Original Contributions

Socio-demographic and spatio-temporal predictors of homicidal strangulation in the City of Johannesburg, South Africa

Shahnaaz Suffla[1]
South African Medical Research Council-University of South Africa Violence, Injury and Peace Research Unit & Institute for Social and Health Sciences, University of South Africa

Mohamed Seedat
Institute for Social and Health Sciences, University of South Africa & South African Medical Research Council-University of South Africa Violence, Injury and Peace Research Unit

ABSTRACT

The literature on the predictors of disaggregated homicide rates exposes a distinct void with respect to strangulation fatality. The current study examines the effects of socio-demographic and spatio-temporal variables on the risk for homicidal strangulation relative to the other leading causes of homicide in the City of Johannesburg for the period 2001-2010. The data were derived from the National Injury Mortality Surveillance System. A series of logistic regressions were performed to assess the independent associations between each of the predictor variables and fatal strangulation relative to the other leading causes of homicide. The analysis revealed that there are several unique socio-demographic and spatio-temporal factors that differentiate homicidal strangulation risk from the risk for other causes of homicide. Sex was found to be the strongest predictor of homicidal strangulation, with the risk significantly higher for females. The elderly (60+ years), were found to be at marked risk of fatal strangulation, as were children between the ages of 0-14 years. The most noteworthy predictive effects for temporality were observed for time of day and day of the week, with daytime and weekdays representing the periods of higher risk. In the current analyses, scene of death did not emerge as a significant predictor of strangulation homicide. The study supports the contention that differentiated risk profiles for the different causes of homicide are important to recognise and delineate for the purposes of strangulation homicide prevention.

Keywords: homicide; strangulation; predictors; socio-demographic; spatio-temporal; South Africa

INTRODUCTION

Homicide studies, using analytic inquiries to test hypotheses and predictive models, report that there are statistically identifiable and predictable patterns to homicide victimisation. These analyses have increasingly sought to disaggregate homicide to discern the occurrence probabilities of different homicide types. Although the value of more refined theoretical understandings of homicide through disaggregation is by now well established, the literature on the predictors of disaggregated homicide rates exposes a distinct void with respect to strangulation fatality. The literature on strangulation homicide reveals evidence on forensic and epidemiological profiles (e.g., Demirci, Dogan, Erkol, & Gunaydin, 2009; Hawley, McClane, & Strack, 2001; Maxeiner & Bockholdt, 2003; Verma, 2007; Verma & Lal, 2006), with descriptive findings

[1] Please direct all correspondence to: Prof Shahnaaz Suffla, South African Medical Research Council-University of South Africa Violence, Injury and Peace Research Unit & Institute for Social and Health Sciences, University of South Africa, PO Box 19070, Tygerberg, 7505; Email: ssuffla@mrc.ac.za

on strangulation homicide in South Africa indicating fatal strangulation to be the fourth leading cause of homicide in the City of Johannesburg (Suffla & Seedat, 2016; Suffla, Van Niekerk, & Arendse, 2008). However, there is a near absence of national and international research on the predictive patterns that characterise homicidal strangulation at the individual and situational level. Certainly, on the African continent, there is currently no published scientific evidence on the socio-demographic and spatio-temporal predictors of fatal strangulation. In contrast, firearm homicide, the leading external cause of death, has obtained dedicated scrutiny across a range of contexts (e.g., Hemenway, Shinoda-Tagawa, & Miller, 2002; United Nations Office on Drugs and Crime [UNODC], 2011).

Accordingly, this study aims to determine the effects that socio-demographic and spatio-temporal variables exert on the risk for death by strangulation relative to the other leading causes of homicide in the City of Johannesburg for the period 2001-2010. Specifically, the study seeks to identify the socio-demographic and spatio-temporal factors that differentiate homicidal strangulation from all firearm, sharp object and blunt object homicides in the City of Johannesburg for the indicated period.

SOCIO-DEMOGRAPHIC AND SPATIO-TEMPORAL VARIATION IN HOMICIDE RISK: THE EVIDENCE

Given the dearth of analytic studies on homicidal strangulation risk specifically, this section will focus on evidence related to homicide in the aggregate and, where available, on firearm homicide which has received the most attention in research on disaggregated homicide. One of the most stable explanations for the disproportionate distributions of fatal violence risk across time and place is demographic variation, as applicable to age, race and gender (e.g., Cohen & Land, 1987; Fox & Piquero, 2003; Ratele, Smith, Van Niekerk, & Seedat, 2011). While demographics are not the only, or strongest, predictor of homicide rates, they are widely accepted as a strong predictor of homicide rates. Spatio-temporal factors call into focus the relationships between homicide and characteristics of the physical and social environments in which homicide concentrations occur (Groff & La Vigne, 2002), as well as temporal variations associated with lethal violence, which are commonly associated with changes in human activity patterns (e.g., Ceccato, 2005).

SOCIO-DEMOGRAPHIC RISKS

The age-homicide link appears to hold across studies, demonstrating a robust association. Research undertaken in the Global North indicates the young, and male, population to be at highest risk for lethal violence (e.g., Schwartz, 2010; Trussler, 2012). Vulnerability is elevated in the 15-29 year age group, followed by the 30-44 age category, and declines steeply with age thereafter; again, this is for males and considerably pronounced relative to the estimated risk for females in the same age groups (UNODC, 2011). When disaggregated, the established predictive patterns are strongly analogous to those for firearm homicide (e.g., Miller, Hemenway, & Azrael, 2007; Wells & Chermak, 2011). In South Africa, the highest homicide rates have been reported among males aged 15-29 years (Norman et al., 2010; Kramer & Ratele, 2012; Seedat, Van Niekerk, Jewkes, Suffla, & Ratele, 2009). The vulnerability of younger men to homicide has been ascribed to their participation in violence related activities, such as gang membership, substance abuse and possession of weapons, typically influenced by dominant performances of masculinities.

The racial homicide gap in risk is reportedly enduring and pervasive. Across contexts, black adults are at increased risk of homicide victimisation compared to other race groups; this risk is higher in urban settings and among young men than in other contexts or among other age-gender groups (e.g., Kramer & Ratele, 2012; O'Flaherty & Sethi, 2010). For example, African-American males are estimated to be approximately six times more at risk of being murdered than white American males (O'Flaherty & Sethi, 2010). In South Africa, black males between the ages 20 and 40 are seventeen times more likely to be murdered compared

to white males in the same age group (Ratele et al., 2011). In extremely unequal societies, such as South Africa, human development opportunities for the population are vastly asymmetrical so that in the absence of employment and other optimal possibilities for young black males, violence comes to represent an alternative mechanism in some men's attempts to assert their masculinity (see Ratele et al., 2011).

Gender remains a significant and stable predictor of homicide victimisation risk. Males are at a higher risk of being murdered compared to females, at a global rate of 11.9 per 100 000 compared to 2.6 per 100 000 for females (UNODC, 2011). Males are far more likely to be murdered by strangers or acquaintances whereas women bear the greater risk of intimate partner homicide (e.g., Cao, Hou, & Huang, 2008; Swart, Seedat, & Nel, 2015). Across country contexts, the female homicide rate appears to be driven by intimate partner homicide. At a rate of 5.6 per 100 000, intimate femicide represents the leading cause of female homicide in South Africa (Abrahams, Mathews, Jewkes, Martin, & Lombard, 2012).

SITUATIONAL RISKS

Situational homicide patterns are also considered as essential to deciphering homicide risk. From a micro-spatial perspective, the crime location is considered to be an important variable both in overall homicide, as well as disaggregated homicide (UNODC, 2011). Research on the geographic distribution of homicide events reports that, in the aggregate, lethal violence is more likely to occur in public places through which people navigate in the course of their daily routines (e.g., Pizarro, 2008). In general, this same pattern is iterated for males, but is the converse for females who are reportedly more likely to be murdered in private places (e.g., UNODC, 2011). There is thus a discernibly gendered orientation to the relationship between sex and scene of homicide. Research also suggests that homicide in private spaces is more likely to involve a known perpetrator, unlike the pattern observed in fatalities in public spaces such as the street (e.g., UNODC, 2011). Cao and colleagues (2008) found that public locations reduced the probability of murder by a known person, but increased the risk of being murdered by a stranger.

Research on temporal patterns indicates that homicide events occur with higher frequency during the evening, weekends and the warmer months of the year (e.g., Pizarro, 2008; Sisti, Rocchi, Macciò, & Preti, 2012). These times are associated with recreational activities, the use of alcohol and other substances, and increased social interaction, which tend to interact to increase homicidal risk. The temporal patterns for South Africa, at least as they relate to urban homicide, are similar (e.g., Ratele, Swart, & Seedat, 2009). When disaggregated, the temporal patterns for homicide show a degree of variation across age groups, locations and type of lethal violence (e.g., Carbone-Lopez & Lauritsen, 2013). These differences are attributed to the distinct routine activities of different groups of individuals across time and space. For example, during the warmer months of the year, people tend to spend more time and longer hours outdoors, increasing the number of available victims in public places. Seasonal patterns have also been associated with weather patterns, but studies show mixed results on the correlation between weather conditions and lethal violence (Murataya & Gutiérrez, 2013).

Explanations for the identified socio-demographic and spatio-temporal risks of homicide victimisation frequently draw from routine activities theory. Routine activities theory, posited as one of the most systematically formulated models of ecological variation in individual-level victimisation risk, argues that homicide is a function of opportunities for victimisation. Cohen and Felson (1979) explain that for a crime to occur there must be convergence in time and space of a motivated offender, suitable target, and lack of a capable guardian. These features are used as proxies and broad indicators of interaction between social actors, living arrangements and normative lifestyle regimes. Routine activities theory has been recognised for offering systematic explanations of criminality patterns that may otherwise have presented as contradictory and disjointed (Mustaine & Tewksbury, 2000).

METHOD

The study adopted a cross-sectional observational design, using data for the City of Johannesburg.

RESEARCH CONTEXT

The City of Johannesburg is the capital of the province of Gauteng, and one of eight metropolitan municipalities in South Africa. Violence is reported to be the leading cause of non-natural death in Gauteng, with an overall rate of 34.3 deaths per 100,000 population (MRC-UNISA Safety & Peace Promotion Research Unit, 2013). The greatest proportion of the South African urban population resides in the City of Johannesburg (Statistics South Africa, 2012). While regarded to be the economic hub of the country, the City of Johannesburg continues to be beset by problems related to urban poverty and under-development, Historical social, geographical and economic inequities, together with current social and economic challenges have manifested in high levels of crime and violence (City of Johannesburg, 2011).

DATA

All cases with valid data for the four leading mechanisms of homicide in the City of Johannesburg (firearm, sharp object, blunt object and strangulation homicides) for the decade spanning 2001-2010 were derived from the National Injury Mortality Surveillance System (NIMSS). The NIMSS is a mortuary surveillance system that collects and disseminates information on deaths due to non-natural causes. At the time of the study, the indicated time span was the only period for which a decade-long record of homicide cases was available. The dataset included the homicide mechanism; age, race and sex of each homicide victim; time, day and month of the victim's death; scene of homicidal injury; and blood alcohol concentration (BAC) level of the victim.

DEPENDENT VARIABLE

The dependent variable for the analyses was homicidal strangulation, measured on a dichotomous scale where the two categories of the dependent variable were considered in terms of the following discrete outcomes: 1) strangulation homicide and firearm homicide; 2) strangulation homicide and sharp object homicide; and 3) strangulation homicide and blunt object homicide. As indicated in Table 1, homicidal strangulation accounted for the smallest proportion of all deaths (2.2%, n = 218), consistent with its epidemiological profile as the rarest of homicidal events in urban South Africa (Suffla & Seedat, 2016). Of the remaining 97.8% (n = 9702), fatalities were caused predominantly by firearm discharge (60.5%, n = 6005), followed by sharp object injuries (25%, n = 2478) and blunt object injuries (12.3%, n = 1219). The strangulation dataset excluded 116 cases with missing data, representing 34.73% of the total number strangulation cases with valid data (n = 334). For the same reason, the combined dataset for the four leading causes of homicide represented 48.17% (n = 9920) of the total number of cases (n = 20 595).

Table 1. Descriptive characteristics of the leading causes of homicide in the City of Johannesburg, 2001-2010 (N = 9920)

	Frequency (N)	Valid Percent (%)
Strangulation	218	2.2
All Other Homicides	9702	97.8
Firearm	6005	60.5
Sharp Objects	2478	25.0
Blunt Objects	1219	12.3

INDEPENDENT VARIABLES

The predictors selected for analyses included two primary groups of categorical variables: socio-demographic correlates and spatio-temporal correlates. These independent variables are captured in the NIMSS and, as reported, also bear an empirical relationship with homicide risk. The socio-demographic category comprised three independent variables: 1) age group: 0-14, 15-29, 30-44, 45-59 and 60+ years of age, with the latter coded as the reference category; 2) race[2]: Indian, coloured, white and black, with the latter coded as the reference group; and 3) sex, with males coded as the reference category. Four spatio-temporal variables were included in the analyses: 1) time of day: day (05h00-18h59) and night (19h00-04h49), with night coded as the reference category; 2) day of the week: weekdays and weekend (commencing on Friday at 16h00), with the latter serving as the reference group; 3) month of fatal injury by seasonality, with spring coded as the reference category in this four-category variable; and 4) scene of death: private and public places, with the latter representing the reference group. Missing cases were excluded from the analyses[3].

Table 2 presents the frequency distribution of all the variables included in the analyses, aggregated for the four leading causes of homicide. The majority of victims were aged between 15 and 29 (41.6%, n = 4128) and 30 to 44 (40.7%, n = 4040). Blacks (87.4%, n = 8670) and males (86.5%, n = 8580) were markedly over-represented in the socio-demographic profile of victims. A slightly higher proportion of homicides were committed at night (55.2%, n = 5475). Weekend (50.5%, n = 5012) and weekday (49.5%, n = 4908) fatalities were almost equal. Fatalities were almost equally distributed across the season of the year. Private places were identified as the scene of injury for a marginally higher number of deaths (54.5%, n = 5411).

Table 2. Socio-demographic and spatio-temporal characteristics of homicide victims, City of Johannesburg, 2001-2010 (N = 9920)

	Frequency (N)	Valid Percent (%)
Socio-demographic Variables		
Age		
0-14	173	1.7
15-29	4128	41.6
30-44	4040	40.7
45-59	1198	12.1
60+	381	3.8
Race		
Indian	188	1.9
Coloured	365	3.7
White	697	7.0
Black	8670	87.4
Sex		
Female	1340	13.5
Male	8580	86.5

[2] The authors subscribe to the view that race is not biologically determined, but is socially and politically constructed through social institutions and practices. In South Africa, the terms Indian, black, coloured (referring to mixed heritage) and white refer to various population groups, and are an artefact of the apartheid era. Their use is contentious and does not imply acceptance of the racist assumptions on which these labels are founded. The terms are used to reflect the differential manner in which the earlier South African policies of racial segregation, or apartheid, had impacted on the lives of various groups of South Africans, and still do.

[3] BAC was eliminated from the analyses due to the small number of cases for which this data was available (40.9%).

Spatio-temporal Variables		
Time of Day		
Day	4445	44.8
Night	5475	55.2
Day of Week		
Weekday	4908	49.5
Weekend	5012	50.5
Season of Year		
Summer	2402	24.2
Autumn	2326	23.4
Winter	2624	26.5
Spring	2568	25.9
Scene of Injury		
Private	5411	54.5
Public	4509	45.5

LOGISTIC REGRESSION ANALYSES

A series of logistic regressions were performed to assess the independent associations between each of the socio-demographic and spatio-temporal predictor variables and the risk for strangulation, relative to other homicide mechanisms (see King & Zeng, 2001 for discussion on logistic regression in rare events data). The logistic models thus allow for descriptions of the variables that distinguish homicidal strangulation from the other leading causes of homicide in the City of Johannesburg. Preliminary analyses were undertaken to ensure that the assumptions of logistic regression were not violated. The analyses focused on a series of comparisons between two discrete outcome categories, strangulation relative to 1) firearm homicide, 2) sharp object homicide and 3) blunt object homicide respectively, with each of the indicated three homicide types serving as the reference category. Two logistic regression analyses were conducted for each of the comparisons, each one examining a different model. The first model examined socio-demographic factors only, and the second model added spatio-temporal variables to the analyses. Model coefficients, exponentiated so that they could be interpreted as adjusted odds ratios (ORs), and 95% confidence intervals (CIs) were used to assess the magnitude and significance of adjusted multivariate associations. A p-value of below 0.05 was considered significant. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS Version 22).

RESULTS

Six logistic regression models were estimated to predict homicidal strangulation in the City of Johannesburg for the period 2001-2010, using socio-demographic and spatio-temporal variables as predictors. The results are discussed in relation to the model that examined only the socio-demographic variables associated with homicide mechanism (Model 1), and the model that assessed both socio-demographic and spatio-temporal factors (Model 2).

MODEL 1: ANALYSIS OF SOCIO-DEMOGRAPHIC VARIABLES

Results from the series of regression models that examined strangulation homicide, where the reference category was firearm, sharp object and blunt object homicide respectively, indicated that the overall models were statistically significant at the $p < 0.05$ level (chi square = 631.354, $p = .000$ with df = 24).

Overall, the socio-demographic variables were strongly associated with homicidal strangulation. The effects for age indicated the risk for strangulation to be elevated among the elderly (60+ years), with the likelihood of being strangled highest in this age category in relation to each of the other causes of homicide (see Tables 3, 4 and 5). Also, of statistical significance, when compared to the elderly, children (0-14 years) were more than two times likely to die from strangulation relative to sharp object homicide (OR = 2.164, $p < 0.05$). It is worth noting that although overall age was significantly associated with homicidal strangulation, the decomposed results indicated that there was no significant effect for the 0-14 year age group when compared to the 60+ year age group relative to firearm and blunt object homicide, and the 15-29 year age group in relation to blunt object homicide.

The odds of strangulation for Indians, coloureds and whites, when compared to blacks, varied in relation to firearm, sharp object and blunt object homicide. Indians were approximately five times (OR = 5.278. $p < 0.05$) and three times (OR = 3.199, $p < 0.05$) more likely to be strangled relative to sharp and blunt object homicide respectively. The risk of strangulation for coloureds, in comparison to blacks, was about two-and-a-half times more relative to firearm homicide (OR = 2.548, $p < 0.05$) and blunt object homicide (OR = 2.382, $p < 0.05$). Whites were about three times more at risk for fatal strangulation (OR = 3.192, $p < 0.05$) as opposed to blunt object homicide, and two-and-a-half times more at risk (OR = 2.613, $p < 0.05$) in relation to sharp object homicide. The decomposed results indicated that compared to blacks, there was no significant difference in the odds of Indians and whites being strangled as opposed to being victims of firearm homicide, and being coloured was not a significant predictor of fatal strangulation relative to sharp object homicide. That is, Indians and whites were not significantly more at risk than blacks for strangulation compared to firearm homicides, and coloureds were not significantly more vulnerable to strangulation than blacks when compared to the risk of death from sharp object injury.

The risk of strangulation homicide increased significantly when the homicide victim was female as opposed to being male, in relation to firearm, sharp object and blunt object homicide. At almost a ten-fold likelihood (OR = 9.501, $p < 0.05$), the risk of female homicidal strangulation was most pronounced relative to firearm homicide, and least indicated in relation to blunt object homicide (OR = 6.669, $p < 0.05$).

MODEL 2: ANALYSIS OF SPATIO-TEMPORAL VARIABLES

The full models for firearm, sharp object and blunt object homicide tested as statistically significant (chi square = 983.963, p = .000 with df = 42). Model 2 fit the data better for each of the regressions. Scene of death was not a significant predictor of strangulation. All the other independent variables were significant in determining risk for homicidal strangulation at the $p < 0.05$ level.

The effects of age and race assumed a similar association with the dependent variable as observed in Model 1 (see Tables 3, 4 and 5). Specifically, the risk of strangulation homicide was significantly higher for females than males across all three comparison homicide categories. The decomposed results indicated the risk for strangulation to be significantly higher during the day than at night relative to firearm homicide, at almost three times the likelihood (OR = 2.657, $p < 0.05$), and in relation to sharp object homicide, at two-and-a-half times the likelihood (OR = 2.280, $p < 0.05$), but not significant for blunt object homicide. Although overall day of death was significantly associated with homicidal strangulation, the decomposed effects indicated that weekdays, compared to weekends, was a significant predictor of strangulation in relation to sharp object (OR = 2.121, $p < 0.05$) and blunt object homicide (OR = 1.382, $p < 0.05$), but not statistically significant in relation to firearm homicide. When compared to spring, the risk of strangulation during the other seasons was almost double when examined in relation to firearm, sharp object and blunt object homicide respectively.

Table 3. Logistic regression analysis for strangulation homicide versus firearm homicide, City of Johannesburg, 2001-2010

	Model 1			Model 2		
	Exp(B)	95% CI for Exp(B)		Exp(B)	95% CI for Exp(B)	
Independent Variable		LL	UL		UL	LL
Socio-demographic Variables						
Age						
0-14 yrs.	1.775	.937	3.365	1.869	.977	3.572
15-29 yrs.	.177*	.106	.296	.202*	.120	.340
30-44 yrs.	.153*	.092	.254	.171*	.102	.286
45-59 yrs.	.176*	.099	.314	.190*	.106	.340
60+ yrs.	.	.	.	.	.	.
Race						
Indian	2.095	.989	4.438	1.999	.950	4.205
Coloured	2.548*	1.429	4.544	2.563*	1.430	4.594
White	1.289	.823	2.018	1.227	.781	1.929
Black	.	.	.	.	.	.
Sex						
Female	9.501*	7.099	12.716	8.704	6.447	11.752
Male	.	.	.	.	.	.
Spatio-temporal Variables						
Time of Day						
Day	…	…		2.657*	1.935	3.650
Night	…	…		.	.	.
Day of Week						
Weekday	…	…		1.128	.832	1.529
Weekend	…	…		.	.	.
Season of Year						
Summer	…	…		2.249*	1.433	3.528
Autumn	…	…		2.144*	1.368	3.359
Winter	…	…		1.697*	1.079	2.669
Spring	…	…		.	.	.
Scene of Injury						
Private	…	…		1.081	.794	1.472
Public	…	…		.	.	.
Likelihood Ratio Tests:	Model Chi-Square = 631.354 p = .000			Model Chi-Square = 983.963 p = .000		
Pseudo R-Square:	Nagelkerke = 0.071			Nagelkerke = 0.109		
N = 9920						

Note. *p < .05; Exp(B) = odds ratio; CI = confidence interval; LL = lower limit; UL = upper limit.
The reference category for the dependent variable is Firearm Homicide.

Table 4. Logistic regression analysis for strangulation homicide versus sharp object homicide, City of Johannesburg, 2001-2010

	Model 1			Model 2		
	Exp(B)	95% CI for Exp(B)		Exp(B)	95% CI for Exp(B)	
Independent Variable		LL	UL		UL	LL
Socio-demographic Variables						
Age						
0-14 yrs.	2.164*	1.057	4.432	2.305*	1.114	4.768
15-29 yrs.	.215*	.124	.372	.267*	.153	.465
30-44 yrs.	.198*	.115	.342	.235*	.135	.407
45-59 yrs.	.237*	.128	.439	.266*	.143	.494
60+ yrs.	.	.	.	.	.	.
Race						
Indian	5.278*	2.289	12.174	4.729*	2.060	10.856
Coloured	1.619	.901	2.910	1.683	.932	3.041
White	2.613*	1.617	4.223	2.425*	1.494	3.937
Black	.	.	.	.	.	.
Sex						
Female	7.720*	5.698	10.460	6.972*	5.099	9.535
Male	.	.	.	.	.	.
Spatio-temporal Variables						
Time of Day						
Day	…	…		2.280*	1.650	3.151
Night	…	…		.	.	.
Day of Week						
Weekday	…	…		2.121*	1.555	2.893
Weekend	…	…		.	.	.
Season of Year						
Summer	…	…		1.976*	1.250	3.122
Autumn	…	…		2.271*	1.437	3.588
Winter	…	…		2.093*	1.320	3.320
Spring	…	…		.	.	.
Scene of Injury						
Private	…	…		.985	.719	1.349
Public	…	…		.	.	.
Likelihood Ratio Tests:	Model Chi-Square = 631.354 p = .000			Model Chi-Square = 983.963 p = .000		
Pseudo R-Square:	Nagelkerke = 0.071			Nagelkerke = 0.109		
N = 9920						

Note. *p < .05; Exp(B) = odds ratio; CI = confidence interval; LL = lower limit; UL = upper limit.
The reference category for the dependent variable is Sharp Object Homicide.

Table 5. Logistic regression analysis for strangulation homicide versus blunt object homicide, City of Johannesburg, 2001-2010

	Model 1			Model 2		
	Exp(B)	95% CI for Exp(B)		Exp(B)	95% CI for Exp(B)	
Independent Variable		LL	UL		UL	LL
Socio-demographic Variables						
Age						
0-14 yrs.	1.706	.864	3.368	1.807	.911	3.588
15-29 yrs.	.724	.418	1.253	.779	.448	1.356
30-44 yrs.	.464*	.270	.800	.498*	.288	.862
45-59 yrs.	.379*	.205	.701	.398*	.215	.738
60+ yrs.	.	.	.	.	.	.
Race						
Indian	3.199*	1.381	7.410	3.224*	1.399	7.433
Coloured	2.382*	1.267	4.479	2.441*	1.295	4.601
White	3.192*	1.928	5.286	3.180*	1.916	5.276
Black	.	.	.	.	.	.
Sex						
Female	6.669*	4.849	9.173	6.307*	4.550	8.744
Male	.	.	.	.	.	.
Spatio-temporal Variables						
Time of Day						
Day	…	…		1.329	.953	1.854
Night	…	…		.	.	.
Day of Week						
Weekday	…	…		1.382*	1.005	1.902
Weekend	…	…		.	.	.
Season of Year						
Summer	…	…		2.033*	1.272	3.247
Autumn	…	…		2.245*	1.405	3.588
Winter	…	…		1.770*	1.105	2.834
Spring	…	…		.	.	.
Scene of Injury						
Private	…	…		1.115	.807	1.539
Public	…	…		.	.	.
Likelihood Ratio Tests:	Model Chi-Square = 631.354 p = .000			Model Chi-Square = 983.963 p = .000		
Pseudo R-Square:	Nagelkerke = 0.071			Nagelkerke = 0.109		
N = 9920						

Note. *p < .05; Exp(B) = odds ratio; CI = confidence interval; LL = lower limit; UL = upper limit.
The reference category for the dependent variable is Blunt Object Homicide.

DISCUSSION

This study investigated the socio-demographic and spatio-temporal factors predictive of homicidal strangulation in the City of Johannesburg. The logistic regression results indicate that both socio-demographic and spatio-temporal predictors distinguish lethal strangulation from other homicides in the City of Johannesburg, thereby supporting the argument that different forms of homicide have different risk patterns.

Sex was found to be the most influential predictor of homicidal strangulation in the City of Johannesburg, with a staggering sixfold to nearly tenfold likelihood of more female than male deaths from strangulation relative to each of the other leading causes of homicide in South Africa. The finding that females are disproportionately at risk for fatal strangulation compared to males in the City of Johannesburg confirms the risk profile implied in existing South African and other descriptive research on homicidal strangulation (Rodge, Hougen, & Poulsen, 2001; Suffla & Seedat, 2016), but diverges from epidemiological observations that describe a marked male preponderance in strangulation fatality (e.g., Maxeiner & Bockholdt, 2003; Verma & Lal, 2006). When compared to homicide in the aggregate, these findings present in stark contrast to the dominant risk pattern established in national and international homicide research, which indicates the concentration of risk to be among males (e.g., Seedat et al., 2009; UNODC, 2011).

A possible explanation for the particularly gendered nature of the sex risk profile is that strangulation perpetration, usually by men, targets individuals who are perceived to be physically vulnerable. However, females are also likely to be perceived as a suitable target for reasons that relate to the articulation of gender roles and power relations in society. The perpetration of violence, in particular by males against females, is frequently the result of gendered power inequities that function to exploit distinctions between males and females, be they physical, psychological, sexual, economic or social (e.g., Seedat et al., 2009). In contrast, men's violence against other males is theorised to be largely a function of antagonistic acts of hegemonic masculinity against subordinate forms of masculinity (Ratele, 2010).

It is not inconceivable that the movement of females into the public domain due to urbanisation, labour force participation, and increased mobility and freedom of movement also increases their risk of victimisation. South Africa's urbanised economy has witnessed the most rapid growth in the City of Johannesburg. Within this context, there has been a notable increase in female mobility for livelihood purposes (Todes, Kok, Wentzel, Van Zyl, & Cross, 2010). Cohen and Felson (1979) conceptualise this as risk that is linked to opportunity structures for legitimate activities. However, the micro-geography of homicidal strangulation is not restricted to public spaces. An equally legitimate hypothesis is that a substantial proportion of homicidal risk is associated with intimates, where females represent the large majority of victims and violence is perpetrated within the home (UNODC, 2011). Here, the victims and offenders are in closer spatial proximity, with violence concentrated in a private place that is devoid of protection due to the lack of capable guardianship, and strangulation representing a proximal act of violence.

The dichotomising of space as public and private has not been without critique. This has stemmed largely from critical feminist scholarship on space and violence, which has argued that the public-private division over-simplifies and rigidifies representations of space (e.g., Pain, 2000; Rasool Bassadien & Hochfeld, 2005). Still, in homicide analyses as the kind undertaken in this study, understanding spatial variations in risk offers a valuable opportunity for developing context-specific interventions. The contributions of feminist work serve as a reminder that these need to be informed by a critical understanding of socio-spatial practices and arrangements as they relate to fatal interpersonal violence.

The result indicating elevated risk for strangulation homicide among the elderly lends empirical support to the descriptive results reported elsewhere in the literature (e.g., Suffla et al., 2008; Suffla & Seedat, 2016).

Here too, the age risk profile presents as especially distinct in comparison to the victimisation risk for overall, firearm, sharp object and blunt object homicide, which demonstrates vulnerability in the younger age groups. In the main, research findings report that the elderly experience low rates of victimisation and high levels of fear of violent crime in comparison to other age groups, and that elderly women experience the most fear about safety on the streets (Kennedy & Silverman, 1990; Policastro, 2013). This evidence highlights the self-protective propensity of the elderly to avoid high risk public spaces, especially at night. However, in the case of strangulation homicide in the City of Johannesburg, the risk representation that emerges is one that in fact highlights the risk attributes of a potentially protective factor, where older individuals are victimised in their homes either by those who occupy the same space or by strangers. Under these circumstances, compromised or absent guardianship and the potential privacy of the scene of victimisation, together with their physical vulnerability may contribute to the identification of the elderly as suitable targets. These results suggest that the theoretical concept of exposure is an important and complex one in homicide risk prediction.

Although the effects are not as consistent across the regression models as evident for the elderly group, children between the ages of 0-14 in the City of Johannesburg also face greater risk for homicidal strangulation. The young are suitable targets since they are physically vulnerable and unable to thwart attack. Children, especially in the younger age groups, spend more time in their homes and interact primarily with immediate family members. They are therefore likely to be protected from strangers and criminality, but the same does not apply in the case of threat from family members. In this situation, there is convergence of a perpetrator with motive, a vulnerable victim, and absent or weak guardianship. A recent study on child homicide patterns in South Africa indicated that overall, among children under the age of 18 years, most victims were killed by someone known but unrelated to them, followed by mothers, who perpetrated almost half of all the girl homicides (Mathews, Abrahams, Jewkes, Martin, & Lombard, 2012). Almost a quarter of the girl victims in this study were strangled (Mathews et al., 2012). The results of the current study, albeit drawn from homicide cases in the City of Johannesburg specifically, therefore echo the growing concern in South Africa about children's vulnerability to homicide.

In relation to blacks, the risk for strangulation death in the City of Johannesburg is shown to be higher in all the other race groups if considered across all the predictive models. In this instance, the research results are more meaningfully understood in inversion that: blacks in the City are less likely to be strangled to death than explained by particular fatal strangulation risk attributes borne by Indians, coloureds and whites. Nonetheless, further scrutiny is clearly warranted for a more distilled understanding of the race risk profile for strangulation homicide in the City of Johannesburg. As it presents, though, this result controverts previous claims that race is a more powerful risk factor than gender; in strangulation homicide in this metropolis, the pattern is evidently converse.

Temporality effects indicated daytime and weekdays to represent the periods of higher risk for fatal strangulation. The results of the current study contradict previous South African and international research that reports overall risk to be concentrated at night and during weekends (e.g., Pizarro, 2008; Ratele et al., 2009), accentuating the distinctive temporal risks for strangulation homicide in the City of Johannesburg. These results also appear to diverge from the traditional emphasis on night and weekend as indicators of peak risk that is driven by the combination of recreational pursuits, the use of substances, and increased social interaction. It is hypothesised that places characterised by low time and day occupancy rates, and therefore limited capable guardianship, are the most likely to be considered as targets by motivated offenders. These are the periods when individuals are home-bound during the day, and when most others are at work or at school, thereby possibly increasing vulnerability to strangulation attack in the City. While seasonality was a statistically significant predictor in the current study, the variation in effects between seasons and across the models did not exhibit a remarkable pattern other than that the risk of strangulation is higher for all the seasons examined in relation to the reference category, that is, spring. Seasonal patterns

in violence have been reported to account for a relatively small fraction of the variance in crime rates and risk (Carbone-Lopez & Lauritsen, 2013), if any at all (Björkstén, Kripke, & Bjerregaard, 2009).

The non-significant effects for scene of death were entirely unexpected given the results reported in other studies, which suggest the association of homicidal strangulation risk with private places (e.g., UNODC, 2011). The altogether non-significant effect of scene of death as an explanatory variable warrants cautious interpretation. This variable was signified by a large number of missing values and a high proportion of cases where scene of death was classified as unknown, resulting in 37.3% of missing cases. It is arguable that had the data been more robust, the effect of scene of strangulation death in the multivariate analysis would have emerged as significant. Accordingly, crime location cannot be discounted as a predictor of fatal strangulation in the City of Johannesburg until further empirical analysis is undertaken.

Several methodological limitations of the current study need to be considered. Firstly, missing data represented a challenge; a large number of missing values resulted in the exclusion of a considerable number of cases in the analysis. This was most pronounced for BAC (65%), which was not included in the analyses, and scene of death (37.3%). Furthermore, the study drew on a single sample for all the models to minimise uncertainty about whether the observed predictive effects were a function of changes in sample characteristics or a valid representation of lethal strangulation risk. A limitation hereof is the diminished sample size. Although this analysis drew from the NIMSS, currently the most reliable and comprehensive source of homicide data for the City of Johannesburg, it does not include perpetrator data, which is likely to offer important information on such factors as the victim-offender relationship and offence motivation. Furthermore, the results cannot be generalised beyond the City of Johannesburg to a larger population of citizens. The data were cross-sectional and therefore examining the stability of the predictor variables over time was not possible. Finally, the current analyses only included individual-level measures, and therefore did not account for the interaction of demographic and situational risk factors with socio-structural ones. Despite these important caveats, the current study offers valuable information on the demographic and situational risk of homicidal strangulation in urban South Africa.

CONCLUSION

The current study offers an initial assessment of the socio-demographic and spatio-temporal predictors of homicidal strangulation in an urban South African context. The analysis reveals that there are several unique socio-demographic and spatio-temporal factors that differentiate fatal strangulation risk from the risk for other causes of homicide in the City of Johannesburg. The predictive effects exerted by these factors are particularly stable for sex, age, and time and day of fatal strangulation.

It is important to emphasise that although multivariate analysis implies causation, it is employed in this study primarily for the purposes of establishing probabilities, thereby offering initial evidence of fatal strangulation risk in the City of Johannesburg. The study also supports the contention that homicide is not a homogeneous crime but exhibits differentiated socio-demographic and situational risk profiles for the different causes of homicide, which are important to recognise and delineate for the purposes of homicidal strangulation prevention.

Thus, the current study reinforces the imperative to study homicidal criminality within a disaggregated analytic frame, and thereby to extend knowledge on fatal strangulation, which in its current form derives almost exclusively from descriptive research. The study also suggests that prevention programmes that are gender-and age-sensitive are essential for decreasing strangulation risk and homicide in the City of Johannesburg.

Screening for the physical and psychological manifestations of strangulation within health, social and legal contexts represents an important strategy for the recognition, management and prevention of fatal

strangulation risk in females. In this respect, the study highlights the need for relevant professionals to adequately identify fatal strangulation risk so that they can intervene appropriately in situations that reveal evidence of non-fatal strangulation.

ACKNOWLEDGMENTS

The authors acknowledge the National Injury Mortality Surveillance System project team and the participating forensic pathology facilities for their joint efforts in the registration and management of the data from which this study draws.

FUNDING

The National Injury Mortality Surveillance System, from which this research draws, is funded by the South African Medical Research Council and the University of South Africa.

REFERENCES

Abrahams, N., Mathews, S., Jewkes, R., Martin, L.J., & Lombard, C. (2012). *Every eight hours: Intimate femicide in South Africa 10 years later!* Tygerberg, South Africa: Medical Research Council.

Björkstén, K.S., Kripke, D.F., & Bjerregaard, P. (2009). Accentuation of suicides but not homicides with rising latitudes of Greenland in the sunny months. *BMC Psychiatry, 9*(20), doi:10.1186/1471-244X-9-20

Cao, L., Hou, C., & Huang, B. (2008). Correlates of the victim-offender relationship in homicide. *International Journal of Offender Therapy and Comparative Criminology, 52*(6), 658-672.

Carbone-Lopez, K., & Lauritsen, J. (2013). Seasonal variation in violent victimization: Opportunity and the annual rhythm of the school calendar. *Journal of Quantitative Criminology, 29*, 399-422.

Ceccato, V. (2005). Homicide in Sao Paulo, Brazil: Assessing spatial-temporal and weather variations. *Environmental Psychology*, *25*, 307-321.

City of Johannesburg. (2011). *Joburg 2040: Growth and development strategy*. Johannesburg, South Africa: City of Johannesburg.

Cohen, L.E., & Felson, M. (1979). Social change and crime rate trends: A routine activity approach. *American Sociological Review*, *44*(4), 588-608.

Cohen, L., & Land, K. (1987). Age structure and crime: Symmetry versus asymmetry and the projection of crime rates through the 1990s. *American Sociological Review*, *52*, 180-183.

Demirci, S., Dogan, K.H., Erkol, Z., & Gunaydin, G. (2009). Ligature strangulation deaths in the province of Konya (Turkey). *Journal of Forensic and Legal Medicine, 16*, 248-252.

Fox, J., & Piquero. A. (2003). Deadly demographics: Population characteristics and forecasting homicide trends. *Crime and Delinquency*, *49*(3), 339-359.

Groff, E.R., & La Vigne, N.G. (2002). Forecasting the future of predictive crime mapping. In N. Tilley (Ed.), *Analysis for crime prevention, Crime Prevention Studies, Volume 13* (pp. 29-57). Monsey, NY, USA: Criminal Justice Press.

Hawley, D.A., McClane, G.E., & Strack, G.B. (2001). A review of 300 attempted strangulation cases. Part II: Injuries in fatal cases. *The Journal of Emergency Medicine*, *21*(3), 317-322.

Hemenway, D., Shinoda-Tagawa, T., & Miller, M. (2002). Firearm availability and female homicide victimization. Rates among 25 populous high-income countries. *Journal of the American Medical Women's Association*, *57*(2), 100-104.

Kennedy, L.W., & Silverman, R.A. (1990). The elderly victim of homicide: An application of the routine activities approach. *The Sociological Quarterly*, *31*(2), 307-319.

King, G., & Zeng, L. (2001). Logistic regression in rare events data. *International Organization, 55*, 693-715.

Kramer, S., & Ratele, K. (2012). Young black men's risk to firearm homicide in night time Johannesburg, South Africa: A retrospective analysis based on the National Injury Mortality Surveillance System. African Safety Promotion: *A Journal of Injury and Violence Prevention*, *10*(1), 16-28.

Mathews, S, Abrahams, N., Jewkes, R., Martin, L.J., & Lombard, C. (2012, August). *Child homicide patterns in South Africa: Is there a link to child abuse?* Research Brief. Tygerberg, South Africa: Medical Research Council.

Maxeiner, H., & Bockholdt, B. (2003). Homicidal and suicidal ligature strangulation – a comparison of the post-mortem findings . *Forensic Science International*, *137*, 60-66.

Miller, M., Hemenway, D., & Azrael, D. (2007). State-level homicide victimization rates in the US in relation to survey measures of household firearm ownership, 2001-2003. *Social Science & Medicine*, *64*, 656-664.

MRC-UNISA Safety & Peace Promotion Research Unit. (2013). *A profile of fatal injuries in Gauteng, 2011*. Tygerberg, South Africa: MRC-UNISA Safety and Peace Promotion Research Unit.

Murataya, R., & Gutiérrez, D.R. (2013). Effects of weather on crime. *International Journal of Humanities, 3(*10), 71-75.

Mustaine, E.E., & Tewksbury, R. (2000). Comparing the lifestyles of victims, offenders, and victim-offenders: A routine activity theory assessment of similarities and differences for criminal incident participants. *Sociological Focus*, *33*(3), 339-362.

Norman, R., Schneider, M., Bradshaw, D., Jewkes, R., Abrahams, N., Matzopoulos, R., & Vos, T. (2010). Interpersonal violence: An important risk factor for disease and injury in South Africa .*Population Health Metrics*, *8*(32), http://www.pophealthmetrics.com/content/8/1/32

O'Flaherty, B., & Sethi, R. (2010). Homicide in black and white. *Journal of Urban Economics*, *68*(3), 215-230.

Pain, R. (2000). Place, social relations and the fear of crime: A review. *Progress in Human Geography*, *24*(3), 365-387.

Pizarro, J.M. (2008). Reassessing the situational covariates of homicides: Is there a need to disaggregate? *Homicide Studies*, *12*(4), 323-349.

Policastro, C.N. (2013). Victimization of the elderly: An application of lifestyles/routine activities theory. (Unpublished doctoral dissertation). Georgia State University, Atlanta, GA, USA.

Rasool Bassadien, S., & Hochfeld, T. (2005). Across the public/private boundary: Contextualising domestic violence in South Africa. *Agenda*, *66*, 4-15.

Ratele, K. (2010). Watch your man: Young black males at risk of homicidal violence. *South African Crime Quarterly*, *33*, 19-24.

Ratele, K., Smith, M., van Niekerk, A., & Seedat, M. (2011). Is it race, age or sex? Masculinity in male homicide victimisation in urban South Africa. In C. Gould (Ed.), *National and international perspectives on crime and policing* (pp. 44-58). Pretoria, South Africa: ISS.

Ratele, K., Swart, L., & Seedat, M. (2009). Night-time fatal violence in South Africa. In P. Hadfield (Ed.), *Nightlife and crime: Social order and governance in international perspective* (pp. 277-293). Oxford, UK: Oxford University Press.

Rodge, S., Hougen, H. P., & Poulsen, K. (2001). Asphyxial homicide in two Scandinavian capitals. *The American Journal of Forensic Medicine and Pathology 22*(2), 128-133.

Schwartz, J. (2010). Murder in a comparative context. In C.J. Ferguson (Ed.), *Violent crime: Clinical and social implications* (pp. 276-299). Los Angeles, CA, USA: Sage Publications.

Seedat, M., Van Niekerk, A., Jewkes, R., Suffla, S., & Ratele, K. (2009). Violence and injuries in South Africa: Prioritising an agenda for prevention. *Lancet*, *374*(9694), 1011-1022.

Sisti, D., Rocchi, M.B**.,** Macciò**,** A., & Preti, A. (2012). The epidemiology of homicide in Italy by season, day of the week and time of day. *Medical Science Law*, *52*(2), 100-106.

Statistics South Africa. (2012). *Census 2011 Statistical release – P0301.4*. Pretoria, South Africa: Statistics South Africa.

Suffla, S., & Seedat, M. (2016). The epidemiology of homicidal strangulation in the City of Johannesburg, South Africa. *Journal of Forensic and Legal Medicine*, *37*, 97-107.

Suffla, S., Van Niekerk, A., & Arendse, N. (2008). Female homicidal strangulation in urban South Africa. *BMC Public Health, 8*(363), doi:10.1186/1471-2458-8-363.

Swart, L., Seedat, M., & Nel, J. (2015). The situational context of adolescent homicide victimization in Johannesburg, South Africa. *Journal of Interpersonal Violence*, DOI: 10.1177/0886260515613342

Todes, A., Kok, P., Wentzel, M., Van Zyl, J., & Cross, C. (2010). Contemporary South African urbanisation dynamics. *Urban Dynamics*, *21*, 331-348.

Trussler, T. (2012). Demographics and homicide in Canada: A fixed-effects analysis of the role of young males on changing homicide rates. *Western Criminology Review*, *13*(1), 53-67.

United Nations Office on Drugs and Crime (UNODC). (2011). *2011 global study on homicide: Trends, contexts, data*. Vienna, Austria: UNODC.

Verma, S. K. (2007). Pediatric and adolescent strangulation deaths. *Journal of Forensic and Legal Medicine 14*, 61-64.

Verma, S. K., & Lal, S. (2006). Strangulation deaths during 1993-2002 in East Delhi (India). *Legal Medicine 8*, 1-4.

Wells, W., & Chermak, S. (2011). Individual-level risk factors for gun victimization in a sample of probationers. *Journal of Interpersonal Violence*, *26*(11), 2143-2164.