

Research Paper

Toxicological analysis in victims of sexual and domestic violence: A retrospective study of a 3-year period (2018–2020)

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ABSTRACT

This manuscript presents an epidemiological investigation carried out on abuse victims who accessed the Sexual and Domestic Violence Service (SVS&D) of IRCCS Ca' Granda in Milan, Italy. The focal point of this research was the detection of alcohol, prescription medications, and illicit substances in victims who solicited help from the SVS&D center between 2018 and 2020. Over this three-year span, biological samples of blood and urine were procured from 207 victims, out of a patient pool of 2470. All collected samples were analyzed via High Performance Liquid Chromatography – Tandem Mass Spectrometry (HPLC-MS/MS) and Gas Chromatography – Mass Spectrometry (GC-MS).

Toxicological examination results demonstrated that 43% of the cases tested positive for substances in 2018, 39% in 2019 and 60% of the cases in 2020. Overall, 45% of the victims tested resulted positive to some substance over a 3-year period, equivalent to 3.6% of the overall cases (2470 victims). Substances of toxicological interest were detected in 104 samples (out of 377, corresponding to 27.6%) belonging to 94 patients. The most detected classes of drugs were stimulants, antidepressants, benzodiazepines and antipsychotics. Moreover, BAC (Blood Alcohol Concentration) indicated positivity in 25 cases (out of 184 cases analyzed - 14% of positive cases). Based on this study's findings, we recommend broadening the range of substances evaluated in drug-facilitated sexual assaults and establishing standardized protocols for both national and international implementation. Implementing procedures would significantly enhance forensic support provided to victims of abuse seeking health-care services post-incident.

1. Introduction

Forensic toxicology plays a pivotal role in cases of sexual abuse where drugs, alcohol, or illicit substances have been utilized by the perpetrator either actively to incapacitate the victim or when the assault

opportunistically takes advantage of the fact that the victim is per se under the influence of some substance which may make him or her more vulnerable. The findings and testimony provided by clinical forensic practitioners can assist the Public Prosecutor in convicting the perpetrators and holding them accountable for their actions.

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Sexual² and domestic³ violence are currently considered as relevant worldwide public health issues.^{1,2} Although more commonly reported as acts perpetrated against women, sexual and domestic violence affect victims of both genders.^{1,3}

The current study aims to provide an epidemiological overview of the most commonly detected drugs and Blood Alcohol Concentration in sexual and domestic abuse cases evaluated at Milan's Center for Sexual and Domestic Violence SVS&D⁴ through the analyses of blood and urine with High Performance Liquid Chromatography – Tandem Mass Spectrometry (HPLC-MS/MS) and Gas Chromatography – Mass Spectrometry (GC-MS). The purpose of the study is to describe the often understated and underrecognized phenomenon such as Drug Facilitated Sexual-Assault (DFSA) and raise awareness among healthcare practitioners who could be involved during their clinical activity in emergency services. Furthermore, beyond the scope of DFSA, it is critical to discern which drugs are more frequently detected among victims of sexual and domestic abuse and understand the support healthcare professionals can offer in such scenarios.

2. Materials and methods

The study was conducted in a single medical center through a retrospective analysis of clinical records regarding victims of violence observed at the SVS&D Center of Milan over a three-year period (January 2018 to December 2020).

2.1. Setting

The SVS&D service, located at the *Ospedale Maggiore Policlinico* of Milan, is specialized in providing support and aid to victims of sexual crimes and domestic violence. The accesses to the center were voluntarily or ordered by law authorities. The victims, based on the reported violence, were evaluated by a group of experts of clinical forensic medicine and other specialties as gynecologists, social workers, psychologists, and lawyers.

2.2. Procedure

During medical examinations of the victims, biological specimens (for genetic and toxicological purposes) were collected based on the narrative of the event. These samples were guaranteed for long-term storage and made available to the authority in charge or to the patients themselves.

2.3. Victims of sexual or domestic harassment

From the analyses of the data emerged a total number of 2470 victims that were admitted to sexual violence (SVS) and domestic violence (SVD) centers in a 3-year period (2018–2020): 1025 were admitted to the center in 2018, 903 in 2019 and 542 in 2020. The population that referred to SVS and SVD center was mainly female (93% of all

individuals). Moreover, more than 50% of the victims were Italian.

Underage individuals (people below 18 years of age) made up for the 20% of the total number of the victims. The population most exposed to the assaults was over 18 years of age for females while 51% of male individuals were minors. In 939 cases (38%), the time elapsed between the occurrence of the violent event and the arrival at the SVS&D Center was 12 h; in 420 cases (17%), it took the victims between 12 and 24 h; in 245 cases (10%), it took less than 48 h; in 166 cases (6.7%), it took one week; and in 700 cases (28.3%), it took more than a week for the victims to seek help from these specialized centers. From the total group of 2470 victims, 1075 of them were examined for sexual violence (SVS center), 1310 for domestic violence (SVD center) and 85 for both (SVS and SVD) (Table 1).

2.4. Sample collection and analyses

Most of the victims (more than 20% of the individuals per year) were aged between 18 and 27 years (Fig. 1). Nonetheless, all the ranges of ages were represented by more than 2% of victims (Fig. 1), maintaining the same trend from 2018 to 2020 (Fig. 1). From 207 victims selected for this study, a total of 377 blood and urine specimens were collected and analyzed using a High-Performance Liquid Chromatography-Tandem Mass Spectrometry (HPLC-MS/MS) system TSQ Fortis II and Blood Alcohol Concentration (BAC) and the detection of volatile substances were performed with Head Space-Solid Phase Micro Extraction (HS-SPME) using a Gas Chromatography-Mass Spectrometry (Thermo Fisher Scientific, DSQII), as reported our previous paper.⁴ All samples were previously screened comparing the results with a NIST library. When matching, molecules were added to a customized inclusion list, and samples were analyzed again to perform a qualitative analysis, as reported in our previous paper.⁵

2.5. Ethical approval

Institutional Review Board approval for the study was obtained, as the victims had released specific informed consent for the use of their data for research. The consent was given according to D. Lgs. n. 196/2003 and GDPR 679/2016.

3. Results

From toxicological analyses, 43% of the cases in 2018, 39% in 2019 and 60% of the cases in 2020 yielded positive results. Overall, 45% of the victims tested, in the 3 years period considered, resulted positive to some substance of toxicological interest (according to drugs or alcohol investigations), equivalent to the 3.6% of all cases (2470 victims).

Substances of toxicological significance were detected in 104 samples (out of 377, corresponding to 27.6%) belonging to 94 patients.

The most frequently detected classes of drugs were represented by stimulants, antidepressants, benzodiazepines and antipsychotics () (Table 2-4). Blood Alcohol Concentration (BAC) tests resulted positive in 25 cases (out of 184 cases analyzed - 14% of positive cases) (Table 3).

4. Discussion

4.1. Analysis of the results

In the current study, the majority of victims who resulted positive for substances of toxicological interest were female, of Italian origin, and aged between 18 and 37 years. Toxicological analyses revealed illicit drugs in 45% of the victims, licit drugs in 30%, and a combination of both in 25% of cases. Specifically, stimulants were detected in 48 cases (out of 73–66%), antidepressants were found in 11 cases (15% of positive patients), benzodiazepines in 14% of the positive patients (10 out of 73) and antipsychotics in 11% of the positive individuals undergoing toxicology testing (8 out of 73) (Table 4). Stimulants were the most

² defined by WHO as “Any sexual act, attempt to obtain a sexual act, unwanted sexual comments or advances, or acts to traffic, or otherwise directed, against a person's sexuality using coercion, by any person regardless of their relationship to the victim, in any setting, including but not limited to home and work”.

³ otherwise called “intimate partner violence”, defined by WHO as “a behaviour by an intimate partner or ex-partner that causes physical, sexual or psychological harm, including physical aggression, sexual coercion, psychological abuse and controlling behaviours” [WHO fact sheets “violence against women”]. “WHO | Responding to intimate partner violence and sexual violence against women. WHO. 2020. <http://www.who.int/reproductivehealth/publications/violence/9789241548595/en/>. Accessed December 14, 2021.”

⁴ SVS&D: Servizio Violenze Sessuali e Domestiche (English translation: Service for Sexual and Domestic Violence).

Table 1

Demographic aspects of positive cases to toxicological analyses.

Total cases			2018		2019		2020	
			SVS	SVS&D	SVS	SVS&D	SVS	SVS&D
			38	2	28	0	22	4
Female	Italian	<18	1		5		4	
		18–27	7		6		7	
		28–37	1		2			1
		38–47	5		1		3	
		48–58	4	1	1		1	
	EU	59+			1			
		<18	2					
		18–27	2					
		28–37						
		38–47	1		1			
	Non-EU	48–58			1			
		59+						
		<18	3					
		18–27	3		5		4	
		28–37	4		2			3
Male	Italian	38–47		1				
		48–58	1					
		59+						
	EU	<18						
		18–27					1	
		28–37	3		3			
		38–47						
	Non-EU	48–58						
		59+						
		<18						
		18–27						
		28–37						
		38–47	1					
		48–58						
		59+						

commonly identified drugs in victims of sexual violence representing 20% of all analyzed cases. This was closely followed by equal percentages of antidepressants, hypnotics, and sedatives, each accounting for 16% of total cases. No instances of “z-drugs” were observed. Then, the research further explored specific cases, involving combinations of different drugs. For instance, one individual tested positive for

amphetamines, cocaine, ketamine and MDMA. Another case showed positive results for amitriptyline, desipramine, diltiazem, mirtazapine, and tramadol. Additional examples include a subject who tested positive for cocaine, clonazepam and sertraline, as well as cases where cocaine was detected along with citalopram and methadone, or methadone in combination with nordiazepam and temazepam. Moreover, the study examined associations between drugs and their respective metabolites, as detailed in Table 4. The results showed that 40 patients tested positive for cocaine, 4 victims for methadone, 2 subjects for tramadol, and 1 victim for ketamine.

4.2. Forensic implications

When victims of sexual abuse are under the influence of substances, recalling the details of the abuse can be extremely challenging. This limitation poses significant obstacles in reporting and prosecuting abuse cases, as the victim's account is often crucial in building a case. Additionally, due to the effects of the intoxication, victims may hesitate to come forward or may be unsure of what happened. Consequently, it is important to emphasize the significance of conducting forensic toxicological analyses in cases where there is substantial doubt about the role of exogenous substances in relation to the victims. In such cases, toxicological results, along with other forms of evidence, such as physical evidence, witnesses and DNA evidence, can corroborate the victim's narrative and play a decisive role in the case.

Alcohol is also a common factor in sexual abuse cases, as it impairs judgment and reduces inhibitions, making individuals more vulnerable to abuse. Perpetrators often take advantage of the effects of alcohol to

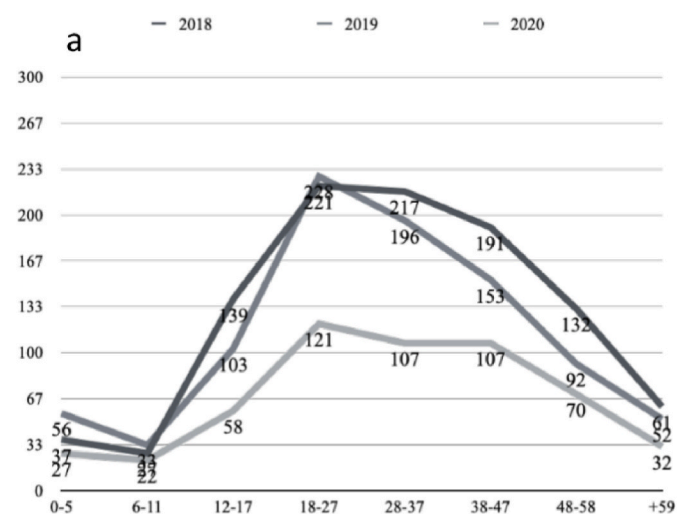


Fig. 1. a) graphic representation of the age-trend over the 3-years period of investigation.

Table 2

List of substances detected and subjects under investigation.

Substances	n. of positive samples to substances	% of substances detected on total amount of positive samples (n = 104)	% of substances detected in all the samples collected (n = 377)	n. of victims positive to different substances	% of victims positive to different substances with respect to the number of positive patients (n = 94)	% of positive victims to substances on patients deemed suitable to the toxicological analyses (n = 207)
Amphetamines	8	8%	2%	8	9%	4%
Amitriptyline	1	1%	<1%	1	1%	<1%
Benzoylecgonine	34	33%	9%	34	36%	16%
Citalopram	3	3%	<1%	3	3%	1%
Clonazepam	4	4%	1%	3	3%	1%
Cocaine	21	20%	6%	20	21%	10%
Cotinine	59	57%	16%	51	54%	25%
Delorazepam	1	1%	<1%	1	1%	<1%
Desipramine	1	1%	<1%	1	1%	<1%
Diltiazem	2	2%	<1%	2	2%	<1%
Ecgonine ethyl ester	2	2%	<1%	2	2%	<1%
Ecgonine methyl ester	3	3%	<1%	3	3%	1%
EDDP ^a	4	4%	1%	4	4%	2%
Ketamine	1	1%	<1%	1	1%	<1%
Ketorolac	8	8%	2%	8	9%	4%
Lidocaine	2	2%	<1%	2	2%	<1%
Lorazepam	2	2%	<1%	2	2%	<1%
MDMA ^b	3	3%	<1%	3	3%	1%
Methadone	4	4%	1%	3	3%	1%
Mirtazapine	1	1%	<1%	1	1%	<1%
Nicotine	14	13%	4%	13	14%	6%
Nordiazepam	2	2%	<1%	2	2%	<1%
Norketamine	1	1%	<1%	1	1%	<1%
O-Desmethyltramadol	1	1%	<1%	1	1%	<1%
Paracetamol	1	1%	<1%	1	1%	<1%
Paroxetine	1	1%	<1%	1	1%	<1%
Phentermine	1	1%	<1%	1	1%	<1%
Pseudoephedrine	1	1%	<1%	1	1%	<1%
Quetiapine	4	4%	1%	4	4%	2%
Risperidone	2	2%	<1%	2	2%	<1%
Sertraline	3	3%	<1%	2	2%	<1%
Temazepam	2	2%	<1%	2	2%	<1%
Theophylline	3	3%	<1%	3	3%	1%
THC ^c	2	2%	<1%	2	2%	<1%
Tramadol	1	1%	<1%	1	1%	<1%
Trimipramine	3	3%	<1%	3	3%	1%
Venlafaxine	1	1%	<1%	1	1%	<1%
Ziprasidone	2	2%	<1%	2	2%	<1%
BAC ^d	25	24%	7%	25	27%	12%

^a EDDP: 2-Ethylidene-1,5-dimethyl-3,3-diphenylpyrrolidine.^b MDMA: 3,4-Methyl enedioxy methamphetamine.^c THC: Tetrahydrocannabinol.^d BAC: Blood Alcohol Concentration.

Table 3

Blood Alcohol Concentration values for each case BAC (g/L) and time elapsed from the aggression (hours).

		BAC (g/L) - Time elapsed from the aggression (hours)								TOTAL
		<2	2–3	3	4–9	10–13	15–18	19–48	Not recall	
184 blood samples analyzed	n. of cases	13 positive cases 2 negative cases	7 positive cases	5 positive cases	34 negative cases	20 negative cases	18 negative cases	40 negative cases	45 negative cases	25 positive cases
	BAC at the time of aggression	0.22–1 g/L (mean: 0.60 g/L)	0.56–0.88 g/L (mean: 0.70 g/L)	0.67–0.91 g/L (mean: 0.76 g/L)	/	/	/	/	/	0.22 g/L–1g/L (mean: 0.66 g/L)

Table 4

Data stratification: drugs and their metabolites found in patients under investigation with and without the exclusion of nicotine and cotinine. Data stratification of the principles class of drugs.

		Unrelated n. of positive cases	Related n. of positive victims	% of victims positive considering the positive patients (n = 94)	% of victims positive excluding nicotine and cotinine (n = 73)	% of positive victims to substances considering all the patients analyzed (n = 207)
Drugs and metabolites	Cocaine + benzoylecgonine	16	40	42.5%	55%	19%
	Cocaine + other metabolites	2				
	Cocaine	4				
	Benzoylecgonine	18				
	Methadone + EDDP	3	4	4%	5.5%	2%
	Methadone	0				
	EDDP	1				
	Ketamine + norketamine	1	1	1%	1.5%	<1%
	O-desmethyldramadol	1	2	2%	3%	<1%
	Tramadol	1				
Class of drugs	Alcohol only	4	25	27%	34%	12%
	Alcohol + drugs	21				
	Antidepressants	/	11	12%	15%	5%
	Benzodiazepines	/	10	11%	14%	5%
	Antipsychotics	/	8	8.5%	11%	4%
	Stimulants	/	48	51%	66%	23%
	Anesthetics	/	3	3%	4%	1.5%
	Opioids	/	6	6%	8%	3%
	NSAIDs ^a	/	9	9.5%	12%	4%

^a NSAIDs: non-steroids anti-inflammatory drugs.

control or manipulate their victims. In addition to the difficulties posed by substance-induced memory impairment, alcohol can further impede a victim's ability to accurately recall or report the abuse. Moreover, females can reach higher BAC concentration (after the consumption of a given dose of alcohol) due to a lower volume of distribution (V_d) of substances and less body water with respect to V_d and less body water in male gender.⁶

4.3. Forensic toxicology applied to the medico-legal context

It is essential to emphasize that analytical data should be interpreted from a medico-legal perspective. In fact, primary focus should always be placed on the victim's testimony and the evidence that supports their decision to seek assistance. The contribution of forensic medicine is to provide investigators, and ultimately judicial authorities, with all the necessary elements for a comprehensive assessment of the abusive incident.⁷

According to current literature, this study confirmed that there is no specific drug category associated with DFSA, when considering both alcohol and other substances. Moreover, it is interesting to note that from our investigation it emerges how, opposite to other studies, cannabis was detected in very few cases. However, due to a lack of contextual information, it was challenging to determine the extent to which these substances contributed to suspected cases of DFSA.

This study elucidates the demographics of 2470 victims of sexual and/or domestic violence in the context of a major metropolitan area like Milan, over a three-year period (2018–2020). The investigations

detected a range of substances of toxicological interest and highlighted those most commonly found in this victim population.

5. Conclusion

In light of the findings from the research, we suggest expanding the range of substances investigated in cases of DFSAs, and to draw up standardized protocols to be used at national and supranational levels. Furthermore, forensic toxicology, collaborating with other experts involved in the case, such as law enforcement agents and medical professionals, can guarantee rigorous sampling and a strict chain of custody with the purpose to maintain and preserve the integrity of the evidence. These procedures would certainly grant adequate forensic assistance to victims of violence and abuse who turn to health facilities after such an abusive and distressing event.

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All the toxicological data were collected for other purposes, and they were enrolled in our study with anonymized information; therefore, the data cannot be reconducted to the identity of the individuals.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of competing interest

The authors declare that they have no conflict of interest.

References

1. Margherita M, Franceschetti L, Maggioni L, Vignali G, Kustermann A, Cattaneo C. Male victims of sexual abuse and domestic violence: a steadily increasing phenomenon. *Med Sci Law*. 2021;61(1_suppl):54–61. <https://doi.org/10.1177/0025802420947003>.
2. WHO. *Responding to Intimate Partner Violence and Sexual Violence against Women*. WHO; 2020. Published online.
3. Casali MB, Palazzo E, Blandino A, et al. The adult male rape victim: forensic description of a series of 57 cases. *Am J Forensic Med Pathol*. 2017;38(3):175–179.
4. Di Candia D, Boracchi M, Muccino E, Gentile G, Zoja R. The lethal cutting: an unexpected cause of death—a methomyl acute intoxication. *J Anal Toxicol*. 2021;00:1–8. <https://doi.org/10.1093/jat/bkab006>.
5. Di Candia D, Giordano G, Boracchi M, Zoja R. Postmortem forensic toxicology cases: a retrospective review from Milan. *Italy. J Forensic Sci. Published online*. 2022. <https://doi.org/10.1111/1556-4029.15050>.
6. Norberg Å, Jones AW, Hahn RG, Gabrielsson JL. Role of variability in explaining ethanol pharmacokinetics research and forensic applications. *Clin Pharmacokinet*. 2003;42(1):1–31. <https://doi.org/10.2165/00003088-200342010-00001>.
7. Franceschetti L, Merelli VG, Margherita M, et al. Older adult abuse in a service for sexual and domestic violence: medico-legal implications from the experience of an Italian center. *Forensic Sci Int*. 2022;338, 111383. <https://doi.org/10.1016/j.forsciint.2022.111383>.