

Investigating gender dynamics in forensic toxicology: The role of masculinity and femininity in alcohol and drug abuse

Arianna Giorgetti^{1,A,D,F}, Rafael Boscolo-Berto^{2,A,D,F}

¹ Unit of Legal Medicine, Department of Medical and Surgical Sciences, University of Bologna, Italy

² Institute of Human Anatomy, Department of Neurosciences, University of Padova, Italy

A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation;

D – writing the article; E – critical revision of the article; F – final approval of the article

Advances in Clinical and Experimental Medicine, ISSN 1899–5276 (print), ISSN 2451–2680 (online)

Adv Clin Exp Med. 2025;34(1):5–8

Address for correspondence

Rafael Boscolo-Berto

E-mail: rafael.boscoloberto@unipd.it

Funding sources

None declared

Conflict of interest

None declared

Received on December 16, 2024

Reviewed on December 23, 2024

Accepted on January 2, 2025

Published online on January 16, 2025

Abstract

The concept of “gender” refers to the socially constructed characteristics that define feminine or masculine behavior, which are constantly changing and can influence access to healthcare and patterns of help-seeking. These factors significantly impact forensic toxicology, a key area within the medicolegal landscape, forcing the adoption of a gender-sensitive approach to better understand the differing impacts of substances on men and women. Research indicates significant disparities in drug use between genders; men are more likely to abuse alcohol and illicit drugs, while women tend to use prescription medications. Although men typically show higher rates of driving under influence (DUI) related to alcohol, significant alcohol-related DUI cases also exist among women. In postmortem toxicology, gender affects drug pharmacokinetics and pharmacodynamics, with a pressing need for more research focused on women’s specific toxic and fatal ranges. The rise of new psychoactive substances (NPS) presents additional challenges; while most users are male, the gender gap appears to be narrowing. Further investigation into the gender differences in drug usage and effects, particularly regarding NPS, is essential for improving justice system responses and healthcare delivery. A gender-based approach in forensic toxicology is vital for addressing these issues effectively.

Key words: gender, forensic toxicology, new psychoactive substances, drugs of abuse

Cite as

Giorgetti A, Boscolo-Berto R. Investigating gender dynamics in forensic toxicology: The role of masculinity and femininity in alcohol and drug abuse. *Adv Clin Exp Med.* 2025;34(1):5–8. doi:10.17219/acem/199712

DOI

10.17219/acem/199712

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Introduction

The term “gender” encompasses the socially constructed characteristics and attributes that define what it means to be a woman or a man in society; this concept is constantly shifting. These characteristics include distinct behaviors, societal roles and expectations, all of which can significantly impact individuals’ access to healthcare services and inform their patterns of seeking assistance when needed.^{1–3} These factors play a role in the medicolegal landscape. Over the years, forensic medicine has expanded to include various subdisciplines, each contributing uniquely to the overall understanding of scientific principles applicable in legal contexts.⁴ This growth has particularly boosted advancements in forensic toxicology, a field that focuses on the effects of drugs and toxins in biological systems and their implications in legal cases.⁵ In developed countries, there has been a marked increase in the integration of scientific research with forensic practices, leading to more informed investigations and reliable evidence in courtrooms.⁶ This enhanced scientific collaboration underscores the importance of forensic toxicology as a vital tool in the pursuit of justice and the resolution of legal matters.

Forensic toxicology plays an essential role in the justice system. It provides critical insights that can inform legal cases and public health policies. A gender-sensitive approach in this field is crucial, as it helps illuminate the diverse and potentially differing impacts of substances on men and women. Understanding these distinctions can lead to more effective interventions and a fairer administration of justice.^{2,7}

Integrating gender perspectives in traditional drugs

Numerous studies have indicated a disparity in the prevalence of drug abuse between men and women, influenced by biological, psychological and sociocultural factors.⁸ Historically, men are considered approx. 2–3 times more likely to consume alcohol and use illicit drugs, while women are more inclined to use prescription medications. Substance use is typically perceived as risky behavior, which is less acceptable for women, particularly in societies characterized by larger gender gap, so the narrowing of the gap might also lead to higher engagement of women in harmful behaviors.⁹ This is particularly relevant for some developing countries, which, due to poor resources, might face additional challenges in implementing gender-sensitive forensic toxicology, while witnessing the closure of the gender gap and an increase in women drug-related issues. This issue is of global significance. The United Nations Sustainable Development Goals were unanimously adopted by member states in 2015.¹⁰ Among these goals, the need to reduce inequalities between nations and to transfer resources, knowledge, technology, and capabilities

to the Global South is emphasized. This transfer is essential for socio-economic development and enhancing global influence worldwide. To continue advancing forensic science as an international endeavor, it is crucial to narrow the inequalities between jurisdictions in alignment with the United Nations Sustainable Development Goals. Conversely, the evolution of jurisdictions cannot be separated from the development of forensic sciences.¹¹ In terms of driving under the influence (DUI), men typically demonstrate a higher rate of alcohol positivity, especially in road traffic incidents. Nevertheless, the prevalence of alcohol-related DUI among women is also significant and has been accompanied by an increase in related arrests.¹² Additionally, research has found no notable gender gap in DUI cases involving opioids and prescription drugs.¹³

Prevalence data can often be heterogeneous and difficult to compare, as recently pointed out in systematic reviews and meta-analyses by Pelletti et al.^{12,13} In this context, hair analysis might provide a reliable tool to retrospectively assess drug use for gender-sensitive research.¹⁴ Nevertheless, gender is a factor that can influence decision-making in post-mortem forensic toxicology, including requests for toxicological analyses. This challenge has also been identified based on other contextual information, such as age and ethnicity.¹⁵ Conversely, in instances involving recently prescribed medications in women who have succumbed to opioid intoxication, such data may provide opportunities for preventing future fatalities.¹⁶

In the realm of postmortem investigations, it is crucial to acknowledge that gender plays a significant role in the pharmacokinetics and pharmacodynamics of drugs.^{16,17} Traditionally, gender impact on toxicity has been mainly attributed to differences in body weight and fat, but additional gender-specific characteristics, such as expression of drug-metabolizing enzymes, drug-transporters and hormonal effects on drug targets and receptors, could provide additional molecular explanation for differential adverse drug reactions.¹⁸ As an example, estrogens have been reported as one of the possible factors explaining the greater vulnerability of women to the reinforcing (rewarding) effects of stimulants.¹⁹

It is known that, despite equivalent consumption of alcohol, women achieve higher blood alcohol levels than men. They are also reportedly more sensible to adverse drug reactions, including misused prescription and illicit drugs, but the pharmacokinetic research is focused on therapeutic drugs.²⁰ Some studies have found no notable differences in clinical states and treatments in the setting of acute recreational drug toxicity or in drug levels between genders considering poisoning suicides.^{21,22}

Nevertheless, toxic and lethal ranges are predominantly derived from male intoxication cases. More research should be devoted to understand how gender-related differences in pharmacokinetics and pharmacodynamics can

impact adverse outcomes secondary to drug use, including fatal intoxications.²⁰

Moreover, for drugs that are also produced endogenously, such as γ -hydroxybutyric acid (GHB), gender may influence baseline or normal levels.²³ The existing literature on this topic is limited, suggesting that each instance of suspected fatal intoxication should be assessed on a case-by-case basis.⁸ On this point, there is a pressing need for more research focused on toxic and fatal ranges specific to women.

Implementing a gender-sensitive strategy for addressing new psychoactive substances

The global rise of new psychoactive substances (NPS) has posed additional challenges for forensic toxicology. These substances typically exhibit heightened potency and health risks compared to traditional drugs, along with a wide range of chemical diversity.²⁴ Recent evidence suggests that the majority of NPS users are male, as supported by a case study of patients with substance use disorders analyzed by hair testing.^{25,26} However, the gender gap seems to be narrowing, particularly for self-reported use of synthetic cannabinoids among 12–34-year olds.²⁷ Considering acute intoxications by synthetic cannabinoids, similar rates of psychosis for women (79%) and men (80%) were seen, while women appeared more severely agitated.²¹ A recent study suggests that the gender gap in NPS-related deaths is also narrowing.²⁸ Indeed, the NPS death risk for men was 1.897 times higher than for women, but this did not reflect the difference between male and female drug-related mortality (approx. 4:1) over the same period. Also, women using NPS are more likely than men to additionally be positive for antidepressant or sedating drugs.²²

However, it has to be highlighted that this trend is not universally observed in all research.^{29,30} There is a clear need for further investigation to understand these trends, especially when distinguishing between various classes of NPS involved.

Current research on NPS has not sufficiently explored gender differences in NPS usage patterns and their effects on humans. For instance, studies related to psychomotor performance, particularly in the context of driving,³¹ have overlooked this important factor. Nevertheless, some evidence of gender-based differences does emerge from animal studies.²⁷

Conclusions

As forensic toxicology advances, it is essential for future research to emphasize a thorough analysis of gender-specific responses to drugs, particularly NPS. Implementing a gender-based approach in forensic toxicology establishes

a crucial framework for deepening our understanding of its implications in the justice system and for improving the appropriateness and personalization of healthcare delivery.

ORCID iDs

Arianna Giorgetti  <https://orcid.org/0000-0002-0441-9787>

Rafael Boscolo-Berto  <https://orcid.org/0000-0001-7556-1943>

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