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Can Homicide Serve as an Indicator of Non-lethal Crime? A Systematic Literature Review

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Abstract
Homicide rates are often used as an indicator of levels of crime. The reasons for this are both practical and conceptual. Practically speaking, homicide statistics tend to be more reliable than statistics for other forms of crime. Conceptually speaking, homicide and other forms of crime are often considered to be related: homicide is seen as the "tip of the iceberg" of underlying crime. However, it remains unclear whether this convention is empirically justifiable. Here, we review empirical evidence for the idea that homicide can serve as an indicator of crime more generally. We identify 31 previous studies that include information on this issue. Findings indicate that homicide is related to other forms of crime (particularly violent crimes) in larger scale, and cross-sectional analyses, but studies focusing on smaller levels of analysis identify substantial variation depending on location or time frame being considered. We conclude that homicide can function as an indicator of violent crime in general, but no clear pattern emerges as to what that means concretely. To those authors wishing to use homicide as an indicator of (violent) crime, we recommend that they conduct and report preliminary work to establish to what extent this notion is justified within the context and time frame on which they wish to focus.

Keywords Homicide · Crime · Systematic Literature review · Empirical data

Introduction

The use of crime data as a social indicator began in the early nineteenth century (Guerry, 1833; Quetelet, 1835), but the quality of such data has been a key obstacle in this line of research—recording practices by authorities vary over regions, and over time, and the public may be unwilling to report certain types of crime (Kwan et al., 2000; Messner, 1984). Therefore, many researchers who are interested in studying crime rely primarily on homicide statistics (Alvazzi del Frate & Mugellini, 2012; Fox & Zawitz, 2000; LaFree & Drass, 2002; Neumayer, 2003; United Nations Office on Drugs and Crime [UNODC], 2011, 2019). This convention arose because homicides tend to be better documented than other forms of crime, and because homicide data can be extracted from various different data sources—for instance, police records and vital statistics data—thereby controlling potential biases in individual data sources. In addition, homicides and other forms of crime are believed to be related in a conceptual sense—after all, they are all crimes. The idea that homicides and other types of crime are part of the same (or similar) underlying phenomenon, is part of many theoretical perspectives on crime, such as routine activities theory (Cohen & Felson, 1979; Felson & Cohen, 1980), situational action theory (Wikström, 2019), as well as anomie and strain theories (Dicristina, 2004). Many authors see a conceptual link between homicide and *violent* crime in particular (Block & Block, 1991; Karstedt & Eisner, 2009; Wikström & Treiber, 2009). For these reasons, many studies rely on homicide statistics when studying crime. Importantly, however, the empirical justification for this choice is often lacking. As such, we believe an overview of the existing empirical support for this convention is warranted. Here, we review evidence for the existence of an empirical link between homicide and other forms of crime.

'Homicide' refers to the unlawful death inflicted by someone upon another person (UNODC, 2019). Homicide includes cases where the event was planned or premeditated (murder) as well as cases where the homicide arose in response to an argument or provocation (voluntary

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manslaughter). In this review, we contrast homicide with non-lethal crimes, which are all crimes that did not result in loss of the victim's life. Non-lethal crimes can be further subdivided into violent and non-violent crimes. Violent crimes are crimes that result in bodily injury toward a person whereas non-violent crimes are crimes that do not cause bodily injury (UNODC, 2019).[1]

The idea that homicide can be used as an indicator of crime more generally is also evident in the "iceberg" metaphor, which is commonly used to illustrate the relationship between homicide and other forms of crime. The metaphor conceptualizes homicide as the tip of a larger iceberg of crime. Although a metaphor can only go so far in describing a real-world phenomenon, it can help us to think about the different elements of the homicide-crime relationship. Most importantly, the iceberg metaphor implies that homicide and other forms of crime are part of the same iceberg, that is—they are different forms of the same underlying phenomenon of 'crime'. Further, in the metaphor, a large bulk of crime is below the surface of the water, and therefore, difficult to detect (the "dark number"), while the tip of the iceberg sits above the water, representing more serious and more easily detectable crimes, including homicide (Suonpää et al., 2018; Zimring & Hawkins, 1999). As outlined above, this issue is also key to the use of homicide as an indicator of other crimes. Although there is quite extensive evidence to support the idea that homicide is well recorded (Neapolitan, 1997; Rogers & Pridemore, 2023), not all homicide data sources are reliable, especially cross-nationally. In general, empirical data tends to be somewhat of a bottleneck for research on crime and homicide. In line with this, we believe that a review of *empirical* evidence on the relationship between homicide and other forms of crime is particularly relevant in this context.

The Current Study

This review is intended to offer insight on past empirical work that has studied the relationship between homicide and other forms of crime, and examines what big-picture patterns we might identify in this literature. The use of homicide statistics as an indicator of (violent) crime is most common in studies that focus on violence and crime at the social-structural level. For instance, in studies that are interested in *rates* of crime across a certain region or time period. We aim to generate insight into whether this use of homicide statistics is appropriate, and therefore, we focus below on studies examining social-structural relationships between homicide and crime, as opposed to individual-level or life-course studies. Further, there is considerable past work where scholars have commented descriptively on the relationship between homicide and crime in their individual studies, with very varied outcomes (e.g. Aebi & Linde, 2012; Appiahene-Gyamfi, 2002; McDowall et al., 2012). However—given the empirical focus of this review—in what follows we review studies in which the relationship between homicide and other types of crime has been established through formal statistical tests.

Contributions

This review aims to make two central contributions to the literature. First, we aim to evaluate the empirical evidence for the convention of using homicide statistics as an indicator of crime more generally. This is relevant in its own right but will also allow us to make recommendations for best practices in future research. The second contribution of this work relates to the format of a systematic literature review. Given that homicide and crime are strongly contextual phenomena, the literature on this topic is likely to be diverse. A systematic literature review gives us the opportunity to bring that literature together to shed light on a key question for criminological research.

Methods

We conducted the systematic review according to the PRISMA guidelines (Moher et al., 2009).

Eligibility Criteria

We searched for studies that report empirical relationships between homicide and forms of non-lethal crime. We applied 11 eligibility criteria to arrive at the final set of eligible studies. Eight of these criteria reflected practical decisions. We focused on (i) empirical, quantitative studies that were (ii) either peer-reviewed articles or completed PhD theses, (iii) published in English (iv) between 2000 and 2020. We chose this publication period as the digitization and indexing of repositories has been reliably applied since the early 2000s (Colavizza et al., 2019). Before the year 2000, digitization is less comprehensive, which might introduce biases in article selection—as some types of articles may be less likely to be digitized and, therefore, not included. As such, we use the year 2000 as the lower boundary of our time frame. Further, for a study to be included, it had to contain (v) a variable capturing homicide rates or a specific subtype of homicide. It also had to contain (vi) a variable reflecting non-lethal violence/crime. In addition, studies had to (vii) comment on the relationship *between* the different crimes—studies

[1] Note that the definitions may differ across the studies we review below, for further details on how we addressed this please refer to the section Preliminary Reflections.

that did not do so were excluded. Finally, (viii) we excluded articles for which full text was not available.

There were also three more specific inclusion criteria designed to tailor the search to studies that are relevant to our research question. The studies had to ix) cover *direct* relationships between homicide and other forms of crime. Studies offering 'indirect' evidence for a relationship between homicide and other crimes are for instance those that demonstrate that homicide and another form of crime are similarly affected by a third variable (e.g. social disorganization). Such findings are of limited utility here, since a similarity can co-exist with many differences (and vice versa). The crime types do not have to be fully the same for an empirical relationship to exist between them—for instance, correlations can be meaningful even if they are not *perfect* correlations. Further, in line with our focus on *rates* of crime in society, we also exclude x) studies on the relationship between homicides and other forms of crime at the individual level, and xi) studies on event characteristics, victim characteristics, and perpetrator characteristics for different crime types. To illustrate why studies on perpetrator characteristics are not relevant here: a study comparing (for example) the average age of homicide perpetrators and robbery perpetrators tells us little about the relationship between those crimes at the societal level.

Search Procedure

Searches were conducted by the first and second authors between December 2020 and September 2021, according to PRISMA guidelines (Moher et al., 2009). Using the search terms shown below, we searched for published articles and completed doctoral dissertations. We applied the search terms to four general platforms, namely Web of Science, Academic Search Premier, Open Grey, and Google Scholar (Armstrong et al., 2005), as well as two more specific databases in the fields of criminology and sociology—Sociological Abstracts and Criminal Justice Abstracts. To counteract publication bias, we also searched for completed doctoral dissertations on dissertation databases—ProQuest Dissertations & Theses, and EThOS. These top-down searches were complemented by a bottom-up search, examining the bibliographies of the relevant studies to identify relevant work cited there that may have been missed in the top-down searches (Cooper et al., 2018). We emailed the authors of articles whose full texts could not be found online, this led to the inclusion of one additional article.

Search Terms

We chose search terms that reflected the two elements of the main research question of this review, namely homicide and non-lethal crime. The link between these two elements was established with the Boolean operator 'AND'; alternative terms were differentiated with the Boolean operator 'OR'. An asterisk is used to accommodate alternative endings to a word (e.g. violent vs violence; crime vs criminal). The search proceeded in two stages. In the first stage, the following *general* search terms were applied to the databases.

(Homicid* OR murder) AND crim*
(Homicid* OR murder) AND crim* AND violen*
(Lethal OR Fatal) AND violen*

In the subsequent second stage, we searched for *specific crimes* in combination with homicide:

(Homicid* OR murder) AND assault.
(Homicid* OR murder) AND robber*
(Homicid* OR murder) AND property AND crim*
(Homicid* OR murder) AND rape.
(Homicid* OR murder) AND theft.
(Homicid* OR murder) AND drug. [2]

Unique records identified by this second search were then added to the records identified by the first search to be screened according to PRISMA guidelines.

Study Selection

The flowchart of the selection process of articles for this review is shown in Fig. 1. The searches identified 11,572 unique records, including 400 dissertations. Eight records were excluded because they were published before the year 2000, and 12 were excluded because they were not peer-reviewed articles (nor dissertations). This left a set of 11,552 to screen. Based on the reading of the titles, 10,705 records were excluded because they focused on topics that had no bearing on the current study. For instance, we excluded an article titled: "Gender and forensic science in the contemporary crime thriller".

This left 847 studies eligible for a reading of the abstract. At this stage, a further 586 records were excluded. Four of these were excluded because their abstracts and full text were unavailable. 82 were excluded because their topic was not relevant to the current study. For instance, we excluded a study titled: "A bioarchaeological perspective on the history of violence". A further 195 were non-empirical or used qualitative methods. 81 did not include homicide amongst

[2] As a side note regarding drug crime, there are several ways in which drugs may contribute to homicide (Goldstein, 1985), and not all are necessarily criminal. Here, we focus on those studies where the drug component represents a crime (to assess its relationship with homicide). We, therefore, focus on the relationship between drug *trafficking* and homicide. Studies that focus on the relationship between drug *use* and homicide are excluded.

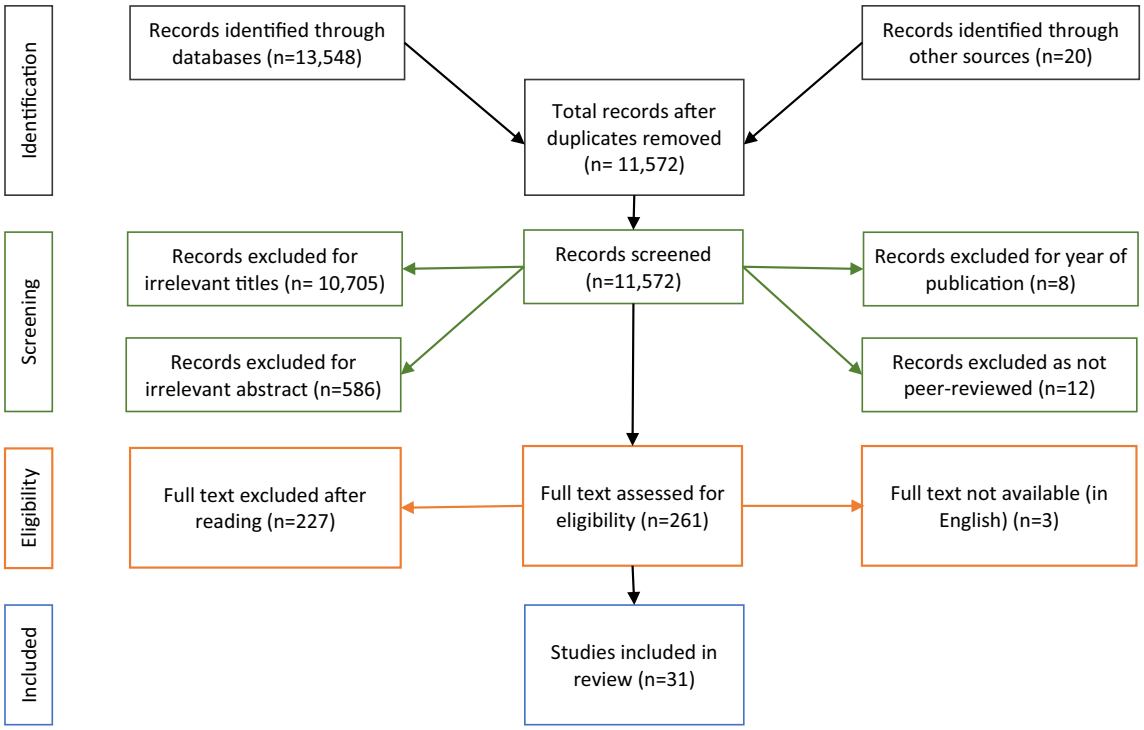

Fig. 1 PRISMA flow diagram of the article selection process

their variables, or *only* focused on homicide but not on other crimes (another 90). 68 were excluded because they did not *differentiate* homicide and other crimes. 70 were excluded because they made only indirect comparisons between the crime types, or did not make any comparisons.

These exclusions left 261 records eligible for a full reading, after which a further 230 were excluded. Of these, 31 were excluded because they were non-empirical. Another 17 were excluded because they did not include homicide data, and 11 were excluded because they *only* focused on homicide data without including any other crimes. Likewise, 48 were excluded because they did not *differentiate* homicide and other crimes. 120 were excluded because they did not make formal comparisons between homicide and other crimes. Two were excluded because the full text could not be accessed, and one was excluded because the full text was not available in English. After the exclusion of these 230 articles, 31 eligible articles remained in the final set.

Preliminary Reflections

In the results below, we report all relevant statistics reported by the original authors, regardless of size or significance. When discussing correlations, the rule of thumb used to assess the strength of correlations is based on Cohen (1988) who suggests that $r < .20$ corresponds to weak, correlations between $r = .50$ and $r = .80$ are moderate and correlations above $r = .80$ are strong.

Table 1 provides an overview of the key characteristics of the 31 eligible studies. The studies identified fell into two categories. First, there were studies that identified cross-sectional relationships between homicide and other crime types—for instance, offering correlations. Second, there were studies that compared homicide and other crimes in terms of their temporal trends. The results section below is structured according to these two categories. Studies are divided over the categories based on the nature of the analyses they offer. Cross-sectional studies might use observations from different cities, or different years (or both), but this does not mean that their analyses are spatial or temporal. Rather, their analyses are cross-sectional over spatial or temporal units of analysis. The temporal section includes only those studies that analyse the temporal element, for instance through time series analysis.

There was some variability in the terminology used. In the studies on drug crime, we follow the terminology used by the authors—the terms 'drug markets' (e.g. Ousey & Lee, 2002, 2007) and 'drug trafficking' (e.g. De Mello, 2015; Portella et al., 2019) are both used, where the term 'drug markets' tends to refer to the local area in which drug trafficking takes place, and drug trafficking to the crime itself. Further, six authors either used the term 'murder' instead of 'homicide' (Carrothers, 2016; Oguntunde et al., 2018; Stretesky et al., 2004), or used the terms interchangeably (Barber, 2000, 2006; Moore & Bergner, 2016). On inspection, in all these cases, the murder variable also included

Table 1 Study characteristics

Authors	Year	Country	Category	Data source for crime data	Data structure	Analytic technique
Barber	(2000)	International	Cross-sectional	Police recorded crime data from Inter-Pol (1990)	National crime data from 70 countries in 1990	Bivariate correlations
Barber	(2006)	International	Cross-sectional	Police recorded crime data from Inter-Pol (1990)	National crime data from 39 countries in 1990	Bivariate correlations
Berg	(2019)	U.S	Cross-sectional	Indicator of non-lethal violence was based on victimization data extracted from the National Crime Victimization Survey. Homicide data was based on police recorded data, extracted from the Supplemental Homicide Report published by the FBI. Corrections developed by Fox and Fridel (2018) were applied to convert the police recorded homicide figures into victimization estimates	Yearly crime data between the years 1992–2016	Bivariate correlations (detrended)
Carrothers	(2016)	U.S	Cross-sectional	Crime data for the rural Iowa counties was obtained from the Iowa Department of Public Safety Program Services Bureau. Crime data and law enforcement data for the years 2010 and 2011 were provided by Iowa State University ICIP	Crime data from 79 rural Iowa counties (aggregated for the years 2006–2010)	Bivariate correlations
De Mello	(2015)	Brazil	Cross-sectional	Police recorded crime data, obtained from the State Secretariat for Public Security for the state of São Paulo	Yearly crime data for i) 39 cities in the state of Sao Paulo between the years 1984—2005, and ii) 643 cities in the state of Sao Paulo between 2001 and 2008	Linear regression model in which drug market activity predicts homicide
Dugato et al	(2020)	Italy	Cross-sectional	Mafia-related homicides, non-mafia homicides, and drug dealing statistics were derived from police data (Banca Dati Interforze database—Italian Ministry of the Interior). Data on confiscated properties (2004–2011) were collected through ANBSC (Agency for the Management of Seized and Confiscated Assets). Information about mafia groups active in the city of Naples and their rivalries came from the reports of the Italian Antimafia Investigative Direction (DIA), a specialized law enforcement unit	Crime data aggregated over the years 2004–2011, for city blocks in the city of Naples	Linear regression model in which mafia-linked activities (2004–2011) in a certain city block predict mafia homicides in that block in 2012

Table 1 (continued)

Authors	Year	Country	Category	Data source for crime data	Data structure	Analytic technique
Farrell et al	(2018)	Canada	Cross-sectional	Homicide data are from the Homicide Survey (The Canadian Centre for Justice Statistics, Statistics Canada; see Mulligan et al. 2016). Property crime rates are from the annual Uniform Crime Reporting Survey (UCR Survey; Keighley 2017)	Yearly crime data between the years 1965–2015	Bivariate correlations
Fajnzylber et al	(2000)	International	Cross-sectional	UN—police recorded data on robberies and homicides. In the case of WHO, homicide rates are based on mortality data	Crime data from 34 countries	Bivariate correlations
Gok	(2010)	Turkey	Cross-sectional	Police recorded crime, from Turkish national police Main Crime Database	Yearly crime data 81 regions (aggregated over the years 2006–2008)	Bivariate correlations
Jung	(2017)	Canada	Cross-sectional	Police recorded crime data from the Uniform Crime Reporting (UCR) Survey collected by the Centre for Justice Statistics (CCJS)	Crime data from 32 metropolitan areas between 1976 and 2011	Bivariate correlations
Kim	(2003)	Russia	Cross-sectional	Homicide victimization estimates based on mortality data, from the vital statistics registration system, called "Zapis Aktov Grazhdanskogo Sostoyaniya" (Registry of Acts of Civil Status). Data on regional robbery and burglary rates are available from the Russian Ministry of the Interior (MYD)	Crime data from 89 regions in the year 2000	Bivariate correlations
Lester	(2003)	International	Cross-sectional	Secondary analysis of data from Lester (1996) Patterns of suicide and homicide in the world	Crime data from 36 countries in the year 1990	Bivariate correlations
Liu	(2006)	China	Temporal	Law yearbook of China (1987–2002) published by the Ministry of Public Security (police)	Yearly crime data between 1987 and 2002	Time series analysis
Minkov and Beaver	(2016)	International	Cross-sectional	Homicide data for the year 2014 taken from UNODC. Violent crime data was based on victimization rates, collated by the International Institute of Social Studies from the International Crime Victims Survey	Crime data from 51 countries over the years 2010–2012	Factor analysis
Moore and Bergner	(2016)	U.S	Cross-sectional	Uniform Crime Report (UCR) recorded crime data	Crime data for 1.997 counties for the year 2010	Bivariate correlations

Table 1 (continued)

Authors	Year	Country	Category	Data source for crime data	Data structure	Analytic technique
O'Brien	(2003)	U.S	Temporal	Crime data from Uniform Crime Report (UCR)—for 1958–1972, as reported in Social Indicators 1973. The remainder comes from UCR data reported in "Crime in the United States" (FBI, various years)	Crime data over the years 1958–2000	Detrended bivariate correlations
Oguntunde et al.	(2018)	Nigeria	Cross-sectional	Crime data published by Nigerian National Bureau of Statistics	Yearly crime data between 1999 and 2013	Bivariate correlations
Ousey and Lee	(2002)	U.S	Cross-sectional	Data on homicide were drawn from the UCR's Supplementary Homicide Reports, covering 1984 to 1997. Data on illicit drug market activity for these same years were taken from a UCR arrests file and from the Drug Use Forecasting Data Program (U.S. Department of Justice)	Yearly crime data between 1984 and 1997 from 122 cities	Linear regression model in which drug market activity predicts homicide
Ousey and Lee	(2007)	U.S	Temporal	Homicide rates are drawn from the FBI's *Crime in the United States* volumes. The measure of drug market activity is based on the arrest rate for drug-related offences, as reported by the UCR. The bulk of arrest data (1984–1997) come from a UCR-based extract file.	Yearly crime data between 1984 and 2001 from 132 cities	Linear regression model in which drug market activity predicts homicide
Portella	(2019)	Brazil	Cross-sectional	Police registration data, provided by the Civil Police of Bahia state	Crime data from 98 city neighbourhoods in the city of Salvador for the 2010	Linear regression model in which drug market activity predicts homicide
Reid	(2005)	U.S	Cross-sectional	Crime data for the year 2000 as reported in the UCR. Several of the metropolitan areas had missing values for one or more crime rates in the UCR. The US Department of Justice, however, imputes annual crime rates for counties with reported crimes for three months or more in a given year. Where possible, these imputed data were used to construct crime rates for those metropolitan areas with missing data.	Crime data for 150 metropolitan areas in the year 2000	Bivariate correlations over 150 metropolitan areas

Table 1 (continued)

Authors	Year	Country	Category	Data source for crime data	Data structure	Analytic technique
Rock	(2008)	UK	Temporal	The homicide data is from the Homicide Index (Home Office, UK govt). This is based on court outcome. The assault data is from the Home Office recorded crime series, which covers offences recorded by the police.	National crime data (England & Wales) for each month of the year (aggregated over the years 1993–1997)	One-way ANOVA in which homicides and assaults are predicted by the factor Periodicity, reflecting the months of the year
Rosenfeld	(2009)	U.S	Temporal	Police recorded crime data, from Uniform Crime Reporting (UCR) database	Yearly crime data for the years 1970–2006	Bivariate correlations over 1970–2006
Skott	(2018)	Scotland	Temporal	Police recorded crime data. Homicide data extracted from the Scottish Homicide Database held by Police Scotland. The violence data was gathered from a pooled dataset created by the Scottish Government containing five sweeps of the Scottish Crime and Justice Survey (2008–2009 to 2014–2015)	Crime data from the years 1976–2015	Detrended bivariate correlations
Stretesky, et al	(2004)	U.S	Cross-sectional	Police recorded crime data from Uniform Crime Reports (UCR), averaged over a 3-year period (1999–2001). The homicide variable includes both murder and non-negligent manslaughter, but the authors prefer 'murder' as the umbrella term	Crime data from 236 cities in the 2000	Bivariate correlations
Stults and Baumer	(2008)	U.S	Cross-sectional	Homicide data based on mortality statistics from the National Center for Health Statistics (NCHS). Data on drug market activity drawn from 1) the UCR arrest data and 2) from NCHS data. Estimates are based on data pooled between 1976 and 1978. The indicator of property crime is a composite variable based on county-level data from the UCR on the number of robberies, burglaries, larcenies, and auto thefts in 1977	Crime data from 74 U.S. counties & metropolitan areas, expressed as 3-year average between 1976 and 1978	Bivariate correlations
Thompson et al	(2001)	Canada	Cross-sectional	Crime data from Statistics Canada	Crime data from 10 different Canadian regions, in 1971 and again in 1981	Bivariate correlations and factor analysis
Varano et al	(2004)	U.S	Cross-sectional	Police recorded homicide data from the Detroit Police Department	Crime data from the city of Detroit, between 1999 and 2002	Multinomial logistic regression

Table 1 (continued)

Authors	Year	Country	Category	Data source for crime data	Data structure	Analytic technique
Weaver et al	(2014)	U.S	Cross-sectional	Homicide counts for each county were extracted from the monthly online reports compiled by the Georgia Bureau of Investigation Crime Statistics. The number of persons admitted to the Georgia Department of Corrections for drug offenses during calendar years 2008 and 2009 was used as the measure of drug market activity. These counts were divided by the county population in the relevant years, and then multiplied by 100,000 to establish rates	159 counties as units of analysis, crime data aggregated over the years the years 2007–2009	Bivariate correlations and negative binomial regression
van Wilsem	(2004)	International	Cross-sectional	Homicide rates taken from the World health statistics annual report. Victimization rates for other crimes were taken from the ICVS. These are based on victims' self-reports. Police-recorded rates for each of these crimes were based on victims' indication in the ICVS of whether they reported these crimes to the police. Assault and robbery rates make up the category of 'non-lethal violent victimization', and burglary, car theft, theft from cars and personal theft are combined into the category 'theft victimization'	27 countries as units of analysis, crime data aggregated over the maximum number of ICVS waves within a 4-year timespan	Bivariate correlations
Lockwood	(2007)	U.S	Cross-sectional/Spatial	Police recorded crime—as recorded by Savannah Police Department	Crime data from 145 census blocks (aggregated over the years 1993–1997)	Bivariate correlations

non-negligent manslaughter, and thus, the term 'homicide' seems to be an accurate alternative. Therefore, we use the term homicide consistently in the text below, to highlight that the variable is similar over studies. The only exception to this is Oguntunde et al. (2018), whose statistics capture murder and manslaughter separately. In some cases, attempted homicide is included under homicide (Dugato et al., 2020; Farrell et al., 2018), we note this in the text where it applies.

Results

We identified 31 studies that met the eligibility criteria outlined in "Eligibility Criteria" section. Of our 31 articles, 13 used data from the United States (42%), three studies used data from Canada, two from Brazil, two from the UK/Scotland, and one each from China, Russia, Turkey, Italy, and Nigeria. A further six used data from multiple countries across different continents. Eighteen of the articles were published between 2000 and 2009, and 13 were published between 2010 and 2020.

Of these 31, 24 evaluated cross-sectional relationships between homicide and other crimes, 7 analysed temporal trends of homicide relative to other crimes. These categories are discussed in turn below, a brief overview can be found in Table 2.

Cross-Sectional Relationships

There were 24 studies that examined cross-sectional relationships between homicide and other forms of crime. Many of the studies included in this section make use of panel data, taking data from different years or geographical units. However, the analyses relevant to the current paper are cross-sectional, and therefore, these studies are described in this cross-sectional category. All but two of the studies in this category found at least some evidence in support of empirical relationships between homicide and other forms of crime. The studies are discussed below in order from the largest level of analysis to the smallest.

At the international level of analysis, Fajnzylber et al. (2000) source data on homicide and robberies for 34 countries from the WHO *and* the UN between 1974 and 1990 and find that robbery rates (sourced from UN) correlated moderately with rates of homicide, both when sourced from the WHO, r (16) = .61, and when sourced from the UN, r (15) = .42, although this last correlation does not reach significance—perhaps due to the low number of observations. Barber (2000) studies sex ratios as a predictor of violent crime in 70 countries, using Interpol data from 1990. To justify the creation of a violent crime index, he describes that homicide correlated moderately with rape, r (68) = .75, and assault, r(68) = .49. In 2006, Barber examines violent crime across the 39 countries of the Americas in 1990 (Barber, 2006). Again, when describing the violent crime index, he confirms that homicide correlates moderately with rape, r (37) = .62, and assault, r (37) = .30. Minkov and Beaver (2016) study violent crime across 51 countries between 2010 and 2012. To justify their composite index of violent crime, they apply a factor analysis procedure, and confirm that rates of homicide, muggings, and 'attacks' all load on the same superordinate factor (factor loadings of 0.87, 0.86, and 0.85, respectively), thereby demonstrating that the crime types have a considerable portion of shared variance. There were also some international studies that consider non-violent crime in relation to homicide. Using data from 36 countries in 1990, Lester (2003) studies the relationship between suicide and crime. As a side note, he highlights that the correlation between homicide and property crime does not reach significance, r (36) = .15. This study, then, was one of two that did not find evidence for relationships between homicide and other crimes. Van Wilsem (2004) studies victimization rates for a variety of crimes across 27 countries, and considers both violent and non-violent crimes. He demonstrates that homicide rates correlate with self-reported violent victimization, r (27) = .56, as well as theft, r (27) = .42, but not with self-reported rates of car vandalism, r (27) = −.14.

Turning to the national level, Berg (2019) compares victimization rates for homicide, robbery, and 'serious disputes' in the United States between 1992 and 2016. He shows that homicide victimization correlates moderately with robbery victimization, r (24) = .36, as well as serious dispute victimization, r (24) = .54. Oguntunde et al. (2018) present data from Nigeria between 1999 and 2013, and show that murder correlates moderately with armed robbery, r (21) = .55, and manslaughter correlates moderately with assault, r (21) = .75. Interestingly, there were also some *negative* correlations, between murder and assault, r (21) = − 0.61, and between manslaughter and robbery, r (21) = − .79, and between murder and manslaughter, r (21) = − .18. This study, then, highlights quite a clear-cut separation between—on the one hand—murder and robbery, and on the other hand manslaughter and assault.

At the regional level, Thompson et al. (2001) source data from 10 Canadian regions, first in 1971 and again in 1981. They show that homicide correlates strongly with rates of attempted homicide, r (10) = .90/.91, and moderately with rape, r (10) = .58/.69, robbery, r (10) = .71/.61, and assault, r (10) = .47/.50, as well as other non-criminal forms of social adversity such as divorce, suicide, and alcohol abuse. Further, all these social issues shared substantial variance—a Factor Analysis procedure showed that the different social issues all loaded highly on a single superordinate factor (factor loadings > .53/.59). Gok (2010) studies crime and violence in 81 regions of Turkey between 2006 and 2008.

Table 2 Overview of studies by category. For further details on each individual study please see Table 1

Study design	Number of articles	Articles (by author)	Focus	Evidence for relationships?
Cross-sectional	24	van Wilsem (2004)	Violent *and* Non-violent crime	Mixed
		Carrothers (2016)	Violent *and* non-violent crime	Yes
		Kim (2003)	Violent *and* non-violent crime	Yes
		Reid et al (2005)	Violent *and* non-violent crime	Yes
		Jung (2017)	Violent *and* non-violent crime	Yes
		Fajnzylber (2000)	Violent crime	Yes
		Barber (2000)	Violent crime	Yes
		Barber (2006)	Violent crime	Yes
		Minkov and Beaver (2016)	Violent crime	Yes
		Berg (2019)	Violent crime	Yes
		Oguntunde et al (2018)	Violent crime	Mixed
		Thompson et al (2001)	Violent crime	Yes
		Gok (2010)	Violent crime	Yes
		Moore and Bergner (2016)	Violent crime	Yes
		Stretesky et al. (2004)	Violent crime	Yes
		Lockwood (2007)	Violent crime	Yes
		Stults and Baumer (2008)	Non-violent crime	Yes
		Weaver et al. (2014)	Non-violent crime	Yes
		Ousey and Lee (2002)	Non-violent crime	Yes
		De Mello (2015)	Non-violent crime	Mixed
		Portella et al. (2019)	Non-violent crime	Yes
		Varano et al (2004)	Non-violent crime	No
		Dugato et al (2020)	Non-violent crime	Yes
		Lester (2003)	Non-violent crime	No
Temporal	7	O'Brien (2003)	Violent crime	Mixed
		Skott (2018)	Violent crime	Mixed
		Farrell et al (2018)	Non-violent crime	Yes
		Rosenfeld (2009)	Non-violent crime	Yes
		Liu (2006)	Non-violent crime	Mixed
		Ousey and Lee (2007)	Non-violent crime	Mixed
		Rock et al (2008)	Non-violent crime	No

Rates of homicide were found to correlate moderately with rates of assault, $r\,(81) = .40$, rape, $r\,(81) = .55$, and robbery, $r\,(81) = .73$.

At the county level, Moore and Bergner (2016) source crime data from the year 2010 in 1.997 counties of the United States. They show strong correlations amongst violent crimes—homicide correlated strongly with rape, $r\,(1.997) = .89$, assault, $r\,(1.997) = .87$, and robbery, $r\,(1.997) = .94$. There were also several county-level studies that consider both violent and non-violent crimes in their comparison with homicide. Kim (2003) studies crime in Russia's 89 regions in 2000, and shows that homicide correlates moderately with robbery, $r\,(89) = .45$, but also with burglary, $r\,(89) = .53$. Stults and Baumer (2008) study the role of financial and economic factors in violent crime between 1976 and 1978, across 74 U.S. counties. As an indicator of violent crime, they use homicide statistics and establish that these are moderately correlated with rates of property crime, $r\,(74) = .50$, and drug arrest rates, $r\,(74) = .50$. Carrothers (2016) focuses on 79 rural counties in the U.S. state of Iowa between 2007 and 2011. He finds that homicide correlates moderately with aggravated assault, $r\,(79) = .48$, and rape, $r\,(79) = .42$, as well as crimes that are not necessarily violent, such as (criminalized) drug abuse, $r\,(79) = .34$, property crime, $r\,(79) = .54$, and burglary, $r\,(79) = .42$. Finally, Weaver et al. (2014) study how inter-state highways contribute to the development of local drug markets, and ultimately to homicide. Across 159 counties in Georgia (United States), they establish that homicide is associated with drug market activity, as evidenced by a significant correlation, $r\,(159) = .66$, as well as by a predictive relationship in a

binomial regression model where drug market activity predicts homicide, IRR = 1.002.

At the city level, Stretesky et al. (2004) create a composite measure of violent crime for the year 2000 across 236 cities in the United States. The authors establish that the different violent crimes are correlated—homicide correlated moderately with robbery, r (236) = .78, rape, r (236) = .39, and aggravated assault, r (236) = .54. There were also a number of city-level studies that consider both violent and non-violent crimes in their comparisons with homicide. Reid et al. (2005) study the relationship between immigration and economic crime in metropolitan areas in the United States, using data from the year 2000. They find that homicide correlates with both violent and non-violent forms of economic crime: rates of homicide correlates with rates of robbery, r (150) = .70, burglary, r (150) = .53, and larceny, r (150) = .41. Jung (2017) studies the relationship between immigration and crime in 32 metropolitan areas in Canada between 1976 and 2011. Homicide was found to correlate with a composite measure of violent crime (which did not include homicide), r (32) = .25, and with property crime, r (32) = .52. Ousey and Lee (2002) use data from 122 U.S. cities to show that the arrest rate for drugs-related offences in a city is a significant predictor of the homicide rate in that city, β = .57. De Mello (2015) uses data from Brazil to examine the relationship between drug market activity and homicide across 39 cities in the state of São Paulo. In this case, the results paint a quite complex picture whereby drug trafficking generally has a negative relationship with homicide, β = − .46, but homicide has a strong positive relationship with the *proportion* of drug trafficking that is due to crack and cocaine specifically, β = 24.70. In other words, cities whose drug markets are more focused on crack and cocaine (relative to other drugs) have higher homicide rates than cities whose drug markets are *less* focused on crack and cocaine.

Finally, at the neighbourhood level, Lockwood (2007) studies violent crime in Savannah (GA) in the United States and shows that city census blocks with higher rates of homicides also tend to have higher rates of simple assault, r (145) = .54, aggravated assault, r(145) = .62, and robbery, r (145) = .36. There were also several studies at the neighbourhood-level that specifically study the relationship between homicide and drug market activity. Portella et al (2019) use data from the Brazilian city of Salvador in 2010, and showed that, relative to neighbourhoods with low incidence of drug trafficking (< 5 incidents), neighbourhoods with high incidence of drug trafficking (> 5 incidents) reported a 34% increase in rates of homicide. Varano et al. (2004) study the relationship between drug markets and the specific subtype of drug-related homicide in the city of Detroit in the United States. They examine whether drug-related homicides are more likely (relative to non-drug homicides) to occur in local areas known to law enforcement as drug markets. However, a multinomial logistic regression finds no evidence for this, suggesting that local drug markets are not linked to *drug-related* homicides specifically. Dugato et al. (2020) focus on mafia homicides (including attempted homicides) in Naples, Italy. They find that drug dealing in a certain city block is a significant risk factor for mafia-related homicides occurring in that same block the following year, β = .019.

Summary

Across these 24 studies, then, there is consistent evidence that there are cross-sectional relationships between homicide and other types of crime. Generally speaking, the most consistent relationships were found when comparing homicide to violent crime. These relationships appear at the smaller and larger levels of analysis and tend to be moderate (and occasionally strong) in size. Although most effects were moderate in size, there was quite a wide range observed. For instance, estimates for the correlation between homicide and property crime fluctuate widely from r = .15 (Lester, 2003) to r = .54 (Carrothers, 2016). Further, the studies vary considerably in *which crimes exactly* are most clearly correlated with homicide.

Temporal Relationships

The second group of studies examined whether homicides and other crimes show similar temporal trends. There were 7 studies in this group, We discuss the studies in the same order as in the previous section, with studies arranged by level of analysis, with an additional distinction between those studies focusing on year-on-year trends (N = 6), and studies focusing on seasonality (N = 1).

Year-on-Year Trends

At the country level, O'Brien, 2003 examines the temporal relationship between homicide and other violent crimes (rape, robbery, and assault) in the United States between 1958 and 2000. Plotting the 10-year moving correlation between homicide and a composite of other violent crimes over the years, the author shows that there is an overall correlation between rates of homicide and violent crime, r(42) = .30, but the estimate of this correlation fluctuates considerably over time. Specifically, the correlation is high, r > .80, early in the timeframe and at the end of the timeframe, but with an extensive interruption during the 1980s and 1990s, where the correlation between homicide and violent crime drops as low as r = .13 (in 1988). Further, the author notes that much higher correlations between homicide and violent crime are observed when focusing not on rates of crime, but on *changes* in rates across the years, r (42) = . 91.

Skott (2018) studies violent crime in Scotland between 1976 and 2016. She shows that, in Scotland, changes in homicide rates since 1976 correlate strongly with changes in attempted homicide, $\rho(40) = .85$, and moderately with serious assault, $\rho(40) = .76$, but not with changes in rates of sexual violence (statistics not given by author). In other words, *changes* in homicide rates track closely with *changes* in rates of violent crime. There were also some studies that considered non-violent crimes in relation to homicide. Farrell et al. (2018) compare trends in homicide (including attempted homicide) to trends in property crime in Canada between 1965 and 2015. They find that changes in rates of homicide and property crime (relative to the 1965 baseline) are strongly correlated, $r\,(50) = .91$. Rosenfeld (2009) uses U.S. data between 1970 and 2006 to examine the relationship between homicide and 'acquisitive crime'—that is, a combined index of robbery, burglary, and motor vehicle theft. Findings indicate, first that the resulting measure of acquisitive crime show a moderate cross-sectional correlation rates of homicide, $r\,(144) = .71$. Further, applying a fixed-effects panel model (including a random effect capturing the yearly structure of the data), the author shows that between 1970 and 2006, rates of acquisitive crime are a significant predictor of rates of homicide, $B = .54$. A different perspective on temporal trends is offered by Liu (2006), who studies rates of violent and non-violent crime in China during the market transition (late 1970s onwards). The author does not examine the correlations between crime types over the years, but instead applies a time series analysis. Results show that—in general—rates of crime grew over the period under study, but at the same time economic crimes, such as larceny and fraud, grew faster than rates of non-economic crimes, such as homicide. Specifically, homicide showed a different trend from larceny, $\alpha = .17$, and fraud, $\alpha = .07$. As such, this work using a different analytical technique provides evidence for *differences* in temporal trends between homicide and other forms of crime.

At the city level, Ousey and Lee (2007) show that drug market activity is a predictor of homicide across 132 U.S. cities, $\beta = .58$, $t\,(132) > 1.96$, in line with Ousey and Lee (2002) discussed in "Cross-Sectional Relationships" section.[3] In terms of temporal relationships between the crimes, they show that this relationship is attenuated over time, so that drug market activity is a predictor of homicide between 1984 and 1993, but this relationship drops to non-significance between 1994 and 2000, $t\,(132) < .29$.

[3] Note that the database underlying the analysis is largely the same as that used in Ousey & Lee (2002) with 10 additional cities and 3 additional years. Thus, the strong similarity between studies is to be expected.

Seasonality

Rock et al. (2008) study *seasonality* of violent crime in the United Kingdom and found that while rates of assault follow a seasonal pattern (peaking in June), rates of homicides are consistent throughout the year. This was confirmed through a one-way ANOVA procedure, which showed that the 'periodicity' factor (months of the year) did not contribute to explained variance in homicide rates, but it did contribute to explained variance in the case of assault. That is, homicide and assault have different temporal patterns.

Summary

Across these seven studies, two found clear evidence of similarities over time between homicide and other crimes (Farrell et al., 2018; Rosenfeld, 2009), one did not find such evidence (Rock et al., 2008), and the four others found mixed evidence. Evidence for similarities in time trends between homicide and other crimes seems to particularly strong when focusing on *changes* in crime rates over the years, rather than rates of crimes per se (Farrell et al., 2018; O'Brien, 2003; Skott, 2018). Finally, the strength of the relationship can vary substantially over different time periods (O'Brien, 2003; Ousey & Lee, 2007). We might summarize the temporal category by saying that results are mixed and provide less clear evidence than cross-sectional analyses.

Discussion

Rates of homicide have often been used as an indicator of crime more generally. This review examined whether there is empirical evidence to support this use of homicide statistics, by synthesizing findings from previous studies. Before we discuss our findings, it is worth re-iterating that the studies included in this review were diverse. Given this heterogeneity, it is perhaps unsurprising that the empirical findings were also diverse. In what follows, we do not discuss each of the studies exhaustively, but rather to extract a 'big picture' from the available evidence.

There are three primary findings we would like to highlight. First, the available evidence indicates that there is an empirical relationship between homicide and other forms of crime. Second, homicide seems to be more clearly related to violent crime (assault; robbery) and drug market activity, than to non-violent crime such as property crime. Third, alongside these general statements, we should also note that the relationships identified incorporated substantial variation, fluctuations, and trend breaks, when disaggregated or when considering smaller units of analysis. This is likely to be due at least in part, to the variety of the studies—it stands to reason that very diverse studies would generate

diverse findings. Still, it is noteworthy that the evidence for overlap between homicide and other crimes is more pronounced precisely in studies with methodologies that—on the whole—are less powerful. Evidence for empirical links between homicide and other crimes is relatively strong in cross-sectional studies, but less strong in the more powerful designs used in temporal studies. The evidence for overlap between homicide and other crimes is relatively clear in studies using cross-national comparisons, which we know to be complex (given differences in data quality), but less clear in more specific contexts. The evidence for overlap between homicide and other crime is clearer in studies of aggregate units of analysis, when we know that the dynamics of homicide and crime are strongly contextual—in studies that take account of context we see considerable fluctuations. Taking these findings together, the idea that homicide can function as an indicator of (violent) crime is justifiable *in general,* but no clear pattern emerges as to what that means specifically. As a concrete example, we might be able to say that homicide is related to robbery in general, but how strong that relationship is exactly, or whether it will appear in a specific context is difficult to say. Importantly, then, although the evidence reviewed here suggests that there is an empirical relationship between homicide and (violent) crime—this does not mean necessarily that homicide and crime can be used *interchangeably*. We advise that scholars should not speak of homicide as if it were interchangeable with crime or violence. Our findings suggest that the latter approach—linking homicide and violence—might be viable, but we require more systematic studies using rigorous methods before such claims can be made with adequate confidence.

To those authors wishing to use homicide as an indicator of (violent) crime in empirical work, we recommend that they conduct and report preliminary work to establish to what extent this notion is justified within the context and time frame on which they wish to focus (see e.g. Barber, 2000, 2006). Of course, in many cases the problem is exactly that there is no good data available on "other crime", with which to establish such a link. Even homicide databases, which are considered the most reliable source of crime data, have their limitations, especially cross-nationally (Rogers & Pridemore, 2023; but see initiatives such as the European Homicide Monitor—Liem et al., 2013). In those cases, we return to the recommendation above: that researchers should not extrapolate homicide statistics to make broader claims about crime or violence in general, but instead tailor the claims they make more closely to the data they have available, and interpret their findings in relation to homicide only. Indeed, many scholars already do so (e.g. Aarten & Liem, 2021; Piatkowska et al., 2016; Zeoli et al., 2014), and study homicide in its own right without making claims about crime more generally, a branch of research that has generated much relevant insight. Further, we recommend that authors whose datasets do include measures of various different crimes include (brief) assessments of the empirical relationships between these crimes to facilitate future reviews and meta-analyses.

Beyond these central findings and recommendations arising from this review, there are three other issues that require discussion. First, of the 31 studies included here, there were only three (Berg, 2019; O'Brien, 2003; van Wilsem, 2004) that were designed to answer research questions related to our own. The other studies answered quite different and varied research questions, where the evidence that was pertinent to our review was secondary to the main aims of the study in question. This is not to criticize those studies but rather to point out that the research question impacts the kind of evidence a study generates. For instance, Liu (2006) shows that both economic and non-economic crimes grow over time in China, but that one grows faster than the other. Thus, differences are identified, but there is also evidence for similarities between homicide and other forms of crime (they both increase over time). The differences are formally evaluated, because they are part of the author's original research question, but the similarities are not. This may mean that the evidence generated does not offer a complete picture of the (lack of) overlap between crime types. On the other hand, the studies that *do* evaluate the relationship between homicide and other forms of crime as a core part of their aims, should get more weight in their interpretation, and it is worth re-iterating briefly the findings of those studies (Berg, 2019; O'Brien, 2003; van Wilsem, 2004). All three of these studies demonstrate moderate relationships between homicide and violent crimes. Van Wilsem (2004) also considers non-violent crime, and there relationships with homicide are less strong. O'Brien (2003) considers time trends, and demonstrates that the overall relationship between homicide and violent crime fluctuates considerably over time. In short, then, these studies mirror the overall conclusions outlined above—an overall relationship between homicide and violent crime, but with several caveats to consider.

Further, with regards to the kind of studies that are particularly relevant to our research question, there were no studies in the set that directly evaluated homicide as a predictor of other crimes. Our research question asks whether homicide can be used as an indicator of other crimes. A high-quality indicator would mean that we are able to *predict* rates of one phenomenon from the other (though causality is not required for such a relationship). That is, studies that evaluate whether homicide can *predict* rates of other crime would provide a very direct answer to our research question. It is relevant to note, then, that no such evidence was represented in the final set. There were four studies that identified predictive relationships (Ousey & Lee, 2002, 2007; Rosenfeld, 2009; Weaver et al., 2014), but there homicide was the *outcome* rather than the predictor. A recommendation

arising from this observation, then, is that future research should attempt to more explicitly evaluate whether homicide rates can *predict* rates of other crime.

Finally, there were some idiosyncratic findings in our set. Overall, relationships between homicide and violent crime tended to be stronger than relationships between homicide and non-violent crime, but there were two studies whose findings departed from that trend. In Jung's (2017) study of various crime types in Canada, the correlation between homicide and property crime ($r = .52$) seems to be stronger than the correlation between homicide and violent crime ($r = .25$). Farrell et al. (2018) compare temporal trends in homicide and property crime in Canada, and they, too, find that changes in homicide rates track very closely with changes in rates of property crime ($r = .91$). In other words, both studies that find relatively strong relationships between homicide and property crime are conducted in Canada—this may indicate a unique aspect of the Canadian context (Parent, 2006). The study by Oguntunde et al. (2018) is the only one in this set to identify *negative* correlations in the relationships between murder, manslaughter, assault, and robbery, suggesting that murder is related to robbery, while manslaughter relates to assault. Their data comes from Nigeria, and this finding may represent a unique feature of the Nigerian context, for instance with regards to how crimes are recorded and classified by police.

If we summarize the findings of this study as showing that homicide *can* be an indicator of *some* other crimes in *some* circumstances, then our findings are in line with previous findings from the European Homicide Monitor (Liem et al.,2013). This work has shown that homicides follow different patterns in different European countries. In the Netherlands, a large proportion of the homicides are associated with organized crime. Conversely, in Finland the use of alcohol plays a relatively large role in homicides (Liem et al., 2013). This goes to show that homicides 'mean different things in different contexts'. The findings from the current study corroborate this idea, by showing that the relationships between homicide and other crime differs over countries, levels of analysis, and time periods. Of course, this begs the question of why and how those differences arise. We would suggest that homicide should be understood as more than 'just' a crime—it is also an interpersonal event, and a cause of mortality. Thus, we may be able to apply the reasoning of the current study in another direction and ask whether homicide can serve as an indicator, not of underlying crime, but problematic social issues *outside* of the realm of crime. Research from our own lab, for instance, has shown that regions with high homicide rates also have higher rates of births to teenage parents, and drug addiction (van Breen & Liem, 2022; see also Thompson et al., 2001). This might also shed some light on why homicide is an imperfect indicator of 'crime', given that that is only one of its features.

Limitations

Our synthesis of the studies' empirical findings would have been strengthened by the application of a meta-analysis, but the approaches of the different studies were too diverse in terms of the data used, and analytical procedures applied, to integrate formally into a meta-analysis. Second (and related), in this review, we rely on the analyses offered by the original authors. It is possible that this introduces biases, for instance because large and significant effects are more likely to be reported by authors. This is especially the case in studies where the relationship between homicide and other forms of crime is not part of the authors' core aims, but only offered as a preliminary check (e.g. a table in an appendix). In those cases, analyses are likely to be more impacted by subjective considerations of what the authors consider worthwhile to include in the appendix. On the other hand, studies where the relationship between homicide and other forms of crime is part of the core aims of the original paper, often evaluate the relevant relationships in a more stringent manner. As such, these studies inspire greater confidence in their findings, and accordingly, we have given these somewhat greater attention in the discussion above. Third, while we followed PRISMA guidelines to achieve saturation of the set, it is possible that we overlooked eligible studies during the search procedure. Finally, a limitation of this work is that it focused on only one of several criteria that need to be met for homicide to function as an indicator for other crimes. We focus here on whether an empirical relationship exists between homicide and other crimes, but the idea that homicide functions as an indicator also requires directionality to that relationship—this was not evaluated here. In sum, this review cannot offer the final word on the nature of empirical relationships between homicide and other forms of crime. Rather, this work should be seen as offering an overview of the evidence that currently exists on this topic.

Conclusion

This systematic review set out to provide insight into the empirical relationship between rates of homicide, and rates of other crimes. The available evidence, from 49 studies, indicates a basic degree of overlap between homicide and other forms of crime, alongside substantial and meaningful differences. We hope that this review of the available evidence will stimulate future research to evaluate this question more thoroughly.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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