTED School Site Data Form. The CSA is an observational tool that can be used to assess physical conditions and use of the school environment on a typical school day. The CSA tool is designed to assess the extent to which ideal CPTED conditions are present in all areas of the school. It is comprised of 351 statements about different observed areas or physical elements of a school campus, divided into subscales used as the main exposures in this analysis (see Appendix S1, Supporting Information, for examples). Each observed area or element is rated on a 5-point Likert scale with values ranging from “1” to “5,” with “1” being the lowest amount of agreement between the actual situation and the perfect situation and “5” being the highest.

The CSA items provide location-specific scores (eg, parking areas, hallways, locker rooms) aggregated to 3 general geographic locations: grounds, buildings, and interiors. Items from the 5 CPTED principles were further divided into the 3 locations to create 15 mutually exclusive principles by general location subscales. Finally, all CSA items were combined to create an average Overall CSA Score for each school campus.

The CPTED Student Survey collected information on perceptions about school risk and safety, bullying, verbal victimization and perpetration, physical victimization and perpetration, missing school because of safety concerns, and demographics (see Appendix S2). Students were asked to reflect on their experiences in the past month. Response options were on 5-point Likert scales (range 1 to 5), for example, to assess frequency of experience (eg “Never,” “Seldom [1–2 Days],” “Sometimes [3–5 Days],” “Often [6–15 Days],” or “Frequently [16 Days]”) or students’ perceived level of safety (eg, “Not At All Safe,” “Not Really Safe,” “Sort of Safe,” “Safe,” and “Very Safe”).

Students’ responses to questions on outcomes were typically dichotomized into either “Never” versus “Ever” or “Safe” versus “Not Safe” depending on the type of response given. One exception is student perceived risk of inappropriate or violent behavior for which a median split of “Never or rarely” versus “More than rarely” was employed. Students who answered at least two thirds of the questions for each of the constructs were given a value for that construct. The Cronbach’s alpha coefficients for the student scales ranged from 0.63 to 0.97. Appendix S2 provides information about specific question wording, scale-specific Cronbach’s alpha coefficients, the construction of the dichotomized outcomes, and the number of students with missing data for each scale.

The student survey also assessed socio-demographic information, including grade level, biological sex, race and ethnicity, and free/reduced lunch eligibility. Free/reduced lunch eligibility was collapsed into “Free or reduced lunch eligible” versus “Not eligible.”

The third component, the CPTED School Site Data Form, was completed by a school administrator to document information about each school including school age, school crowding (ie, student enrollment divided by capacity), school SES (ie, high, average, and low), and school urbanicity (ie, large/mid-sized central city, urban fringe of city, and large or small town, or rural).

## Procedure

Observational assessments were conducted by 1 expert in CPTED and 1 school CPTED trained architect using the CSA. The observations began 30 minutes prior to the start of the school day and ended 30 minutes after the end of the school day. These assessors conducted observations independently and refrained from communication about the observations until they had assessed all areas of the school campus. At the end of each assessment day, the 2 assessors compared ratings and discussed any discrepancies in their scores to reach a consensus score for each item. The CPTED Student Survey was administered to students in their classroom by trained school-based data collectors. This process began in September of 2011 and was completed in February of 2012.

## Data Analysis

Multivariate analyses based on generalized linear mixed models accounted for the hierarchical study design, using the SAS procedure PROC GLIMMIX with random intercepts for school. Crude odds ratios (ORs) were calculated from models including each of the CSA rating scales or subscales modeled singularly against each student outcome. In order to control population and setting differences across schools that may confound the relationship of CSA ratings and student outcomes, adjusted odds ratios (AORs) were calculated from models also including school-level and student-level covariates. The school-level covariates were SES, urbanicity, a continuous crowding variable, and a continuous variable for “In what year was the school originally built?” The student-level characteristics included grade, race/ethnicity, sex, and free and reduced-price lunch. Students missing any outcome or covariate data for each model were excluded from analyses as detailed in Appendix S2.

## RESULTS

Table 1 presents the demographic characteristics of both the student participants and schools. Among the participating students, the majority were either non-Hispanic black (41.2%) or non-Hispanic white (34.8%), with roughly one-third of students coming from each of the 6th through 8th grades. Sixty percent of students were eligible for either free or reduced-priced lunch, and there were slightly more male participants (53.1%). Among the participating schools, 46.0% were high SES, and 70.0% were in the urban fringe of a city. Over one-third of schools (38.0%) were built between 2000 and 2007. Student enrollment was over capacity at 24.0% of schools.

For each student outcome variable, a total of 24 ORs were calculated. These include 1 for each of the 5 CPTED principles (Natural Surveillance, Access Management, Territoriality, Physical Maintenance, Order Maintenance), 1 for each of 3 general geographic locations (Interiors, Buildings, Grounds), 1 for each principle by general geographic location (15 total), and an overall CSA score.

Table 2 shows the crude ORs between general CPTED principles by location exposures and student experiences of victimization and perpetration. Few findings were significant for verbal or physical abuse victimization, and no results were significant for reports of bullying. For verbal abuse perpetration, the overall CSA score was protective (OR = 0.61), as well as 17 of 23 significant subscales ranging from 0.64 (interiors and grounds) to 0.82 (physical maintenance—buildings). For physical abuse perpetration, the overall CSA score was protective (OR = 0.46), as well as 18 of 23 significant subscales ranging from 0.46 (grounds) to 0.75 (physical maintenance—buildings). When models were run adjusting for the school- and student-level covariates, none of the results were significant, although the majority remained in the expected direction (data not shown).

Table 3 shows the crude ORs between general CPTED principles by location exposures and student perceived safety, student perceived risk, and missing school in the past 30 days out of concern for safety. For student perceived safety, the overall CSA score was significant (OR = 2.20) as well as 19 of 23 significant subscales ranging from 1.34 (natural surveillance

—buildings) to 2.13 (grounds). For student perceived risk, the overall CSA score was protective (OR = 0.40) as well as 18 of 23 significant subscales ranging from 0.37 (grounds) to 0.70 (natural surveillance—buildings, physical maintenance—buildings). For missing school out of concern for safety, the overall CSA score was protective (OR = 0.19) as well as 20 out of 23 significant subscales ranging from 0.22 (grounds) to 0.54 (territoriality—buildings). Some locations, such as school grounds, were highly significant across all variables in the table.

Table 4 shows the adjusted ORs between general CPTED principles by location exposures and student perceived safety, student perceived risk, and missing school in the past 30 days out of concern for safety. With few exceptions (eg, natural surveillance—grounds and access management—interiors), most of the crude significant findings for student perceived safety and student perceived risk became nonsignificant upon adjusting for covariates. Missing school out of concern for safety, on the other hand, remained largely significant in the adjusted model, with the overall CSA score remaining protective (OR = 0.32) as well as 14 of 23 significant subscales ranging from 0.36 (grounds) to 0.63 (territoriality—grounds).

Table 5 shows the crude and adjusted ORs between location-specific CPTED exposures and location-specific student outcomes. The ORs for feeling safe at school in corridors, restrooms, girls locker rooms, cafeterias, parking areas, pathway and gathering areas, exterior athletic areas, and bus loading and unloading areas were all significant in the crude analyses, with ORs ranging from 1.33 to 1.91. The adjusted models show that higher CSA scores, indicating environment conditions that are more consistent with CPTED principles, were associated with increased perceptions of safety in restrooms, girls' locker rooms, parking areas, and bus loading/unloading areas. The ORs for perceived risk at school for corridors, restrooms, cafeterias, parking areas, pathway and gathering areas, and bus loading and unloading areas were all significant in the crude analyses with ORs ranging from 0.54 to 0.69. In the adjusted model, parking areas (AOR = 0.73) and bus loading and unloading areas (AOR = 0.66) remained significant, meaning that these areas are associated with lower student perceived risk (and consistent with the greater perceived safety).

## DISCUSSION

The purpose of this study was to determine whether environmental conditions, as measured by a new standardized assessment tool, in a purposive sample of Atlanta-area middle school students are associated with students' perceptions of risk of violence, safety, and violence perpetration and victimization experience. In the crude analyses testing general location exposures (ie, grounds, buildings, and interiors), CSA scores reflecting agreement with CPTED principles were associated with higher scores on student perceived safety and lower scores on most of the verbal and physical abuse perpetration items as well as student perceived risk, and missing school out of concern for safety in the past 30 days. After controlling for school- and student-level covariates, many of these findings were no longer statistically significant. However, missing school because of concerns for one's personal safety in the past 30 days remained strongly associated with CSA scores. Also, the AORs for location-specific exposures indicated that students from schools where environmental conditions were consistent with CPTED principles felt safer in the restrooms, girls' locker

rooms, parking areas, and bus loading and unloading areas than students from schools that scored low on the CSA. Students attending schools with high CPTED scores also reported lower risk in parking areas and bus loading and unloading areas relative to students from schools that scored low on the CSA. These findings are similar to ones that demonstrate certain areas of the school where adults are not normally present are especially vulnerable to fear and violence.<sup>17,21</sup> Overall, the results suggest that the CSA has the potential to be a helpful tool for developing and evaluating CPTED-based prevention strategies in schools.

The association between better CPTED scores and lower odds of students missing school out of safety concerns might be particularly useful to schools. Absenteeism is one of the most important issues facing schools today given the academic and social problems that accompany it.<sup>22</sup> The fact that significantly fewer students from schools that scored high on the CSA are missing school out of concern for safety than students from schools with lower CSA scores suggests that modifications to the school environment, including supervision strategies, might reduce absenteeism.

It is also worth noting that while violence perpetration and perceptions of safety and risk were often associated with scores on the CSA, victimization was not in either the crude or adjusted analyses. The explanation for this is unclear and additional research is needed to determine why victimization was not related to CSA scores. It is possible that social influences on disclosure of victimization could contribute to these differences. For example, students from schools with problematic CSA scores might be less willing to disclose victimization experiences if they think they will be seen as weak or as a victim.

### Limitations

This is the first study to empirically test the link between CSA scores and students' experiences with violence, missing school out of concern for safety, and perceptions of safety and risk. Several limiting factors should be considered when interpreting the results. First, although a range of violence-related outcomes were examined, there are other behaviors and experiences that could potentially be associated with CPTED scores that were not studied. To more fully assess the potential benefits of CPTED-related changes, it would be useful to understand the link between CSA scores on other types of violence such as sexual harassment, as well as student discipline problems and academic success, teacher experiences and retention, and risk for unintentional injuries such as falls. Second, the results are cross-sectional and causal inference is inappropriate. In addition, it is possible that high levels of community violence increase risk for both low CSA scores and exposure to violence in the community that extends to the school context. The extent to which violence and other community-level factors account for the differences between the crude and adjusted models is unclear. The study had limited statistical power at the school level to examine how school-level covariates influenced the association between CSA scores and the outcomes examined. Finally, the purposive sampling design focused on metropolitan Atlanta, so it is unclear whether the results would generalize to other communities.



## Future Research

The CSA provides an opportunity to quantify school adherence to CPTED principles in a standard way. There are several promising directions for future research on CPTED in schools that are consistent with research priorities of CDC's Division of Violence Prevention.<sup>23,24</sup> Additional research is needed to examine the extent to which CPTED-based improvements in schools can result in changes in CSA scores and reductions in fear or violence, as well as other outcomes such as reduced absenteeism, increased educational success, teacher retention, and risk for unintentional injury. Another promising area for future research is to examine how CPTED strategies and characteristics in the school are associated with positive social interactions among students. Past research has shown that students' feelings of being connected to their school are protective for a range of violence outcomes.<sup>25</sup> Finally, future research is needed to understand why the associations found in the present analyses are diminished in the adjusted models. Future research with a larger number of schools could potentially stratify analyses by school-level risk factors or focus specifically on schools in high-risk areas.

## Conclusion

Overall, the results suggest that multiple indicators of violence-related behaviors and perceptions are strongly associated with objective ratings of how well the school environment adheres to CPTED principles. Some of the associations, particularly student reports of missing school because of safety concerns and location specific associations with perceptions of risk and safety remained significant even after adjusting for school and individual level covariates. Although future research is needed to evaluate the effects of CPTED-related changes to the environment, schools could benefit by using the CSA to examine their buildings and grounds, reflect on how the school environment is being used and maintained, and to identify strategies for improving the school environment. CPTED-related enhancements have the potential to improve the school experience for students and could potentially result in a range of benefits, including lower feelings of risk, enhanced feelings of safety, and lower rates of school absenteeism because of safety concerns.

## IMPLICATIONS FOR SCHOOL HEALTH

This study suggests that school-level factors may be influential in understanding and preventing violence. Most of the risk and protective factors that are associated with violence perpetration and victimization are at the individual (eg, impulsivity) and relationship (eg, delinquent peers) levels. We know less about the aspects of schools that may contribute to perpetrating or being a victim of violence. Modifying these school-level factors that are related to violence experiences has the potential to have a broader impact on violence prevention by impacting an entire school rather than individuals or smaller groups within the school. The findings from this study have implications that may be beneficial for schools and school health. For instance, results suggest that increasing school staff monitoring of restrooms, locker rooms, parking areas, and bus loading and unloading areas may be influential in increasing feelings of safety, perhaps by reducing opportunities for violence. Identifying ways to change the built environment of a school through structural or policy changes may be a cost-effective approach to preventing violence, and should be considered

as part of a comprehensive strategy to prevent school violence. CDC's new technical package to help communities make use of the best evidence for youth violence prevention includes a description of CPTED and other approaches to enhance the physical and social environment to promote safety.<sup>24</sup> Future research that rigorously evaluates structural or policy changes to schools based on CSA results, and testing the added impact of a building-level intervention to a larger school violence prevention strategy, would be beneficial in understanding the effectiveness of school level changes on violence prevention. For instance, Taylor and colleagues,<sup>26</sup> in an evaluation of *Shifting Boundaries*, an intervention to prevent dating violence and sexual harassment among middle school youth, found that the building level intervention was the only portion of the intervention (not the student curriculum) that was associated with reductions in violence victimization and perpetration. The *Shifting Boundaries* building level intervention had multiple components including increasing school staff monitoring based on "hotspot" mapping by students. More research like this, informed by the results of the present study, is needed to understand the unique contribution of school-level factors in the prevention of school violence.

### Human Subjects Approval Statement

This study was approved by EMT Associates, Inc. Institutional Review Board, number 1241.

### Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

### Acknowledgments

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the US Centers for Disease Control and Prevention. We acknowledge the hard work of the late Dr. Merle E. Hamburger, without whom this project would not have been possible.

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**Natural Surveillance** is the design and placement of features and persons to facilitate observations and maximize visibility. The objectives are to eliminate hiding or hard to see places and increase the ability of authorized adults to monitor and respond. This deters aggressive behaviors by increasing the threat of detection and increases feelings of security for students and staff.

**Access Management** is the use of real or perceived barriers and other features to orient and guide people and vehicles along appropriate paths and to restrict inappropriate access. The objectives are to increase comfort and decrease prohibited behaviors by providing safe routes and restricting unauthorized access.

**Territoriality** is the use of physical attributes to delineate space and to express a sense of ownership and pride. The objective is to communicate to others that an area is claimed and cared for and therefore unacceptable behavior will not be tolerated.

**Physical Maintenance** is the repair, replacement and general upkeep of a building or area. The objectives are to allow for the continued use of features and spaces and to further convey a sense of ownership and caring.

**Order Maintenance** is the attention to and reduction of minor inappropriate behaviors. The objectives are to maintain decorum and promote pro-social behaviors by preventing the escalation of tension, conflicts or inappropriate behaviors.

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**Figure 1.**  
Description of the 5 CPTED Principles

**Table 1**

## Demographic Characteristics of the CPTED Student Participants and Schools

		Total Site Sample (N)	Total Sample (Valid %)
CPTED student survey		4717	100.0
Grade level	6th grade	1533	32.9
	7th grade	1561	33.1
	8th grade	1603	34.0
Race (N= 4556; 3.4%missing)	Hispanic	596	13.1
	Non-Hispanic American Indian/Alaska Native	64	1.4
	Non-Hispanic Asian or Pacific Islander	224	4.9
	Non-Hispanic black or African American	1879	41.2
	Non-Hispanic White	1584	34.8
	Non-Hispanic Other	209	4.6
Free/Reduced lunch eligibility (N= 4346; 7.9%missing)	Free/Reduced-price lunch eligibility	2611	60.1
	No eligibility	1735	39.9
Biological sex (N= 4706; 0.2% missing)	Female	2208	46.9
	Male	2498	53.1
CPTED school site data form		50	100.0
School SES	High	23	46.0
	Average	12	24.0
	Low	15	30.0
School urbanicity	Large/midsized central city	10	20.0
	Urban fringe of city	35	70.0
	Large or small town, or rural	5	10.0
Year school was built*	Prior to 1950	2	4.0
	1950–1959	3	6.0
	1960–1969	9	18.0
	1970–1979	4	8.0
	1980–1989	4	8.0
	1990–1999	9	18.0
	2000–2007	19	38.0
School crowding <sup>†</sup>	Below capacity	37	74.0
	At capacity	1	2.0
	Over capacity	12	24.0

CPTED, Crime Prevention Through Environmental Design; SES, socioeconomic status.

\* Year School was Built was modeled as a continuous variable with a mean of 1985.4 and a standard deviation of 20.9, presented here as categorical for descriptive purposes only.

<sup>†</sup> School Crowding (ie, student enrollment divided by capacity) was modeled as a continuous variable with a mean of 85.7% and a standard deviation of 21.7%, presented here as categorical for descriptive purposes only.

**Table 2** Crude OR Between General CPTED Principles by Location Exposures and Student Victimization and Perpetration

	Victimization			Perpetration		
	Bullying (N = 4162) Crude OR (95% CI)	Verbal Abuse (N = 3953) Crude OR (95% CI)	Physical Abuse (N = 3957) Crude OR (95% CI)	Verbal Abuse (N = 3968) Crude OR (95% CI)	Physical Abuse (N = 3982) Crude OR (95% CI)	
Overall CSA score	1.02 (0.81–1.29)	0.81 (0.62–1.04)	0.81 (0.63–1.03)	0.61 (0.46–0.80)***	0.46 (0.32–0.67)***	
CSA scores—principles by location						
Natural surveillance	0.94 (0.76–1.16)	0.83 (0.66–1.05)	0.82 (0.66–1.03)	0.67 (0.51–0.86)**	0.58 (0.41–0.83)**	
Grounds	0.90 (0.77–1.04)	0.85 (0.72–1.00)	0.83 (0.71–0.98)*	0.73 (0.61–0.87)***	0.62 (0.49–0.79)***	
Buildings	0.92 (0.81–1.05)	0.87 (0.76–1.00)	0.88 (0.77–1.01)	0.79 (0.67–0.93)**	0.73 (0.59–0.92)**	
Interiors	1.01 (0.80–1.28)	0.90 (0.69–1.15)	0.88 (0.69–1.13)	0.72 (0.54–0.96)*	0.67 (0.45–1.01)	
Access management	1.09 (0.88–1.36)	0.92 (0.72–1.17)	0.89 (0.70–1.13)	0.85 (0.64–1.13)	0.63 (0.43–0.92)*	
Grounds	1.08 (0.92–1.28)	0.95 (0.79–1.14)	0.89 (0.74–1.06)	0.85 (0.69–1.06)	0.62 (0.47–0.82)***	
Buildings	1.02 (0.91–1.13)	0.98 (0.87–1.10)	1.01 (0.90–1.13)	1.02 (0.89–1.17)	0.96 (0.79–1.16)	
Interiors	1.04 (0.87–1.26)	0.95 (0.77–1.17)	0.96 (0.78–1.18)	0.93 (0.73–1.19)	0.84 (0.60–1.18)	
Territoriality	1.04 (0.88–1.24)	0.91 (0.75–1.09)	0.86 (0.72–1.04)	0.70 (0.57–0.85)***	0.54 (0.42–0.69)***	
Grounds	1.09 (0.95–1.25)	0.94 (0.81–1.09)	0.95 (0.82–1.10)	0.77 (0.65–0.90)**	0.64 (0.52–0.80)***	
Buildings	0.97 (0.85–1.11)	0.88 (0.76–1.02)	0.89 (0.76–1.02)	0.76 (0.65–0.90)***	0.71 (0.57–0.89)**	
Interiors	1.02 (0.87–1.20)	0.95 (0.79–1.13)	0.87 (0.73–1.03)	0.77 (0.63–0.94)**	0.59 (0.45–0.76)***	
Physical maintenance	1.03 (0.87–1.23)	0.83 (0.69–1.01)	0.90 (0.74–1.09)	0.68 (0.55–0.83)***	0.59 (0.44–0.78)***	
Grounds	1.08 (0.91–1.27)	0.87 (0.72–1.04)	0.93 (0.77–1.12)	0.74 (0.60–0.91)**	0.64 (0.48–0.85)**	
Buildings	1.01 (0.88–1.17)	0.85 (0.73–0.99)*	0.92 (0.79–1.07)	0.82 (0.69–0.98)*	0.75 (0.59–0.96)*	
Interiors	1.01 (0.85–1.19)	0.86 (0.72–1.02)	0.91 (0.76–1.08)	0.68 (0.56–0.83)***	0.61 (0.47–0.79)***	
Order maintenance	0.99 (0.81–1.21)	0.83 (0.66–1.03)	0.81 (0.66–1.00)	0.73 (0.57–0.94)*	0.64 (0.46–0.90)*	
Grounds	0.97 (0.83–1.14)	0.87 (0.73–1.04)	0.83 (0.71–0.98)*	0.83 (0.68–1.02)	0.70 (0.54–0.92)**	
Buildings <sup>†</sup>	0.91 (0.72–1.15)	0.84 (0.65–1.09)	1.02 (0.78–1.33)	0.84 (0.62–1.14)	0.87 (0.56–1.34)	
Interiors	1.04 (0.87–1.25)	0.88 (0.72–1.08)	0.91 (0.74–1.11)	0.75 (0.60–0.94)*	0.75 (0.54–1.04)	
CSA scores—locations						

	Victimization			Perpetration		
	Bullying (N = 4162) Crude OR (95% CI)	Verbal Abuse (N = 3953) Crude OR (95% CI)	Physical Abuse (N = 3957) Crude OR (95% CI)	Verbal Abuse (N = 3968) Crude OR (95% CI)	Physical Abuse (N = 3982) Crude OR (95% CI)	
Interiors	1.03 (0.81–1.31)	0.85 (0.66–1.11)	0.85 (0.66–1.10)	0.64 (0.48–0.86)**	0.53 (0.36–0.80)**	
Buildings	0.95 (0.80–1.12)	0.83 (0.69–0.99)*	0.87 (0.72–1.04)	0.74 (0.60–0.91)**	0.66 (0.49–0.87)**	
Grounds	1.02 (0.83–1.25)	0.82 (0.65–1.02)	0.80 (0.64–0.99)*	0.64 (0.50–0.82)***	0.46 (0.34–0.62)***	

\* p < .05;

\*\* p < .01;

\*\*\* p < .001.

CPTED, Crime Prevention Through Environmental Design; CSA, CPTED School Assessment; OR, odds ratio.

<sup>†</sup>The Order Maintenance: Buildings exposure is the only exposure missing school data for 15 schools and 1557 students within, leaving N = 3160 before deletion of students missing other covariate or outcome data.

**Table 3**

Crude OR Between General CPTED Principles by Location Exposures and Student Perceived Safety, Student Perceived Risk, and Missing School out of Concern for Safety

	Student Perceived Safety (N = 4586) Crude OR (95% CI)	Student Perceived Risk (N = 4510) Crude OR (95% CI)	Missing School Out of Concern for Safety (N = 4160) Crude OR (95% CI)
Overall CSA score	2.20 (1.51–3.20) ***	0.40 (0.25–0.65) ***	0.19 (0.11–0.34) ***
CSA scores—principles by location			
Natural surveillance	1.84 (1.30–2.62) ***	0.48 (0.31–0.75) **	0.26 (0.15–0.46) ***
Grounds	1.59 (1.24–2.04) ***	0.52 (0.39–0.72) ***	0.39 (0.26–0.59) ***
Buildings	1.34 (1.06–1.67) *	0.70 (0.52–0.93) *	0.51 (0.35–0.76) ***
Interiors	1.72 (1.16–2.56) **	0.56 (0.34–0.93) *	0.29 (0.15–0.54) ***
Access management	1.44 (0.98–2.12)	0.58 (0.36–0.95) *	0.40 (0.21–0.78) **
Grounds	1.36 (1.01–1.82) *	0.60 (0.41–0.86) **	0.42 (0.26–0.68) ***
Buildings	0.93 (0.77–1.13)	1.00 (0.78–1.27)	1.05 (0.74–1.50)
Interiors	1.26 (0.90–1.77)	0.78 (0.50–1.21)	0.68 (0.37–1.24)
Territoriality	1.76 (1.34–2.31) ***	0.58 (0.40–0.84) **	0.35 (0.22–0.55) ***
Grounds	1.53 (1.22–1.91) ***	0.68 (0.50–0.92) *	0.44 (0.30–0.65) ***
Buildings	1.37 (1.08–1.72) **	0.75 (0.55–1.02)	0.54 (0.36–0.81) **
Interiors	1.59 (1.21–2.09) ***	0.62 (0.44–0.89) *	0.44 (0.28–0.71) ***
Physical maintenance	1.71 (1.28–2.29) ***	0.52 (0.36–0.76) ***	0.27 (0.18–0.41) ***
Grounds	1.58 (1.19–2.10) **	0.57 (0.40–0.82) **	0.30 (0.20–0.47) ***
Buildings	1.35 (1.05–1.73) *	0.70 (0.51–0.96) *	0.41 (0.28–0.60) ***
Interiors	1.63 (1.24–2.15) ***	0.56 (0.39–0.79) **	0.33 (0.22–0.50) ***
Order maintenance	1.74 (1.24–2.44) **	0.50 (0.33–0.76) **	0.38 (0.22–0.65) ***
Grounds	1.58 (1.21–2.06) ***	0.55 (0.39–0.76) ***	0.48 (0.31–0.74) ***
Buildings <sup>†</sup>	1.12 (0.73–1.71)	0.83 (0.48–1.46)	0.70 (0.34–1.44)
Interiors	1.40 (1.01–1.94) *	0.68 (0.45–1.02)	0.48 (0.28–0.83) **
CSA scores—locations			
Interiors	2.01 (1.34–3.00) ***	0.47 (0.28–0.78) **	0.24 (0.13–0.45) ***
Buildings	1.43 (1.07–1.92) *	0.65 (0.45–0.95) *	0.39 (0.24–0.65) ***
Grounds	2.13 (1.55–2.93) ***	0.37 (0.25–0.55) ***	0.22 (0.14–0.35) ***

\* p < .05;

\*\* p < .01;

\*\*\* p < .001.

CPTED, Crime Prevention Through Environmental Design; CSA, CPTED School Assessment; OR, odds ratio.

<sup>†</sup>The Order Maintenance: Buildings exposure is the only exposure missing school data for 15 schools and 1557 students within, leaving N = 3160 before deletion of students missing other covariate or outcome data.



**Table 4**

AOR Between General CPTED Principles by Location Exposures and Student Perceived Safety, Student Perceived Risk, and Missing School out of Concern for Safety

	Student Perceived Safety (N = 4134) AOR (95% CI)	Student Perceived Risk (N = 4076) AOR (95% CI)	Missing School out of Concern for Safety (N = 3759) AOR (95% CI)
Overall CSA score	1.37 (0.90–2.07)	0.73 (0.42–1.25)	0.32 (0.17–0.61) ***
CSA scores—principles by location			
Natural surveillance	1.30 (0.92–1.83)	0.75 (0.48–1.18)	0.42 (0.24–0.74) **
Grounds	1.22 (0.95–1.56)	0.71 (0.52–0.98) *	0.57 (0.38–0.86) **
Buildings	1.03 (0.83–1.28)	0.96 (0.72–1.27)	0.71 (0.49–1.03)
Interiors	1.28 (0.89–1.84)	0.85 (0.53–1.37)	0.47 (0.26–0.84) *
Access management	1.23 (0.88–1.73)	0.68 (0.44–1.04)	0.46 (0.27–0.79) **
Grounds	0.96 (0.72–1.29)	0.90 (0.62–1.31)	0.71 (0.42–1.18)
Buildings	0.97 (0.83–1.14)	0.91 (0.74–1.11)	0.92 (0.70–1.21)
Interiors	1.34 (1.02–1.77) *	0.69 (0.48–0.99) *	0.54 (0.35–0.85) **
Territoriality	1.13 (0.80–1.61)	1.08 (0.68–1.70)	0.53 (0.29–0.96) *
Grounds	1.14 (0.89–1.47)	0.98 (0.70–1.36)	0.63 (0.42–0.93) *
Buildings	1.06 (0.85–1.33)	0.96 (0.72–1.29)	0.70 (0.48–1.03)
Interiors	0.99 (0.71–1.39)	1.24 (0.80–1.91)	0.84 (0.47–1.52)
Physical maintenance	1.17 (0.85–1.61)	0.83 (0.55–1.26)	0.37 (0.24–0.59) ***
Grounds	1.20 (0.91–1.57)	0.75 (0.53–1.06)	0.42 (0.28–0.61) ***
Buildings	1.09 (0.87–1.37)	0.89 (0.66–1.19)	0.55 (0.39–0.77) ***
Interiors	1.09 (0.80–1.49)	0.95 (0.64–1.43)	0.48 (0.30–0.79) **
Order maintenance	1.26 (0.88–1.79)	0.86 (0.54–1.36)	0.77 (0.43–1.38)
Grounds	1.27 (0.97–1.66)	0.81 (0.57–1.15)	0.88 (0.55–1.38)
Buildings <sup>†</sup>	0.95 (0.63–1.42)	1.22 (0.75–2.00)	0.85 (0.43–1.65)
Interiors	1.07 (0.79–1.44)	0.99 (0.67–1.46)	0.78 (0.47–1.30)
CSA scores—locations			
Interiors	1.29 (0.86–1.93)	0.85 (0.50–1.44)	0.43 (0.22–0.81) **
Buildings	1.05 (0.80–1.38)	0.91 (0.63–1.30)	0.55 (0.34–0.87) *
Grounds	1.39 (0.94–2.05)	0.61 (0.37–1.01)	0.36 (0.20–0.66) ***

\* p < .05;

\*\* p < .01;

\*\*\* p < .001.

AOR, adjusted odds ratio; CPTED, Crime Prevention Through Environmental Design; CSA, CPTED School Assessment; SES, socioeconomic status.

Controlling for school-level covariates SES (3 way), Urban/Rural (3 way), crowding (continuous student enrollment/capacity), and continuous “year school was built”; also controlling for student level covariates grade, race/ethnicity, sex, and free/reduced-priced lunch.

<sup>†</sup>The order maintenance: Buildings exposure is the only exposure missing school data for 15 schools and 1557 students within, leaving N = 3160 before deletion of students missing other covariate or outcome data.

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**Table 5**

Crude and Adjusted OR Between Location-Specific CPTED Exposures and Location-Specific Outcomes

	Student Perceived Safety Specific to Location Crude OR (95% CI)	Student Perceived Safety Specific to Location Adjusted OR (95% CI)	Student Perceived Risk Specific to Location Crude OR (95% CI)	Student Perceived Risk Specific to Location Adjusted OR (95% CI)
CSAscores—specific to location				
Interiors				
Corridors	1.45 (1.09, 1.94)*	1.19 (0.91–1.56)	0.69 (0.49–0.98)*	0.87 (0.60–1.25)
Restrooms	1.57 (1.28, 1.92)***	1.31 (1.06–1.62)*	0.68 (0.51–0.90)**	0.79 (0.55–1.11)
Classrooms	1.66 (0.91, 3.04)	1.06 (0.70–1.63)	0.57 (0.27–1.22)	0.95 (0.60–1.51)
Boys locker (boys only)	1.24 (0.99, 1.55)	1.21 (0.96–1.52)	0.95 (0.72–1.25)	1.01 (0.75–1.35)
Girls locker (girls only)	1.91 (1.34, 2.72)***	1.62 (1.18–2.23)**	0.82 (0.57–1.20)	1.10 (0.75–1.60)
Gym	1.01 (0.77, 1.34)	0.92 (0.74–1.14)	1.02 (0.81–1.29)	1.09 (0.90–1.33)
Cafeteria	1.43 (1.00, 2.04)*	1.09 (0.79–1.49)	0.54 (0.35–0.83)**	0.81 (0.56–1.15)
Buildings				
Entries and exits	1.20 (0.88, 1.62)	0.94 (0.74–1.20)	0.85 (0.65–1.11)	0.98 (0.79–1.21)
Grounds				
Parking areas	1.74 (1.42, 2.13)***	1.28 (1.04–1.59)*	0.61 (0.48–0.77)***	0.73 (0.54–0.99)*
Pathway and gathering areas	1.84 (1.29, 2.62)***	1.11 (0.81–1.53)	0.67 (0.45–0.99)*	0.98 (0.66–1.45)
Exterior athletic areas	1.33 (1.02, 1.74)*	1.03 (0.81–1.31)	0.88 (0.71–1.08)	1.07 (0.85–1.33)
Bus loading and unloading areas	1.50 (1.23, 1.83)***	1.32 (1.07–1.63)*	0.56 (0.43–0.74)***	0.66 (0.49–0.90)**

\*  
p < .05;\*\*  
p < .01;\*\*\*  
p < .001.

CPTED, Crime Prevention Through Environmental Design; OR, odds ratio; SES, socioeconomic status.

Adjusted odds ratios controlling for school-level covariates SES (3 way), Urban/Rural (3 way), crowding (continuous student enrollment/capacity), and continuous “year school was built”; also controlling for student level covariates grade, race/ethnicity, sex, and free/reduced-priced lunch.