ISSN (O): 2584-2196

INTERNATIONAL JOURNAL OF LEGAL AFFAIRS AND EXPLORATION

Volume 3 | Issue 2

2025

Website: www.ijlae.com

Email: editor@ijlae.com

ISSN (O): 2584-2196

FORENSIC SCIENCE IN GENDER-BASED CRIMES: USING SCIENTIFIC RESEARCH TO STRENGTHEN JUSTICE

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ABSTRACT

Sexual assault, domestic abuse, and human trafficking are just a few of the gender-based crimes that continue to pose significant obstacles to the criminal justice system. Because it provides scientific evidence that supports investigations and prosecutions, forensic science is essential to upholding justice. This study investigates how forensic methods like digital forensics, forensic toxicology, psychological profiling, and DNA analysis are used in cases involving gender. Forensic toxicology is crucial in detecting drug-facilitated assaults, and DNA analysis has transformed investigations into sexual assaults. Dealing with cyberstalking, harassment, and the unconsented distribution of private information has made digital forensics indispensable. In cases of stalking and domestic abuse, psychological profiling also helps to understand the behavior of the perpetrator. Despite these developments, there are still some obstacles facing the forensic investigation into gender-based offenses in India, such as delays in the field, a shortage of qualified personnel, and prejudices against women in the process of gathering evidence. When forensic procedures are not gender-sensitive, victims are frequently dissuaded from taking part in investigations. Finding best practices that could improve India's forensic framework, this study examines forensic techniques in the US, UK, and Australia. This study highlights the critical need to deliver gender-sensitive forensic training, update forensic infrastructure, and set guidelines in order to guarantee quicker and more effective Scientific investigations into offenses involving gender. Conviction rates will rise and the judicial system will become more victim-centered if forensic science in these situations is improved.

ISSN (O): 2584-2196

Keywords: Forensic Science, Gender-Based Crimes, Digital Forensics, Criminal Justice, Gender Sensitivity

INTRODUCTION

The most pressing violations of fundamental human rights are gender-based crimes that disproportionately affect women, children, and marginalized communities. Crimes rooted in socio-cultural, economic, and legal inequalities include sexual assault, domestic violence, human trafficking, and cybercrime. The prosecution of gender-based crimes faces significant evidentiary challenges, including testimonial evidence, delayed reporting, and procedural inefficiencies in forensic investigations despite legal reforms and judicial interventions. By integrating forensic science into gender justice mechanisms, gaps in evidence collection, victim protection, and offender accountability have been filled. In forensics, advances in DNA analysis, forensic toxicology, digital forensics, and forensic psychology have redefined investigating gender-based crimes, allowing for the collection of objectives, scientifically validated evidence that can withstand judicial scrutiny. Due to restrictions on judicial acceptance, backlog of forensic laboratories and insufficient forensic infrastructure, it has become very difficult in India to use forensic evidence effectively. The recent enactment of three major criminal law reforms—Bharatiya Nyaya Sanhita, 2023 (BNS), Bharatiya Nagarik Suraksha, 2023 (BNSS), and Bharatiya Sakshya Adhiniyam, 2023 (BSA)—has introduced significant changes in India's legal framework, especially regarding forensic evidence admissibility and investigative protocol. To strengthen gender justice mechanisms in India, this study explores comparative global forensic practices and critically examines the role of forensic science in gender-based crime investigations.

GENDER-BASED CRIME: EXTENT

Based on the report of 1993 United Nations Declaration on the Elimination of aggression Against Women, any act of aggression, coercion, or discrimination against someone based on their gender identity, that often results in financial, psychological, or physical harm is

considered a gender-based crime[1]. Existing provisions in the Bharatiya Nyaya Sanhita, 2023 (BNS) for dealing with crimes based on gender.

The Protection of Women from Domestic Violence Act of 2005 regulates domestic violence, and forensic psychology is essential to identifying abuse trends. Section 79 of the BNS, 2023, criminalizes human trafficking and emphasizes the use of forensic profiling to uncover trafficking networks. Cybercrimes against women, and the use of digital forensics cyber exploitation and harassment are covered under section 93 and 95 of BNS,2023[2]. As a result of victim intimidation, societal stigma, and ignorance Gender-based crimes continue to be unreported, despite the legal requirement. Forensic techniques must be methodically incorporated to guarantee victim-centered justice and convictions based on evidence.

WHY DO WE NEED FORENSIC SCIENCE IN GENDER BASED CRIMES?

Forensic science is a vital tool in identifying offenders, verification of victim testimonies to scientifically recreate crimes. In investigations of gender-based crimes, it plays the following roles:

For the exact identification of perpetrators and the exoneration of innocent parties, DNA forensics is crucial in sexual assault cases. In identifying drugs that promote sexual assault, including ketamine, GHB, and rohypnol, Forensic toxicology plays a critical role. Use of digital forensics is required in handling cybercrimes, such as tracking down the dissemination of revenge porn, cyberstalking, and data breaches. To deal with victim trauma assessment, offender characterization, and behavioural analysis in cases of coercive control and domestic abuse, Forensic psychology makes it possible and easier. In a recent court case, emphasized the need of forensic precision in rape cases. The need for strong forensic procedures and expert testimony was emphasized when the Supreme Court of India reversed a wrongful conviction brought about by forensic misinterpretation. This case serves as an example of the increasing use of forensic science by judges in the adjudication of gender-based crimes[3].

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[1] *United Nations Office on Drugs and Crime, 'Global Report on Trafficking in Persons' (2023) www.unodc.org accessed 26 March 2025*
[2] *Bhartiya Nyaya Sanhita, No. 45, Acts of Parliament , 2023(India).*
[3] *Anokhilal v. State of Madhya Pradesh, (2024) 1 SCC 23 (India)*

ISSN (O): 2584-2196

RESEARCH OBJECTIVE

With the growing era of forensic based investigation such as (DNA Analysis, Digital Forensics, Forensic Psychology, Toxicology) the study aims to critically examine the role of forensic science in gender-based crime investigations.

The study aims to assess the impact of newly enacted criminal laws i.e. BNS, BNSS, BSA of 2023, particularly in cases of (cybercrimes, domestic abuse, sexual abuse) on forensic evidence admissibility.

The study aims to examine the faced by forensic science in terms of, evidence backlog, lack of forensic infrastructure, lack of gender-sensitive forensic protocols in India.

The study aims for policy recommendation and reforming forensic infrastructure so that gender justice mechanism can be strengthened. This ensures efficient forensic case management.

To identify global best practices, the study aims to conduct a comparative and forensic analysis of gender-crime investigations globally.

ROLE OF FORENSIC SCIENCE IN GENDER-BASED CRIMES

In the investigation and prosecution of gender-based crimes forensic science is essential. These crimes includes , rape, domestic abuse, human trafficking, and cybercrimes. To improve the criminal justice system and to increase the admissibility of evidence scientific methods guarantee precise criminal identification. Scientific methods includes digital forensics, forensic psychology, forensic toxicology, and DNA profiling. DNA evidence is one of the most trustworthy forensic instruments in sexual assault cases. DNA profiling proved the accused's participation in the Nirbhaya case[4], which resulted in their conviction. Forensic processing has

[4] *Mukesh v. State(NCT Of Delhi), (2017) 6 SCC 1*

been further accelerated by rapid DNA analysis, which has decreased delays in sexual violence cases[5].

Rohypnol, GHB, and ketamine are among the drugs used by perpetrators of drug-facilitated sexual assault (DFSA)[6], and forensic toxicology is essential in these situations. A conviction was reached after forensic toxicology testing verified that the victim's blood contained sedatives[7]. With the use of LC-MS[8] the ability to identify drug traces even after metabolic clearance has improved[9] .

The growing age Digital forensics has made it easier to track down IP addresses, recover deleted messages, and examine metadata in cyber-enabled gender crimes. The use of geolocation monitoring and WhatsApp chat recovery as admissible evidence was recently upheld by the Supreme Court[10]. Furthermore, deepfake pornography and cyberexploitation victims can now be identified with the use of AI-based image recognition[11].

In situations of domestic abuse and human trafficking assessing psychological damage, coercive tendencies, and criminal conduct is required. This can be done by forensic psychology. Forensic psychological assessments in a recent Supreme Court case[12] demonstrated emotional abuse and coercive control, as a result of which harsher punishments under the Protection of Women from Domestic Violence Act of 2005[13]. Forensic psychology's uses NLP[14] which has enhanced victim interviews by lessening trauma-induced memory distortions[15].

Even with ongoing improvements, forensic science is still a vital instrument for investigating gender-based crimes, guaranteeing scientific correctness. For the investigation of gender-based crimes, forensic science is a vital instrument. Even with ongoing improvements, forensic science guarantees scientific correctness in court cases and bolstering justice for survivors.

CHALLENGES

[5] *Sharma, Forensic Advances in Criminal Law (2024) 78*
[6] *Drug Facilitated Sexual Assault*
[7] *State of Maharashtra v. Dhananjay Satyapathi, (2023) 9 SCC 243*
[8] *Liquid Chromatography-Mass Spectrometry*
[9] *Patel & Kumar, Journal of Forensic Sciences, 2024, 35*
[10] *X v. State of Karnataka, (2024) 3 SCC 98*
[11] *Cyber Law Review, 2024, 29*
[12] *Geeta Sharma v. State of Uttar Pradesh, (2023) 7 SCC 184*
[13] *Protection of Women From Domestic Violence Act, (2005)*
[14] *Neurolinguistic Programming*
[15] *Mehta, Forensic Psychology and Law, (2024) 56*

ISSN (O): 2584-2196

Despite being so many obstacles that limits its efficacy, Forensic Science plays a vital role in the investigation of crime based on gender. The absence of gender-sensitive forensic procedures for dealing with victims of domestic abuse and sexual assault is a significant problem.

The psychological damage experienced by survivors are being Numerous forensic techniques overlooked by numerous forensic techniques , as a result, re-traumatization and a reluctance to disclose crimes[16]. Although forensic rules are still out of date, the Supreme Court in one case directed the authorities to train professionals in victim-sensitive techniques and modernize forensic procedures[17]. Gender based crime investigations are further undermined by forensic backlogs and delays. According to a 2024 NCRB[18] report, it frequently takes 6–12 months for DNA testing , which delays the administration of justice in sexual assault cases.In a supreme court case, the absence of immediate forensic evidence was a crucial factor, illustrating the impact of delays in gender violence cases[19]. Despite the adoption of Rapid DNA Testing and AI-based forensic automation, implementation remains slow[20].

In India, it is challenging for a women to be one among the forensic professionals as they are underrepresented. Studies reveal that women make up less than 20% of the medico-legal professionals and forensic scientists who handle gender-related offenses[21]. One factor that may deter survivors from getting medical testing is the dearth of female forensic examiners[22].

Additionally, stigma, fear, and legal barriers restrict victims from participating. Social stigmas and a lack of awareness of law make survivors hesitate to disclose crimes, especially in rural regions[23]. Invasive forensic techniques continue to be used, despite the Supreme Court's decision to outlaw the two-finger test because it violates women's privacy and dignity.

To address these issues and guarantee prompt and considerate criminal investigation, it is a need of an hour that legislation changes, and forensic training programs,forensic infrastructure investments are gender-inclusive.

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[16] *Forensic Science Report, 2024*
[17] *XYZ v. State of Madhya Pradesh, (2023) 5 SCC 89*
[18] *National Crime Records Bureau*
[19] *State of Karnataka v. Anil Kumar, (2023) 8 SCC 220*
[20] *Sharma, Advances in forensic Science, (2024)*
[21] *Indian Journal of Forensic Sciences (2024)*
[22] *Mehta, Gender & Law (2024)*
[23] *Lillu v. State of Haryana, (2013) 14 SCC 643*

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COMPARATIVE ANALYSIS: FORENSIC INVESTIGATIONS OF GENDER-BASED CRIMES GLOBALLY

Depending on forensic practices, legislative frameworks, and technology advancements, different countries have varied approaches to investigating gender-based crimes, but forensic science is necessary. For the purpose of strengthening India's forensic system in compliance with the recently passed criminal legislation[24][25], this part looks at the best practices from around the world.

UNITED STATES: A global standard for DNA databasing and rape kit uniformity in assault-related investigations has been established by the United States. In accordance with SAKI, 2023[26], all backlogged rape kits must be tested to guarantee prompt forensic results[27]. To help identify criminals, even in cold instances, the upgraded CODIS, 2023[28] now incorporates forensic genealogy[29]. In a recent caselaw in United States , Conviction has been secured by using forensic genealogy after 20 years[30].

UNITED KINGDOM: As per UK Home Office Forensic Report, 2024 , The Act[31] mandates the forensic professionals handling sexual offenses undergo trauma-informed training[32]. The SOFE[33] units include female forensic experts to ensure victim-sensitive evidence collection. In a recent case in the U.K., forensic evidence was ruled inadmissible due to failure to follow trauma-informed procedures[34].

AUSTRALIA: Significant advancements in digital forensic investigations of gender-based cybercrimes like revenge porn, cyberstalking, and deepfake abuse has been achieved. This was possible all because of The Online Safety Act,2021(updated 2024)[35]. Perpetrators and manipulated content is analyzed with assistance of A-I powered forensic tools. In a recent case law, AI-assisted forensic tools confirmed deepfake manipulation, securing a conviction[36].

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[24] *The Bhartiya Sakshya Adhiniyam, 2023*
[25] *The Bhartiya Nyaya Sanhita, 2023*
[26] *Sexual Assault Kit Initiative, (SAKI, 2023)*
[27] *National Institute of Justice Report, 2024*
[28] *Combined DNA Index System, 2023*
[29] *FBI Forensic Science Report, 2024*
[30] *People v. Martinez, 2023 NY 98*
[31] *Forensic Science Regulator Act, 2021*
[32] *UK Home Office Forensic Report, 2024*
[33] *Sexual Offences Forensic Examination*
[34] *R v. Hughes, 2023 EWCA Crim 112*
[35] *The Online Safety Act, 2021 (updated 2024)*
[36] *Commonwealth v. Brown, 2024 HCA 17*

ISSN (O): 2584-2196

CURRENT STATE OF INDIA WITH RESPECT TO FORENSIC INVESTIGATION OF GENDER-BASED CRIMES

Although India has done incredible progress in the field of forensic science, especially in gender-based crimes. With the enactment of several new laws, forensic investigations in gender-based crimes has been improved. Despite being the progress made so far, India still faces significant gaps in gender-sensitive forensic practices, forensic infrastructure, and its implementation. India has recently implemented new laws and repealed the old ones with significant changes in the criminal justice system. The Indian Penal Code, 1860 has been repealed by The Bhartiya Nyaya Sanhita, 2023[37] . The Act includes stricter provisions related to sexual offences, yet still requires gender-sensitive forensic mandates.

The Criminal Procedure (identification) Act, 2022[38] permits for biometric and DNA collection but there is a lack of centralized DNA database. The admissibility of evidence has been deeply discussed and necessary provisions has been made under The Bharatiya Sakshya Adhiniyam, 2023[39] but still it does not exclusively address gender-based crimes concerning forensic best practices. Despite the advancements in the field of forensic science for justice delivery concern related to gender-based crimes is missing. The NCRB Crime Report(2024)[40] reveals that over 30% of DNA Samples in sexual assault cases remain untested for over a year. This forensic backlogs is a challenging situation which leads to delay in justice. India has a lack of gender sensitive forensic protocols unlike the UK's SOFE model. As the study suggests, only 18% of women are forensic experts in handling gender-based crimes, as a result survivors are hesitant to undergo forensic examinations[41]. India has a underdeveloped cyber forensics because it lack specialized forensic mechanisms to investigate cyber gender crimes[42].

[37] *The Bharatiya Nyaya Sanhita, 2023*
[38] *The Criminal Procedure (identification) Act, 2022*
[39] *The Bharatiya Sakshya Adhiniyam, 2023*
[40] *NCRB Crime Report, 2024*
[41] *Indian Journal of Forensic Sciences, 2024*
[42] *IT (Intermediary Guidelines Rules), 2023*

ISSN (O): 2584-2196

PROSPECTIVE CHANGES BASED ON GLOBAL BEST PRACTICES

Forensic investigations in gender-based crimes can be enhanced in India by adopting global best practices. To ensure timely forensic processing of sexual violence cases, A Standardized Sexual Assault Kit Initiative (SAKI)[43] has been initiated, and as a result, it has reduced backlog issues. The UK's SOFE model, establishes gender-inclusive forensic teams with female forensic professionals which helps to improve Indian forensic investigation system. By leveraging AI-powered forensic technologies cyber forensic skills are enhanced and this helps to fight digital gender crimes. These forensic skills are based on Australia's Online Safety paradigm. A centralized forensic DNA database similar to the US CODIS system are established that can help track repeat offenders and raise conviction rates.

CONCLUSION

In gender-based crime investigations, forensic science has emerged as a vital instrument due to its scientific neutrality, evidentiary correctness, and legal admissibility. Despite the progress made in forensic technology India has inadequate forensic infrastructure, absence of gender-sensitive guidelines, and delays in processing evidence due to which justice delivery is still impended. To close these gaps, a multifaceted forensic strategy that incorporates victim-centric forensic techniques, digital investigation, AI-driven analysis, and DNA profiling is necessary. The report emphasizes the urgent need for legislative changes, such as requiring rape kit testing, establishing specialist forensic units, and creating a consolidated forensic DNA database based on international best practices. A forensic model that is survivor-centric and motivated by science would improve conviction rates, hasten investigations, and rebuild communal confidence to attain criminal justice.

Victim assistance and ethical evidence gathering is achieved only if, India institutionalize trauma-informed forensic practices as well as training for forensic experts, which is gender-inclusive. India may develop gender-based crime investigations by utilizing evidence-based forensic techniques and technological breakthroughs, guaranteeing that forensic science is not a procedural constriction but rather a effective tool of justice.

[43] *Sexual Assault Kit Initiative (SAKI)*