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A meta-analysis of marijuana, cocaine and opiate toxicology study findings among homicide victims

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ABSTRACT

Aim To synthesize the results of marijuana, cocaine and opiate drug toxicology studies of homicide victims and examine variation in results across person and setting characteristics. **Methods** A meta-analysis of 18 independent studies identified from an extensive review of 239 published articles that met the inclusion criteria of reporting marijuana, cocaine and/or opiate toxicology test results for homicide victims. A total of 28 868 toxicology test results derived from 30 482 homicide victims across five countries were examined. **Results** On average, 6% of homicide victims tested positive for marijuana, 11% tested positive for cocaine, and 5% tested positive for opiates. The proportion of homicide victims testing positive for illicit drugs has increased over time. Age had a strong curvilinear relationship with toxicology test results, but gender differences were not apparent. Hispanic and African American homicide victims were more likely to test positive for cocaine; Caucasians were most likely to test positive for opiates. Cocaine use appeared to be related to increased risk of death from a firearm and was a greater risk factor for violent victimization in the United States than in Newfoundland and Scandinavia. **Conclusion** There are relatively few studies of illicit drug toxicology reports from homicide victims that allow for cross-cultural comparisons. This study provides a basis for comparing future local toxicology test results to estimates from existing research.

Keywords Drugs, homicide, meta-analysis, toxicology, victimization.

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INTRODUCTION

Toxicology tests are conducted routinely by coroners and forensic laboratories in cases of unnatural or unexpected death in most communities throughout the developed world. However, the analysis of toxicology findings from homicide victims is used only occasionally in diagnosing community-level drug and violence problems. The criminological utility of toxicology reports is probably underdeveloped, for two primary reasons. First, nearly all the research using toxicology data has been published in medical or forensic science journals, instead of criminal justice outlets (although see [1]). Secondly, in most past studies, a forensic pathologist, medical examiner or physician presents the results from one community or region.

This frequent use of the case study approach limits the cumulative or systematic development of research on homicide victim toxicology, a limitation with implications for both policy makers and scholars. Policy makers currently have no scientific basis for comparing local toxicology findings with those from other communities. Cross-sectional comparisons with other communities would be useful for conducting self-assessments of local drug markets. Similarly, longitudinal assessments of toxicology results could serve as one indicator of drug market changes or one component of an early warning system of emerging trends in drugs and violence [2]. For instance, as New York City struggled with a drug and violence epidemic in the 1980s associated with a rapid increase in crack cocaine usage, toxicology findings reflected a concomitant increase in the proportion of homicide victims testing positive for cocaine metabolites [3–5]. A more in-depth understanding of homicide victim toxicology can also help to clarify the relationships between victim

drug use and lethal violence outcomes. As the scientific evidence on homicide victim toxicology becomes more cumulative and systematic, it will enable scholars to make more definitive statements about the various causal pathways through which drug use might influence violent offending and victimization [1].

This paper presents the results of a meta-analysis of drug toxicology findings from samples of homicide victims reported in 18 studies. We first present descriptive statistics on the proportion of homicide victims testing positive for marijuana, cocaine and opiates across these studies. Next, we examine the impact of several moderator variables including testing procedures, the location where the study was conducted, the year(s) when the data were collected and demographic composition of the sample on toxicology findings. We conclude with some more general observations on the role of homicide victim toxicology data as one of many diagnostic tools available for assessing and understanding drugs and violence.

DATA AND METHODS

Study search and retrieval strategy

We began the process of locating relevant studies in June 2007 by searching for the terms 'toxicology' and 'homicide victims' within the abstracts of articles in three databases: Medline, Criminal Justice Abstracts and the National Criminal Justice Reference Service. In addition, we ran a full-text search for these same terms in Google Scholar. Excluding duplicate hits across databases, together these four searches resulted in 173 separate studies. We then harvested the reference lists from these 173 studies and identified an additional 66 studies that appeared potentially relevant. One of the authors then reviewed abstracts (where available) for the 239 studies returned during these initial searches to determine in each case whether the study reported toxicology findings for homicide victims. Of the 239 studies that were considered originally for inclusion, we retained 19 studies that met our eligibility criteria for the meta-analysis. A total of 28 868 toxicology test results derived from 30 482 homicide victims across five countries were examined.

Eligibility criteria

Studies were included based on their consistency with the eligibility criteria. First, the study sample must have consisted of homicide victims, or results were presented separately for homicide victims. Secondly, the study must have provided toxicology results. These results were presented in a statistical form that allowed for calculation of the percentage of the sample testing positive for one or more of the following drugs: marijuana, cocaine or opiates. Results must have been reported separately for one or more of these drugs; that is, if a study reported only the percentage testing positive for a combination of two or more of these drugs, that study was not eligible. Thirdly, the study must have been written in English. Fourthly, the sample must not have been restricted by weapon type (e.g. firearms or sharp instruments) or homicide type (e.g. domestic or gang-related homicides). However, two articles that were excluded from the overall analysis for this reason were later included for coding as part of a subanalysis of homicide victims killed with sharp instruments. Fifthly, the sample must not have been restricted by victim type (e.g. female or juvenile victims). Many of the studies that we excluded examined different subpopulations of homicide victims (adolescent victims, victims killed only with firearms or with blunt weapons, etc.).

We did not restrict inclusion based on the type of testing protocol used. Test methods have changed over time and testing protocols vary depending on the specific drug or sample (blood, urine or other body parts). Also, some testing equipment may have been readily available in some areas or countries but not in others. We also placed no restrictions on the geographic location of the study and therefore included studies conducted from all available nations. Our English language restriction, however, is likely to have limited the international breadth of the review. The only restriction we placed on the year of publication was that the study was published after 1950. However, most of the studies have been conducted since the early 1980s and published as journal articles. A few studies were books, chapters or technical reports.

Coding procedures

The coding forms (available from the first author) captured information on the characteristics of the study, such as the years for the homicide data, testing procedures used, etc. as well as the results of the toxicology tests. Multiple publications based on the same independent study, sample or data set were treated as a single study for coding purposes. The protocol allowed for the coding of multiple toxicology results (effect sizes) per study, such as the results for different drugs. Whenever possible, separate effect sizes were also coded for breakouts of the overall results by gender, race/ethnicity, age, sample year and weapon type used in the homicide. All studies were double-coded by independent coders and any discrepancies were resolved by an author who had not coded that particular study. The coding guidelines and procedures followed general systematic coding advice [6].

Statistical analyses

The effect size of interest for this meta-analysis was the proportion (p) of homicide victims testing positive for marijuana, cocaine or opiates. The meta-analytical

analyses, however, were performed using the *logit* of the proportion given its more desirable statistical properties [7,8]. If the reported proportion was zero, then the logit was computed based on a proportion equal to $1/n$. Final results were converted back into proportions for ease of interpretation. Meta-analytical analyses, including the mean effect size, estimates of heterogeneity and moderator analyses, were performed using the inverse variance weight method [7,9]. We assumed a priori that the data conformed to a random-effects model [7,10]. Under a random effects model, effect sizes are assumed to vary as a result of both within-study sampling error and between-study unobserved random differences. The full-information maximum likelihood estimator of the random effects variance component (tau-squared) was used [11]. All analyses were performed in Stata using macros available at http://mason.gmu.edu/~dwilsonb/ma.html. Effect sizes for each substance type were analyzed separately and only a single effect size per sample was included in a given analysis, maintaining statistical independence among effect sizes. An exception was made for analyses of breakouts. In these analyses, a study could contribute an effect size to each level of a breakout.

FINDINGS

Based on our comprehensive search of the literature, we identified 19 published books, journal articles, chapters or reports containing drug toxicology results from homicide victims [3–5,12–27]. The 19 publications represented 18 independent studies. Two of the studies were based on the same data [3,4], so we used only one of these studies [3] for all analyses, with two exceptions. In our analysis of the age breakout for opiates and the analysis by weapon type, we used the other study [4] because these breakouts were not available in the first.

Appendix I summarizes the characteristics of these 19 studies and the primary rates of toxicology for marijuana, cocaine and opiates. Three studies from outside the United States reported drug toxicology findings and met our inclusion criteria (Stockholm, Newfoundland, Oslo and Copenhagen). The rest of the studies were conducted within the United States and occurred in various states including California, Florida, Georgia, Louisiana, Michigan, New York, Pennsylvania, Tennessee and Texas. Some of the studies used city samples; others were collected from county records or a combination of both.

Table 1 provides the random effects mean and related statistics for marijuana, cocaine and opiates across the 18 independent studies. These overall results are based on the toxicology results reported on the full sample or largest sample available within each study. Eight of the 18 studies reported toxicology results for marijuana, with a range of 0–34%. The random effects mean was 6% [95% confidence interval (CI) = 2–17%, Q (test of homogeneity) = 290.76, df = 7, $P < 0.00005$]. Cocaine toxicology was reported in 16 of the 18 samples, with a range of 0–40%. The random effects mean was 11% (95% CI = 6–19%, $Q = 969.79$, df = 15, $P < 0.00005$), nearly double the mean for marijuana. The presence of opiates in homicide victims was reported in 12 of these studies, with a range of 0–17.7% and a random effects mean of 5% (95% CI = 3–7%, $Q = 307.51$, df = 10, $P < 0.00005$). These results are displayed graphically in forest plots in Figs 1–3. As indicated by the significant Q statistic, all three distributions were highly heterogeneous, suggesting significant variability across samples in the percentage of victims testing positive for these substances. Thus, different samples produce different estimates. Sources for this variability are explored below.

Table 1 Random effects mean percentage testing positive by drug type.

		95% C.I.				
Drug type	*Mean %*	*Lower*	*Upper*	Q^a	*P*	k^b
Marijuana	6%	2%	17%	290.76	<0.0005	8
Cocaine	11%	6%	19%	969.79	<0.0005	16
Opiates	5%	3%	7%	307.51	<0.0005	11

Meta-analyses performed on logged odds (logits) and converted back into percents. [a]Q is the test of homogeneity. [b]k is the number of effect sizes.

Year of data

The rate of illicit drug toxicology among homicide victims may change over time due to changing drug use patterns, dynamics within the drug trafficking business, law enforcement practices and other factors [28]. To explore changes in toxicology over time, we examined the results by year. Five of the 18 studies provided results separately by year. Four of these studies reported the results by individual years [16,18,21,12], whereas one study [26] reported results for two separate year ranges. For this study and studies that did not break out the results separately by year, we used the mid-point year (e.g. 1990.5 would be used if the years of data were 1990 and 1991). The relationship between the logit for the proportion testing positive for each drug and year of data was examined using meta-analytical regression methods. A visual inspection of the scatterplot for all three drugs revealed a positive relationship between proportion testing positive and year of data. For marijuana and cocaine the relationship was small, positive and statistically significant ($B = 0.16$, $Z = 2.40$, $P = 0.016$, $n = 13$; $B = 0.16$, $Z = 3.55$, $P = 0.00046$, $n = 26$). For opiates, the relationship was small and positive, but not statistically significant ($B = 0.04$, $Z = 1.16$, $P = 0.25$, $n = 20$).

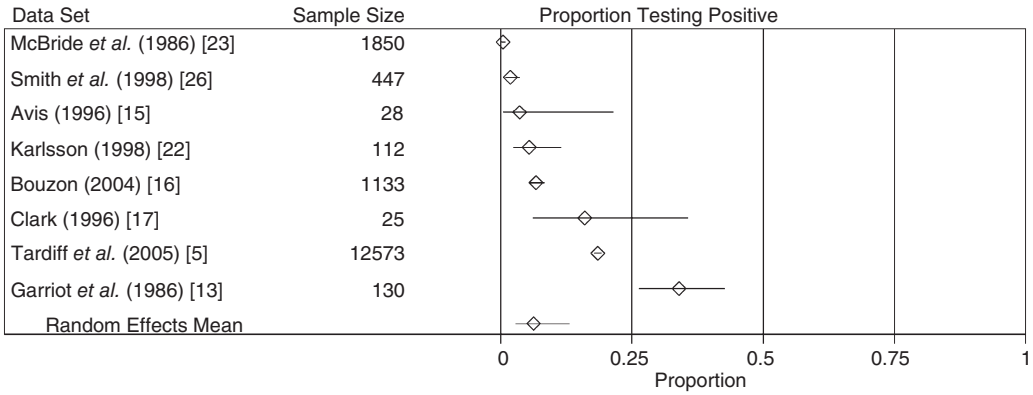

Figure 1 Proportion testing positive for marijuana and 95% confidence interval by study

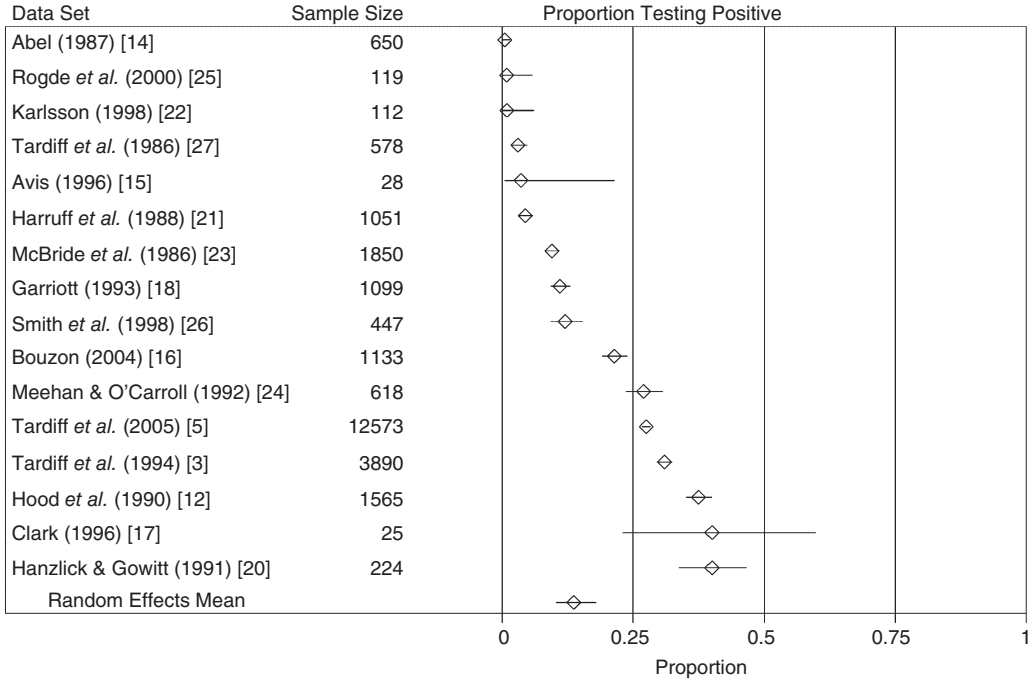

Figure 2 Proportion testing positive for cocaine and 95% confidence interval by study

The results were also comparable if effect sizes based on only a single data year were used. These findings suggest that some of the variability across samples in the proportion of homicide victims testing positive for marijuana and cocaine can be explained by the data year, with newer samples having higher rates of victims testing positive for marijuana and cocaine. This might be a function of improved testing technologies or increased efficiencies in sample preservation practices.

Victim age

Of the 18 samples, 10 included minors and adults and two were based exclusively on adult samples; for six studies we were unable to determine the age mix of the sample. A total of five studies were excluded because results were presented only for homicide victims from a particular age, race or gender category. Of these, four were excluded because the sample was restricted by age. Although several studies provided breakouts of toxicology results by age categories, the categories used were not consistent across studies. For example, Harruff *et al.* [21] used the following categories: 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50+; in contrast, Hood *et al.* [12] used: 0–19, 20–29, 30–39, 40+. A curvilinear regression line was fitted to the effects for each study. The results were remarkably consistent across studies, with all exhibiting a strong curvilinear relationship with the highest toxicology levels occurring during early to middle adulthood. More specifically, for marijuana the highest toxicol-

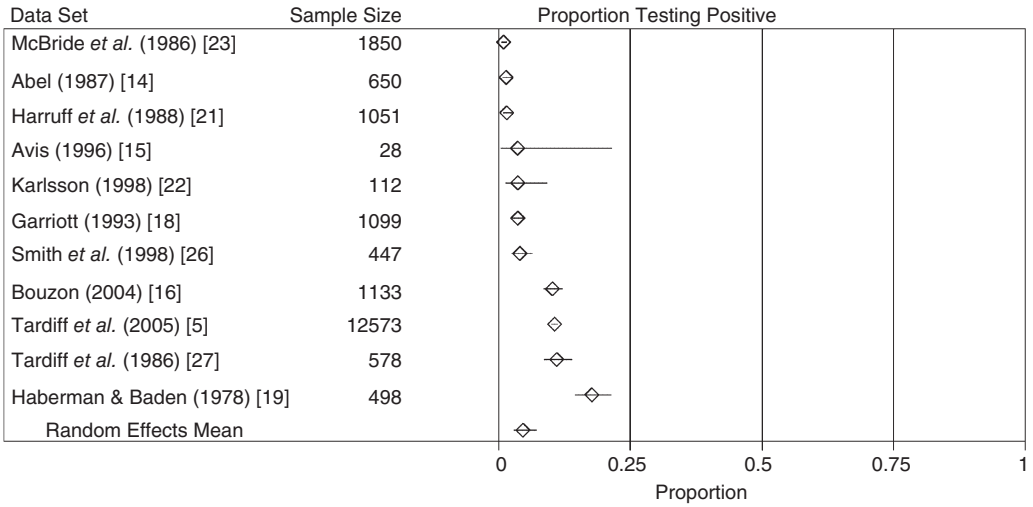

Figure 3 Proportion testing positive for opiates and 95% confidence interval by study

ogy level was for the age category 20–29 (40%) [3]). For opiates, the two highest age categories were for 25–34 (10%) and 35–44 (13%) [4], with the other age categories having opiate toxicology levels at 4% or less. Four studies provided age category breakouts for cocaine toxicology. One study dichotomized age as 10–24 and 25+ with the latter category having a significantly higher percentage testing positive for cocaine (18% and 33%, respectively) [24]. For the other three studies, the young adult age categories had the highest percentage testing positive: age category 30–34 [21]; age category 20–29 [12]; and age category 25–34 [3]. Thus, age appears to have a strong curvilinear relationship with the probability of a homicide victim testing positive for an illicit drug.

Gender

Gender breakouts were reported for cocaine in five studies [3,4,20,21,25] and for opiates in only one study [5]. No studies provided a gender breakout for marijuana test results. The results of the analyses of the percentage testing positive by drug by gender are shown in Table 2. The results are essentially the same for males and females, suggesting no gender differences in the rates of homicide victims testing positive.

Race/ethnicity

Racial/ethnic composition varied across samples. Four studies provided information on the relationship between race/ethnicity and cocaine toxicity [3,4,20,21]. The Q statistic for the test between means (analogous to a one-way F) for cocaine was significant, suggesting that the mean percentage testing positive varied by race/ethnicity. Hispanics had the highest level testing positive, followed by African Americans and Caucasians. All of the studies that included race/ethnicity breakdowns were conducted in the United States. As such, we use the term 'African American' to describe victims of African descent, but we also recognize that the racial and ethnic categories may be different within a global context.

When only the two studies that reported results for all four race categories were examined, Hispanics and African American were similar (37% and 33%, respectively), with Caucasians at 24% and other races at 5%. Only one study reported the results for opiate toxicology by race/ethnicity. Caucasians were the most likely to test positive (11%) followed closely by Hispanics (9%). African Americans were approximately half as likely (6%) to test positive as Caucasians. As with cocaine, the differences in victims testing positive across racial and ethnic groups was statistically significant, suggesting different patterns of use among homicide victims for different racial/ethnic groups.

Geographic location

Although we coded the specific geographic location for each sample, the only meaningful analysis possible at the meta-analytical level was whether the data came from the United States or elsewhere (see Table 1). For all three drugs, the percentage testing positive was higher in the United States than other countries, although this difference was small for marijuana (7% versus 5%) and opiates (5% and 4%). For cocaine, the difference was substantial (15% versus 1%) and statistically significant ($Q = 7.15$, $df = 1$, $P = 0.01$). Thus, it appears that cocaine use is a greater risk factor for violent victimization in the United States than Newfoundland and Scandinavia. This may reflect lower levels of cocaine availability and use in other parts of the world compared with North America [see 29].

Table 2 Random effects mean percent testing positive by drug type and gender, race, geographic region, and weapon.

		95% CI				
Drug type	*Mean percent*	*Lower*	*Upper*	*Q*[a]	*P*	*k*[b]
Gender						
Cocaine				0.02	0.90	
Males	16%	5%	41%			5
Females	14%	4%	38%			5
Opiates				NA	NA	
Males	7%	6%	8%			1
Females	8%	5%	11%			1
Race						
Cocaine				8.4	0.04	
African American	24%	12%	43%			4
Caucasian	15%	7%	31%			4
Hispanic	36%	15%	65%			2
Other	5%	1%	15%			2
Opiates				21.23	<0.0005	
African American	6%	4%	7%			1
Caucasian	11%	7%	16%			1
Hispanic	9%	8%	11%			1
Other	0%	0%	6%			1
Geographic region						
Marijuana				0.10	0.75	
United States	7%	2%	19%			6
Other	5%	1%	30%			2
Cocaine				6.60	0.01	
United States	15%	8%	25%			13
Other	1%	0%	8%			3
Opiates				0.08	0.78	
United States	5%	2%	8%			9
Other	4%	1%	17%			2
Weapon						
Cocaine				3.01	0.08	
Gun	36%	31%	43%			2
Other	28%	22%	35%			2
Opiates				NA	NA	
Gun	7%	6%	8%			1
Other	8%	6%	10%			1

Meta-analyses performed on logged odds (logits) and converted back into percentages. [a]*Q*: test of homogeneity; [b]*k*: number of effect sizes; CI: confidence interval; NA: not applicable.

Weapon type

A higher percentage of homicide victims killed from a gunshot wound tested positive for cocaine than those killed by other weapon types (36% versus 28%, respectively). This difference, however, was not statistically significant and was based on only two studies. Across the 17 studies that provided cocaine results, six reported the percentage of the sample killed from a gunshot wound. These values ranged from two studies with 0% gunshot victims to four studies with between 64% and 79% gunshot victims. The mean percentage testing positive for these two sets of studies was statistically significantly different (1% versus 23%, respectively). These analyses suggest that cocaine use increases risk of death from a firearm.

The evidence of a relationship between weapon type and opiate toxicology is sparse, with only one study providing a relevant breakout. Rates of opiate toxicology were similar for victims of a gunshot wound or other wound (7% versus 8%, respectively). Similarly, comparing the one sample with no gunshot victims to two samples with 70% and 79% gunshot victims, we found highly similar rates of opiate toxicity (3.6% versus 3.5%, respectively). Albeit limited, this evidence suggests that opiate use may be unrelated to the type of weapon used.

Publication-selection bias

An important issue in meta-analysis is publication-selection bias [30]. However, we believe that publication-selection bias is less likely to affect this meta-analysis for the following reason. Publication bias stems from the increased likelihood that statistically significant findings will be published relative to statistically non-significant findings. However, statistical significance is not an issue in the literature synthesized in this meta-analysis. None of the studies reviewed reported on the statistical significance of the toxicology results and such tests would not have been meaningful given the nature of this research. As such, the mechanism that produces publication-selection bias is unlikely to affect which results were published and which were not published within this research area. To bolster this assumption, two assessments of publication-selection bias were performed. First, we examined the funnel-plot for each drug type. The only asymmetry was fewer large effects from small studies than would be expected due to sampling error. This is opposite to what is seen typically when publication-selection bias is present. Secondly, we performed the Duval and Tweedie trim-and-fill analysis for each distribution [31]. This analysis also suggested there was no publication-selection bias associated with this meta-analysis.

DISCUSSION

This synthesis of the results of toxicology tests for marijuana, cocaine and opiates among homicide victims provides a basis of comparison for cities, counties, states and countries that are interested in diagnosing local drug problems. The findings suggest that on average 6% of homicide victims tested positive for marijuana, 11% tested positive for cocaine and 5% tested positive for opiates. Substantial variability existed across samples, suggesting that a single overall estimate will not be very predictive of the rates for a specific city or region. Analyses suggest that patterns in drug toxicology test results vary over time and across geographic location. Age had a strong curvilinear relationship with the probability of a homicide victim testing positive for marijuana, cocaine or opiates. Additionally, racial variations were apparent and the rate of positive cocaine tests may be linked to deaths by firearms versus other types of weapons.

Researchers interested in studying toxicology test results might begin with these two meta-analyses as reference points for comparing local toxicology results to findings from other parts of the region or world and to aggregate findings derived from the meta-analysis estimates. There are some clear advantages to using toxicology test results as one step towards diagnosing a local drug problem. First, toxicology data are gathered typically by trained professionals and the results are generated using sophisticated technologies that continue to evolve. To the extent that police are interested in test results, investigative processes associated with drug-related violence might be improved. Secondly, toxicology test results could be monitored easily over time, a process that would allow law enforcement agencies to recognize changes in the stability of drug markets and identify emerging drug markets. Thirdly, toxicology results could be used together with geographic analysis of homicide incident locations to determine whether there are observable spatial patterns in drug use and violence.

Limitations of using toxicology test results as indicators of drug-related violence

The conclusions that can be drawn from toxicology test results are limited in several ways. First and foremost, we cannot conclude that a positive drug test means that a homicide was drug-related without a review of the individual case circumstances, documented temporal correspondence between drug use and lethal outcome and elimination of other precipitating causes of violence. We might infer that substance use is a risk factor for lethal violent victimization to the extent that homicide victims test positive for drugs at higher rates than other populations. To our knowledge, this type of comparative study has not yet been conducted. Some toxicology studies have compared toxicology test results of homicide victims with victims of other forms of lethal violence (motor vehicle fatalities, suicides and general populations, for example). Some of these studies concluded that homicide victims tested positive for alcohol [32,33] and illicit drugs [33,12,13] at higher rates, supporting the proposition that these substances increase risk through some mechanism.

Secondly, few toxicology studies have considered and controlled for the elapsed time between victim intoxication and lethal injury and/or between the initial injury and eventual death. The sole exception was a New York City study that explored survival intervals (the elapsed time between injury and death) among homicide victims [4]. Considering and controlling for this critical timeframe is important, because if sufficient time has elapsed between intoxication and the violent event, a psychopharmacological or causal link cannot be established (because the effects of substances dissipate over time).

Thirdly, there are often differences in the types of tests used and the thresholds for confirming a positive test. For example, some states and/or countries use 80 mg/dl as the threshold for alcohol intoxication while others use 100 mg/dl. Some countries, such as the United States, have changed their threshold over time. The thresholds

for testing positive for illicit drugs can also vary based on the testing protocols. Distinguishing between legal and illegal opiate use in toxicology findings is also vital for drawing credible inferences. Although such tests are available, they are not always used [34]. Further, the specific tests for many drugs have changed as science progresses and testing technologies have advanced. Finally, some drug testing protocols allow for an initial screening test, followed by a confirmation test. However, such confirmation tests are not always available or used. Finally, few studies have examined toxicology results over time or attempted to link results to local crime patterns. One notable exception was a New York City study that linked toxicology reports from 1990 to 1998 to homicide and fatal accident data [5].

Improving future toxicology studies

Future toxicology studies might be improved in several ways. First, many studies provided limited or no information on demographic patterns, links to homicide motives, information on weapons used and other important components of homicide. Linking toxicology test results to homicide case data and victim characteristics will improve the relevance of the information. Secondly, some studies that we excluded from the meta-analysis explored subsamples of homicide victims (e.g. victims who tested positive only for cocaine or were killed by firearms only). Those studies should be continued, but overall sample or population characteristics should also be included to allow sample-to-sample comparisons. Thirdly, some studies did not report percentages or raw numbers; most did not report means or other aggregate statistics. Fourthly, we did not identify any studies that considered evidence processing time-frames or evidence preservation procedures. The elapsed time between intoxication and the lethal outcome and sample evidence preservation is an important consideration, particularly for alcohol, which metabolizes prior to and following death [34–36]. Fifthly, only one study considered victim survival intervals and the implications for false negative test results [3]. Finally, while blood alcohol content is quantified easily and readily, the volumes of other illicit substances are not reported routinely in drug toxicology test results. As forensic science evolves and as technology progresses, we hope such measures will become more available and standardized.

In conclusion, toxicology test results constitute a readily available tool for criminologists, forensic scientists, law enforcement officials, policy makers and others who are interested in diagnosing drug and violence problems. Such information should be supplemented with other sources of data, including ethnographic research in distressed communities [37], self-report surveys and/or urinalysis test results from arrestees [38], prisoners [39], drug treatment recipients [40], households [41] or youth in schools [42]; intelligence reports and/or official data (e.g. numbers of arrests for drug offenses) from law enforcement agencies [43]; drug seizure data [44]; and hospital admissions or mortality data [45]. Examining these data sources collectively will result in more well-informed diagnoses of drug and violence problems and more effective remedies. Further, a recent Australian study compared toxicology results from homicide victims to drug prevalence estimates from the general population, and concluded that the rates of testing positive were higher among the victims [46]. Most of the studies included in this meta-analysis occurred in the United States. Estimates among the general US population suggest that 5.8% (14.4 million) are current users (past month) of marijuana, 0.8% (2.1 million) use cocaine and 0.06% (153 000) use heroin, and these use rates have remained relatively stable over recent years [47]. While recognizing the inherent difficulties associated with comparisons, estimates of illicit drug use among the general population are typically lower than average toxicology results among homicide victims in this study, suggesting that illicit drug use may be a risk factor for homicide in multiple locations around the world.

Declarations of interest

None.

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Appendix I Articles included in the meta-analysis and toxicology findings for marijuana, cocaine and opiates.

(Study ID) citation	*Place*	*Years*	*n*	*Marijuana*	*Cocaine*	*Opiates*
Abel (1987) [14]	Erie County, NY	1973–1983	650	NA	.5%	1.4%
Avis (1996) [15]	Newfoundland	1985–1993	28	.00%	.00%	.00%
Bouzon (2004) [16]	Orleans Parish, LA	1980, 1985, 1990, 1995, 2000	1 133	6.7%	21.4%	10.2%
Clark (1996) [17]	St John Parish, LA	1992–1996	25	16%	40%	NA
Garriott (1993) [18]	Bexar County, TX	1985, 1987, 1990, 1991	1 099	NA	11%	3.6%
Garriott *et al.* (1986) [13]	Bexar County, TX	1985	130	34%	NA	NA
Haberman & Baden (1978) [19]	New York City, NY	1974–1975	498	NA	NA	17.7%
Hanzlick & Gowitt (1991) [20]	Fulton County, GA	1989	224	NA	40%	NA
Harruff *et al.* (1988) [21]	Shelby County, TN	1980–1986	1 051	NA	4.4%	1.5%
Hood *et al.* (1990) [12]	Wayne County, MI	1984–1987	1 565	NA	37.5%	NA
Karlsson (1998) [22]	Stockholm	1983–1992	112	5.4%	.9%	3.6%
McBride *et al.* (1986) [23]	Miami-Dade County, FL	1978–1982	1 850	.4%	9.5%	.9%
Meehan & O'Carroll (1992) [24]	Los Angeles, CA	1987	618	NA	27%	NA
Rodge *et al.* (2000) [25]	Oslo and Copenhagen	1985–1994	119	NA	0%	NA
Smith *et al.* (1998) [26]	Allegheny County, PA	1984–1993	447	1.8%	12%	4%
Tardiff *et al.* (1986) [27]	Manhattan, NY	1981	578	NA	3%	11%
Tardiff *et al.* (1994) [3]	New York City, NY	1990–1991	3 890	NA	31%	NA
Tardiff *et al.* (1995) [4]	New York City, NY	1990–1991	2 824	NA	31.3%	7.3%
Tardiff *et al.* (2005) [5]	New York City, NY	1990–1998	12 573	18.5%	27.5%	10.6%