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Violent crime rates as a proxy for the social determinants of sexually transmissible infection rates: the consistent state-level correlation between violent crime and reported sexually transmissible infections in the United States, 1981–2010

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Abstract

Background: Numerous social determinants of health are associated with violent crime rates and sexually transmissible infection (STI) rates. This report aims to illustrate the potential usefulness of violent crime rates as a proxy for the social determinants of STI rates.

Methods: For each year from 1981 to 2010, we assessed the strength of the association between the violent crime rate and the gonorrhoea (*Neisseria gonorrhoeae*) rate (number of total reported cases per 100 000) at the state level. Specifically, for each year, we calculated Pearson correlation coefficients (and *P*-values) between two variables (the violent crime rate and the natural log of the gonorrhoea rate) for all 50 states and Washington, DC. For comparison, we also examined the correlation between gonorrhoea rates, and rates of poverty and unemployment. We repeated the analysis using overall syphilis rates instead of overall gonorrhoea rates.

Results: The correlation between gonorrhoea and violent crime was significant at the $P < 0.001$ level for every year from 1981 to 2010. Syphilis rates were also consistently correlated with violent crime rates. In contrast, the *P*-value for the correlation coefficient exceeded 0.05 in 9 of the 30 years for the association between gonorrhoea and poverty, and in 17 of the 30 years for that between gonorrhoea and unemployment.

Conclusions: Because violent crime is associated with many social determinants of STIs and because it is consistently associated with STI rates, violent crime rates can be a useful proxy for the social determinants of health in statistical analyses of STI rates.

Keywords

epidemiology; gonorrhoea; poverty; syphilis

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Conflicts of interest

None declared.

Introduction

The key role of the social determinants of health in sexually transmissible infection (STI) transmission and acquisition has been well documented.^{1–3} One of the most well known determinants of STIs is socioeconomic status, as factors such as poverty, income inequality, unemployment and lack of health care are correlated with STI rates.^{2,4–6} High rates of incarceration might also contribute to increased STI rates through disruption of sexual networks and destabilisation of communities.^{1,7,8}

Statistical analyses of STI incidence and prevalence rates often attempt to control for social determinants of health.^{9–13} However, social determinants of STI rates can be difficult to quantify, especially factors such as social disorganisation, illegal drug use, the exchange of sex for money or drugs, and stress and other outcomes caused by the effects of racism.^{1,3} Cohen and colleagues found that gonorrhoea rates in New Orleans neighbourhoods (as designated by the United States (US) census as ‘block groups’) were more strongly correlated with a composite measure of neighbourhood deterioration (‘broken windows’) than a composite measure of poverty.¹⁴ However, calculation of neighbourhood environmental measures such as Cohen *et al.*’s ‘broken windows index’ requires intensive data collection methods that might not be practical in many settings such as state- or national-level analyses.^{14,15} Thus, a simpler and more readily available measure would be useful for certain public health efforts.

Violent crime rates have been proposed as a measure for community wellbeing and have been shown to be associated with STI rates.⁴ The purpose of this paper is to explore the stability and suitability of violent crime rates as a proxy measure for hard-to-measure social determinants of STI rates. To do so, we assessed the correlation between violent crime rates and gonorrhoea rates in the US at the state level from 1981 to 2010. Because violent crime is unlikely to be a direct causal factor for STI transmission and acquisition (with the possible exception of rape), any association between violent crime and STIs would reflect the influence of confounding factors.

The potential confounding factors that might link violent crime rates to STI rates are numerous. For example, illegal drug use is a risk factor for STIs and has been shown to increase violent crime rates.^{16,17} Violent crime rates might also capture the disrupting effects of incarceration rates on sexual networks, which can contribute to increases in STI rates, particularly among minority populations with disproportionate incarceration rates.^{1,7,8} In fact, Thomas and colleagues found a high correlation between homicide rates and gonorrhoea rates at the neighbourhood level in Chicago, and suggested that homicide rates are a useful proxy for incarceration rates.¹⁸ Violent crime is associated with racial segregation,¹⁹ which can influence sexual mixing patterns and is another key social determinant of STIs.^{1,2} Violent crime rates are also associated with physical deterioration in the neighbourhood (‘broken windows’),²⁰ which, as noted above, has been shown to be correlated with neighbourhood gonorrhoea rates.¹⁴

The fact that numerous social determinants of health are associated with both violent crime rates and STI rates supports the use of violent crime rates as a proxy for the social

determinants of STI rates. Further, several published statistical studies have included violent crime rates (or some closely related measure such as robbery rates) as a control variable for STI rates and found these crime-related control variables were often highly significant in explaining variation in STI rates, even when including a variety of other sociodemographic control variables.^{9–13,21} In this study, we provide additional insights into the utility of violent crime rates as a proxy measure for the social determinants of STI rates by examining the strength and consistency of the association between violent crime rates and STI rates at the state level over time.

Methods

State-level STI data were obtained from surveillance records maintained by the Centers for Disease Control and Prevention²² and violent crime rates were obtained online from uniform crime reports maintained by the Federal Bureau of Investigation (<http://www.ucrdatatool.gov>). For each year from 1981 to 2010, we assessed the strength of the association between the violent crime rate (number of reported offences of murder and non-negligent manslaughter, forcible rape, robbery and aggravated assault per 100 000)²³ and the gonorrhoea rate (number of total reported cases per 100 000) at the state level. Specifically, for each year, we calculated Pearson correlation coefficients (and associated *P*-values) between two variables (the violent crime rate and the natural log of the gonorrhoea rate) for all 50 states and Washington, DC. Observations with missing data for a given year were excluded from the analysis of the correlation coefficient in the given year.

For comparison, we also examined the correlation between gonorrhoea rates, and rates of poverty and unemployment. Poverty and unemployment data were obtained online from the US Census Bureau (<http://www.census.gov/hhes/www/poverty/data/historical/people.html>) and the Bureau of Labour Statistics (<http://www.bls.gov/data/#unemployment>), respectively. We then repeated the analysis using overall primary and secondary (P&S) syphilis rates instead of overall gonorrhoea rates. Results were calculated using SAS (ver. 9.3; SAS Institute, Cary, NC, USA) and Microsoft Excel ver. 2010 (Microsoft Corporation, Redmond, WA, USA).

Results

Violent crime rates were consistently correlated with overall gonorrhoea rates (Fig. 1; Table 1). The correlation between violent crime and gonorrhoea at the state level was significant at the $P < 0.001$ level for every year from 1981 to 2010 (Table 1). In all years, the correlation coefficient was greater for violent crime rates than for poverty rates or unemployment rates. The correlation between gonorrhoea and the other sociodemographic variables (poverty and unemployment) was significant in some years but not every year. For example, in the 30 years we examined, the *P*-value for the correlation coefficient exceeded 0.05 in 9 of the years for poverty and in 17 of the years for unemployment.

Violent crime rates were consistently correlated with P&S syphilis rates as well (Table 1). The correlation between violent crime and P&S syphilis at the state level was significant at the $P < 0.01$ level for every year from 1981 to 2010. In contrast, the *P*-value for the

correlation coefficient exceeded 0.05 in 11 of the 30 years for poverty and in 19 of the 30 years for unemployment (Table 1, final columns).

Discussion

This report documents a strong and consistent association between violent crime rates and STI rates at the state level. Because violent crime is unlikely to be a direct causal factor for STI transmission and acquisition, this association almost certainly reflects the influence of confounding factors. Our hypothesis is that the confounding factors that give rise to the association between violent crime and STI rates include the hard-to-measure social determinants of STI rates. For example, violent crime is associated with a range of social determinants that have been linked to increased risk for STIs, including community wellbeing,⁴ illegal drug use,^{16,17} incarceration rates^{1,7,8} and racial segregation.¹⁹ However, we are unable to test this hypothesis owing to the lack of annual state-level data on many of these social determinants, such as the impact of incarceration rates and racial segregation on sexual networks. In the future, a more comprehensive and detailed analysis might help to determine how much of the association between violent crime and STI rates can be explained by known and measurable factors.

Because violent crime is associated with many social determinants of STIs and because violent crime is consistently associated with STI rates, violent crime rates can be a useful proxy for the social determinants of health in statistical analyses of STI rates. In fact, we are aware of several published statistical studies that included a crime-related measure as a control variable for STI rates, and these crime-related control variables were often significant in explaining geographic variation in STI rates, even when controlling for a wide range of sociodemographic factors for which data were available.^{9–13,21} The fact that these previous studies found an association between crime rates and STI rates even when using available data to control for confounding factors suggests that crime rates may indeed be associated with hard-to-measure factors that influence STI rates.

We focussed on violent crime rates as a proxy for social determinants because this proxy has been suggested previously and has actually been employed in statistical analyses of STI rates. However, we did not systematically search for the best proxy variable for the social determinants of STI rates, and it is certainly possible that better proxy variables exist. Our analysis focussed on the association between violent crime and gonorrhoea rates in each year from 1981 to 2010. Results were consistent when we also examined the association between gonorrhoea rates in a given year and crime rates in the previous year, and vice versa (results not shown). However, a detailed analysis of the temporal association between violent crime rates and gonorrhoea rates is beyond the scope of this study.

Our analysis is subject to the usual limitations associated with STI surveillance data, such as incomplete reporting and inconsistent reporting across states.²² Under-reporting of STIs arises for at least two main reasons. First, STIs can be asymptomatic and can go undetected (and therefore not reported).²⁴ Second, even when an STI is diagnosed and treated, the health care provider may nonetheless fail to report the case.²⁴ Roughly half of gonorrhoea cases and one-fifth of syphilis cases may go unreported.^{24,25} As noted in the Centers for

Disease Control and Prevention's annual STI surveillance report, 'Although most state and local [STI] programs generally adhere to the national notifiable [STI] case definitions ..., differences in policies and systems for collecting surveillance data may exist. Thus, comparisons of case numbers and rates between jurisdictions should be interpreted with caution. However, because case definitions and surveillance activities within a given area remain relatively stable over time, trends should be minimally affected by these differences.' The uniform crime reports from which we obtained state-level violent crime rates are subject to similar limitations.²³ For example, as noted in the Federal Bureau of Investigation uniform crime reports,²³ one state or city 'may report more crime than a comparable one, not because there is more crime, but rather because its law enforcement agency, through proactive efforts, identifies more offenses.' If reporting practices for STIs are correlated with reporting practices for violent crimes at the state level, the association we observed between violent crimes and STI rates might be an artefact of reporting practices across states. If, indeed, reporting practices for STIs are correlated with reporting practices for violent crimes at the state level, however, violent crime rates would still be a valuable control variable to include in statistical analyses of state-level STI rates (to control for differences in STI reporting practices across states). The poverty and unemployment data we applied (from the Census Bureau and the Bureau of Labour Statistics, respectively) were based on several sources, including the Current Population Survey. Potential limitations of the Current Population Survey are discussed in detail elsewhere.²⁶

Conclusions

This study documents a consistent association between violent crime and STI rates at the state level. Combined with the existing literature showing that STI rates and violent crime rates are correlated with many social determinants of health, our study offers evidence of the suitability of violent crime rates as a proxy measure for social determinants of STI rates.

Acknowledgments

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Fig. 1. State-level correlation of gonorrhoea and three social determinants of health, 1981–2010. The correlation coefficient (r) between the reported gonorrhoea rates and three sociodemographic factors (violent crime rates, poverty rates and unemployment rates) at the state level is shown for each year from 1981 to 2010. In all years, the correlation coefficient was greater for violent crime rates than for poverty rates or unemployment rates, indicating a stronger correlation between gonorrhoea and violent crime than between gonorrhoea and the other two measures (poverty and unemployment). The solid line (at which r is approximately 0.28) shows the approximate cutoff for statistical significance, such that $P < 0.05$ when r is above this line and $P > 0.05$ when r is below this line. See Table 1 for precise correlation coefficients and P -values.

Table 1.

State-level association between state-level STI rates (gonorrhoea, primary & secondary (P&S) syphilis) and three demographic factors (violent crime rates, poverty rates, unemployment rates) in the United States, 1981–2010

Data show Pearson correlation coefficients, with two-tailed P -values in parentheses, for correlations between STI rates (gonorrhoea and primary and secondary syphilis rates) and three sociodemographic variables (violent crime rate, poverty rate and unemployment rate), calculated for each year from 1980 to 2010, for all 50 states and the District of Columbia. For example, in 2010, the correlation coefficient for gonorrhoea rates and violent crime rates was 0.621 ($P < 0.001$). The final row shows the average correlation coefficient for all years.

Year	Violent crime rate		Gonorrhoea rate		Unemployment rate		Violent crime rate		P&S syphilis rate		Unemployment rate	
			Poverty rate						Poverty rate			
1981	0.699 (<0.001)		0.317 (0.025)		0.320 (0.024)		0.680 (<0.001)		0.275 (0.051)		0.200 (0.160)	
1982	0.721 (<0.001)		0.324 (0.022)		0.281 (0.048)		0.689 (<0.001)		0.377 (0.006)		0.218 (0.124)	
1983	0.720 (<0.001)		0.313 (0.034)		0.313 (0.034)		0.628 (<0.001)		0.224 (0.118)		0.178 (0.216)	
1984	0.703 (<0.001)		0.310 (0.028)		0.253 (0.076)		0.600 (<0.001)		0.257 (0.075)		0.176 (0.227)	
1985	0.747 (<0.001)		0.294 (0.038)		0.251 (0.079)		0.687 (<0.001)		0.251 (0.076)		0.115 (0.423)	
1986	0.777 (<0.001)		0.163 (0.257)		0.223 (0.120)		0.684 (<0.001)		0.174 (0.222)		0.068 (0.638)	
1987	0.774 (<0.001)		0.222 (0.121)		0.161 (0.264)		0.765 (<0.001)		0.261 (0.065)		0.072 (0.616)	
1988	0.751 (<0.001)		0.263 (0.066)		0.187 (0.194)		0.740 (<0.001)		0.238 (0.100)		0.012 (0.936)	
1989	0.718 (<0.001)		0.332 (0.019)		0.206 (0.152)		0.709 (<0.001)		0.243 (0.085)		0.117 (0.415)	
1990	0.710 (<0.001)		0.308 (0.030)		0.228 (0.112)		0.711 (<0.001)		0.325 (0.021)		0.243 (0.089)	
1991	0.701 (<0.001)		0.258 (0.070)		0.218 (0.129)		0.696 (<0.001)		0.270 (0.056)		0.339 (0.015)	
1992	0.667 (<0.001)		0.391 (0.005)		0.216 (0.131)		0.578 (<0.001)		0.397 (0.004)		0.257 (0.072)	
1993	0.644 (<0.001)		0.412 (0.003)		0.216 (0.133)		0.564 (<0.001)		0.520 (<0.001)		0.258 (0.068)	
1994	0.663 (<0.001)		0.499 (<0.001)		0.230 (0.112)		0.501 (<0.001)		0.495 (<0.001)		0.109 (0.462)	
1995	0.646 (<0.001)		0.341 (0.016)		0.268 (0.060)		0.408 (0.005)		0.401 (0.006)		0.022 (0.888)	
1996	0.657 (<0.001)		0.285 (0.043)		0.241 (0.088)		0.510 (<0.001)		0.335 (0.023)		0.125 (0.407)	
1997	0.696 (<0.001)		0.254 (0.073)		0.260 (0.066)		0.569 (<0.001)		0.269 (0.071)		0.138 (0.359)	
1998	0.671 (<0.001)		0.253 (0.074)		0.131 (0.358)		0.614 (<0.001)		0.350 (0.014)		0.104 (0.479)	
1999	0.669 (<0.001)		0.177 (0.215)		0.037 (0.796)		0.549 (<0.001)		0.266 (0.071)		0.011 (0.940)	
2000	0.643 (<0.001)		0.247 (0.080)		0.156 (0.276)		0.610 (<0.001)		0.448 (0.002)		0.168 (0.265)	
2001	0.644 (<0.001)		0.264 (0.061)		0.336 (0.016)		0.676 (<0.001)		0.494 (<0.001)		0.442 (0.002)	
2002	0.631 (<0.001)		0.316 (0.024)		0.337 (0.016)		0.703 (<0.001)		0.315 (0.033)		0.412 (0.005)	
2003	0.600 (<0.001)		0.347 (0.013)		0.343 (0.014)		0.600 (<0.001)		0.344 (0.015)		0.286 (0.047)	

Year	Violent crime rate	Gonorrhoea rate Poverty rate	Unemployment rate	Violent crime rate	P&S syphilis rate Poverty rate	Unemployment rate
2004	0.659 (<0.001)	0.477 (<0.001)	0.491 (<0.001)	0.715 (<0.001)	0.484 (<0.001)	0.443 (0.001)
2005	0.672 (<0.001)	0.508 (<0.001)	0.554 (<0.001)	0.730 (<0.001)	0.388 (0.005)	0.366 (0.009)
2006	0.654 (<0.001)	0.493 (<0.001)	0.443 (0.001)	0.667 (<0.001)	0.364 (0.009)	0.297 (0.036)
2007	0.672 (<0.001)	0.532 (<0.001)	0.457 (<0.001)	0.639 (<0.001)	0.450 (<0.001)	0.314 (0.025)
2008	0.653 (<0.001)	0.472 (<0.001)	0.400 (0.004)	0.505 (<0.001)	0.496 (<0.001)	0.356 (0.011)
2009	0.646 (<0.001)	0.473 (<0.001)	0.397 (0.004)	0.661 (<0.001)	0.513 (<0.001)	0.418 (0.003)
2010	0.621 (<0.001)	0.545 (<0.001)	0.339 (0.015)	0.452 (<0.001)	0.458 (<0.001)	0.544 (<0.001)
Average	0.681	0.346	0.283	0.628	0.356	0.227