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# Ethical Issues in DNA Profiling and Database Maintenance

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## Abstract

DNA profiling has profoundly changed the way the criminal investigation took place. It came as a powerful tool to identify individuals, solve crimes, and reunite loved ones. Since its first use in a criminal case in 1986, DNA evidence has helped not only to convict the guilty but also to exonerate the innocent. However, the growing use of DNA technology has brought numerous challenges ranging from legal, ethical and privacy concerns particularly concerning data protection, informed consent, and the potential for misuse. Indian laws on use of DNA profiling have been fragmented as the existing legislation falls short of providing clear guidelines for the collection, storage, and use of DNA data. This paper explores the judicial decisions and critically analysing the existing legal framework regarding the evolution of DNA profiling in India its admissibility in the courtroom. This paper further explores the international framework and how India can benefit from the use of DNA technology while ensuring and the dignity and rights of its people and balancing the advancement of forensic science with the protection of fundamental rights.

**Keywords:** *Data Protection, innocent, misuse, admissibility, consent.*

## 1. Introduction

Goan DNA profiling has revolutionized forensic science, offering an unparalleled means of identifying individuals with high precision. Since its first use in a criminal case in 1986, DNA evidence has played a crucial role in solving crimes, exonerating the innocent, and establishing biological relationships. Its scientific accuracy has made it a cornerstone of modern law enforcement and legal proceedings. However, while DNA profiling enhances the effectiveness of the criminal justice system, it also raises significant legal, ethical, and privacy concerns, particularly regarding data protection, consent, and the potential for misuse. These concerns necessitate a robust regulatory framework to ensure that DNA technology is used responsibly.

In India, despite the increasing reliance on DNA evidence in criminal and civil cases, there is no comprehensive statutory framework governing its collection, storage, and use. While the *Bharatiya Sakshya Adhiniyam, 2023* and *Bharatiya Nagarik Suraksha Sanhita, 2023* acknowledge forensic evidence, they do not explicitly regulate DNA profiling. The *DNA Technology (Use and Application)*

*Regulation Bill, 2022*, seeks to establish a national DNA database, but it has raised concerns over privacy, surveillance, and the risk of wrongful profiling. Similarly, the *Criminal Procedure (Identification) Act, 2022*, grants law enforcement agencies broad powers to collect biological samples, posing challenges to individual rights and data security. The absence of clear legal safeguards leaves DNA evidence vulnerable to misuse, further compounded by issues such as inadequate forensic infrastructure, lack of standardized procedures, and concerns over the accuracy of forensic testing.

A comparative analysis of international frameworks, such as those in the United Kingdom and the Netherlands, demonstrates how legal systems can balance forensic efficiency with privacy protections. These models provide valuable insights for India in developing a legally sound and ethically responsible approach to DNA profiling. Given the potential risks associated with indiscriminate DNA collection and storage, it is imperative to establish stringent legal and procedural safeguards to prevent misuse while ensuring the integrity of forensic investigations.

**1.1 History of DNA Profiling:** DNA is found in almost every cell in our bodies, and we unknowingly leave cells behind wherever we go. Skin flakes, blood droplets, hair, and saliva all contain DNA that can be used to identify us [1]. These biological materials come in various forms, including buccal swabs, saliva, semen, blood, vaginal swabs, and touch DNA [1]. DNA was first identified by Swiss Chemist Friedric Miescher in 1860, after which it was recognized that DNA exists as three-dimensional double helix, by James Watson and Francis Crick [2].

**1.2 Evolution of DNA Forensics:** The credit of using DNA profiling is mainly attributed to Sir Alec Jeffreys, in an interview he said, "These patterns were individual-specific and seemed to be inherited within the family. That was a real eureka moment because we were suddenly onto something completely new, which was DNA-based identification."

**LANDMARK CASE: LYNDA MANN & DAWN ASHWORTH MURDERS**  
DNA evidence was first used in the landmark criminal case in 1986, involving the rape and murder of two teenagers, Lynda Mann and Dawn Ashworth, from Narborough. These two crimes, which occurred two and a half years apart, showed significant similarities in the nature of the assaults and the age of the victims. Therefore, the police sought assistance from Sir Alec Jeffreys' team to solve these crimes, police suspected 17-year-old Richard Buckland responsible for both murders. Jeffreys' team was provided with semen samples from both crime scenes as well as from Buckland for comparison. The results of the DNA analysis showed that although the DNA from both rape kits was identical, it did not match Buckland's, and he was exonerated from the charges leading the significance of DNA profiling as a tool for proving innocence in criminal investigations [3]. The case took a dramatic turn in September 1987 when Colin Pitchfork, a 27-year-old father of two, was arrested for the murders. A man at a pub had confessed to his friends that he had taken the DNA test on behalf of Pitchfork as a favour. When the police uncovered this deception, they brought Pitchfork in for questioning, where he confessed to the crimes. DNA testing subsequently confirmed Pitchfork as the perpetrator, marking the first instance in which a conviction was secured through DNA evidence. The Lynda Mann and Dawn Ashworth cases, stands as a watershed moment in forensic science, this case showed the potential of DNA evidence not only in identifying perpetrators but also in exonerating the innocent [4]. This case led to the widespread adoption of DNA profiling in criminal investigations, establishing its crucial role in modern forensic practice.

**1.2.1 Development of DNA in Forensic Science:** In the United States, the DNA Identification Act of 1994 authorized the Federal Bureau of Investigation (FBI) to expand pilot program into a national DNA database, known as the Combined DNA Index System (CODIS). CODIS serves as a crucial tool for solving violent crimes by integrating DNA analysis with computer technology, allowing crime laboratories at the local, state, and federal levels to electronically exchange and compare DNA profiles. This system has become an essential tool for law enforcement agencies enhancing their ability to collaborate and efficiently process forensic evidence [5]. The database is divided into two indexes: the Forensic Index, which contains DNA profiles derived from crime scene evidence, and the Offender Index, which stores profiles of individuals convicted of felony sex offenses and other violent crimes [6]. DNA identity testing is now widely applied in forensic science and paternity verification. Furthermore, various clinical applications have evolved from the methods initially created for forensic testing [7]. Although DNA evidence alone may not be enough to guarantee a conviction today, DNA profiling has become the gold standard in forensic science over the past 30 years. Despite facing delays in sample processing due to forensic lab backlogs, the technique has continually improved in speed and sensitivity. Today, investigators can obtain DNA profiles from skin cells left behind by a criminal with just a touch on a surface [8]. Forensic DNA typing has undergone substantial development since it first began, moving past the initial method of using restriction fragment length polymorphism. From the mid-1990s onward, the primary methods of forensic DNA typing have centred on analysing short tandem repeats (STRs) using polymerase chain reaction-based capillary electrophoresis (PCR-CE) [9].

**Table 1.** Timeline of DNA profiling & legal developments.

Year	Event	Significance
1869	Discovery of DNA by Friedrich Miescher	Foundation of molecular biology
1953	DNA double helix model proposed by Watson & Crick	Understanding DNA structure
1984	Sir Alec Jeffreys develops DNA profiling	Marks the beginning of forensic DNA testing
1986	First criminal case using DNA profiling (UK - Pitchfork case)	Case solved in 1986–87. DNA used to exonerate Richard Buckland and convict Colin Pitchfork
1994	DNA Identification Act (USA) establishes CODIS	Enables national DNA database for criminal investigations

2001	UK allows retention of DNA samples post-acquittal (CJPA, 2001)	Raised privacy debates
2003	UK expands DNA collection for all recordable offences (CJA, 2003)	Creation of National DNA Database
2010	Selvi v. State of Karnataka (India)	Consent made mandatory for invasive techniques
2012	UK's Protection of Freedoms Act	Limits indefinite storage of DNA

**1.3 Admissibility of DNA Evidence in Courtroom:** There were two important tests, related to admissibility of DNA evidence the first Frye test, court held that, for a technique to be accepted it should be “generally acceptable” in scientific community [10]. The second, test was Daubert [11] that broadened standards set in Frye, and adopted a more liberal, and relaxed approach, the case gave several factors to consider namely, “whether the expert's technique or theory can be tested and assessed for reliability, whether the technique or theory has been subject to peer review and publication, the known or potential rate of error of the technique or theory, the existence and maintenance of standards and controls, whether the technique or theory has been generally accepted in the scientific community.” In India, there are no specific guidelines of what has to be accepted, Indian Courts generally accept what all has been accepted widely.

**1.4 Admissibility Through the Lens of Indian Judicial Approach:** In India, there were many cases, mainly related to paternity disputes, that was resolved through DNA analysis, with the majority of these cases being conducted at the Centre for Cellular and Molecular Biology (CCMB) in Hyderabad, India. The first paternity dispute involving DNA analysis, also performed at CCMB, that gained widespread attention in the Indian judicial system and media. This case namely, Kunhiraman v. Manoj was presented before the Chief Judicial Magistrate (C.J.M.) of Telicherry (Thalassery), Kerala. The case involved a village girl, Vilasini, who filed a maintenance claim against her lover, Kunhiraman, for her son Manoj. She alleged that Manoj was born as a result of their illicit relationship, on the contrary, Kunhiraman, denied her allegations and refused to accept responsibility. The C.J.M. ordered DNA testing for Vilasini, Kunhiraman, and their son at CCMB, Hyderabad. Dr. Lalji Singh, a forensic scientist, and his team conducted the DNA test, which conclusively proved that Kunhiraman was the father. The C.J.M. ruled that under Section 45 of the Indian Evidence Act, expert opinions are admissible in court, and DNA evidence, as a scientific analysis, is valid in the same way that chemical or fingerprint experts' opinions are accepted. This verdict was upheld by the Kerala High Court, which confirmed that DNA test results alone could determine paternity. In the case of Sharda v. Dharmpal court addressed the issue of the Constitutional validity of directing a party to undergo a medical examination, the hon’ble apex

court ruled that such a direction would not infringe upon the right to personal liberty under Article 21 of the Indian Constitution or the right against self-incrimination under Article 20(3).

**1.5 DNA Profiling and its Implications in Law in India:** DNA evidence is commonly used in court to connect suspects to crime scenes, exonerate those wrongfully convicted, and determine paternity. It is considered more dependable than many other forms of crime scene evidence [15]. DNA is used; these materials can be unknowingly left behind by the perpetrator in trace amounts on a surface. In India, currently, lacks explicit regulations governing DNA Profiling. There are though certain provisions in Bharatiya Sakshya Adhiniyam, 2023 and Bharatiya Nagarik Suraksha Sanhita 2023, but they are not explicit provisions. Therefore, it is generally left open to the judiciary to interpret, about the acceptance of DNA testing and about the technique used etc. As discussed earlier, *Kunhiraman v. Manoj*, was the first case where the dispute was solved through DNA evidence. The courts, then started ballistics expert, biological expert, chemical expert, document analysis expert, polygraph (lie detector) expert, serology expert, toxicology expert, and others as evidence [16].

**1.6 Laws in India Related to Conduct of Medical Examination:** Section 52 of BNSS, permits the medical examination of a person arrested for rape or attempted rape if there are reasonable grounds to believe that such an examination will provide evidence of the crime.

Further S.184 of BNSS, provides that if a woman is alleged to be the victim of rape or attempted rape during the investigation, her medical examination must be conducted by a registered medical practitioner from a government or local authority hospital.

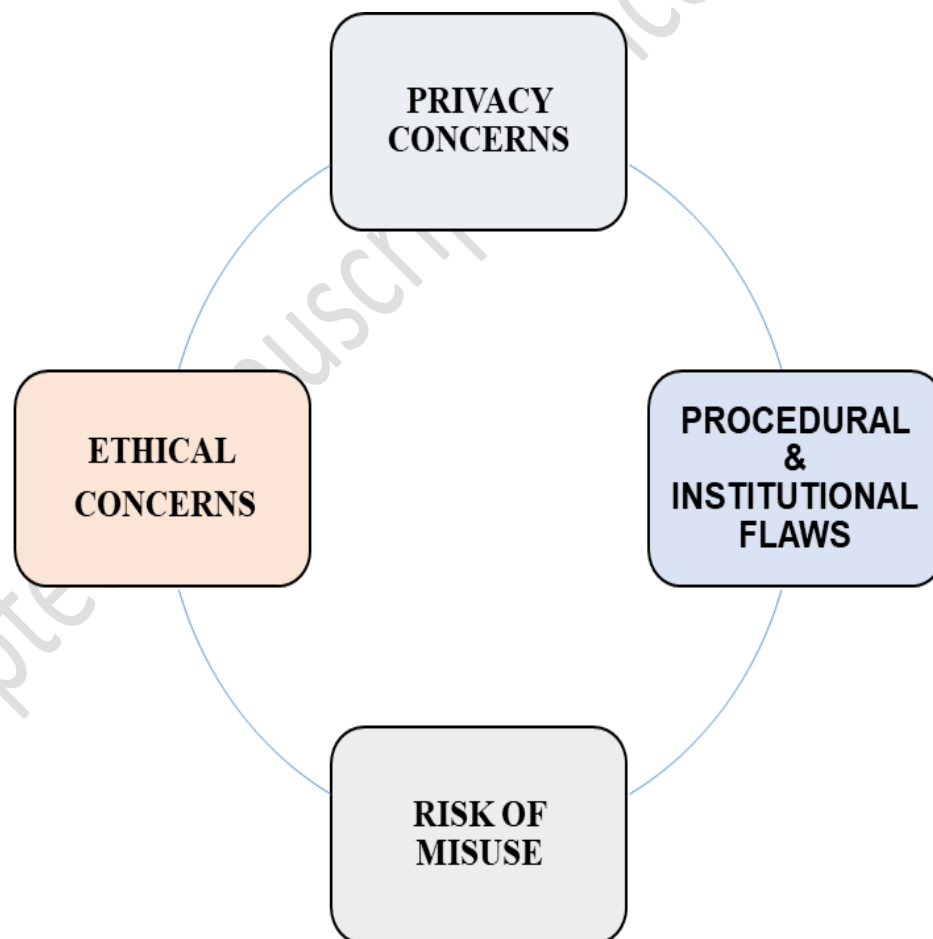
Section 39(1) of BSA, 2023, provides that, when a court needs to form an opinion on foreign law, science, art or any other field, or regarding the identity of handwriting or fingerprints, the opinions of individuals skilled in those areas are considered relevant. These individuals are referred to as experts.

Section 166 of BSA, 2023, deals with a person born during a valid marriage or within 280 days after the dissolution of the marriage, with the mother remaining unmarried, is conclusively presumed to be the legitimate child of the man. However, this presumption can be challenged if it is proven that the couple had no access to each other during the time the child could have been conceived.

After analysing these sections there is nowhere mentioning of DNA being used explicitly.

DNA technology (use and application) regulation bill: In 2019 the Ministry of Science and Technology (MST) introduced the draft DNA Technology (Use and Application) Regulation Bill. With the draft, MST also announced plans to train more than 20,000 investigation officers, prosecutors, and medical professionals in the proper collection of forensic evidence in sexual assault cases using standardized sexual assault evidence collection kits. The draft DNA Technology Bill aims to create DNA data banks across the country and establish DNA laboratories for the testing and storage of DNA profiles. These facilities are intended to assist in solving criminal cases, with particular emphasis on cases of sexual assault. Preceding to this Bill, India lacked any specific legislation related to DNA evidence and guidelines related to it. The Bill provides civil matters, where DNA profiling can be used lawfully, such as issues relating to establishing national identity, also covers special laws such as Medical Termination of Pregnancy Act, 1971, The Immoral Traffic (Prevention) Act, 1956 etc.

Criminal procedure (identification) act, 2022: This bill was approved by Indian Parliament, in April 2022, Criminal Procedure (Identification) Act, 2022 came into effect. The act police officers and prison officers to collect certain identifiable information from convicted individuals or those arrested for an offence. The information collected, may include, fingerprints, photographs, iris and retina scans, biological samples and their analysis, as well as behavioural traits. Further, the act also empowers the National Crime Records Bureau (NCRB) to collect, store, process, share, disseminate, if necessary or destroy records of such measurements, in accordance with rules. This data can be collected, from state governments, union territories, and other law enforcement agencies. If that person, resists or refuses to provide these measurements, they may be charged with an offence under Section 186 of the Indian Penal Code [17]. The issue of privacy can be tackled because the act provides for the destruction of the records, if the person has not been convicted of an offence with imprisonment, or the person has been discharged, or acquitted by the court [18]. This act is not completely free from lacunae, as under the act, the NCRB is allowed to share personal data with any law enforcement agency. But this is not in coherence, with the principle of purpose limitation, as according to this principle, data collected for one specific purpose should only be used for that purpose. Therefore, impeding the right to privacy of the person whose personal data has been stored.



**Figure 1.** Issues pertaining to DNA evidence.



## 2. Ethical Concerns

**2.1 Ethical Issues:** Establishing a DNA Database is significant in a densely populated country like India. Establishing a DNA database is essential, as it would aid in the identification of offenders and will exonerate the innocent and also facilitate in identifying unidentified deceased individuals [19]. The Supreme Court has on multiple occasions, questioned the absence of such a system, particularly in cases involving unidentified bodies. But this comes with number of challenges, as DNA profiling has both benefits and drawbacks.

**2.2 Privacy:** Privacy infringement is one of the major challenges in DNA Profiling, privacy has been recognized integral part of human rights, in the Indian Constitution that recognizes privacy as a fundamental right, after the Supreme Court Judgement, of Justice K. S Puttaswamy and Anr v. Union of India [20], in which hon'ble apex court held that personal liberty and right to life under article 21 of Indian Constitution also includes, right to privacy, further, various international legal framework, such as Article 12 of Universal Declaration of Human Rights, mandates, "one shall not be subject to arbitrary interference with his privacy, family, home or correspondence etc." In, International Covenant on Civil and Political Rights, also recognized privacy as a right. There are privacy concerns with DNA profiling as misuse and abuse of genetic information [21]. Further, concerns for many family members who may be affected by broader crime response and a concern for the innocent individuals, whose lives could be affected by being placed under suspicion [22]. Furthermore, there are fears that DNA databases could be used for bio surveillance, allowing governments to track citizens and their families without probable cause [23].

**2.3 Ethical and Socio-Legal Concerns:** There are several legal, ethical and socio legal challenges regarding the use of DNA, because DNA samples contain information regarding personal genetic information [24]. Scientists believe that DNA may have the potential to reveal traits such as aggression, substance addiction criminal tendencies, and sexual orientation etc. This makes access to such sensitive genetic information vulnerable to misuse by miscreants in the society, could target people and their families. Moreover, DNA analysis could result in caste or religion-based profiling, where specific castes or religious groups may be unfairly with criminal behaviour or face other forms of discrimination because of finding. There is also issue with storing of samples of DNA, of people involved in civil disputes or any other related matter, and contention with it, coming under reasonable constraints [25]. With the introduction of DNA Technology (Use and Application) Regulation Bill, privacy concerns have raised, the use of DNA information in forensic evidence is a contentious issue, mainly because of concerns about data security in DNA laboratories, inherent biases in artificial intelligence, existing databases, and the algorithms that analyse them, as well as the policies that govern these processes. DNA testing in medical or research labs can uncover personal details such as an individual's identity, background, relationships, and other sensitive information that poses potential harm to minority groups [26].

**2.4 Used in Insurance Companies:** There is possibility of misuse of the DNA Sample, In Australia, life insurance companies are legally authorized to mandate the disclosure of all genetic test results by the people applying for the insurance for the purpose of underwriting and risk assessment. This includes genetic tests that are performed by accredited laboratories as well as research participation and direct-to-consumer (DTC) testing, even if these do not meet the scientific and medical standards that are expected from the clinical tests, but these contracts are subject to duties of disclosure under the Insurance Contracts Act, 1984, if it is found that essential information was

withheld, the contract may be invalidated afterward. There is ongoing research that reveals instances of unlawful genetic discrimination, where insurance applications are rejected or issued with non-standard terms (e.g., increased premiums, applied exclusions) without proper justification or explanation to the consumer. Many cases, involve life insurance companies failing to consider preventive actions, such as prophylactic surgery, in violation of the industry's own guidelines [28].

**2.5 Informed Consent and Self – Incrimination:** The right against self-incrimination and the right to life and personal liberty are enshrined as fundamental rights under Articles 20(3) and 21 of the Constitution of India (COI). Moreover, the informed consent is based on ethical and moral principles. The core principles of informed consent are respect, beneficence, and justice based on three essential components: information, understanding, and voluntary participation [29]. In the landmark case of *State of Bombay v. Kathi Kalu Oghad* [30], the hon'ble apex court held that submitting handwriting, signature samples, or palm, finger, or footprints does not require consent and does not constitute a violation of Article 20(3). In the case of *Selvi v. State of Karnataka* [27] the court held that, if a technique is invasive, consent is mandatory. By following this judgment, narco-analysis, polygraph tests, and brain mapping must be conducted with the individual's consent. In such cases, the court does not have the inherent power to compel an individual to provide a blood sample for testing. There is difficulty in law to balance between the rights of the baby, husband and wife. Sometimes contrary to the guidelines as an exception, the high court ordered to take the samples forcefully [31]. These guidelines were formulated by Supreme case in the case of *Gautam Kundu v. State of Bengal* [32] related to DNA, including that no one can be compelled to give sample of blood for analysis, but court has itself departed from these guidelines in various exceptional cases [33].

**2.6 Current Issues Pertaining to DNA Evidence:** Forensic methods such as fingerprints, dental impressions, bullet striations, hair and fibre analysis, voice spectrograms, neutron activation analysis, blood grouping, serum protein and enzyme typing, as well as DNA profiling require the ability to accurately match samples based on unique characteristics. For such evidence, to be admissible in court, scientific procedures should be allowed for the reliable measurement and comparison of these physical features [34].

**2.6.1. Institutional Challenges in India:** There are issues such as firstly, they do not operate independently, as they are currently overseen by law enforcement agencies and their respective Home Departments [35]. Hence, they lack autonomy. Secondly, forensic laboratories face a shortage of manpower and lack adequate infrastructure. Thirdly, there is no proper training for police officers and investigators to handle crime scenes and collect evidence properly, so sometimes due to inadequate or even non-existent basic training, individuals at the crime scene often unintentionally [36]. Fourthly, though there is presence of technology but handling of evidence in these laboratories, sometimes taints this evidence because of which they become unreliable.

## 2.7 Reliability and Chain of Custody Issues

**2.7.1 Challenges in Handling and Evaluating DNA Evidence:** Courts has time and again, noted various instances of handling of physical evidence uncarefully such as improper or incomplete



collection, not preserving evidence, not maintaining the chain of custody, delayed submission of evidence for analysis, not sending the accused for a medical legal examination, the investigating officer failing to lift fingerprints, or sending blood-stained objects for chemical examination, without wrapping them after seizure [37]. In evaluating such evidences, various other factors are also considered, such as whether the time taken was appropriate, the qualifications of the expert, the scientific validity of the procedures used, and the gap in the chain of custody. DNA evidence is generally accepted in paternity disputes, rape and murder cases.

**2.8 Judicial Interpretation and Case Studies:** In the cases where, even after the factors are considered, then also the DNA evidence is considered to be valid, in a case where the accused was charged with killing his girlfriend by hitting her with car tools like a jack and spanner, cutting her with shaving blades, and throwing acid on her, because she pregnant and she refused to abort. The DNA report after death, linked the accused as the biological father of the foetus taken from the deceased's body. The sample from the foetus was collected on the day of the post-mortem and preserved in ice. There was delay in conducting the DNA test, a Junior Scientific Officer from the Central Forensic Laboratory admitted that mishandling of the sample can lead to incorrect results but affirmed that the results in this case were accurate. The hon'ble apex court held that burden was on the accused to prove that the prosecution's case was compromised due to the delay or improper preservation of the sample. The accused was liable under Sections 302/34 and 316/34 of the IPC as he failed to prove that [38]. In the case of Sarbjit Singh and Anr. vs. The State of Punjab [39] the accused were charged with the murders of two deceased, one of the accused was sentenced to death for the murders and two months of rigorous imprisonment for house trespass, while the second accused, was sentenced to life imprisonment for abetting the crimes, the important evidence in the case was the footprint evidence, that was found on the crime scene but both the shoes and the crime moulds remained in police custody for an extended period in an unsealed condition, that raised the concerns of tampering of evidence. Because of the delay, there was question of reliability of the forensic evidence, that lead court to disregard the evidence.

### 3. DNA Testing in Rape Cases

Considering the usefulness of the DNA evidence, because of improving technology. Seminal fluid does not contain DNA on its own, but sperm cells do and because semen typically contains a high concentration of sperm cells, a significant amount of DNA can be extracted for analysis when a semen sample is present [40]. DNA evidence is useful in rape cases as many a times; it becomes difficult to identify a perpetrator [41]. It is reasonable to assume that people accused of sexual offences, would be unlikely to voluntarily undergo DNA testing, as a result, courts often require rape accused to submit to involuntary testing, typically through a blood sample. This raises the issue of whether such compelled testing infringes on the constitutional right against self-incrimination of the accused [42]. The courts have time and again held that DNA report is not conclusive evidence to establish rape [43]. DNA evidence can only be used as the corroborative evidence [44]. In the landmark case of Mukesh v. State [45] DNA evidence played a crucial role in establishing the involvement of the accused and corroborating the prosecution's case. The forensic analysis confirmed that bloodstains found on multiple surfaces inside the bus—including iron rods, curtains, seat covers, and various floor and door areas—matched the DNA profile of the victim (prosecutrix), proving the location of the crime. Additionally, DNA from the accused's clothing (underwear, T-shirts, pants, jackets, slippers, and shoes) was found to be consistent with the prosecutrix's blood, further linking them to the crime. Biological samples from the victim, such as rectal and breast swabs, contained DNA of male origin, consistent with the accused, reinforcing the rape charges.

#### 4. International Standards of the DNA Profiling and Evidence

**4.1 United Kingdom:** After the criminal Justice and Police Act 2001, the act allowed the police to retain DNA samples from individuals charged with offences, even after acquittal. However, these samples could only be used by the police 'for purposes related to the prevention or detection of crime, the investigation of an offence or the conduct of a prosecution.' Now, Under the Criminal Justice Act 2003, the police have authority to collect and retain DNA samples from anyone arrested for any recordable offence, regardless of whether the individual is charged or, if charged, or acquitted later. This led to establishment of National DNA Database (NDNAD) having samples of more than 3.5 million people in UK [46]. After coming of Protection of Freedoms Act, 2012, in which Section 1 to 25 covers DNA and fingerprint retention asked the samples to be deleted within six months in most cases, for instance if there is no charge or conviction, but it has exceptions in the act itself because of which it allows record to be kept [47], for instance, if the sample is to be presented as evidence in Court. The act also establishes Biometric Commissioner, to whom police can request for extension in retention in the DNA profiles at several instances, the commissioner have authority to order the destruction of a DNA profile or fingerprint record if they find that retaining a DNA profile or fingerprint record is unnecessary [48].

**4.2 Netherland:** The Dutch DNA law, first introduced in 1994, underwent major revisions in 2001 and 2002 that impacted Netherlands Forensic Institute (NFI). It is the primary body responsible for DNA testing and managing the Dutch DNA-database. The law includes the police to obtain authorization from a prosecutor or investigative judge before conducting a DNA test, with suspects legally compelled to undergo DNA testing if they are charged with crimes carrying a potential prison sentence of four years or more. The DNA profiles of suspects are removed if they are acquitted, and for those convicted, they have their profiles retained for varying periods based on the severity of their crime. Because of the complexity in managing personal information, a system was established to track the status of individuals in the DNA-database, to ensure that profiles are stored or removed as required and monitors timelines for profile storage after conviction [49].

**Table 2.** Comparison between United Kingdom, Netherland and India.

Aspect	United Kingdom	Netherlands	India
Key Legislations	Criminal Justice and Police Act, 2001; Criminal Justice Act, 2003; Protection of Freedoms Act, 2012.	Dutch DNA Law (1994), substantially revised in 2001 and 2002.	No standalone legislation enacted; DNA Technology (Use and Application) Regulation Bill, 2019 (pending).
Authority for DNA Collection	Police are authorized to collect DNA from any individual arrested for a recordable offence (post-	Collection requires authorisation from a public prosecutor or investigative judge;	Currently collected under judicial orders or relevant provisions of the BNSS. The

	2003).	mandatory for offences with a potential sentence of four years or more.	Bill proposes collecting both civil and criminal matters by authorized persons.
Retention After Acquittal	Previously allowed indefinite retention. Under the Protection of Freedoms Act 2012, DNA profiles must be deleted within six months if no charge or conviction occurs, subject to certain exceptions (e.g., court evidence).	DNA profiles must be removed upon the acquittal of the individual.	No standardized policy. Current practice is inconsistent and relies on judicial discretion.
Use of DNA Database	The National DNA Database (NDNAD), established in 1995, contains profiles of over 3.5 million individuals and is primarily used for crime detection and prevention.	The national DNA database is managed by the Netherlands Forensic Institute (NFI) and is utilized for criminal investigation and identification.	A national DNA database is yet to be established. The Bill proposes the creation of a National DNA Data Bank and Regional Data Banks under statutory authority.

## 5. Conclusion

DNA profiling has become an indispensable tool in forensic science evidence gathering that offers high level of accuracy in different matters such as in criminal investigations, paternity disputes, and the identification of unknown individuals. However, it comes with serious issues of ethical and legal questions. As highlighted in the case of *Pattu Rajan v. State of T.N* [50], court said that expert opinions, depends on the specific facts and circumstances of each case and must be considered alongside other available evidence. While advancements in science have made DNA testing more accurate and reliable, it is not infallible. Therefore, the absence of DNA evidence should not automatically be seen as negative for a party if there is other strong and credible evidence in their favour. It shows that, it is also essential to carefully consider all the factors associated with DNA Profiling, as both over-reliance and complete disregard for DNA evidence can be detrimental. A balanced approach is necessary to ensure its fair and effective use. The absence of a comprehensive regulatory framework in India has led to inconsistencies in its application, leaving critical issues such as privacy, data protection, and wrongful profiling largely unaddressed. A well-defined legal and

ethical framework is imperative to harness the benefits of DNA technology while mitigating its risks, ensuring that justice is served without compromising fundamental rights, because justice must not only be served and it must be seen to be fair, ethical, and respectful of fundamental rights.

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## Author Contributions

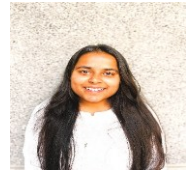
All author(s) listed on this manuscript have made substantial contributions to its creation and are accountable for all aspects of the work. Each author has participated in the following aspects of the research and manuscript preparation:

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- **Data Curation:** P.S
- **Writing - Original Draft:** P.S
- **Writing - Review & Editing:** P.S
- **Visualization:** P.S
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