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Article

Societal determinants of violent death: The extent to which social, economic, and structural characteristics explain differences in violence across Australia, Canada, and the United States

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ABSTRACT

In this ecological study, we attempt to quantify the extent to which differences in homicide and suicide death rates between three countries, and among states/provinces within those countries, may be explained by differences in their social, economic, and structural characteristics. We examine the relationship between state/province level measures of societal risk factors and state/province level rates of violent death (homicide and suicide) across Australia, Canada, and the United States. Census and mortality data from each of these three countries were used. Rates of societal level characteristics were assessed and included residential instability, self-employment, income inequality, gender economic inequity, economic stress, alcohol outlet density, and employment opportunities). Residential instability, self-employment, and income inequality were associated with rates of both homicide and suicide and gender economic inequity was associated with rates of suicide only. This study opens lines of inquiry around what contributes to the overall burden of violence-related injuries in societies and provides preliminary findings on potential societal characteristics that are associated with differences in injury and violence rates across populations.

It is well documented that rates of death due to violence vary between countries. The World Health Organization, for example, reported that in 2016 homicide death rates ranged from 0.2 per 100,000 in Luxemborg to 55.5 per 100,000 in Honduras (World Health Organization, 2018a) and suicide rates ranged internationally from 0.4 per 100,000 in Barbados to 30.2 per 100,000 in Guyana (World Health Organization, 2018b). Substantial variations in violence death rates have also been reported within countries. For example, the range of age adjusted homicide rates by state within the United States in 2016 was from 1.3 per 100,000 in New Hampshire to 14.2 per 100,000 in Louisiana (Centers for Disease Control and Prevention, 2018a). This variability within countries also holds true for suicide, with the range

between states in Australia in 2010/2011 spanning 7.8 per 100,000 in New South Wales to 18.1 per 100,000 in Northern Territory (Harrison & Henley, 2014).

The contemporary public health model for prevention of injury and violence is a four step process; 1) define the problem, 2) identify risk and protective factors, 3) develop and test prevention strategies, and 4) ensure widespread adoption (Centers for Disease Control and Prevention, 2018b). Differences in rates of death from injury and violence are considered a consequence of either a difference in the frequency and distribution of risk and protective factors for injury, or the differences in effectiveness of interventions (or both). An important nuance to consider when applying the public health model to injury and

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violence prevention is that the frequency and distribution of risk and protective factors at the individual and relationship level (e.g., substance use, poor parent-child relationships), and the capacity of a jurisdiction to implement prevention strategies, are products of the underlying social characteristics and community/societal level risk and protective factors of that jurisdiction. Thus the differences in social and structural factors between states or countries has a bearing on the extent to which these states and countries manifest different rates of death from injury and violence (Galea & Vaughan, 2018; Smith & Kawachi, 2014).

While the majority of research on risk and protective factors for violence has focused on characteristics of the individual and their relationships, there is a growing body of research examining correlations between social and structural phenomena at the community and societal level (e.g., community support and connectedness, alcohol outlet density, income inequality), and rates of violence (Asal & Brown, 2010; Deyoung & Zigler, 1994; Eckenrode, Smith, McCarthy, & Dineen, 2014; Fajnzylber, Lederman, & Loayza, 2002). One current gap in the literature, however, is the lack of an analysis of the extent to which these social and structural characteristics can contribute to variations in rates of violence across states and nations. The importance of this information is emphasized by the perspective underlying the United Nations' Millennium Development Goals (United Nations, 2018a) and Sustainable Development Goals (United Nations, 2018b), which are explicitly predicated on the observed relationships between the social strengths of communities and the consequent health and wellbeing of their populations (Griggs et al., 2013; Sachs, 2005). Other work has noted that the occurrence of injuries is largely determined by characteristics of the environment and while host factors (e.g. age, sex) can be markers of risk, injury prevention itself often focuses on structural and population level interventions (Stevenson & McClure, 2005). In line with current frameworks on population health (Galea, 2018) and a call for ecological study designs (Stevenson & McClure, 2005), this research uses advances in ecological approaches, such as multilevel designs, to inform a population health perspective on violence. The aim of this research was to conduct exploratory analyses that would begin to address an identified gap in the literature by quantifying the extent to which differences in homicide and suicide rates between states/provinces across three countries may be explained by differences in societal characteristics. Multilevel model analyses were applied to generate intracluster correlation estimates to illustrate which factors influenced the between country variation and within country variation of suicide and homicide deaths in Australia, Canada, and the U.S.

1. Methods

1.1. Study design

An ecological study was conducted examining the relationship between state/province level measures of societal risk factors ascertained from each countries' national census data, and state/province level rates of violent death (homicide and suicide) across Australia, Canada, and the U.S. obtained from national vital record databases. We assessed rates of societal characteristics through measures of alcohol outlet density, economic stress, economic opportunities, gender economic inequity, income inequality, residential instability, and self-employment (see *Definition of Variables* below). Data used in this study were from 2011, as this was the most recent year the explanatory variables were available at both the national and sub-national levels across all three countries. Finally, we examined whether these characteristics accounted for a significant portion of the variation in violence rates across countries and states/provinces.

1.2. Setting

This study used measures from Australia, Canada, and the U.S. at

the province/state level of each country. These three countries were chosen due to similarities in their historical development, national wealth, language, and culture, and also the quality of their data collection systems in relation to explanatory variables and injury deaths.

1.3. Definition of variables

The characteristics selected for analysis were factors at the societal or community level that have been linked to violence outcomes in the literature (Wilkins, Tsao, Hertz, Davis, & Klevens, 2014) and can be measured across states and countries using community and/or societal indicators (Armstead, Wilkins, & Doreson, 2018).

We measured residential instability using census data from each country as the percentage of the population not currently living in the same residence that they were five years prior. Community and social support and connectedness, or the lack thereof, have been linked to multiple forms of violence including child abuse and neglect (Coulton, Crampton, Irwin, Spilsbury, & Korbin, 2007; Freisthler, Merritt, & LaScala, 2006), intimate partner violence (Capaldi, Knoble, Shortt, & Kim, 2012; Pinchevsky & Wright, 2012), sexual violence (DeGue et al., 2013), youth violence (Sampson, Morenoff, & Gannon-Rowley, 2002), suicide (Arango, Opperman, Gipson, & King, 2016; Desai, Dausey, & Rosenheck, 2005; Smith & Kawachi, 2014), and elder abuse and neglect (Johannesen & LoGiudice, 2013). Lack of community connectedness and cohesion has been measured in a number of studies using societal-level census data on residential stability/instability which include the indicator used in this study (Drake, Jonson-Reid, & Sapokaite, 2006) as well as others such as percentage of vacant housing units (Abrams & Freisthler, 2010), and percentage of rental housing units (Ahern et al., 2013). Self-employment was measured as the percentage of workers that were self-employed. Self-employment has been linked to health and quality of life concerns such as stress, fatigue, and negative behavioral, psychological, and physical health outcomes (Benach, Gimeno, Benavides, Martinez, & del Mar Torné, 2004; Dolinsky & Caputo, 2003) as well as other social and economic characteristics that could potentially be linked to violence outcomes (Earle & Sakova, 2000; Saridakis, Mendoza, Muñoz Torres, & Glover, 2016; Svaleryd, 2015).

Other economic characteristics included variables that measure general income inequality, gender-related economic inequity, and economic stress. Income inequality has been found to correlate with child abuse and neglect (Eckenrode et al., 2014), intimate partner violence (Asal & Brown, 2010), youth violence (Fajnzylber et al., 2002; Kennedy, Kawachi, Prothrow-Stith, Lochner, & Gupta, 1998; Nivette, 2011), and bullying (Elgar, Craig, Boyce, Morgan, & Vella-Zarb, 2009). Consistent with other studies that have measured income inequality (Phillips, 2002; Singh, Kogan, & van Dyck, 2008; Smith & Kawachi, 2014), we measured income inequality using Gini coefficients from census data.

Gender inequity, including harmful norms around masculinity and femininity, has been linked to multiple forms of violence (Briggs & Cutright, 1994; Connolly, Pepler, Craig, & Taradash, 2000; Espelage, Basile, & Hamburger, 2012; Espelage & Swearer, 2008; Ferrari, 2002; Fleming et al., 2015; Reitzel-Jaffe & Wolfe, 2016; Whitehead, 2005). While gender norms are typically measured at the individual level through surveys or interviews, U.S. census data has been used in previous studies to develop societal-level indicators of gender socio-economic equity, including the female-to-male ratio of 1) college completion, 2) employment in managerial or professional occupations, 3) income, 4) full-time employment, and 5) households above the poverty level (Armstead et al., 2018; Titterington, 2006). We adapted the indicators used by Titterington (2006) and measured gender economic inequity using census data on the female-to-male ratio of unemployment (total number of females aged 16 years and over that are unemployed, but looking for work, divided by the total number of males age 16 years and over that are unemployed, but looking for work). (Titterington, 2006).

Neighborhood poverty and markers of economic stress, such as food insecurity, and financial dependence, have been linked to many forms of violence (Bonomi, Trabert, Anderson, Kernic, & Holt, 2014; Capaldi et al., 2012; Freisthler et al., 2006; Jewkes, Fulu, Roselli, & Garcia-Moreno, 2013; Johannesen & LoGiudice, 2013; Losel & Farrington, 2012; Luo, Florence, Quispe-Agnoli, Ouyang, & Crosby, 2011; Rehkopf & Buka, 2006; Slack et al., 2011). Previous ecological studies have linked national, regional, and state-level rates of poverty and economic stress to violence and other health outcomes (Holtgrave & Crosby, 2003; Page et al., 2016; Wolf, Gray, & Fazel, 2014), and research on indicators of financial hardship suggest that housing-related expenses contribute substantially to individuals' and families' financial stress (Bray, 2001; Kutty, 2005). As such, we measure economic stress using census data on residents' median rent-to-income ratio.

Alcohol outlet density in Canada and the U.S. was measured using census data on the total number of beer, wine and liquor stores per 100,000 people. In Australia, alcohol outlet density was measured using data from liquor licensing agencies in each state on the total number of businesses with a packaged liquor, off-premises, or liquor store/merchant license per 100,000 people. Alcohol outlet density has been linked to child abuse and neglect (Freisthler, Needell, & Gruenewald, 2005), intimate partner violence (Cunradi, Mair, Ponicki, & Remer, 2012; Livingston, 2011), sexual violence (Lippy & DeGue, 2016), youth violence (Resko et al., 2010), and suicide (Escobedo & Ortiz, 2002). Diminished economic opportunities in neighborhoods and high unemployment have also been associated with a number of different forms of violence including child abuse and neglect, (Runyan, Wattam, Ikeda, Hassan, & Ramiro, 2002) intimate partner violence (Heise et al., 2002; Pinchevsky & Wright, 2012), suicide (Luo et al., 2011; Reeves et al., 2012), sexual violence (Coker, Smith, McKeown, & King, 2000), and youth violence (Wilson, 2011). We measured employment opportunities using census data on the total number of business establishments per capita.

1.1.1. Outcome variables

The source for homicide and suicide death rates were national vital statistics systems. U.S. data were obtained from WISQARS (http://www.cdc.gov/injury/wisqars/fatal_injury_reports.html); Canadian data from Statistics Canada (<http://www.statcan.gc.ca/>), and Australian data were provided by the Victorian Injury Surveillance Unit (VISU) and obtained from the Australian Coordinating Registry for the Cause of Death Unit Record File (COD URF). The Australian Bureau of Statistics introduced a revisions process for all coroner certified deaths registered after January 1, 2006. The process means data are preliminary when published for the first time, revised when published the following year, and final when published two years after initial publication. Analyses used the revised data for 2011. We obtained the number of deaths by 5 year age groups. Mortality data for Australia was obtained via special request. U.S. and Canadian de-identified aggregate data were obtained from administrative datasets already in the public domain, therefore ethics approval was not sought. VISU has ethics approval for the use and dissemination of the COD URF.

1.4. Data management and analysis

The distribution of all variables is shown in Table 1. The variation between countries was significantly different (Pearson chi-square test) for homicide rates, residential instability, self-employment, income inequality, and employment opportunities. Explanatory variables (residential instability, self-employment, income inequality, gender economic inequity, economic stress, alcohol outlet density, economic opportunities) were standardized to have a mean of zero and standard deviation of 1. Data were missing for three out of 72 variables across states/provinces (data on income inequality, self-employment, and economic stress were missing for three Canadian provinces). After checking for patterns in missing data, the missing values in each

explanatory variable were multiple imputed by using fully conditional specification (FCS) predictive mean matching method (REGPMM).

Multilevel models were used to assess associations between suicide and homicide rates and each of the social, economic, and structural explanatory variables. Bivariate analyses were conducted to assess whether explanatory variables were individually associated with dependent variables (homicide and suicide deaths). Then, a multivariate analysis was performed between both dependent variables (suicide and homicide rates) and all seven explanatory variables. This multilevel model approach enables analysis of correlations among observations in the same cluster (country), as well as an estimate of intraclass correlation (ICC). ICC is the ratio of the between-cluster variance (suicide and homicide death rate variation between countries) to the total variance (suicide death and homicide death rate variation between country + suicide and homicide death rate variation within country). It can also be interpreted as the correlation among suicide and homicide rates (at state level) within the same cluster (country).

2. Results

Alcohol outlet density was not significantly associated with homicide or suicide deaths in either bivariate or multivariate analyses. Employment opportunities were significantly and inversely associated with homicide and suicide deaths at the bivariate level only.

Gender economic inequity was significantly associated with both homicide (positive) and suicide (inverse) in bivariate analysis, but only with suicide in multivariate analyses. The inverse association between gender economic inequity and suicide suggests that the higher the female-to-male unemployment ratio, the lower the suicide rate. For suicide, gender economic inequity accounted for 31.25 % of within country variance, and 68.76% of between country variance. Economic stress was significant only at the bivariate level for suicide, and not significant for homicide or suicide in multivariate analyses.

Income inequality was significantly associated with homicide and suicide in both bivariate and multivariate analyses, although the association with suicide was inverse. For homicide, there was not a suitable variance-covariance structure appropriate to model the country effect (between variations of homicide rate). For suicide, income inequality accounted for 56.98% of between country variation, and 43.02% of the within country variation.

Residential instability was significantly associated with both homicide and suicide rates in bivariate and multivariate analyses. The between country variance estimate for suicide was 9.95, and the within country variance (state/province effect) estimate was 51.01. The ICC indicated residential instability explained 16.3% of between country variation (country effect) of suicide rate. The between country variance for migration and homicide was 0 and therefore ignorable. Self-employment was also significantly associated with homicide (inverse) and suicide in both bivariate and multivariate analyses. For homicide, self-employment accounted for 5.49% of the total variance in homicide between countries and it accounted for 34.39% of between country variance in suicide.

3. Discussion

The main finding of this research is that the distribution of deaths from intentional injury (homicide and suicide) across state/provinces in Australia, Canada and the U.S. is correlated with specific state/province's social contexts. Residential instability, self-employment, and income inequality were all associated with both homicide and suicide rates, and gender economic inequity was associated with suicide rates only. Some of these associations were in expected directions, and others were not based on extant literature.

These findings are cross-sectional so the direction of the associations found, and how they function over time are still unknown. Findings from this ecological study also do not allow for any inference on

Table 1
Descriptive statistics for homicide and suicide rates and explanatory variables by country (Australia, Canada, and the United States 2011).

	Australia (n = 8)	Canada (n = 13)	United States (n = 51)	All Jurisdictions (n = 72)	P value*
Suicide crude death rate per 100,000					**
5.96–10.50	3 (37.5%)	3 (23.1%)	9 (17.6%)	15 (20.8%)	
10.51–12.77	2 (25.0%)	3 (23.1%)	9 (17.6%)	14 (19.4%)	
12.78–14.00	1 (12.5%)	4 (30.8%)	9 (17.6%)	14 (19.4%)	
14.01–16.96	1 (12.5%)	2 (15.4%)	12 (23.5%)	15 (20.8%)	
16.97–68.60	1 (12.5%)	1 (7.7%)	12 (23.5%)	14 (19.4%)	
Homicide crude death rate per 100,000^a					< .001
0–1.67	7 (87.5)	6 (46.2%)	2 (4.0%)	15 (21.1%)	
1.68–2.70	0 (0%)	4 (30.8%)	9 (18.0%)	13 (18.3%)	
2.71–4.60	1 (12.5%)	2 (15.4%)	12 (24.0%)	15 (21.1%)	
4.61–6.21	0 (0%)	0 (0%)	13 (26.0%)	13 (18.3%)	
6.22–17.9	0 (0%)	1 (7.7%)	14 (28.0%)	15 (21.1%)	
Explanatory Variables (quintiles)					
Alcohol Outlet Density (Number of outlets per 100,000 people) ^a					**
1.92–5.58	1 (14.3%)	1 (7.7%)	12 (23.5%)	14 (19.7%)	
5.59–7.71	0 (0.0%)	4 (30.8%)	10 (19.6%)	14 (19.7%)	
7.72–11.75	1 (14.3%)	3 (23.1%)	10 (19.6%)	14 (19.7%)	
11.76–19.71	0 (0.0%)	3 (23.1%)	11 (21.6%)	14 (19.7%)	
19.72–55.20	5 (71.4%)	2 (15.4%)	8 (15.7%)	15 (21.1%)	
Economic Stress (Median rent to income ratio)					**
.046–.160	0 (0.0%)	10 (76.9%)	4 (7.8%)	14 (19.4%)	
.161–.185	1 (12.5%)	3 (23.1%)	11 (21.6%)	15 (20.8%)	
.186–.196	0 (0.0%)	0 (0.0%)	14 (27.5%)	14 (19.4%)	
.197–.218	0 (0.0%)	0 (0.0%)	15 (29.4%)	15 (20.8%)	
.219–.269	7 (87.5%)	0 (0.0%)	7 (13.7%)	14 (19.4%)	
Employment Opportunities (Number of employer establishments per capita)					< 0.001
.0190–.0220	0 (0.0%)	0 (0.0%)	15 (29.4%)	15 (20.8%)	
.0221–.0246	0 (0.0%)	1 (7.7%)	13 (25.5%)	14 (19.4%)	
.0247–.0280	0 (0.0%)	0 (0.0%)	14 (27.5%)	14 (19.4%)	
.0281–.0618	0 (0.0%)	5 (38.5%)	9 (17.6%)	14 (19.4%)	
.0619–.1022	8 (100.0%)	7 (53.8%)	0 (0.0%)	15 (20.8%)	
Gender Economic Inequity (Female-to-male ratio of unemployment)					**
.620–.731	0 (0%)	4 (40.0%)	9 (17.6%)	13 (18.8%)	
.732–.803	2 (25.0%)	4 (40.0%)	9 (17.6%)	15 (21.7%)	
.804–.827	1 (12.5%)	0 (0%)	13 (25.5%)	14 (20.3%)	
.828–.887	2 (25.0%)	2 (20.0%)	10 (19.6%)	14 (20.3%)	
.888–1.05	3 (37.5%)	0 (0%)	10 (19.6%)	13 (18.8%)	
Income Inequality (GINI coefficient)					< 0.001
.353–.425	5 (62.5%)	6 (60.0%)	3 (5.9%)	14 (20.3%)	
.426–.439	3 (37.5%)	3 (30.0%)	8 (15.7%)	14 (20.3%)	
.440–.459	0 (0.0%)	1 (10.0%)	13 (25.5%)	14 (20.3%)	
.460–.472	0 (0.0%)	0 (0.0%)	14 (27.5%)	14 (20.3%)	
.473–.534	0 (0.0%)	0 (0.0%)	13 (25.5%)	13 (18.8%)	
Residential Instability (Percentage of people not in same residence 5 years ago)					< 0.001
28.17–36.09%	6 (75%)	8 (61.5%)	0 (0%)	14 (19.4%)	
36.10–43.35%	2 (25%)	4 (30.8%)	9 (17.6%)	15 (20.8%)	
43.36–47.31%	0 (0%)	1 (7.7%)	14 (27.5%)	15 (20.8%)	
47.32–50.53%	0 (0%)	0 (0%)	13 (25.5%)	13 (18.1%)	
50.54–61.78%	0 (0%)	0 (0%)	15 (29.4%)	15 (20.8%)	
Self-Employment (Proportion of workers in the state that are self-employed)					< 0.001
6.23–8.56%	0 (0.0%)	0 (0.0%)	14 (27.5%)	14 (20.3%)	
8.57–9.36%	1 (12.5%)	0 (0.0%)	12 (23.5%)	13 (18.8%)	
9.37–10.46%	1 (12.5%)	1 (10.0%)	13 (25.5%)	15 (21.7%)	
10.47–13.91%	0 (0.0%)	3 (30.0%)	11 (21.6%)	14 (20.3%)	
13.92–18.55%	6 (75.0%)	6 (60.0%)	1 (2.0%)	13 (18.8%)	

*Pearson chi-square test; **Not significant at p < .05.

^a n = number of states/provinces in each country; n = 50 for US homicide rate due to one state reporting < 10 homicides in the study year; n = 7 for Australian alcohol outlets due to unavailability of estimate in one state.

associations between the factors considered and individual level risk, nor do they preclude the possibility that the observed state-level associations may reflect differential distributions of risk among individuals in states. However, understanding what contributes to population health and uncovering “foundational drivers” is important (Galea & Vaughan, 2018). The observed association found in this exploratory analysis between social context and intentional injury rates begins to examine this. Self-employment and residential instability, for example, were linked to higher rates of suicide both within and across countries,

and self-employment was also inversely associated with homicide. The findings related to residential instability are consistent with literature to date that has shown a link between lack of social cohesion at the relational and community levels and multiple forms of violence, including suicide (Arango et al., 2016; Desai et al., 2005; Holma et al., 2010; Kennedy et al., 1998; Sampson et al., 2002). Findings on self-employment also align with previous research that suggests occupations with typically high rates of self-employment (e.g. construction and extraction) are also among those with the highest suicide rates (Hippel

& Hammond, 2016; Peterson, 2018, p. 67). Other studies on self-employment have suggested that social isolation, a well-documented risk factor for suicide (Arango et al., 2016), is a substantial concern among those who are self-employed (Feldman & Bolino, 2000; Grant & Ferris, 2012). Some research also suggests that self-employment may be a marker of economic isolation in communities, in that poor economic conditions and unemployment may “push” individuals into self-employment as an alternative particularly if they experience other social risk factors such as low educational attainment (Earle & Sakova, 2000; Saridakis et al., 2016; Svaleryd, 2015), although other studies have shown mixed findings on this link (Henley, 2017). Other factors directly or indirectly linked to both self-employment and suicide such as stress, risk for financial loss, rural region, and access to lethal means may also potentially contribute to this association (Benach et al., 2004; Dolinsky & Caputo, 2003; Jamal, 2007; Stallones, Doenges, Dik, & Valley, 2013). The inverse association between self-employment and homicide suggests that self-employment may function differently for suicide and homicide. It is possible that areas experiencing higher levels of self-employment may also exhibit other social, economic, and structural characteristics that more strongly correlate with homicide, such as population density (Lee, Maume, & Ousey, 2003) or entrepreneurship (Carree, Congregado, Golpe, & van Stel, 2015). Other correlates such as these may be important to consider and investigate in future research. Understanding how residential instability and self-employment operate at the state and societal levels provides us with an opportunity to broaden our lens for prevention and consider the ways in which social and economic characteristics serve as important potential levers for impacting violence outcomes, as well as critical contextual elements likely interacting with and impacting the effectiveness of other public health approaches to violence prevention.

Income inequality was significantly associated with both homicide and suicide rates in both bivariate and multivariate analyses, although the association with suicide was inverse. Previous research has shown links between community violence and homicide with income inequality at both the national (Fajnzylber et al., 2002; Nivette, 2011) and sub-national level (Kennedy et al., 1998). For suicide, while findings linking higher income inequality with lower suicide rates may seem counterintuitive, these findings have been previously observed. For example, in a cross-national study of 15 European countries, Andres and colleagues (2005) found that income inequality (also measured via the Gini index) was negatively associated with suicide among women in particular, and these associations were not statistically significant (Andrés, 2005). They also recommend cautious interpretation of these findings due to concerns with the quality of aggregated data in studies examining income inequality using the Gini Index (Andrés, 2005; Gravelle, Wildman, & Sutton, 2002), and other studies suggest additional methodological limitations associated with the Gini Index due to some of the confounding associations between income inequity, absolute income, and other forms of inequity (Chen, Dai, Pu, Hou & Feng, 2018; Deaton, 2003).

The inverse association observed between gender economic inequity and suicide deaths was particularly interesting. Women's unemployment, overall, was lower than men's, however when women's unemployment approached or surpassed that of men's, significantly lower rates of suicide were observed. This association may be at least partially explained as a function of the way in which traditional gender norms are tied to economic success. For example, Moller-Leimkuhler (2003) makes the case that traditional norms around masculinity make men more vulnerable to some of the maladaptive behaviors known to contribute to suicide (e.g. substance abuse, lack of help-seeking), and contends that shifts in gender roles, particularly in relation to women moving into the workforce, have caused a dilemma for many men for whom masculinity is still very tied to one's role as “breadwinner” (Moller-Leimkuhler, 2003). Studies on unemployment and mental health also indicate that men may be more susceptible to the psychological stressors of unemployment than their female counterparts (Paul

& Moser, 2009). Given that men's unemployment tends to be higher and less stable than women's overall (Albanesi & Şahin, 2018), this finding may also be a reflection of the association between broader economic and employment conditions and suicide.

Unexpectedly our data did not show an association between violence outcomes and alcohol outlet density, despite findings from previous literature suggesting these links for both community violence (Resko et al., 2010) and suicide (Escobedo & Ortiz, 2002). One potential explanation for this discrepancy is that extant research on alcohol outlet density has focused primarily on violence-related morbidity (e.g. emergency department visits, reported sexual assaults) and less so on mortality (Cunradi et al., 2012; Lippy & DeGue, 2016) as measured in this study. Alcohol outlet density may be a stronger predictor of less severe violent outcomes than of violent deaths. Future studies should investigate these nuances further. Analyses also revealed no significant association between economic stress and homicide and suicide deaths, a finding that was also surprising and inconsistent with previous literature linking various indicators of economic stress with violence outcomes (Capaldi et al., 2012; Jewkes et al., 2013; Johannesen & LoGiudice, 2013; Luo et al., 2011; Slack et al., 2011), and in particular during the global housing and financial crisis which was occurring at the time of this study (Mucci, Giorgi, Roncaioli, Perez, & Arcangeli, 2016). The indicator we used in this study to measure economic stress (median rent to income ratio) may account for this divergence. While housing-related costs have been shown to be a meaningful contributor to financial stress (Bray, 2001; Kutty, 2005), some have argued that rent to income ratios can offer an overly simplistic depiction of housing-related financial strain (Hui, 2001). Future research may consider examining more sensitive measures or other markers of economic stress, such as food insecurity. Finally, results on employment opportunities were not expected based on findings from previous research (Luo et al., 2011; Reeves et al., 2012; Wilson, 2011). Increased economic opportunities (as measured by number of employer establishments per capita) were not significantly associated with homicide or suicide rates. This unexpected finding may be explained, at least in part, by the influence of the global economic recession following the housing and financial crises of 2008 (Lazear & Spletzer, 2012). It is possible that employer establishments were not hiring new employees at typically expected rates during the time of this study, resulting in lower levels of actual employment opportunities than the data would suggest (Lazear & Spletzer, 2012).

3.1. Limitations

There are several strengths and weaknesses of this study's methods that should be taken into account when interpreting results. One strength of the study is the multilevel modelling approach that allowed for the computation of ICC estimates to explain which societal characters influenced both between country variation and within country variation of suicide and homicide death across the three countries. For example, in Table 2, for self-employment, the ICC estimates for suicide and homicide are 34.39 and 5.49, respectively. This indicates that in terms of between country variation, the contribution of self-employment is seven times higher for suicide death (34.39%), than homicide deaths (5.49%). Also, the three countries included in this study share many similarities in terms of historical development, national wealth, language and culture, and have uniformly good (albeit susceptible to typical limitations, such as misclassification bias) data collection systems in relation to census variables and injury deaths. This similarity is a strength in terms of ensuring simplicity of study design (Mack et al., 2017), although it does limit generalizability of the study results. The data are from 2011 as at the time of undertaking the analyses this was the most recent year data were available across all three countries. However, given the aim of this study was to explore relationships between homicide and suicide rates with social, economic, and structural characteristics measured at the state and country levels, rather than

Table 2 Multilevel bivariate regression estimates for societal characteristics and crude homicide and suicide death rates, Australia, Canada, and the United States, 2011

Explanatory Variable	Homicide			Suicide			
	Covariate effect (bivariate)	Fixed effect (multivariate)	Country effect (percent, ICC)? ^a	Covariate effect (bivariate)	Fixed effect (multivariate) ^b	Between (within) country variance	Country effect (percent, ICC) ^a
Alcohol outlet density	-0.02	0.21	-	-1.42	-0.71	-	-
Economic stress	-0.37	-0.07	-	-4.81**	-0.92	-	-
Employment opportunities	-1.71**	0.61	-	-8.07**	-1.19	-	-
Gender economic inequity	1.06**	0.50	-	-1.93**	-1.29**	8.76 (3.98)	68.76
Income inequality	1.91**	1.40*	-	-2.38**	-1.20*	11.87 (8.96)	56.98
Residential instability	1.42**	1.08*	-	2.59*	1.89**	9.95 (51.01)	16.33
Self-employment	-1.48**	-1.46*	0.35 (6.07)	1.15*	1.53*	6.05 (11.54)	34.39

*p < .05; **p < .001.

Note: Missing values indicate that country effect was ignorable or a suitable variance-covariance structure was not available.

^a ICC: The intraclass correlation is the ratio of the between-cluster (country) variance and the total variance. Computed as ICC = Var_{Between Countries} / (Var_{Between Countries} + Var_{within countries}).

^b Multivariate model contains alcohol outlet density, economic stress, employment opportunities, gender economic inequity, income inequality, residential instability, and self-employment.

produce a prevalence estimate, the fact that the data are not immediately contemporary does not undermine the results. It is also worth noting that variables used in this study are measured using data that could be gathered at the state level across all three countries and thus may not be the best/most precise measures of the underlying concepts. Certainly other measures could be used which may offer a better fit to the construct (e.g. comprehensive economic indices to measure gender economic inequity) however, variations in how the measures were defined and collected across the countries meant we had to choose between a better fit to the construct or consistency in measurement across countries. We chose the latter. Finally, it should be noted that the overall U.S. homicide rate was significantly higher than in the other two countries included in the study. Results from the country analyses suggested that the majority of the homicide rate variation was due to between state factors rather than characteristics of the countries themselves, although rate outliers in state/province level homicide rates could be the main reason for the small between country variations and large within country variation for homicide.

Future research may build upon the findings of this ecological study, which was intended to open lines of inquiry around what contributes to the overall burden of violence-related injuries in societies, to examine some of the associations that exist between societal characteristics and violence outcomes. Future research may investigate, for example, whether population demographics such as gender and age or rurality moderate the associations between societal characteristics (e.g. rates of self-employment) and violence outcomes. Future studies may also expand upon findings from this study to examine these associations at the sub-state level, and explore additional ubiquitous risk factors for violence where small changes can result in more substantial shifts in the health of populations (Galea, 2018).

Achieving population-level impact in injury and violence prevention necessitates an understanding of the underlying factors that are driving current population-level differences in violence death rates. The findings from this study present the potential that may exist to improve the health of less healthy populations by focusing prevention efforts on the key societal characteristics that are driving differences in violence rates across populations (Galea & Vaughan, 2018). Such approaches are likely to require systemic change at the societal level consistent with the principles of ecological public health (Mack et al., 2017; McClure, Mack, Wilkins, & Davey, 2015), and necessitate the development of infrastructure and empowerment processes at the local level to achieve responsive and sustained public health impact on injury and violence.

Ethics approval statement

No data meeting the definition of human subjects research were collected for the study reported in this paper.

Societal Determinants of Violent Death: The Extent to Which Social, Economic, and Structural Characteristics Explain Differences in Violence across Australia, Canada, and the United States. All data in this study were accessed from publicly available, secondary data sources. As such, no ethics approval was required or obtained.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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