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Comparative evaluation of toxicology and sociodemographic characteristics in homicide and suicide victims

Uporedna analiza socijalno-demografskih i toksikoloških karakteristika žrtava ubistava i počinioca samoubistava

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Abstract

Background/Aim. Suicide and homicide are crucial social problems, especially frequent among the population younger than 40 years. The aim of this study was to assess the influence of different sociodemographic factors and relevant psychoactive substances on the difference between homicide and suicide victims. **Methods.** A cross-sectional study analyzed autopsy reports of 714 suicide and 166 homicide cases autopsied in five years (2011–2016). Out of these, 666 suicide and 127 homicide cases met the inclusion criteria for this study. Blood-ethanol concentration was determined by headspace gas chromatography with flame ionization detection. Analysis of substances other than ethanol was accomplished by gas chromatography-mass spectrometry and liquid chromatography with tandem mass spectrometry. **Results.** There was a significant difference in age, level of education, and employment rate between suicide and homicide cases ($p < 0.05$). The distribution of suicide and homicide cases differed significantly on weekdays compared to weekends [odds ratio(OR) = 1.5; 95 % confidence interval (CI) = 1–2.3; $p < 0.05$]. The presence of a psychoactive substance remained a nonsignificant predictor of whether a person would become a homicide or suicide victim ($p > 0.05$). Homicide victims were more likely to have significantly higher blood alcohol concentration (0.2–0.3 g/dL) than suicide victims (OR = 2.2; 95 % CI = 1–5; $p < 0.05$). **Conclusion.** The age, level of education, employment status, and high blood alcohol concentration (0.2–0.3 g/dL) of the victim were significantly different between suicide and homicide cases.

Key words:
autopsy; alcohol drinking; chromatography; education; homicide; risk factors; sex factors; sociodemographic factors; suicide; substance related disorders.

Apstrakt

Uvod/Cilj. Samoubistva i ubistva su veoma važan socijalni problem, koji je posebno čest kod osoba mlađih od 40 godina. Cilj rada bio je da se proceni uticaj socijalno-demografskih faktora i psihoaktivnih supstanci na razliku među žrtvama ubistava i počinioca samoubistava. **Metode.** Studijom preseka obuhvaćeno je 714 slučajeva samoubistava i 166 slučajeva ubistava, obdukovanih u periodu od pet godina (2011–2016). Nakon selekcije, u studiju je uključeno 666 slučajeva samoubistava i 127 slučajeva ubistava. Prisutvo alkohola u krvi određivano je metodom gasne hromatografije sa detekcijom plamene jonizacije. Analiza drugih supstanci, osim etanola, rađena je metodom gasne hromatografije sa masenom spektrometrijom i tečnom hromatografijom tandem-masenom spektrometrijom. **Rezultati.** Utvrđena je statistički značajna razlika u životnom dobu, nivou obrazovanja i statusu zaposlenja među slučajevima ubistava i samoubistava ($p < 0,05$). Distribucija slučajeva samoubistava i ubistava značajno se razlikovala radnim danima u odnosu na vikende [*odds ratio* (OR) = 1,5; 95 % *confidence interval* (CI) = 1–2,3; $p < 0,05$]. Prisustvo psihoaktivnih supstanci nije bilo značajan pokazatelj da li će osoba postati žrtva ubistva ili će izvršiti samoubistvo ($p > 0,05$). Žrtve ubistava su češće imale značajno veću koncentraciju alkohola u krvi (0,2–0,3 g/dL) nego žrtve samoubistva (OR = 2,2; 95 % CI = 1–5; $p < 0,05$). **Zaključak.** Starost, nivo obrazovanja, status zaposlenja i visoka koncentracija alkohola u krvi (0,2–0,3 g/dL) značajno su se razlikovali među žrtvama samoubistava i ubistava.

Ključne reči:
autopsija; alkohol, pijenje; hromatografija; obrazovanje; ubistvo; faktori rizika; pol, faktor; socijalno-demografski faktori; samoubistvo; poremećaji izazvani supstancama.

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Introduction

Suicide and homicide as forms of violent death represent conscious and intentional destruction of one's own or others' life. The frequency of these forms constantly declined between 2000–2015 on the global level [1, 2]. Different factors are associated with variations in homicide and suicide mortality rates. In previous decades, the influence of many social, economic, geographic, and demographic factors on the frequency of appropriate violent death types was particularly studied [3–10]. Furthermore, essential determinants connected with violence are generally the consumption of alcohol, different narcotics, and some psychoactive drugs [11–15]. Namely, previous studies showed that more than half of suicide and homicide victims had positive toxicological findings on psychoactive substances in the blood [11, 12, 16, 17]. However, presented results vary in different world regions, and many other factors such as gender, age, cause of death, and methodological procedures on data collection could affect the distribution of the presence of substances in suicide and homicide victims [14, 15, 18, 19].

The number of death cases due to injuries, poisoning, and other external causes shows a decreasing trend in Serbia [20]. Although distribution data of different forms of violent death exist, a relatively small number of studies examined the association between certain sociodemographic factors and the incidence of homicide and suicide in our region [2, 7]. In addition, the connection between psychoactive substance usage and these violent forms of death was insufficiently analyzed. Until now, only the influence of alcohol consumption on homicide and suicide rates has been extensively studied [5, 21].

The aim of this study was to assess the influence of different sociodemographic factors and relevant psychoactive substances on the difference between homicide and suicide victims.

Methods

Case identification

This study was designed as a cross-sectional. All homicide and suicide cases autopsied at the Institute of Forensic Medicine "Milovan Milovanović" in Belgrade, Serbia from 1st January 2011 to 31st December 2016 were included. From a total of 880 autopsy cases, 127 homicide and 666 suicide cases fulfilled the selection criteria. Considering that the aim of our study was to examine the indirect influence of psychoactive substances on suicide and homicide frequency, all those cases in which the cause of death was deliberate or accidental drug overdose were excluded. All cases in which the victim died in a hospital after being treated for 24 hrs without undergoing toxicological analysis were also excluded. After the selection, 793 cases (127 homicides and 666 suicides) remained in our study. For this type of study, formal consent was not required.

Toxicological analysis

Toxicological analyses were performed in the Laboratory of Toxicology of the Institute of Forensic Medicine "Milovan Milovanović". The presence and concentration of ethanol were determined in all cases; however, not all suicide and homicide victims were examined for the presence of other psychoactive substances. Hence, the influence of psychoactive drugs besides ethanol on homicide and suicide rates and their other features was analyzed only in cases with complete toxicological findings (47 homicide and 129 suicide cases).

Blood-alcohol concentration (BAC) was determined by head-space gas chromatography with flame-ionization detection (HS-GC-FID). The limit of ethanol detection was set at 0.0001 g/dL, and the limit of quantification was 0.0003 g/dL. In this study, the cut-off concentration was 0.03 g/dL to report positive alcohol results because lower values can be the result of endogenous *post-mortem* alcohol production [22].

Analysis of other psychoactive substances was performed by gas chromatography with mass spectrometry (GC-MS) and liquid chromatography with tandem mass spectrometry (LC-MS/MS).

Case categorization

All included cases of homicide and suicide were divided into categories according to the victim's gender, age, marital status, level of education, employment status, day of death, suicidal or homicidal method, and toxicological analysis findings. To simplify our analysis, we defined age groups as < 40, 40–65, and > 65 years of age. According to the education level, subjects were divided into two categories, those with a high level of education (if the victim had a university degree) and those with lower levels of education (finished elementary and/or high school). The day of death was categorized into a weekend (Friday, Saturday, and Sunday) or a workday, accordingly. Psychoactive substances were categorized as alcohol (ethanol), methadone and opioids (heroin, 6-monoacetylmorphine, codeine, morphine, and/or tramadol), cannabinoids (D-9-tetrahydrocannabinol – THC and/or THC acid), psychostimulants (cocaine, benzoylecgonine, and/or 3,4 methylenedioxymethamphetamine – DMA), and psychoactive drugs (benzodiazepines, antidepressants, antipsychotics, and/or anticonvulsants). Heavy alcohol intoxication was defined as the presence of BAC of 0.2–0.3 g/dL.

Statistical analysis

Statistical analysis was conducted using the commercial statistical package SPSS (Statistical Package for the Social Sciences software – IBM Statistics) version 20.0. The evaluation of differences between variables was performed by Student's *t*-test and Mann-Whitney *U* test depending on the normality of data distribution. In order to define the influence of psychoactive substances and concordant social demographic factors on homicide or suicide risk, the odds ratio (OR) and 95% confidence interval (CI) were estimated using logistic regression. A *p*-value below 0.05 was considered significant, and below 0.01 was considered highly significant.

Results

The victim's demographic and forensic characteristics are shown in Table 1. There was no statistically significant difference in gender distribution between suicide and homicide cases ($p = 0.062$). According to the mean age between homicide and suicide victims, the difference was statistically significant ($p < 0.001$).

The distribution of homicide and suicide victims according to age groups is shown in Figure 1. Persons aged under 40 years were significantly more frequent among homicide victims compared to suicide victims (OR = 3.8; 95% CI = 2.5–5.6; $p < 0.01$). Marital status in homicide cases was not significantly different from suicide cases. There were significantly more victims with a higher level of education in the suicide group (15.9%) compared to the homicide group (7.8%). Better-educated persons had a lower risk of being killed than committing suicide (Table 1).

Among homicide cases, more victims were employed compared to the suicide cases. The most common homicidal method was a gunshot (55.6%), whereas, in the suicide group, it was hanging (42.3%) (Table 1). The distribution of cases depending on the day of death is shown in Figure 2. Those who died on workdays were more often victims of homicide in relation to those killed on weekends (OR = 1.5; 95% CI = 1–2.3; $p = 0.049$).

Table 1

Demographic and forensic characteristics of homicide and suicide cases

Variable	Homicide	Suicide	OR (95% CI)	*p*
Age	45.2 ± 17.34	57.3 ± 17.4		< 0.001
Gender				
male	85 (66.9)	499 (74.9)	1.0	
female	42 (33.1)	167 (25.1)	1.5 (1–2.2)	0.062
Married				
no	68 (56.2)	370 (57.1)	1.0	
yes	53 (43.8)	278 (42.9)	1.0 (0.7–1.5)	0.854
Education (higher level)				
no	106 (92.2)	499 (84.1)	1.0	
yes	9 (7.8)	94 (15.9)	0.4 (0.2–0.9)	0.029
Employed				
no	81 (67.5)	489 (76.8)	1.0	
yes	39 (32.5)	148 (23.2)	1.6 (1–2.4)	0.032
Method				
gunshot	70 (55.6)	170 (25.5)		
cuts/stabbing	29 (23)	29 (4.4)		
fall from height	0	122 (18.3)		
hanging	0	282 (42.3)		
blunt force injury	18 (14.3)	0		
drowning	0	33 (5)		
poisoning	0	9 (1.4)		
vehicle injury	0	10 (1.5)		
strangulation/asphyxia	7 (5.6)	2 (0.3)		
other	2 (1.6)	9 (1.4)		

OR – Odds ratio; CI – confidence interval.
All values are expressed as numbers (percentages) except for the age, which is expressed as mean ± standard deviation.

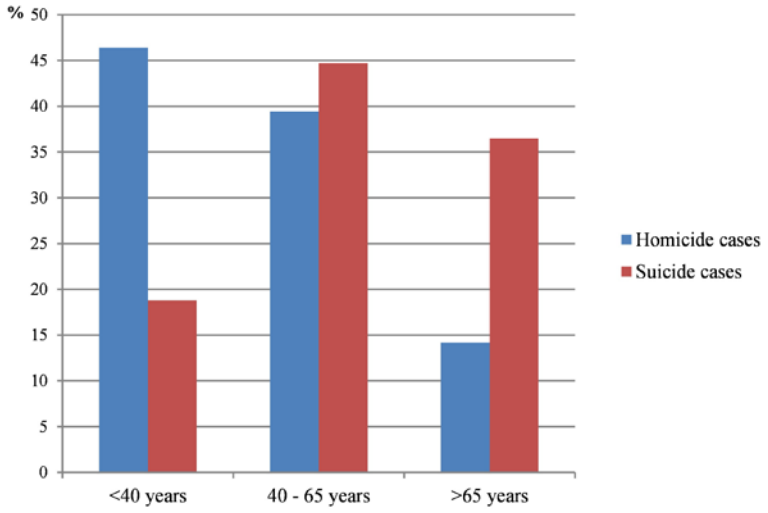

Fig. 1 – Distribution of suicide and homicide cases according to age groups.

The relationship between toxicological findings and the distribution of homicide and suicide cases is presented in Table 2. There were no statistically significant differences in the presence of opioids and methadone, psychostimulants, and psychoactive drugs between the group of homicide and suicide cases. As cannabis was not detected in any of the suicide cases, its influence could not be examined.

Alcohol (ethanol) was present in 15.5% of all cases (18.1% of homicide and 15% of suicide cases); however, its presence did not affect the distribution of victims owing to appropriate forms of violent death. The median blood-ethanol concentration of homicide victims was 0.19 g/dL (ratio 0.04–0.48 g/dL), while in the population of suicide victims, it was 0.14 g/dL (ratio 0.04–0.51 g/dL), and the difference was not significant (U = 909.000; $p = 0.12$). Nevertheless, the blood-ethanol concentration corresponding to heavy alcohol intoxication (0.2–0.3 g/dL) was significantly more frequent in homicide victims (7.1% to 3.3% OR = 2.2; 95% CI = 1–5; $p = 0.049$).

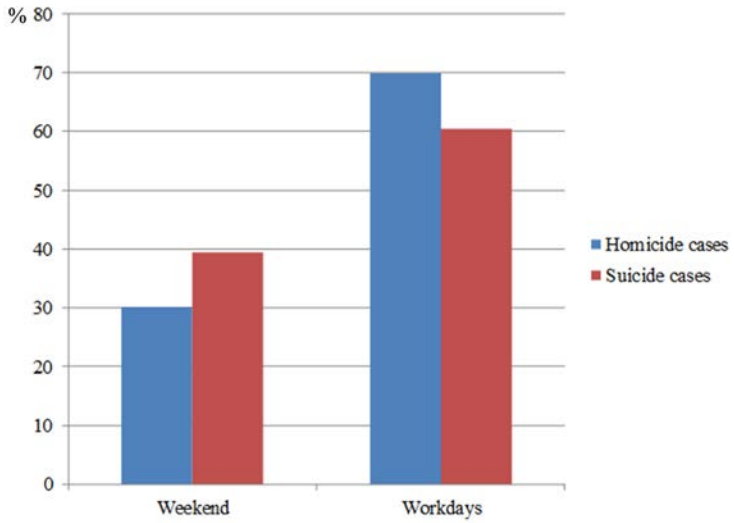

Fig. 2 − Distribution of suicide and homicide cases according to the day of death.

Table 2

Toxicology results of homicide and suicide cases

Variable	Homicide	Suicide	OR (95% CI)	*p*
Alcohol				
no	104 (81.9)	566 (85)		
yes	23 (18.1)	100 (15)	1.3 (0.8–2.1)	0.38
Blood-ethanol concentration (g/dL)	0.19 (0.04–0.48)	0.14 (0.04–0.51)		0.12
High level of alcohol intoxication (0.2–0.3 g/dL)				
no	118 (92.9)	644 (96.7)		
yes	9 (7.1)	22 (3.3)	2.2 (1–5)	0.04
Opioids and methadone				
no	42 (89.4)	111 (86)		
yes	5 (10.6)	18 (14)	0.7 (0.3–2.1)	0.56
Cannabis				
no	44 (93.6)	129 (100)		
yes	3 (6.4)	0		
Psychostimulants				
no	45 (95.7)	128 (98.5)		
yes	2 (4.3)	2 (1.5)	2.8 (0.4–20.8)	0.30
Psychoactive drugs				
no	41 (87.2)	96 (74.4)		
yes	6 (12.8)	33 (25.6)	0.4 (0.2–1.1)	0.07
Illicit substances				
no	39 (83)	113 (87.6)		
yes	8 (17)	16 (12.4)	1.4 (0.6–3.6)	0.43

OR – Odds ratio; CI – confidence interval.
All values are expressed as numbers (percentages) except for the blood-ethanol concentration, which is expressed as median and range.

Discussion

In particular world regions such as India, the USA, and Japan, the incidence of homicide and suicide is stagnant or rising [2, 23, 24]. On the other hand, in some countries, these forms of lethal violence are considered the most common causes of death in the population under 40 years of age [25]. The effect of these forms of violent death on overall mortality rates will likely become more notable in the future following numerous societal and technological changes worldwide. Sociodemographic characteristics of the population and the abuse of psychoactive substances probably play an important role in the cases of suicide and homicide, but their influence is still insufficiently estimated.

Our study examined the influence of different sociodemographic factors and relevant psychoactive substances on the difference between homicide and suicide victims. It was shown that certain sociodemographic characteristics (e.g., gender, educational level, marital status, etc.) could increase or decrease a person's risk of becoming a victim of homicide or suicide. Nevertheless, it was shown that there was no significant difference between homicide and suicide cases in terms of the usage and type of abused psychoactive substances.

In our study, there was a significant age difference between the homicide and suicide populations. Younger persons were more prevalent in the group of murder victims, while older more often committed suicide. These results could, to some extent, explain the differences in homicide and suicide rates between younger and older persons. Our results are in concordance with numerous studies that showed that most of the population of suicide victims are persons older than 65 years, whereas victims of murder were most often persons under 40 years of age [5, 18, 25–27]. The older population is prone to developing different organic diseases connected with certain psychiatric disorders. Moreover, the cumulative effect of stress increases with age, and it can negatively affect mental health and contribute to suicidal behavior [27]. On the contrary, the population younger than 40 years is more exposed to various circumstances associated with interpersonal violence [4, 28].

The previous studies also showed male predominance in homicide and suicide cases, and our study showed that the distribution of males and females did not differ significantly between homicide and suicide victims, which is consistent with the results of Molina and Hargrove [16]. In contrast, Darke et al. [11] found that males are more prone to suicide, three times as often as women. This difference could be explained by the fact that in some parts of the world, females primarily choose methods to commit suicide that do not result in immediate death. That could lead to an underestimate of the number of suicide cases, even though there is an equal or higher prevalence of suicide attempts in females compared to males [7, 29].

Like in other studies [9, 29], our results showed no significant association between marital status and type of violent death. Obtained results also pointed out that suicide and homicide cases did not differ significantly in terms of the victim's marital status. However, our results indicated that the level of education and employment status could have a specific influence on homicide and suicide rates. Highly educated and unemployed persons had a lower risk of becoming murder victims than committing suicide. In contrast, the employed had a greater risk of being killed. Our results are in concordance with the data of Bando and Lester [9] and Milner et al. [30]. It is considered that a population of highly educated individuals is more likely to avoid engaging in dangerous behavior. Likewise, these people are less exposed to a social environment where interpersonal violence plays an important role in dealing with misery and unhappiness [9]. Highly educated persons, in most cases, have a better quality of life and thus often have no clear external source to blame for their misery. That could lead to depression and specific autoaggressive behavior. On the contrary, persons with a lower quality of life mainly represent the poorly educated people who solve their conflicts with violence that could result in murder [31]. Prolonged unemployment is usually followed by a sense of underachievement and self-deprecation that could result in vulnerability to suicide [30].

In the presented report, more murders were observed on workdays rather than suicides. The possible explanation could be careful planning of the murder as well as knowledge of the daily routine of the victim. As opposed to these, suicides were more frequent on weekends. However, fewer studies have analyzed the association between the day of death and suicide and homicide rates. Kattimani et al. [32] reported in their study that Sunday is the day with the highest number of suicide attempts.

In agreement with several previous studies [11, 12, 16, 17], more than half of included homicide and suicide victims were positive for a psychoactive substance. These drugs have direct psychopharmacological effects on the user, making them more prone to endanger their own or others' health. The consumer is also often forced to use violence (through robbery or burglary) to obtain money for drugs. Finally, illicit drugs cause systemic violence as a result of activities on illegal drug markets, where conflicts are regularly solved using violent behavior [12]. Regardless of the obtained results, the influence of psychoactive substance uses on violence, in general, cannot be ignored.

Ethanol was detected in 15.5% of all analyzed suicide and homicide cases. Results of our study showed that the presence of ethanol in the blood did not differ significantly between suicide and homicide victims. This finding was in accordance with results obtained by Darke et al. [11]. Despite this finding, the fact that 4.7% of the population in Serbia consumes alcohol daily [20] emphasizes the importance of alcohol in the expression of lethal violence. Darke et al. [11] also found that the concentration of ethanol was significantly higher in murdered persons than that among suicide victims; however, our study did not show a similar difference between homicide and suicide cases. In the present study, a significantly higher number of murder victims were in a state of heavy alcohol intoxication (0.2–0.3 g/dL) in comparison to suicide victims. That can imply that high blood-ethanol concentrations have a particular influence on differences be-

tween homicide and suicide rates. Additionally, a possible explanation for this finding could be that victims with heavy alcohol intoxication are more vulnerable and are less competent to perform complicated forms of suicide such as hanging.

In our study, there was no significant difference between homicide and suicide cases in terms of the presence of opioids, psychostimulants, and psychoactive drugs. On the contrary, other studies [11, 16] showed that the presence of opioids and psychostimulants was more prevalent among the murdered than the suicide victims, while certain psychoactive drugs were more often detected in the victims of suicide. On the one hand, the insufficient number of complete toxicological analyses directly affected the sample size of our study. On the other hand, unjustified and uncontrolled usage of certain psychotropic drugs in the general population could explain our results.

Conclusion

The results of our study pointed out that some sociodemographic characteristics, primarily age, level of education, and employment status, could affect the differences between the victims of homicide and suicide. Additionally, murders were more prevalent on workdays, while suicides occurred more frequently on weekends. The presence of a psychoactive substance was not associated with differences between homicide and suicide rates. Heavy alcohol intoxication could increase the chances of becoming a murder victim in comparison to committing suicide.

Considering that some of the toxicological findings could be predictors of homicide and suicide, it should be advised that the complete toxicological analysis be performed not only in the herein discussed but also in all other forms of violent deaths in the future.

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