

Serious Injuries and Deaths of Adolescent Girls Resulting From Interpersonal Violence

Characteristics and Trends From the United States, 1989-1998

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Background: Little published data are available concerning the death and disability of adolescent girls resulting from interpersonal violence (adolescents are defined as those aged 12-18 years in this study).

Objectives: To determine whether there were sex differences in (a) the characteristics of those who were injured or died, (b) injury severity and outcomes, and (c) injury mechanism; and to describe time trends in these differences.

Design: Analysis of data concerning serious injuries due to assaults, recorded in the National Pediatric Trauma Registry (from January 1, 1989, through December 31, 1998), and homicides, recorded in the Web-Based Injury Statistics and Query Reporting System database (from January 1, 1990, through December 31, 1997).

Setting: Patient data from participating pediatric trauma centers (National Pediatric Trauma Registry) in 45 states and national death certificate data (Web-Based Injury Statistics and Query Reporting System).

Patients: Six hundred twelve adolescent girls who were seriously injured because of an assault were compared with 2656 adolescent boys who were seriously injured because of an assault. Three thousand four hundred

eighty-seven adolescent girls who died due to a homicide were compared with 17 292 adolescent boys who died due to a homicide.

Results: Assaulted adolescent girls were more likely to have preexisting cognitive or psychosocial impairments than were adolescent boys (odds ratio, 1.68; 95% confidence interval, 1.12-2.51). Adolescent girls trended toward more injury-related impairments at discharge from the hospital (odds ratio, 1.16; 95% confidence interval, 0.92-1.47). Adolescent girls were more likely to have been stabbed, and less likely to have been shot. Also, adolescent girls were more likely to have been injured at a home or a residence. Compared with all National Pediatric Trauma Registry admissions, assaults declined at the same rate for adolescent girls and boys. The proportion resulting from penetrating trauma declined more slowly for adolescent girls.

Conclusions: Interpersonal violence causes considerable morbidity and mortality for young women. Research and interventions should be developed to respond to adolescent girls who experience interpersonal violence.

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WOMEN in the United States experience violence from strangers and intimate partners, with distinct medical and psychological sequelae.¹ In contrast to adult-oriented research, research on youth violence has focused mainly on boys.

One in three adolescents reports being in a physical fight in the past year.² Because of this high prevalence of adolescent violence in the United States, the problem of violence as it affects adolescent girls is a public health problem in its own right. Recent surveillance studies conducted in the primary care³ and emergency depart-

ment⁴⁻⁶ settings, for example, have shown that young women experience one third of nonlethal violence-related injuries that require medical attention. Recent trends show that the gap between male and female victimization rates is declining, and that two thirds of the violence against women is not perpetrated by an intimate partner.⁷

Previous studies^{8,9} have examined characteristics of the offenders of youth violence. These studies revealed that the use of violent behaviors was associated with personal victimization, depression, family conflict, number of sexual partners, and hopelessness.

This study was undertaken to better understand the pattern of severe violence-

PATIENTS AND METHODS

The data analyzed in this study were obtained from 2 existing national databases. Data concerning severe injuries to adolescents, including pregnant adolescents, were obtained from the NPTR. Data concerning adolescents who died due to a homicide were obtained from the Centers for Disease Control and Prevention's WISQARS, which is a database compiled using data from the National Center for Health Statistics data tapes.

INJURY DATA

The NPTR study population consists of persons assaulted, aged 12 to 18 years, and hospitalized in a participating institution during the 10-year period ending December 31, 1998.

The NPTR database contains detailed information concerning pediatric trauma patients, voluntarily submitted by participating pediatric trauma centers and children's hospitals throughout the United States. At the time this study was undertaken, 91 trauma centers from 45 states were participating.

At each NPTR site, a trained trauma nurse coordinator completes a data collection form for each patient admitted for an injury in accordance with NPTR guidelines. To guarantee uniformity across institutions, coding for natural and external causes of injury, severity scoring, data management, analyses, and reporting are performed centrally at the NPTR. There is a full-time staff member at the registry who manually reviews each record for completeness. This reviewer then enters data into specially designed computer programs, which then automatically cross-check the data. If the reviewer finds missing or illogical data,

the submitting hospital is then asked to provide information for correction or verification. These methods of data collection and quality assurance have been described in detail elsewhere.¹⁰

Items from the NPTR data collection form, such as the intent of injury and the determination of preexisting conditions, are established by asking the patients, family members, physicians, and police officers.¹⁰ Assaults are coded according to *International Classification of Diseases, Ninth Revision (ICD-9)*, criteria and include all injuries inflicted by another person with the intent to harm, including sexual abuse and excluding child abuse.¹¹

Patients in the NPTR database represent a severe subset of all injuries seen in children because only injuries severe enough to require hospitalization are included. Furthermore, since the NPTR's participating institutions are hospitals specializing in the treatment of pediatric trauma, children treated at NPTR sites are likely to be more severely injured than are children admitted to other hospitals.¹²

DEATHS: VITAL STATISTICS DATA

The Centers for Disease Control and Prevention's National Center for Health Statistics compiles the data in WISQARS, which contains mortality data from January 1981 to December 1997. The information in this database comes from death certificates and includes causes of death as determined by physicians, medical examiners, and coroners. Population data come from the Bureau of Census.¹³

SUBJECTS

Of the 79894 cases recorded in the NPTR for patients treated between January 1, 1989, through December 31, 1998, we

related injuries among adolescent girls in the United States (*adolescents* are defined as those aged 12-18 years in this study). Violence-related injuries included violence perpetrated by a stranger and violence committed by an intimate partner. By analyzing data from the National Pediatric Trauma Registry (NPTR) and the Centers for Disease Control and Prevention's Web-Based Injury Statistics and Query Reporting System (WISQARS), we were able to detect differences in demographics, injury characteristics, and injury outcomes for adolescent boys and girls who were killed or seriously injured by interpersonal violence. These differences will help to better tailor violence prevention tactics more specifically to adolescent girls.

RESULTS

SEVERE INJURIES

Of the 79894 patients in the NPTR, there were 3268 persons assaulted, 612 adolescent girls and 2656 adolescent boys. **Table 1** shows patient characteristics before and after the assault. Overall, 15% of the patients had data missing for the scene of injury and 12% had data missing for preexisting impairments. For children missing data for the scene of injury, we used a public place as the scene of in-

jury, as this was the most common place for injury. We will report here the results for the model that had missing data. For the patients who were missing data for preexisting cognitive or psychosocial impairments, we took the conservative approach and assumed those patients with missing data had no impairments. This conservative approach reports a lower incidence of preexisting cognitive or psychosocial impairments and, therefore, underestimates the odds ratio (OR) to one that is lower than one might find if the data were complete. Assaulted adolescent girls were slightly younger than adolescent boys and had a higher incidence of preexisting cognitive or psychosocial impairments. Adolescent girls sustained less severe injuries and had fewer impairments at discharge from the hospital. More specifically, assaulted adolescent girls were 1.68 (95% confidence interval [CI], 1.12-2.51) times more likely to have a preexisting cognitive or psychosocial impairment than were assaulted adolescent boys. In bivariate analysis, adolescent girls were less likely (OR, 0.75; 95% CI, 0.61-0.92) to have impairments at discharge from the hospital due to an assault than were adolescent boys. However, after adjusting for the age of the person assaulted, the year of injury, the scene of injury, and any preexisting impairments, adolescent girls had a trend toward more impairments at discharge from the hospital than did adolescent boys (OR, 1.16; 95% CI, 0.92-1.47).

extracted all cases of assaults, exclusive of child abuse, of patients aged 12 through 18 years. There were 3268 patients assaulted, 612 adolescent girls and 2656 adolescent boys. Injury intent was assigned at the treating hospital. These assault cases represented 13.8% of all the NPTR cases in this age group.

From the WISQARS database, we extracted all cases of homicide of those aged 12 to 18 years, except homicides due to legal intervention, that occurred during the 8-year interval between January 1, 1990, and December 31, 1997. This resulted in a total of 20779 homicides, including 3487 adolescent girls and 17292 adolescent boys. The period for the WISQARS database is different than for the NPTR database because customized age groups are not available for data before 1990.

MEASURES

The analysis included the following variables from the NPTR and WISQARS: sex, age, and mechanism of assault. Additional variables from the NPTR used in the analyses included preinjury medical and psychosocial history, scene of the injury (home, school, or public place), year of injury, season of injury, injury severity, and outcomes. Preexisting medical conditions included mental retardation and learning disabilities. Preexisting psychosocial problems included problems with social interactions, such as violent or physically aggressive behaviors.¹¹

The severity of injury was measured by the Injury Severity Score.¹⁴ Outcomes included in-hospital death and functional impairments at hospital discharge caused by the injury. Nine functional activities were evaluated: feeding, vision, hearing, cognition, speech, bathing, dressing,

walking, and behavior. A clinician evaluated the patient's performance in these domains using performance and neurological tests, and rated the patient in each functional area as age appropriate, impaired, or unable. In this study, impaired and unable were combined to reflect any degree of impairment at discharge from the hospital.

DATA ANALYSIS

Data analysis was performed using Statistical Product and Service Solutions for Windows, version 9.0.0,¹⁵ statistical software. Bivariate analysis was accomplished with χ^2 tests and *t* tests. Because of the observational nature of the data, multivariable models were used to adjust for potential confounders. Variables found to be significant in previous studies or found to be significant in bivariate analysis were included as candidates for the final logistic regression models. Interaction terms were also examined and placed in these models. Models were examined using stepwise likelihood ratios to determine significance. Variables with $P \leq .05$ were entered into the model. Subsequently, variables with $P \geq .10$ were removed from the model.

The NPTR data set was found to have missing data, which were not evenly distributed by sex. We, therefore, ran 2 separate analyses. One analysis consisted of eliminating all cases with missing data. For the second analysis, data were reanalyzed with the missing scene of injury being assigned as a public place, as this was the most common scene. For cases missing preexisting cognitive or psychosocial impairments, we took the conservative approach and assumed that those patients missing data had no preexisting cognitive or psychosocial impairments.

When compared with injuries due to all causes in the NPTR, assaulted adolescent girls accounted for 9.3% of all injured adolescent girls, while assaulted adolescent boys accounted for 16.1% of all injured adolescent boys. Thus, injured adolescent girls were only half as likely as injured adolescent boys to be assaulted (OR, 0.53; 95% CI, 0.48-0.58).

The proportion of injuries caused by assaults declined for adolescent girls and boys during the 10-year study period. In a linear regression model, the percentage of injuries caused by assaults declined at a similar rate for adolescent boys and girls, with injured adolescent girls continuing to be assaulted at approximately half the rate of injured adolescent boys ($P = .32$) (**Figure 1**).

The sex-specific trends during the 10-year study period, however, diverged for the subset of patients who sustained penetrating injuries (stab wounds and gunshot wounds). The percentage of adolescent boys who were injured by penetrating assaults declined almost 28% during the 10-year study period. Penetrating assaults declined by only 6.8% in adolescent girls (**Figure 2**). The differences in decline between sexes during the 10-year study period were statistically significant ($P = .04$).

Significant differences were found in the scene of injury for adolescent girls and boys ($P < .01$). Adolescent girls were more likely than adolescent boys to be

injured in their home or another private dwelling than a public place and were more likely than adolescent boys to be injured in a school than a public place, with an unadjusted OR of 1.56 (95% CI, 1.09-2.24). After adjusting for preexisting conditions, age, and the type of injury, adolescent girls were 2.27 (95% CI, 1.82-2.83) times more likely to be injured in a home than a public place. Adolescent boys, by contrast, were 1.75 (95% CI, 1.17-2.63) times more likely to be injured in school, and 2.27 (95% CI, 1.82-2.83) times more likely to be injured in a public place than a home, after adjusting for the factors previously described.

Adolescents assaulted also differed markedly in the mechanism of their injury. Adolescent girls were more likely than adolescent boys to have stab wounds, while adolescent boys were more likely than adolescent girls to have gunshot wounds ($P < .001$) (**Table 2**). Variables determined to be significant by bivariate analysis, including preexisting conditions ($P = .01$), age ($P < .01$), and scene of injury ($P < .01$), were then placed into a multivariable logistic regression model. After adjusting for these same variables, adolescent girls were 2.15 times more likely to be stabbed vs shot, and were 1.68 times more likely to have an injury due to a stabbing vs a blunt injury (**Table 3**). Again, using a multivariable logistic regression model adjusting for the same variables, adoles-

Table 1. Patient Characteristics From the NPTR*

Variable	Adolescent Girls (n = 612)	Adolescent Boys (n = 2656)	P
Age, mean, y	14.7	15.3	<.01
Injury Severity Score, mean	6.0	6.8	<.01
No. of deaths	24	100	.86
Patients with a preexisting cognitive or psychosocial impairment	34 (5.6)	90 (3.4)	.01
Patients with an impairment at hospital discharge	142 (23.2)	761 (28.7)	<.01

*Data are given as number (percentage) of patients unless otherwise indicated. NPTR indicates National Pediatric Trauma Registry.

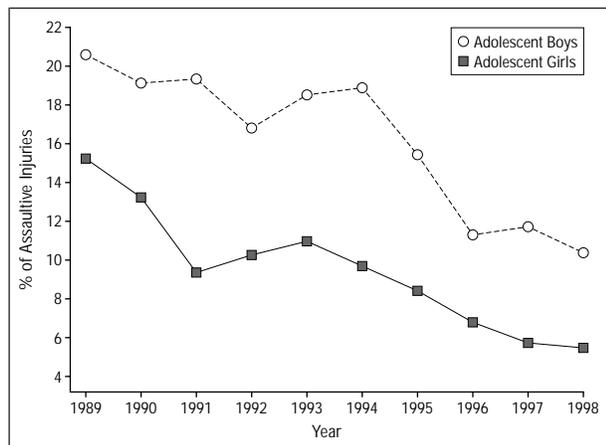


Figure 1. Percentage of injuries from the National Pediatric Trauma Registry caused by assaults.

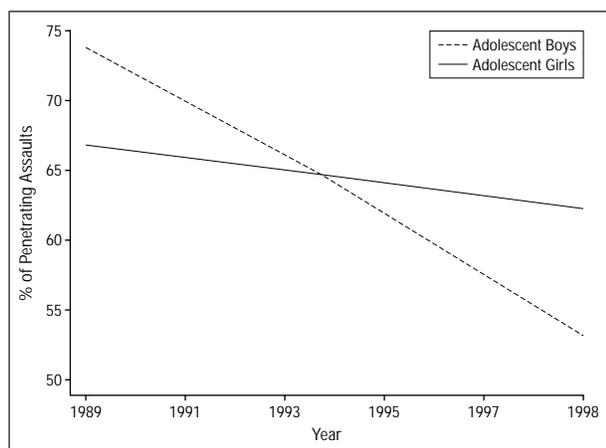


Figure 2. Percentage of assaults from the National Pediatric Trauma Registry in which penetrating weapons were used.

cent boys were found to be 2.08 times more likely to be shot than stabbed. In addition, adolescent boys were found to be 1.36 times more likely to have an injury due to a shooting vs a blunt injury.

DEATHS

The findings concerning the mechanism of injury were then compared with homicide data available in the

Table 2. Injury Characteristics From the NPTR

Injury Characteristic	No. (%) of Injuries*		
	Adolescent Girls (n = 6587)	Adolescent Boys (n = 16 475)	Total (N = 23 062)
Unintentional	5975 (90.7)	13 819 (83.9)	19 794 (85.8)
Intentional	612 (9.3)	2656 (16.1)	3268 (14.2)
Mechanism			
Gunshot	235 (38.4)	1319 (49.7)	1554 (47.6)
Stabbing	162 (26.5)	403 (15.2)	565 (17.3)
Blunt	215 (35.1)	934 (35.2)	1149 (35.2)
Scene			
Private home	185 (30.2)	402 (15.1)	587 (18.0)
School	43 (7.0)	149 (5.6)	192 (5.9)
Public place or other	312 (51.0)	1687 (63.5)	1999 (61.2)
Not available	72 (11.8)	418 (15.7)	490 (15.0)

*Percentages may not total 100 because of rounding.

WISQARS database to determine if the data from the NPTR would be consistent with population-based homicide data. After adjusting for the age of the person killed and the year of the homicide, adolescent girls from WISQARS were similarly found to be 2.50 times more likely to be murdered by a stabbing than by a shooting. The situation for adolescent boys was reversed, ie, they were less likely to be murdered by a stabbing than by a shooting (Table 3). These findings mirrored those from the NPTR concerning penetrating injuries.

During the 8-year period for which we have data from WISQARS, the homicide rate declined for adolescent boys and girls. In 1990, the homicide rate for adolescent boys was 16.21 per 100 000 and declined to a rate of 12.57 per 100 000 by 1997, for a decline of 22.5%. For adolescent girls, this decline was less pronounced. The homicide rate for adolescent girls in 1990 was 3.81 per 100 000 and declined to a rate of 2.66 per 100 000 by 1997. This represents a decline of 30.2%. In a multivariable linear regression model, we examined the interaction between sex and year of injury and found that the differences in the decline between sexes trended toward significance ($P = .14$). Similarly, there was a larger decline in the rate of homicides due to penetrating weapons for adolescent boys (22.8%) compared with that seen in adolescent girls (30.6%) (Figure 3), again trending toward significance ($P = .14$).

COMMENT

Peer violence remains a common problem for adolescent girls and boys. Because of their higher incidence of severe injury and death, most studies of adolescent violence have focused on boys. However, violence is also a significant problem for young women. This study indicates that there are specific differences between adolescent girls and boys who are assaulted that are relevant to violence prevention research and prevention strategies.

Although more adolescent boys than adolescent girls were treated by the NPTR participants for assault-related injury, the actual number of assaulted adoles-

Table 3. Crude and Adjusted ORs for Cause of Injury*

Cause of Injury	OR (95% CI)			
	Adolescent Girls		Adolescent Boys	
	Crude	Adjusted	Crude	Adjusted
NPTR†				
Stabbing vs gunshot	1.75 (1.38-2.21)	2.15 (1.63-2.84)	0.57 (0.45-0.72)	0.44 (0.34-0.58)
Stabbing vs blunt injury	2.26 (1.79-2.84)	1.68 (1.28-2.22)	0.44 (0.35-0.56)	0.59 (0.46-0.78)
WISQARS‡				
Stabbing vs gunshot	2.49 (2.22-2.80)	2.50 (2.22-2.81)	0.40 (0.36-0.45)	0.40 (0.36-0.45)
Stabbing vs blunt injury	0.38 (0.33-0.44)	0.40 (0.35-0.47)	2.62 (2.26-3.03)	2.48 (2.14-2.89)

*OR indicates odds ratio; CI, confidence interval; NPTR, National Pediatric Trauma Registry; and WISQARS, Web-Based Injury Statistics and Query Reporting System.

†The ORs are adjusted for age of the victim, year of assault, scene of assault, and preexisting cognitive or psychosocial impairments.

‡The ORs are adjusted for age of the victim and year of homicide.

cent girls continues to be alarming, especially given the high injury severity typical of patients included in the NPTR. Encouragingly, the NPTR recorded an overall decline in the proportion of injuries caused by assault for adolescent girls and boys. These findings are mirrored in other studies and databases.^{2,3,16}

An alarming number of adolescents continue to engage in behaviors that contribute to intentional injuries. The Youth Risk Behavior Surveillance² survey revealed that 17.3% of students nationwide reported carrying a weapon in the 30 days before the survey. This same survey also revealed that 35.7% of adolescents had been in at least 1 physical fight in the preceding 12 months before the survey. The combination of these 2 factors reveals that many adolescents are at risk for intentional injuries, such as assaults carried out with a weapon.

In the NPTR, there was a significant difference in the decline of penetrating assaults involving adolescent girls and boys during the 10 years included in this study. Adolescent boys have experienced a decline of almost 28% in the proportion of penetrating assaults. Adolescent girls, on the other hand, have experienced a much slower decline, showing only a 6.8% reduction in the proportion of penetrating assaults. In fact, the proportion of assaults in which a penetrating weapon was used has switched from being higher in adolescent boys in 1989 to being higher in adolescent girls since 1994. This slower decrease for adolescent girls may reflect increasing violence among girls³ or an increase in the severity of dating violence or abuse. The WISQARS database also revealed a slower decline in the rates of deaths caused by penetrating weapons in adolescent girls. These 2 databases were compared to show that, although the NPTR cannot be used to infer rates, the findings are similar to a national database and, therefore, the NPTR findings are likely to be more broadly generalizable. Taken in combination, these findings seem to represent a failure of public health messages that focus mainly on violence risks among adolescent boys rather than adolescent girls.

Assaulted adolescent girls were at an increased risk of having a preexisting cognitive or psychosocial impairment when compared with assaulted adolescent boys. Adolescent girls with preexisting psychosocial prob-

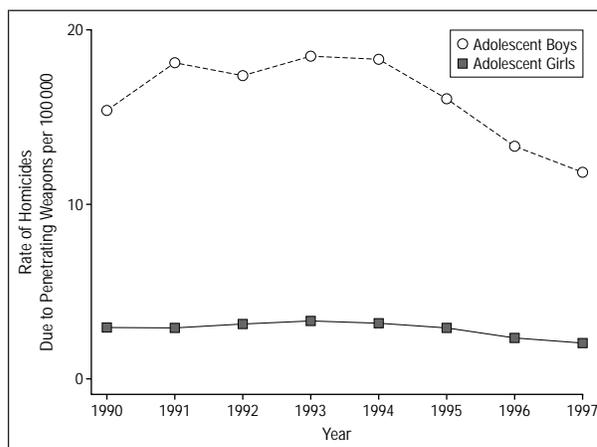


Figure 3. Percentage of homicides from the Web-Based Injury Statistics and Query Reporting System in which penetrating weapons were used.

lems have been found to be at an increased risk for being abusers of alcohol and other drugs, which has also been shown to increase the risk of date rape.^{17,18} Thus, adolescent girls with psychosocial problems are at increased risk for adverse outcomes and there should be a focusing of violence prevention efforts on these girls. Since 12% of patients had data missing on preexisting impairments, with a higher percentage of adolescent girls missing data, we have probably underestimated the number of adolescent girls with preexisting cognitive or psychosocial impairments. This further underscores the risks for these girls.

While many recent articles¹⁹⁻²¹ have focused on handgun use in assaults and homicides, the results from this study of injuries (NPTR data) and deaths (WISQARS data) show that adolescent girls are more likely to be injured by piercing weapons, such as knives, than by guns or other weapons. In general, adolescent girls are less likely to own and use handguns than are adolescent boys. Recent efforts by handgun manufacturers to market weapons to young women may trickle down to teenagers and reduce this gap.

Much public and media attention is focused on violence in schools. Data from the NPTR revealed, however, that adolescent girls were more likely to be as-

saulted in their home or another private dwelling. This appears to indicate that adolescent girls are likely to be intentionally injured by a friend, acquaintance, or intimate partner who was with them in a residential location. This may reflect the higher incidence of domestic violence and dating violence seen in adolescent girls.^{3,5,22} However, because the NPTR does not include data on perpetrators, definitive conclusions may not be drawn. Again, because of missing data from the NPTR, we have probably underestimated the number of adolescent girls who have been injured in a home and, therefore, we need to improve our violence prevention programs to protect this vulnerable population.

Since hospitalization for assaults only represents a small fraction of all assaults involving adolescents,²³ several limitations should be kept in mind. Patients in the NPTR represent only those who were admitted to trauma centers and, therefore, represent only the most severe forms of assault. In addition, because the NPTR is essentially a large case series collected by voluntary participants and is not a representative sample of the country, incidence rates and national estimates cannot be inferred from NPTR data. Although this study included data on patients up to the age of 18 years, some older adolescents may have been treated in adult trauma centers and, therefore, would not be recorded in the NPTR. This would result in an underestimation of the overall number of assaults. Data collected from the WISQARS database are limited by the lack of outside confirmation of the cause of death or the mechanism of injury, which could result in an inaccurate estimate of the number of homicides.

CONCLUSIONS

Violence affects many teenaged girls in the United States. We found marked differences between adolescent girls and boys who experienced assaults and homicides. From the point of view of prevention, 2 important differences became apparent. First, adolescent girls with preexisting psychosocial or medical conditions appeared particularly vulnerable to serious injury. Second, the dramatic decline in weapons-related injury among adolescent boys in the 1990s was only weakly mirrored among adolescent girls.

This study demonstrates the need to further refine violence prevention strategies to account for these differences. We may need different prevention strategies for adolescent girls than for adolescent boys. Violence prevention programs geared specifically toward adolescent girls should focus on preventing attacks from occurring in the girl's or a friend's home. Other studies are needed to better understand the antecedents of adolescent violence and its long-term physical and emotional consequences.

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