NEIGHBOURHOOD CORRELATES OF HOMICIDAL STRANGULATION IN THE CITY OF JOHANNESBURG, SOUTH AFRICA

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ABSTRACT

Drawing on the structural theories of strain and control, the current study examined the neighbourhood correlates of homicidal strangulation in the City of Johannesburg in South Africa for the period 2001-2010. A principal components analysis was conducted, and binomial regression models fitted to examine the relationships between neighbourhood characteristics and fatal strangulation. The results demonstrated partial support for the theories of strain and control and indicated that the effect of theoretically and empirically derived socio-structural factors on homicidal strangulation is variant for different socio-demographic groups, with significant effects most distinct for blacks. The study recognises strangulation as a unique phenomenon that is distinct from overall homicide.

Keywords: *homicide; socio-structural; determinants; strain; control.*

INTRODUCTION

Empirical research on the relationship between social structure and homicide has established the association of neighbourhood-level characteristics with the spatial patterning of homicide rates (McCall, Land & Parker, 2010; Pridemore, 2002). Although some variance exists across studies, factors such as economic disadvantage, racial and ethnic heterogeneity, mobility and community change, housing and population density, and family structure have emerged as leading explanations of neighbourhood-level homicide risk for both females and males (Frye, Galea, Tracy, Bucciarelli, Putnam & Wilt, 2008; Kubrin & Herting, 2003; Madkour, Martin, Halpern & Schoenbach, 2010; Sampson & Lauritsen, 1994).

While there are numerous descriptive analyses of homicide victimisation in post-apartheid South Africa (Abrahams, Martin, Mathews, Vetten & Lombard, 2009; Ratele, Smith, Van Niekerk & Seedat, 2011; Seedat, Van Niekerk, Jewkes, Suffla & Ratele, 2009; Suffla, Van Niekerk & Arendse, 2008), neighbourhood-level studies have trailed, in large part due to the unavailability of reliable unit-specific data and to methodological challenges related to incompatible spatial boundaries between homicide geodata and census geography (Breetzke, 2010a). Exceptions are studies by Breetzke (2010a) on the socio-structural determinants of contact crime in an urban South African context (also see Breetzke, 2010b); Swart, Seedat and Nel (2016) on the association between poverty and deprivation and levels of male and female adolescent homicide; and another by Swart, Kramer, Ratele and Seedat (in press) that indicated concentrated disadvantage to be significantly positively associated with male homicide in the City of Johannesburg, irrespective of race, and female-headed households significantly negatively associated with the homicide rate of white males and males of mixed heritage.

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An exhaustive search and review of the literature indicates an absence of published research on area disadvantage and homicidal strangulation (Brookman, Maguire & Maguire, 2017; Chabot & Ouimet, 2018; Suffla & Seedat, 2016). Analyses are either coarsely disaggregated in terms of mechanism of death and type of homicide, exemplified by the focus on female and intimate partner homicide for example, or not disaggregated at all. Studies on fatal strangulation have been limited to post-mortem examinations of victims and epidemiological descriptions (e.g. Demirci, Dogan, Erkol & Gunaydin, 2009; Maxeiner & Bockholdt, 2003; Verma, 2007). Yet, in many contexts, including South Africa, strangulation presents as a leading external cause of homicide, especially among females (Suffla et al, 2008), meriting closer investigation towards the development of population-based and local-level intervention measures.

The current study examined the socio-structural determinants of homicidal strangulation in the City of Johannesburg in South Africa. Although identified as the economic hub of the country, the city is faced with complex challenges related to urbanisation, poverty and inequality, and social exclusion, and mirrors South Africa's quadruple burden of disease since it relates to intentional and unintentional injury, human immunodeficiency virus infection and acquired immune deficiency syndrome (HIV/AIDS), infectious diseases and the growing incidence of lifestyle diseases (Mayosi, Lawn, Van Niekerk, Bradshaw, Abdool Karim & Coovadia, 2012).

THEORETICAL PERSPECTIVES AND EMPIRICAL EVIDENCE
The theoretical and empirical contributions on social structure and homicide draw principally from structural theories, which are differentiated by their accent on the constructs of strain and control (Land, McCall & Cohen, 1990; Pridemore, 2002; Sampson & Lauritsen, 1994). Strain theories posit that the strain of deprivation and structural inequalities may impel people to commit crime, whilst control theories contend that crime occurs when social bonds are weakened or are not well established. This study draws from the theories of economic deprivation (strain), and social disorganisation (control).

Economic deprivation
Economic deprivation is considered to be a key contributor to urban violence. Strain is operationalised as either absolute or relative deprivation, typically indexed on the basis of low levels of income, high levels of unemployment, low levels of educational attainment and the Gini coefficient. Although highly correlated (Pridemore, 2002), discrepant explanations account for the relative importance and relationship of each to homicide. Some researchers theorise that the social and psychological strain engendered by absolute deprivation results in higher homicide rates, where violence represents a means of coping with everyday hardships (Messner & Rosenfeld, 1994; Sampson, 1986; Shaw & McKay, 1942). In contrast, other scholars maintain that relative deprivation is the more important mechanism that leads to strain and higher homicide rates (McCall & Nieuwbeerta, 2007; Parker & McCall, 1999; Pridemore, 2002). This latter group of scholars explain that awareness of the inequitable distribution of resources and the consequent competition for limited material and social resources may be accompanied by a range of agitating psychological manifestations, including feelings of injustice, anger, anxiety, alienation and hopelessness, which in turn can lead to fatal violence of both an expressive and instrumental nature. These theoretical explanations suggest that rising poverty and income inequality will produce increasing rates of violent crime, including homicide. However, stark empirical disparities exist across the numerous studies that have tested the Theory of Economic Deprivation, attributed to methodological variations and errors, level of aggregation, use of unsuitable measures, nature of the data used, samples, time periods studied, model specifications, and also theoretical

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ambiguities and inadequacies (Land et al, 1990; Ousey, 2000; Pridemore, 2002). Correcting for the errors and inconsistencies observed in earlier studies, a well-cited study by Land et al (1990), found that of all the socio-structural covariates analysed, their resource deprivation/affluence index, comprising measures of both absolute and relative deprivation, had the strongest and most consistent effect on homicide victimisation across levels of aggregation and time periods. Others who have employed similar techniques have since indicated relatively even empirical support for the supposition that socio-structural indicators of economic deprivation predict rates of homicide (McCall & Nieuwbeerta, 2007; UNODC, 2011).

In contrast, the findings on inequality and the spatial variation of homicide rates are variable. In a landmark study on inequality and crime, Blau and Blau (1982) established that inequality based on race and ethnicity provides a more robust explanation of homicide rates than overall inequality of wealth. However, some North American investigations into the effect of economic inequality on racially disaggregated homicide rates indicate that inequality has little or no effect on black homicide rates but is positively associated with the homicide rates of whites (Haynie & Armstrong, 2006; Kposowa, Tsunokai & McElvain, 2006). This finding has been explained by the high level of resource deprivation in many African American neighbourhoods, which is considered to moderate inequality and its effect on homicide rates. There is consensus in the literature that high levels of economic inequality are exacerbated by racial residential segregation, which may elevate urban crime levels, particularly in black neighbourhoods (Haynie & Armstrong, 2006; Lee, 2000; Parker & McCall, 1999). This body of research highlights the concepts of social isolation and concentration effects in explanations about the relationship between the ecological separation of the races and rates of black homicide. According to Wilson (1987, 1996), race-based residential segregation has created socially isolated geographic clusters of poverty and discouraged contact between blacks and mainstream middle-class groups, thereby limiting the disadvantaged groups' access to opportunities and social networks, and therefore their economic, social and geographic mobility. These social and economic dislocations in urban black neighbourhoods result in a further clustering of characteristics of community disadvantage, including rampant poverty, unemployment and lack of educational success, resulting in what has been termed as concentration effects (Wilson, 1987), used to describe centres of extremely concentrated disadvantage. Under conditions of such structural restraint, violence assumes legitimacy in modes of interaction and as a source of status attainment. Concentration effects have resulted in the absolute and relative dimensions of deprivation becoming less distinct over time, resulting in methodological challenges in separating regression effects, and researchers combining the two in a single deprivation index (Land et al, 1990; Ousey, 2000).

Social disorganisation
Theories of social disorganisation explain that the disruption of social bonds and group solidarity through structural barriers diminishes the ability of communities to control its members, thereby predisposing them to commit crime (Land et al, 1990; Pridemore, 2002). This variant of social control theory has come to represent the theoretical foundation for contemporary studies on the ecology of violence. Wirth (1938) recorded that large population size, high density and greater heterogeneity of urban areas construct transitory and superficial interpersonal relationships, frequently lessening shared cultural understandings and other forms of social cohesion. Shaw and McKay (1942) augmented this argument by proposing two additional contextual indicators, economic hardship and population mobility, with the list of socio-structural variables considered to account for the variation in crime rates subsequently expanded to include such factors as family disruption (Sampson & Lauritsen, 1994).

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In what is considered to be a milestone in homicide research, Land et al (1990), established that findings across different time periods and geographical units tend to be fairly variable. They concluded that collinearity among the socio-structural covariates included in earlier analyses explained much of the observed inconsistency. They found that the most consistent socio-structural predictors of the North American homicide rate across time and levels of analysis were those related to population structure (size and density), resource deprivation/affluence (including measures of absolute and relative deprivation), and percentage divorced males (relating to family disruption). Twenty years later the explanatory power of these covariates was empirically assessed and supported in a study by McCall, Land and Parker (2010), and continue to be employed in homicide research across countries.

Population structure is viewed as potentially undermining social relationships and thereby weakening social integration and control in urban settings (McCall & Nieuwbeerta, 2007). This formulation theorises homicide to be a consequence of urban anonymity and the related lessening of guardianship behaviours. The spatial distribution of homicide is further influenced through the built environment of urban settings where multiple and closely erected dwellings may increase opportunities for crime and obstruct defense against victimisation. Several investigations have reported a significant association between population structure and homicide (Kubrin, 2003: Land et al, 1990; McCall et al, 2010; Pridemore & Trent, 2010).

Family disruption is one of the more invariant predictors of homicide rate. Family is formulated as an important mechanism of social control in its attempt to respond to urban disadvantage, with high levels of family disruption theorised to facilitate crime by decreasing community networks of informal social control (Tcherni, 2011). Land et al (1990), found that family disruption, indexed as the percent divorced, to be either significantly positive or null, a result that has generally endured across subsequent studies (Beaulieu & Messner, 2010; McCall & Nieuwbeerta, 2007). Another widely used indicator of family structure, the percent of households that are female headed, appears to be an equally robust correlate of homicide. In her study of homicide across 1 600 counties in the United States, Schwartz (2006) determined that family structure exerted the strongest effect on homicide compared to other ecological variables. Until more recently, much of this research did not account for the multiplicity in family structure in urban contexts, the social mechanisms evident in diverse family forms, and the link hereof to homicide. In a study that extends the analysis of the relationship between family and urban homicide beyond the conventional focus on family disruption, Parker and Johns (2002) established that diversity in family structure has a differential impact on race-specific homicide, and that non-traditional family forms are not necessarily positively associated with black homicide victimisation in urban areas.

Ethnic diversity and racial heterogeneity are regarded as a potential obstacle to local integration and the realisation of shared goals. Indexed as percentage black, the racial composition of a neighbourhood has been found to be a strong predictor of homicide rate in many North American studies (Ousey, 2000). This is frequently ascribed to the frustration and sense of alienation that is the result of discrimination, marginalisation and the resultant response to secure respect and honour. While some studies have observed that percentage black predicts crime even when other indicators of economic strain and social disorganisation are controlled (McCall & Nieuwbeerta, 2007), others have found a distinctly attenuated effect of race and ethnicity when other factors are controlled (Sampson & Lauritsen, 1994; Jones-Webb & Wall, 2008). These latter contributions have questioned the assumption that racial composition has unique explanatory power, suggesting that the relationship between percentages of different racial groups in an area

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and homicide rate may be due to a range of other correlating factors that overlap with race and ethnicity. Tcherni (2011) argues that blacks and whites occupy vastly different ecological contexts, with blacks typically residing in resource-deprived conditions and exposed to manifold disadvantages and adversities, while whites much less so.

Using measures of control (and also strain), studies on female homicide victimisation have supported both the backlash hypothesis, which contends that gender equality is positively associated with men's fatal violence against women, as well as the ameliorative hypothesis that considers women's increased social status to insulate them from violence and therefore decrease risk of homicidal victimisation (Pizarro, DeJong & McGarrell, 2010; Titterington, 2006; Whaley & Messner, 2002). This body of research has not only underlined the masculinised sub-culture of violence, but also the need for gender stratification in the explanation of macro-level determinants of homicide.

High residential mobility is also theorised to have adverse consequences for social control and integration into local social networks (Shaw & McKay, 1942). A high rate of mobility is argued to disrupt the construction of social relationships and weaken community controls though producing anonymity and feelings of impermanence, as well as undermining institutional development. In the main, research has found a significant positive relationship between residential mobility and rates of violent victimisation, particularly in low-income neighbourhoods. Sampson and Lauritsen (1994) underline the finding that where mobility and neighbourhood change is related to violence, it is typically associated with neighbourhoods becoming increasingly impoverished. Contradicting the commonly held notion that immigration is criminogenic through its association with weakened social control, Lee, Martinez and Rosenfeld (2001) have speculated that community social control may in fact be strengthened where immigration acts as a stabilising and revitalising influence on economic, social and cultural institutions.

The Social Disorganisation Theory is an explanatory framework for the association between a neighbourhood's socio-structural characteristics and homicide rates and does not construct disadvantaged neighbourhoods as inherently disintegrated or predisposed to crime. The critical contribution of this classic theoretical perspective is the recognition that violence is driven by persisting socio-structural forces and that its prevention is therefore ultimately bound to processes of social transformation. This is an especially critical issue in the context of research on racial differences in crime rate, and of South Africa's socio-political history, which rendered black and poor individuals and communities as deficient.

The discriminatory legislation that governed apartheid continues to have an adverse spatial, economic and social impact on the structure of South African society. Post-apartheid South Africa represents a unique socio-political and socio-economic milieu within which to test the applicability of structural theories of violence. This study examined the neighbourhood correlates of homicidal strangulation in the City of Johannesburg for the period 2001-2010. Specifically, the following three study questions were examined:

1. *Which clusters of socio-structural area attributes are descriptive of the living situations of the residents of the City of Johannesburg?*

2. *Do these clusters of disadvantage impact on homicidal strangulation in the City of Johannesburg?*

3. *What is the differential influence of neighbourhood disadvantage on homicidal strangulation risk for females, males, adults and blacks?*

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METHOD
An ecological analysis of select area-level correlates of homicidal strangulation was applied to establish whether neighbourhood socio-structural characteristics were associated with homicidal strangulation. Ecological studies on homicide investigate risk factors based on populations that are defined by geography (Jones-Webb & Wall, 2008). The current study:

1) delineated the unit of analysis;

2) for the dependent variables, extracted data on strangulation fatalities from the National Injury Mortality Surveillance System (NIMSS);[1]

3) for the explanatory variables, derived area-level descriptions for the city from the 2001 South African National Census, which provided the most recent and comprehensive census data at the time that the analysis was undertaken;

4) conducted a principal components analysis to combine the explanatory variables that cluster into single factors; and

5) fitted binomial regression models to examine the relationships between neighbourhood characteristics and homicidal strangulation of females, males, adults and blacks.[2]

Unit of analysis
The 2001 South African Census data allow for the disaggregation of information by enumerator area, identified by province, local municipality, main place name and subplace name, with subplace representing the lowest geographical level (Statistics South Africa, 2003a). In this study, area-based comparisons were conducted at the subplace level. The unit of analysis was therefore residential areas in the city, distinguished by subplace names provided by census data. The 2001 Census demarcated 684 subplaces for the city, comprising of living precincts that primarily include suburbs, but also sections of a township, smallholding, village, sub-village, ward or informal settlement (Statistics South Africa, 2003b). Of these, 132 were smaller living zones located within larger residential areas. Since the available homicide data were specific to only larger geographical units, these 132 areas were merged to comprise a total of 40 residential areas. Eighty-four subplaces, including nature reserves, industrial parks, hospitals, universities and recreational areas, were excluded from the analyses since these registered a restricted number of permanent residents, as were areas with a population of less than 200. The final number of residential areas included in the analyses was 508.

Following precedence (see Sampson, Morenoff & Gannon-Rowley, 2002), in this study, the neighbourhood-level of aggregation was supported by the availability of data, the theoretical assumption that neighbourhoods tend to be more homogenous ecological units than larger aggregations, and the absence of research on neighbourhood correlates of homicidal strangulation.

Dependent variables
Four dependent variables were considered for this study, namely:

1) number of female homicidal strangulation victims;
2) number of male homicidal strangulation victims;
3) number of adult homicidal strangulation victims; and
4) number of black homicidal strangulation victims.

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The size of the dataset limited the analysis to the 15-59-year age category, specified here as the adult group following the World Health Organisation's (WHO) classification (WHO, 2008), and to black victims. These groups accounted for the higher proportion of cases, approximately 72 percent and 73 percent of all valid cases respectively. Previous research has found the association between age structure and homicide victimisation to differ with level of aggregation, while percentage black is often consistently positively correlated with homicide rates (McCall & Nieuwbeerta, 2007).

To ensure the stability and sufficiency of estimates, homicidal strangulations for each of the indicated variables were represented by the combined total of deaths across the study period. Following Osgood (2000), homicide counts were preferred to the use of homicide rates since a sizeable number of neighbourhoods registered no homicidal strangulations for the selected period. Low counts of crime are usual for offense-specific analyses and tend to be too small to generate rates that reflect appropriate distributions and the necessary accuracy (Osgood, 2000). The neighbourhoods specified as the suburb of strangulation injury in the dataset were matched to neighbourhoods indicated by subplace names in the Census.

Explanatory variables

Eleven explanatory variables that were considered to be descriptive of the social and economic living circumstances of the City of Johannesburg were extracted from the Census (Statistics South Africa, 2003a). Table 1 provides a description of the explanatory variables and their distribution parameters, calculated for each of the 508 suburbs. The variables were classified into five conceptual domains: 1) poverty and deprivation (indicated by low household income, unemployment and low educational attainment); 2) family disruption (indicated by female headed households and divorced status); 3) population density and housing (indicated by household density and proportions of informal dwellings); 4) residential mobility (indicated by population turnover and proportions of owned dwellings); and 5) demographic composition (indicated by percentage of black individuals and non-citizens in the population).

Table 1:   **Description of explanatory variables and their distribution parameters, calculated for each of the 508 suburbs of the City of Johannesburg**

Domain & Variable	Social Characteristic	Mean	Min	Max
Poverty and deprivation				
1. Low household income	Percentage of households earning less than R9 600 annually	22.21	0.00	88.00
2. Unemployment	Percentage of persons unemployed in 15 to 64-year age group	13.57	0.00	58.30
3. Low educational attainment	Percentage of persons with less than Grade 12 aged 25 years and older	49.13	11.50	94.12
Family disruption				
4. Female-headed household	Percentage of female-headed households	37.12	0.00	71.43
5. Divorced	Percentage of persons divorced aged 15 and older	5.14	0.00	14.96

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Population density and housing				
6. Household density	The number of residents per the number of household rooms (excluding kitchens and bathrooms)	.79	.32	3.81
7. Informal dwelling	Percentage of households living in informal dwellings	9.50	0.00	97.79
Residential mobility				
8. Population turnover	Percentage of persons ages five and over who have changed residences in the past five years	29.8	1.20	82.17
9. Owned dwellings	Percentage of owner-occupied dwellings	49.13	0.00	99.10
Demographic composition				
10. Black residents	Percentage of black residents	45.90	1.49	100.0
11. Non-citizenship	Percentage of non-South African citizens	4.66	0.00	31.13

Research on homicide has observed high multicollinearity among the socio-structural predictors of homicide rates (Land et al, 1990). Since multicollinearity results in unstable and unreliable regression coefficient estimates in response to minor changes in the model or the data, results about individual explanatory variables and their relative contribution to the regression model may be distorted. To address this, a principal components factor analysis was performed using orthogonal rotation (varimax with Kaiser normalisation) to combine the explanatory variables that cluster together into single factors. A principal components analysis is a statistical procedure to systematically reduce a set of possibly correlated variables into a smaller and conceptually more coherent set of uncorrelated variables and is commonly undertaken to simplify a dataset before a regression analysis is conducted (Dunteman, 1989). A three-factor model was derived that explained 73.7 percent of the cumulative variance (see Table 2). These three neighbourhood factors comprised the explanatory variables for the study. The dependent variables and the outcomes of the exploratory factor analysis were linked by neighbourhood.

Table 2: **Pattern matrix of 11 explanatory variables with factor loading values for each**

Variable	Varimax Rotated Factor Pattern		
	Factor 1 Socio-economic Disadvantage	**Factor 2 Residential Mobility**	**Factor 3 Female-headed Households**
Low household income	**.898**	-.237	.021
Low educational attainment	**.844**	-.314	-.103
Unemployment	**.840**	-.368	-.109
Household density	**.839**	-.121	-.132
Owned dwellings	**-.781**	-.259	-.024
Black residents	**.776**	-.122	-.296
Informal dwelling	**.753**	-.177	-.078
Population turnover	-.179	**.774**	-.050
Non-citizenship	-.090	**.834**	.038
Female-headed household	.013	-.086	**.916**
Divorced	-.527	.149	**.618**
Note: Values in bold represent the highest loading of each variable on one factor.			

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Factor 1 accounted for 50.6 percent of the variance between the three neighbourhood factors, and consisted of percent low household income, percent low educational attainment, percent unemployment, household density, percent owned dwellings and percent black residents. Since these measures are primarily indicators of poverty and economic deprivation, and therefore of high socio-economic burden, Factor 1 was characterised as *socio-economic disadvantage*. Prior research has demonstrated comparable factor loadings on indicators of economic strain, and of percent black in the population where blacks tend to be disproportionately concentrated in high-density poverty areas (Kubrin, 2003; Land et al, 1990; Sampson & Lauritsen, 1994), as is the case in South Africa. Race-class intersections in post-apartheid South Africa, which are a legacy of apartheid, demonstrate that poverty, wealth and inequality continue to be racialised (Whitehead, 2013). Unlike in some studies (e.g. Hannon, 2005; Wang & Arnold, 2008), percent female-headed households did not load on this factor but exhibited correspondence with those studies in which the measure was a representation of family structure and composition or family disruption (e.g. Parker & Johns, 2002; Swart et al, 2016). The second factor was identified as: *residential mobility*, and accounted for 12.9 percent of the variance. This factor included percent population turnover and percent non-South African citizens, thereby emphasising change to neighbourhood composition. Factor 3, labelled as: *female-headed households*, accounted for 10.2 percent of the variance, and loaded highly on percent female-headed households and percent divorce. This factor pertains to diversity in family structures and is reflective of the existence of multiple family forms in urban areas (see Parker & Johns, 2002). In contrast to its loading on Factor 1, the factor scoring for divorce on this component appears to suggest that diversification from traditional family forms does not necessarily reflect non-intact or disintegrated families in these areas.

Regression analysis
Poisson-based regression models, which relate explanatory variables to dependent variables that are counts of events, have been found to be better suited to the analysis of disaggregated homicide data, which typically yield low counts (Osgood, 2000). The statistical rationale for the use of the Poisson regression approach in studies of crime emerged from the attempt to address the problem of prediction errors and biased regression coefficients associated with crime rates based on small counts, and is now well established (Osgood, 2000). Negative binomial regression, the Poisson-based regression model that is considered most widely available for this purpose, was applied to account for the highly skewed and over-dispersed dependent variables, which represent count data, and which are prevalent in analyses of homicide data (see Osgood, 2000). Four negative binomial regression models were fitted to analyse the relationships between neighbourhood characteristics and homicidal strangulation of females, males, adults and blacks.

Given the use of homicide counts in the current analysis, variation in the size of the population at risk across neighbourhoods was controlled for by including the natural logarithm of the population at risk as an offset variable with a fixed coefficient of one to the regression models. This procedure standardises the regression model by transforming the counts of homicidal strangulation into values that are the equivalent of a homicide rate for each neighbourhood (Osgood, 2000). The final regression model for each of the four dependent variables consisted of the three neighbourhood factors and the natural logarithm of the population at risk (i.e. total female, male, 15-59-year old and black population) as an offset. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS Version 22).

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RESULTS

A total of 334 homicidal strangulations were registered for the City of Johannesburg for the period 2000-2010, of which 194 (58.1 percent) were female victims; 140 (41.9 percent) were males; 203 (60.1 percent) were adult victims (15-59 years); and 242 (72.5 percent) were black. Of these homicides, 39 (11.7 percent) were excluded from the analyses due to missing information on the suburb (place) of strangulation death. The regression models were therefore based on a total of 295 homicidal strangulation cases (see Table 3). The number of cases extracted from the NIMSS represents the majority, but not necessarily all the fatal strangulation events for the city for the indicated period. Due to under-reporting and misreporting, it is not possible to determine the exact percentage of these NIMSS-recorded cases relative to what may be the actual total number of strangulation fatalities for the decade under study. As in many other contexts, the systematic, accurate and comprehensive surveillance of fatal injuries is hindered by either non-existent or under-developed data collection systems (EuroSafe, 2010: np).

Table 3:   Homicidal strangulation per neighbourhood in the City of Johannesburg, 2001-2010 (N = 295)

	Total	Mean	Standard Deviation
All homicidal strangulations	295	.58	1.670
Homicidal strangulation of females	171	.34	.753
Homicidal strangulation of males	120	.24	1.049
Homicidal strangulation of adults	184	.36	1.224
Homicidal strangulation of blacks	211	.42	1.433
N of neighbourhoods: 508			

The standardised coefficients and the standard errors for the four negative binomial regression models are presented in Table 4. The results indicate that residential mobility was significantly related with the homicidal strangulation of both females ($\beta = .262$, $p < .01$) and males ($\beta = .421$, $p < .001$), with one unit change in residential mobility resulting in an increase of 30 percent in female deaths and 52 percent in male deaths (following the method used by Kubrin [2003], percentage change = 100 x [exp(.421) – 1]). The remaining two factors: socio-economic disadvantage and female-headed households, were not shown to be significant in predicting female and male homicidal strangulation. In contrast, female-headed households were significantly negatively related to adult strangulation homicides ($\beta = -.278$, $p < .05$), with a unit increase in this factor being associated with a decrease of 24 percent in these fatalities. Socio-economic disadvantage and residential mobility were not significant in explaining adult homicidal strangulations.

Two of the three neighbourhood factors were significantly related to the fatal strangulation of blacks; residential mobility was significantly positively associated with strangulation homicides ($\beta = .247$, $p < .05$), while socio-economic disadvantage was significantly negatively associated with these deaths ($\beta = -.345$, $p < .01$). One unit change in residential mobility in the neighbourhood leads to an increase of 28 percent in the strangulation deaths of black residents. In contrast, one unit change in socio-economic disadvantage within the neighbourhood results in a 29 percent decrease in these deaths. Female-headed households was not significantly associated with the strangulation homicide of blacks.

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Table 4:   Negative binomial regression results for neighbourhood characteristics on homicidal strangulation, City of Johannesburg, 2001-2010

Variable	Homicidal Strangulation of Females		Homicidal Strangulation of Males		Homicidal Strangulation of Adults (15-59 years)		Homicidal Strangulation of Blacks	
	β	SE	β	SE	β	SE	β	SE
Socio-economic Disadvantage	-.060	.1053	-.059	.1190	-.018	.1073	-.345**	.1049
Residential Mobility	.262**	.0992	.421***	.1067	.165	.0958	.247*	.0970
Female-headed Households	-.202	.1345	-.096	.1476	-.278*	.1334	-.080	.1375
Intercept (constant)	-8.965***	.1130	-9.265***	.1267	-9.345***	.1164	-8.737***	.1198
Likelihood Ratio Chi-Square	9.497*		16.157***		7.806*		16.385***	
*=p<0.05,**= p<0.01, ***p<0.001								

DISCUSSION

Results indicated that socio-economic disadvantage has a null effect with respect to the homicidal strangulation of females, males and adults, but is evidently predictive of lower strangulation rates among black residents of the city. In accordance with social disorganisation theory, residential mobility was highly correlated with the rate of homicidal strangulation, with the strongest effect noted for males. Diverging from the theoretically expected direction, female-headed households was found to have a protective effect against adult strangulation homicides. Collectively, the results suggest that the impact of theoretically and empirically derived socio-structural factors on homicidal strangulation in the City of Johannesburg is variant for different socio-demographic groups, with significant effects most distinct for blacks.

These results are counter to prevailing claims about the relationship between economic deprivation and urban homicide rates, especially when considered against the rapid rate of urbanisation in the city and the concomitant poverty and unemployment facing residents (De Wet, Patel, Korth & Forrester, 2008). The finding that socio-economic disadvantage is negatively correlated with strangulation rates among blacks is unexpected. On average, black South Africans reside in neighbourhoods characterised by high levels of poverty, unemployment, educational barriers, and dense and informal housing settlements, all of which are markedly in contrast to the economic organisation that typically shapes the living conditions of white South Africans and are generally associated with unequal victimisation on the basis of race (Shaw & Gastrow, 2001).

Some researchers argue that extreme structural disadvantage, in part explained by social isolation and concentration effects, may account for this non-linear decelerating relationship (Hannon, 2005; Kposowa et al, 2006). These researchers suggest that a high threshold of resource deprivation in such harsh living environments, rather than race itself, may produce sub-cultures

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that sanction and regulate violence, with these contributing to normative inversion and supplanting socio-structural factors as the primary correlates of violent crime. Although this theory cannot be corroborated here, it is plausible that as a proximal crime and sometimes a crime of passion, homicidal strangulation in some contexts is more significantly associated with normative inversion than it is with socio-structural factors.

An alternative explanation may be that in the impoverished neighbourhoods where most blacks reside, strangulation is less frequently employed as a method of murder relative to firearm discharge and sharp and blunt object injury. The epidemiological profile of homicide in the City of Johannesburg for the years 2001-2010 indicates that 59.4 percent of victims died from firearm discharge, 23.2 percent from sharp object injury and 15.9 percent from blunt object injury, with strangulation accounting for 1.6 percent of all deaths (Suffla & Seedat, 2016). Perhaps, then, this finding is more reflective of the chosen mode of killing than it is a veritable claim about the link between socio-economic disadvantage and the fatal strangulation of blacks.

Mobility was significantly positively associated with the rate of lethal strangulation for females, males and blacks. This is a commonly reported finding in the international homicide literature for all lethal violence and a result that is shared with a recent study on the predictors of male homicide in the City of Johannesburg (Swart et al, in press), as well as Breetzke's (2010a) macro-level analysis of contact crime in the City of Tshwane (Pretoria). Residential mobility exerted the strongest influence on male homicidal strangulation. This finding bears some resemblance to the study by Swart et al (in press), which found residential mobility to be positively associated with black males. Post-apartheid Johannesburg has come to be the main destination for migrants from other parts of the country and the African continent, with rapid immigration becoming a defining characteristic of the city (Peberdy, 2010). Notwithstanding the increasing feminisation of migration, most internal and cross-border migrants still tend to be black males. Out-migration, due to factors such as the insecurity of livelihoods, and poor basic amenities and social services in especially low-income neighbourhoods, is also not uncommon. According to social disorganisation theory, the potentially destabilising sequelae of such mobility include reduced social cohesion. It is conceivable that the accelerated rate of urbanisation and migration in the City of Johannesburg has weakened informal social controls over collective life in contexts of mobility and change, increasing risk of fatal strangulation for almost all the socio-demographic groups included in this study, but particularly for men. One possible explanation is that while economic imperatives drive residential mobility for both men and women, social ties significantly influence women's decisions about where and whether to move (Kihato, 2013). It may be speculated that, relative to men, this social aspect of mobility in women likely functions to attenuate women's risk of homicidal strangulation, thus signifying the gendered nature of mobility that appears to create increased risk for lethal homicidal strangulation in men.

The effect of female-headed households did not present in the theoretically expected direction and, contrary to the reported strong effect in prior research, was found to be significantly negatively associated with the rate of homicidal strangulation in adults in the City of Johannesburg. This result bears parallels with the South African studies by Swart et al (2016) and Swart et al (in press), which demonstrated a similar inverse correlation between level of female-headed households and rate of homicide. As with these two studies, and unlike those that show the measures of female-headed households and divorce to be highly correlated with economic disadvantage (Land et al, 1990; Strom & MacDonald, 2007; Wang & Arnold, 2008), in the current study female-headed households and marital dissolution did not correlate with measures of poverty

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and deprivation. While this may account for family structure not being predictive of fatal strangulation, it does not necessarily explain the negative effect detected here.

Previous explanations suggesting that the presence of higher concentrations of female-headed households in neighbourhoods may be associated with a less entrenched dominant masculinity ideology, which is frequently implicated in violence, may very well hold true (Swart, 2014). It may also be useful to consider that the protective influence of female-headed households is a distinctive feature of the South African context and particularly the nature of family structure in the country. Parker and Johns (2002) determined that non-traditional family forms are not necessarily positively associated with black homicide victimisation in urban areas in North America. In South Africa, non-traditional family types characterised by extended kinship ties that transcend time and space are common in the urban landscape. The emergence of female-headed households, at least in black communities, traces back to the pre-apartheid era, and was shaped by such factors as the rise of capitalism in South Africa, land dispossession, migratory labour, traditional social norms, and the agency of individuals to effect life choices related to family (Amoateng & Heaton, 2007; Van Driel, 2011). It is not inconceivable, then, that in many South African communities, the non-traditional family culture has over time developed forms of social control and indigenous mechanisms for accessing extra-familial sources of support that mitigate against the lack of social cohesion theorised by the social disorganisation perspective. Another explanation is that the negative association observed and the null effects for females, males and blacks is in fact reflective of the reduced risk of being strangled relative to death from firearm discharge, and sharp and blunt object injury in the city. It is, however, important to note that these results need to be interpreted with caution as the measure did not include households with children.

The findings ought to be considered in the context of several limitations. As is the case with all place-based research, generalisability of the findings to other urban areas in South Africa is limited. Since the results are based on 2001 census data and homicide data spanning the period 2001-2010, research based on more recent records may yield a different set of findings based on changes in population and fatality data, and neighbourhood characteristics and boundaries. It is not possible to know if the findings reported here are valid over time or whether they are reflective of the post-apartheid social structure in the period following South Africa's transition to democracy. However, previous area-level studies have shown that the overall pace of change in neighbourhoods is typically moderate (Frye et al, 2008; Jones-Webb & Wall, 2008). Although the study contributes to a growing body of work that disaggregates homicide events into meaningful units of analysis, doing so here resulted in analyses based on a relatively small number of strangulation deaths. Further, missing data represent a common shortcoming in homicide research. In this study, 11.7 percent of cases could not be included due to incomplete homicide geodata. A smaller number of cases may result in structural models being sensitive to slight changes in model specification (Pridemore, 2002). To address this concern, at least in part, the study applied techniques appropriate to the study of small or rare events. The small dataset on which the study is based did not allow for the control of spatial autocorrelation, which measures the degree to which spatial features and their associated data values tend to be either clustered or dispersed in space. This tests the degree to which levels of homicide in one neighbourhood are likely to influence the same in surrounding neighbourhoods. In the case of small datasets, including the additional parameters for spatial models tends to destabilise the model parameters, and may distort the spatial correction. The size of the dataset also did not allow for the examination of racial invariance and effects as they relate to children. The collection and publication of South African homicide data, such as in many other low- and middle-income contexts, is a relatively new

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phenomenon. Official crime statistics, as recorded by the South African Police Service, are frequently questioned regarding accuracy and completeness. Data reporting systems such as the NIMSS are in a developmental stage. They also face challenges related to unavailable or missing data, highlighting the assiduous concern with the reliability and validity of homicide data. Nonetheless, this study draws from what is considered to be the most systematic source of homicidal strangulation data in the City of Johannesburg. For similar reasons, variables measuring mediating social mechanisms, such as collective efficacy and sense of community, were not included in the current investigation. Comprehensive neighbourhood-level data for such variables are non-existent in South Africa. The observed effects therefore do not suggest a direct causal link between socio-structural factors and fatal strangulation but are to be understood as potentially a result of complex mechanisms that have not been studied here.

CONCLUSION
This empirical analysis may be the first in South Africa and internationally to examine the influence of neighbourhood-level factors in shaping risk of homicidal strangulation. Located within a disaggregated data approach, the study demonstrates partial support for the theories of strain and control and presents initial evidence of the complex and seemingly variable risk factors for fatal strangulation in South Africa's largest metropolis. Even with the caveats noted, this study offers preliminary theoretical contributions to homicide research in South Africa and therefore beyond the countries of the Global North where much of this research has been undertaken. The study also advances support for analyses of the neighbourhood socio-structural context towards a more refined understanding of the predictors of specific mechanisms of death in urban South Africa. Accordingly, it recognises strangulation as a unique phenomenon that is distinct from overall homicide.

Longitudinal analyses are recommended to improve the understanding of neighbourhood-level social processes over time and that influence patterns of homicidal strangulation in the city. Future research – available data permitting – should undertake a more fully racially disaggregated analysis to determine the differential aspects of risk across racial groups. The availability of relevant data will also allow for research to test for mediating effects between urban disadvantage and homicidal strangulation. Future studies may include socio-structural factors not captured by the covariates used in the current study and undertake comparative analyses that distinguish neighbourhood-level fatal strangulation risks relative to the risks for the other leading external causes of homicide.

Policies, particularly at the city level, and interventions at the community level, that focus on both places and people represent important channels for reducing the risk of fatal strangulation. City-wide policy that assumes an inter-sectoral approach to social development is an important tool to address the residential instability implied by this study. Interventions to strengthen collective efficacy and community connectedness are potentially valuable to promote community solidarity, social cohesion and social inclusion, and thereby the protective mechanisms that moderate risk of fatal violence.

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ENDNOTES:

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

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