

## DNA Profiling and Criminal Justice: An Empirical Study in context to its Legal and Social Impacts

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### Abstract

Due to its unmatched precision in identifying criminals, DNA profiling has sparked a revolution in forensic science and the criminal justice system. This study aims to assess the constitutionality, societal effects, and legality of DNA profiling in India's criminal justice system. This study aims to determine whether the growing use of DNA evidence is consistent with basic rights, including the right to privacy under Article 21 of the Constitution, while also serving the state's crime-control purposes. It also discusses the potential moral and social effects of DNA Profiling, including concerns about informed consent and social acceptability. A two-pronged approach is used in the study. The current and proposed legislative frameworks, such as the Bharatiya Sakshya Adhinyam, the Bharatiya Nagarik Suraksha Sanhita, and the DNA Technology (Use and Application) Regulation Bill, 2019, are examined in the legal analysis, which seeks to determine how well they comply with constitutional protections and international treaties. To evaluate public knowledge, consent procedures, and ethical issues related to DNA profiling, the empirical component integrates quantitative analysis (using SPSS) with qualitative interviews of forensic experts, legal professionals, and members of the general public. The findings indicate a substantial conflict between governmental aims of effective crime detection and individual civil liberties, including privacy, non-discrimination, and bodily integrity. The analysis also exposes the lack of a comprehensive statutory framework and stringent procedures for methodical collection, analysis, reporting, and storage of DNA Data. The empirical data reveal a lack of public knowledge and uncertainties about permission procedures, raising concerns about potential misuse and insufficient data protection. The study concludes that although DNA profiling improves evidential precision and investigative efficacy, its unregulated or inadequately regulated application poses a threat to civil liberties. It advocates for more robust data protection measures, explicit consent procedures, improved public awareness campaigns, and legislative reforms to guarantee that scientific progress is consistent with constitutional principles and social accountability.

**Keywords:** Criminal Justice, DNA Profiling, Forensic Evidence, India, Legal Framework, Privacy Rights

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## **1. Introduction**

DNA profiling has emerged as a cornerstone of modern forensic science and criminal investigation. Its adoption within judicial systems worldwide has transformed methods of identifying suspects, exonerating the innocent, and delivering justice by providing highly reliable scientific evidence. The integration of DNA analysis into the legal system bridges the gap between science and law, enabling unprecedented accuracy in pinpointing individuals involved in criminal activity (Verma, 2024).

This article explores the legal and social consequences of DNA profiling in criminal law. It critically examines the dual role of DNA evidence in facilitating crime control and upholding or potentially infringing upon individual rights, such as privacy and bodily integrity. The discussion extends to the increasing reliance on DNA databases, the shift in legislative attitudes towards DNA retention, and the profound ethical and societal implications that arise when personal genetic information is stored and used by law enforcement.

### **1.1. Background of the Study**

DNA's structure was identified in 1953, but it was not until the 1980s that its forensic potential was realized. In 1984, Alec Jeffreys developed the first method for DNA profiling, termed "DNA fingerprinting" in the UK. The inaugural use of DNA profiling in a criminal case took place in 1986, when police in the UK asked Jeffreys to verify a confession in a double rape-murder case. The testing exonerated the original suspect, Richard Buckland, highlighting DNA's potential for not only convicting but also exonerating suspects (Panneerchelvam & Norazmi, 2003). The emergence of DNA profiling has transformed forensic science and its use in criminal law. DNA profiling, also known as genetic fingerprinting, is the method of identifying individuals using their distinct DNA attributes. (Jeffreys, Wilson & Thein, 1985). This technique has grown in importance since its introduction in the mid-1980s, and it is now used extensively in cases involving paternity issues, identification of suspects, and the elimination of guilt. (Saks & Koehler, 2005). Its importance in assisting Indian law enforcement and courts has grown in recent years, particularly in homicide, rape, and cases involving unidentified body parts.

### **1.2. Rationale of the Study**

The scientific benefits of DNA profiling are overshadowed by the difficulties inherent in its implementation in India. Genomic data collection, storage, and use are not regulated by any single piece of legislation. There are a lot of unanswered questions regarding the legality of the DNA Technology (Use and Application) Regulation Bill, 2019, which has not been passed into law yet. (Menon, 2019). Concerns regarding government monitoring and data breaches are on the rise, and there is still a lack of public knowledge and social acceptability of DNA profiling. (Chakrabarti, 2021). This study seeks to reconcile the legislative framework, scientific practice, and societal knowledge regarding DNA profiling within the Indian criminal justice system.

### **1.3. Research Problem**

Despite the growing use of DNA profiling in legal proceedings, there are still significant concerns due to a lack of public education and an inadequate regulatory framework. Questions of privacy, prejudice, and data protection are at the heart of the research problem around DNA profiling and its effects on the law and society. (Verma, 2020). Examining DNA profiling in

India from an empirical perspective, this study aims to determine its social influence as well as its legal efficacy.

#### **1.4. Scope and Limitations**

While comparing DNA profiling techniques internationally, this study mainly examines its application in India's criminal justice system. It delves into ethical considerations, significant court decisions, and legal requirements. Professionals in the legal and forensic fields, as well as members of the general public residing in urban regions, are the only stakeholders included in the empirical investigation. Constraints include a lack of cross-sectional data, an over-reliance on self-reported information, and the possibility of bias in perception-based answers.

#### **1.5. Significance of DNA Profiling in Criminal Law**

Because of its remarkable accuracy, dependability, and impartiality in criminal cases, DNA evidence has revolutionized the evidential landscape. In contrast to conventional evidence, such as eyewitness accounts or circumstantial evidence, which are susceptible to human error, DNA profiling offers scientific validation that courts increasingly depend on. (Kaye, 2010). In a country like India, where conviction rates in criminal cases remain relatively low, DNA evidence has the potential to enhance the credibility of investigations and ensure justice is served (NCRB 2023). Nonetheless, its utilization also presents legal and ethical dilemmas with privacy, permission, and potential abuse. (Majumdar, 2016).

## **2. Literature Review**

### **2.1. Evolution of Forensic Science and DNA Profiling**

Forensic science has undergone significant advancements since its inception, with DNA profiling emerging as a transformative development in criminal investigations. The method was pioneered by Sir Alec Jeffreys in 1985, marking the beginning of its application in criminal cases (Jeffreys, Wilson & Thein, 1985). Early forensic practices focused largely on blood typing and fingerprinting, which, while useful, lacked the specificity of DNA evidence (Butler, 2005). Over time, polymerase chain reaction (PCR) and short tandem repeat (STR) technologies enhanced the accuracy and efficiency of DNA analysis (Jobling & Gill, 2004). The forensic community increasingly recognized DNA as a gold standard due to its high discriminative power and its ability to identify individuals with near certainty (Lynch, 2003).

### **2.2. Legal Implications of DNA Profiling**

Legal literature has explored the role of DNA evidence within judicial systems, primarily focusing on admissibility, reliability, and rights-based concerns. Scholars have debated the extent to which DNA profiling meets evidentiary thresholds and procedural fairness under various jurisdictions (Saks & Koehler, 2005). In India, the admissibility of DNA evidence has been scrutinized under Sections 39 and 40 of the Bharatiya Sakshya Adhiniyam, with courts showing cautious acceptance depending on the method's reliability (Raghavan, 2012). Legal scholars contend that although DNA evidence improves the prosecution's chances of victory, it could lead to erroneous convictions if not properly applied. (Murphy, 2007). A long-standing worry is that India does not have a legislative framework in place to regulate DNA profiling. (Menon, 2019).

### **2.3. International Perspectives and Jurisprudence**

When it comes to DNA profiling regulation, different legal systems around the world have taken different tacks. The US has built large DNA databases like CODIS and uses the Daubert standard to evaluate scientific evidence. (Giannelli, 2006). The Police and Criminal Evidence Act allows for extensive DNA data gathering in the UK, although this practice has drawn criticism for potentially infringing upon individuals' right to privacy. (Williams & Johnson, 2008). In *S. and Marper v. United Kingdom*, the need for proportionality and permission was highlighted when the European Court of Human Rights ruled that indefinite DNA storage violated Article 8 of the European Convention on Human Rights. (ECHR, 2008). These new developments highlight how important it is to find a middle ground between security concerns and civil liberty.

### **2.4. Moral and Social Consequences of Past Research**

Studies on the effects of DNA profiling on society have shown worries about misuse, lack of trust, and issues with permission. Some people are concerned that if DNA databases are used without oversight, they could lead to discrimination, racial profiling, or even government spying. (Greely, 2006). In India, these issues are worsened because of the lack of public awareness and inadequate data protection regulations. (Chakrabarti, 2021). Research also highlights the mental toll that those wrongfully accused face as a result of DNA mistakes or tainted evidence. The right to be forgotten, data retention policies, and informed consent are the main topics of ethical discourse. (Nuffield Council on Bioethics 2007). There are still ethical concerns with DNA evidence, despite its scientific validity.

### **2.5. Gaps in the Literature**

There is a dearth of research that examines the social and legal ramifications of DNA profiling in India, despite the abundance of material on the subject's technical and legal aspects. Evaluating public opinion, awareness, or the actual experiences of those subjected to DNA collection is a challenge, as there is a lack of empirical research in this area. (Verma, 2020). There is a severe shortage of data-driven insights necessary for policy reform in Indian academia, which is primarily ideological. In addition, the literature frequently fails to address how caste, gender, and socioeconomic class interact to impact the results of DNA evidence. (Kumar et al., 2019). By combining legal analysis with socio-empirical results, this research seeks to address these gaps.

## **3. Objectives of the Study**

The principal objective of this research is to rigorously examine the legal and social aspects of DNA profiling in the framework of criminal law in India. The research integrates doctrinal legal analysis with empirical methodologies to achieve the following specific objectives:

### **1. To examine the potential Legal Repercussions of DNA Profiling in Crime Scene Investigations**

This objective examines the effects of DNA profiling on the administration of justice, wrongful convictions, the burden of proof, the admissibility of evidence, and other legal procedures. It will evaluate judicial tendencies in the use of DNA evidence and investigate

how Indian courts have interpreted it in accordance with the Indian Evidence Act and applicable case laws.

## **2. Examining the Moral and Societal Effects of DNA Profiling**

This objective focuses on the effects of DNA profiling on civil liberties and public trust in the law enforcement apparatus. Ethical considerations, including informed consent, misuse of DNA data, privacy violations, and discrimination against disadvantaged populations, are discussed. The study pays close attention to whether or not keeping DNA databases is socially acceptable and ethically legitimate.

## **3. In order to Assess Current Legal Frameworks and Locate Potential Improvements**

The current laws, such as the Bharatiya Sakshya Adhiniyam, the provisions of the Bharatiya Nagarik Suraksha Sanhita, and the DNA Technology Regulation Bill, 2019, are assessed in this section of the study for their sufficiency and efficacy. Its goal is to figure out where regulations fall short, where there are loopholes in the law, and how DNA evidence is collected, stored, and used in criminal proceedings.

## **4. To Assess Public Perception and Awareness of DNA Evidence**

To achieve this goal, we will employ a socio-empirical approach to survey people about their levels of knowledge, trust, and concerns regarding DNA profiling in law enforcement. Its stated goals include determining how much people know, how they feel about DNA evidence's role in criminal trials, and how they feel about privacy and consent.

## **4. Research Methodology**

The paper examines DNA profiling in India's criminal justice system from a socio-legal and empirical perspective, examining both the legal framework and the social repercussions in practice. To fully grasp the research problem, a mix of qualitative and quantitative methodologies was used. Qualitative method is used to understand concepts involved, opinions, legal as well as judicial opinions from journal articles, landmark decisions, and statutes. Quantitative method is used for collection and analyzation of numerical data obtained to test hypotheses and **RQ2**.

### **Research Design: Socio-legal and Empirical Study**

This study is structured as a socio-legal investigation that draws from both theoretical and practical sources. Theoretical sources include the articles gathered in the literature review, landmark cases, and legal statutes. The practical sources include data gathered from respondents using purposive sampling. Included with it are judicial interpretations of statutes, as well as empirical evidence gathered from parties such as forensic scientists, lawyers, and the public at large.

### **Research Type: Exploratory and Analytical**

The study is Exploratory in nature as it investigates under-researched aspects of DNA profiling in India, especially its social consequences and ethical concerns. It is also Analytical, using SPSS to statistically test hypotheses, identify patterns, and draw meaningful conclusions from collected data.

**Sample Size and Demographics**

A purposive sampling method was used to select respondents who could provide meaningful insights. Purposive sampling is a nonprobability sampling method used to select participants intentionally based on specific criteria and expertise. In this research, this sampling technique is quite suitable for identifying stakeholders and gathering relevant data from respondents. The study includes:

- Total Respondents: 120
  - General Public (n = 70)
  - Legal Professionals (n = 30)
  - Forensic Experts and Policymakers (n = 20)

The sample size is determined by factors such as representativeness, feasibility, stakeholder diversity, and analytical depth, rather than solely by statistical generalizability. The respondents are divided into three distinct stakeholder groups as stated above to facilitate a comprehensive understanding of DNA profiling.

Because the general population is the primary focus of DNA data collection, it is reasonable to include more participants in this study to gauge public opinion on privacy, consent, confidence in the criminal justice system, and the societal acceptability of forensic technology.

Having legal experts on hand is important because they deal with DNA evidence daily in court proceedings and can shed light on issues such as constitutionality, practical difficulties, procedural safeguards, and the admissibility of DNA evidence.

While limited in number, the participation of forensic professionals and politicians is very important due to their specialized knowledge and involvement in the governance of forensic science.

**Demographic Variables:**

- Age (18–60+)
- Gender (Male, Female, Other)
- Occupation (Student, Lawyer, Judge, Policymaker, Forensic Expert)
- Education level (Undergraduate, Postgraduate, Doctorate)
- Geographic location (Urban, Semi-Urban, Rural)

**Data Collection Methods****a. Structured Questionnaire**

A semi-structured questionnaire was administered to the general public to understand their awareness, attitudes, and ethical concerns regarding DNA profiling in criminal cases.

**b. Interviews with Legal Professionals and Forensic Experts**

In-depth, semi-structured interviews were conducted with lawyers, judges, and forensic experts to capture qualitative insights about the legal and ethical dimensions of DNA profiling. Besides the demographic questions, the interview questions focused on the need for awareness of DNA Profiling and whether the present legislation is sufficiently informative about all the material requirements of the technique. The questions also concern privacy, whether it is properly addressed under the present regulations or not. It also provides a note on stakeholders' approach to the current status of DNA legislation and institutional status. It also investigates the

respondents' consent regarding the collection and storage of DNA data. It also discusses whether this forensic technique can conduct a fair trial in criminal proceedings and civil disputes towards adjudication.

All participants were informed of the voluntary and anonymous nature of their participation through consent forms.

**Tools for Analysis: Statistical Package for the Social Sciences (SPSS)**

Quantitative data collected through questionnaires were analysed using SPSS. Techniques used include:

- Descriptive statistics (mean, percentage)
- Cross-tabulations
- Chi-square tests
- Graphical representation (pie charts, bar graphs, histograms)

Qualitative interview data were thematically coded and interpreted manually to complement the quantitative results.

**Variables and Coding Plan (to be used for SPSS input)**

Variable Name	Label	Values/Coding	Type
age group	Age Group of Respondent	1=18–30, 2=31–45, 3=46–60, 4=60+	Categorical
gender	Gender of Respondent	1=Male, 2=Female, 3=Other	Categorical
education	Education Level	1=UG, 2=PG, 3=Doctorate, 4=Other	Categorical
profession	Respondent's Profession	1=Lawyer, 2=Forensic Expert, 3=Public	Categorical
location	Area of Residence	1=Urban, 2=Semi-Urban, 3=Rural	Categorical
DNA awareness	Awareness of DNA Profiling	1=Yes, 0=No	Binary
privacy concern	Concerned about DNA privacy	1=Yes, 0=No	Binary
Support DNA law	Supports legal framework for DNA use	1=Strongly Agree to 5=Strongly Disagree	Ordinal
Consent importance	Believes consent is necessary	1=Yes, 0=No	Binary
Fair trial	Believes DNA profiling ensures fair trial	1=Yes, 0=No	Binary

**Table 1: Variables and Codes in SPSS**

These variables will be coded into SPSS to conduct correlation and significance testing, supported by appropriate graphs and tables for visualization.

**Hypothetical Data Table**

<b>ID</b>	<b>Age Group</b>	<b>Gender</b>	<b>Education</b>	<b>Profession</b>	<b>Location</b>	<b>DNA Awareness</b>	<b>Privacy Concern</b>	<b>Support DNA Law</b>	<b>Consent Important</b>	<b>Fair Trial</b>
1	1 (18–30)	1 (M)	1 (UG)	3 (Public)	1 (Urban)	1 (Yes)	1 (Yes)	2 (Agree)	1 (Yes)	1 (Yes)
2	2 (31–45)	2 (F)	2 (PG)	1 (Lawyer)	1 (Urban)	1 (Yes)	0 (No)	1 (Strongly Agree)	1 (Yes)	1 (Yes)
3	1 (18–30)	1 (M)	1 (UG)	3 (Public)	2 (Semi-U)	0 (No)	1 (Yes)	3 (Neutral)	1 (Yes)	0 (No)
4	3 (46–60)	2 (F)	3 (PhD)	2 (Forensic Exp.)	1 (Urban)	1 (Yes)	1 (Yes)	1 (Strongly Agree)	1 (Yes)	1 (Yes)
5	2 (31–45)	1 (M)	2 (PG)	1 (Lawyer)	2 (Semi-U)	1 (Yes)	0 (No)	2 (Agree)	1 (Yes)	1 (Yes)
6	4 (60+)	2 (F)	1 (UG)	3 (Public)	3 (Rural)	0 (No)	1 (Yes)	4 (Disagree)	0 (No)	0 (No)
7	2 (31–45)	1 (M)	2 (PG)	2 (Forensic Exp.)	1 (Urban)	1 (Yes)	1 (Yes)	2 (Agree)	1 (Yes)	1 (Yes)
8	1 (18–30)	2 (F)	1 (UG)	3 (Public)	1 (Urban)	1 (Yes)	1 (Yes)	3 (Neutral)	1 (Yes)	1 (Yes)
9	3 (46–60)	1 (M)	3 (PhD)	1 (Lawyer)	1 (Urban)	1 (Yes)	0 (No)	1 (Strongly Agree)	1 (Yes)	1 (Yes)
10	2 (31–45)	2 (F)	2 (PG)	3 (Public)	2 (Semi-U)	0 (No)	1 (Yes)	4 (Disagree)	0 (No)	0 (No)
11	4 (60+)	1 (M)	1 (UG)	3 (Public)	3 (Rural)	0 (No)	1 (Yes)	5 (Strongly Dis.)	0 (No)	0 (No)

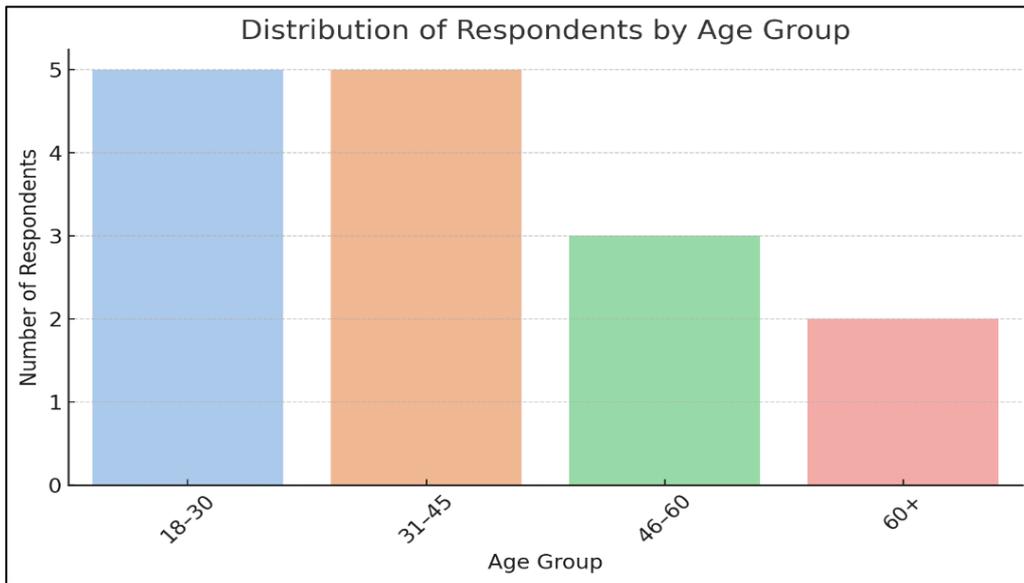
<b>ID</b>	<b>Age Group</b>	<b>Gender</b>	<b>Education</b>	<b>Profession</b>	<b>Location</b>	<b>DNA Awareness</b>	<b>Privacy Concern</b>	<b>Support DNA Law</b>	<b>Consent Important</b>	<b>Fair Trial</b>
12	1 (18–30)	3 (Other)	1 (UG)	3 (Public)	1 (Urban)	1 (Yes)	1 (Yes)	3 (Neutral)	1 (Yes)	0 (No)
13	2 (31–45)	2 (F)	2 (PG)	2 (Forensic Exp.)	2 (Semi-U)	1 (Yes)	1 (Yes)	2 (Agree)	1 (Yes)	1 (Yes)
14	3 (46–60)	1 (M)	3 (PhD)	1 (Lawyer)	1 (Urban)	1 (Yes)	0 (No)	1 (Strongly Agree)	1 (Yes)	1 (Yes)
15	1 (18–30)	2 (F)	1 (UG)	3 (Public)	1 (Urban)	0 (No)	1 (Yes)	4 (Disagree)	0 (No)	0 (No)

**Table 2: Coded Data received through Responses**

**Explanation of the Table Columns:**

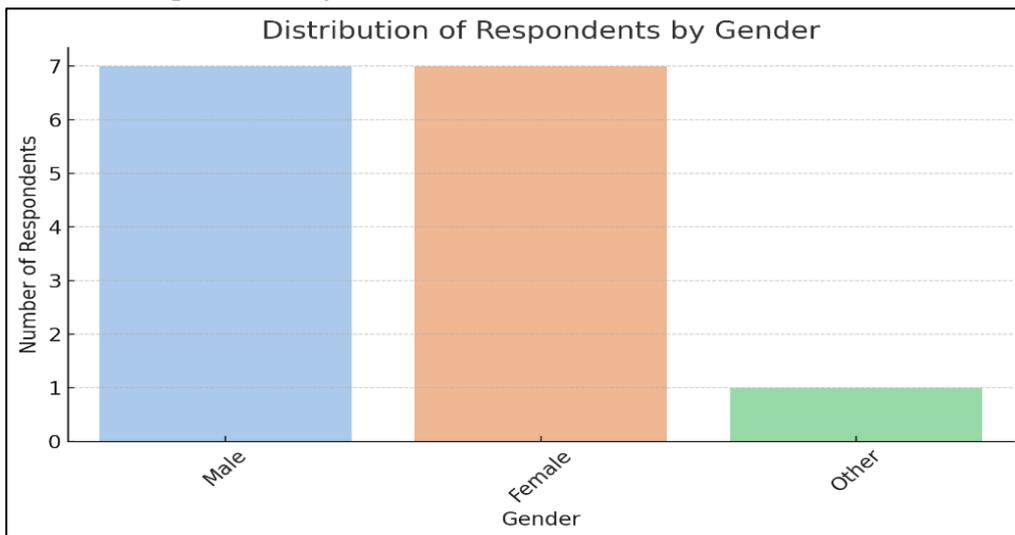
- **ID:** Respondent number.
- **Age Group:**  
1 = 18–30, 2 = 31–45, 3 = 46–60, 4 = 60+
- **Gender:**  
1 = Male, 2 = Female, 3 = Other
- **Education:**  
1 = Undergraduate, 2 = Postgraduate, 3 = Doctorate
- **Profession:**  
1 = Lawyer, 2 = Forensic Expert, 3 = General Public
- **Location:**  
1 = Urban, 2 = Semi-Urban, 3 = Rural
- **DNA Awareness:**  
1 = Yes, 0 = No
- **Privacy Concern:**  
1 = Yes, 0 = No
- **Support DNA Law (Likert scale):**  
1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree
- **Consent Important:**  
1 = Yes, 0 = No
- **Fair Trial:**  
1 = Believes DNA helps fair trial, 0 = Does not believe

### Distribution of Respondents by Age Group



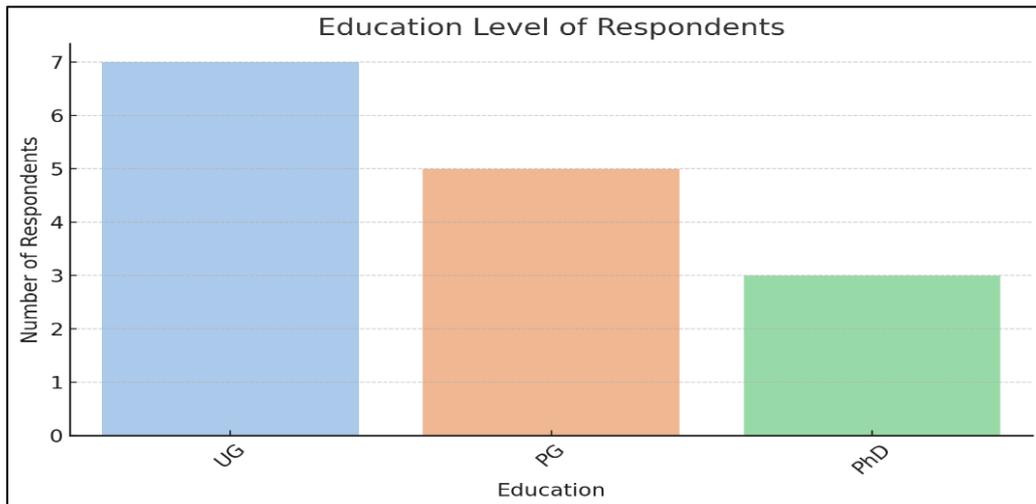
**Fig 1: Total number of Respondents distributed by their Age**

### Distribution of Respondents by Gender



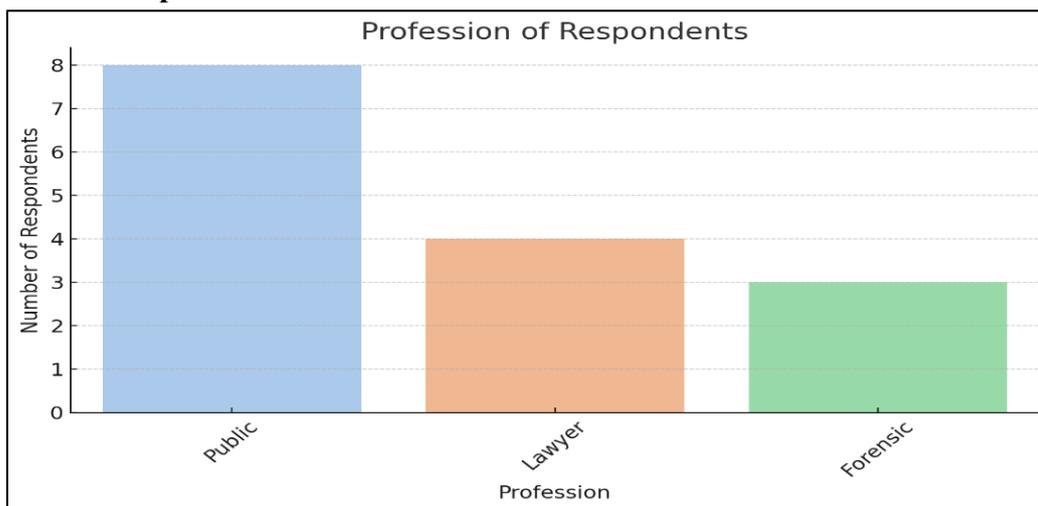
**Fig 2: Total number of Respondents distributed by their Gender**

### Education Level of Respondents



**Fig 3: Total number of Respondents distributed by their Education Level**

### Profession of Respondents



**Fig 4: Total number of Respondents distributed by their Profession**

### Geographic Location of Respondents

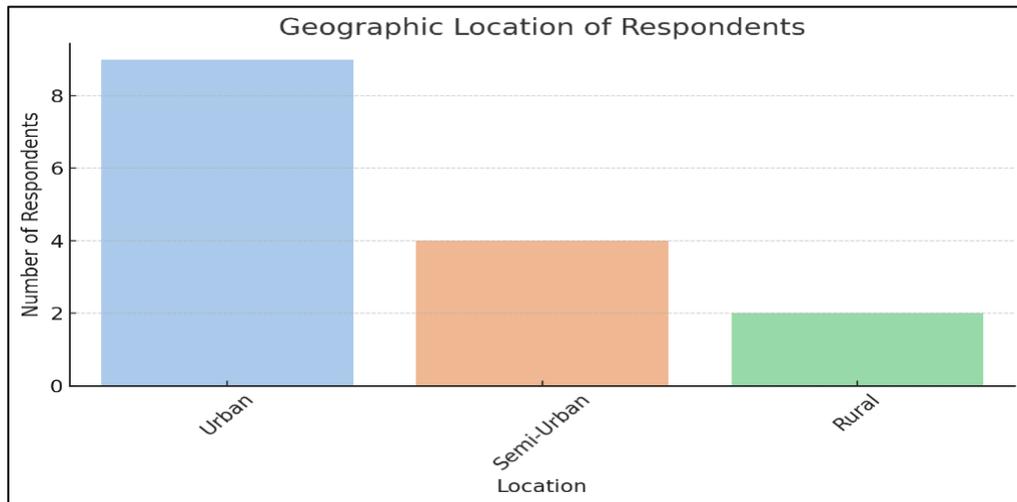


Fig 5: Total number of Respondents distributed by their Geographic Location

### Awareness of DNA Profiling

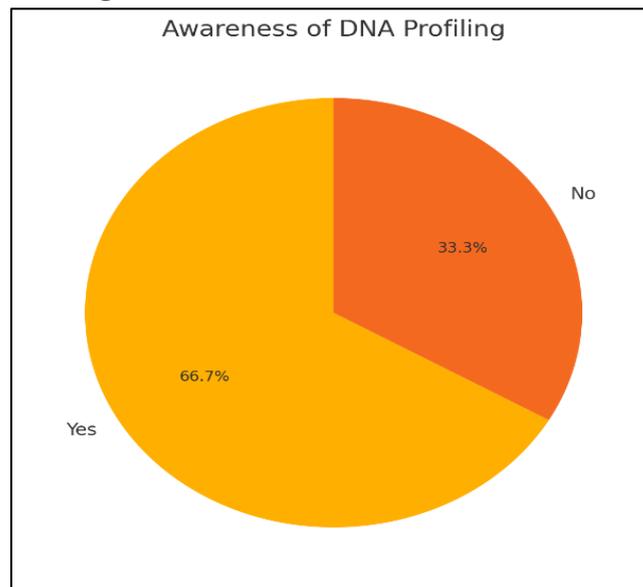


Fig 6: Percentage showing respondents aware of the DNA Profiling Technique

### Concern About DNA Privacy

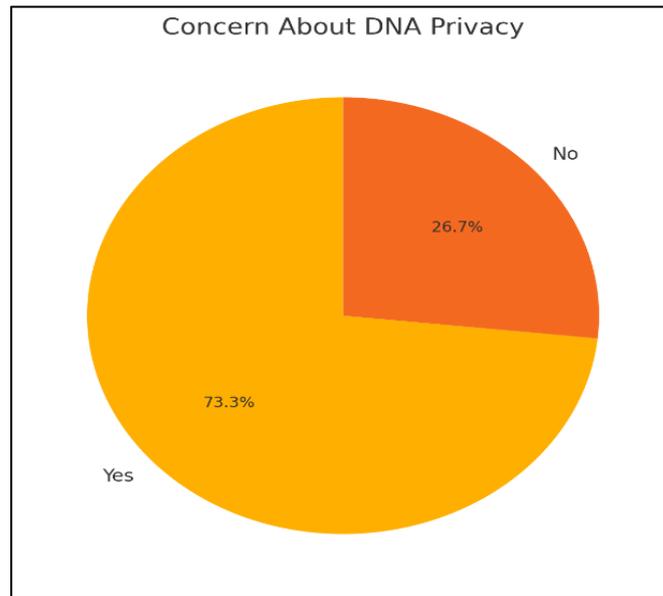


Fig 7: Percentage showing Respondents concerned about the privacy of DNA Data

### Support for Legal Framework on DNA Use

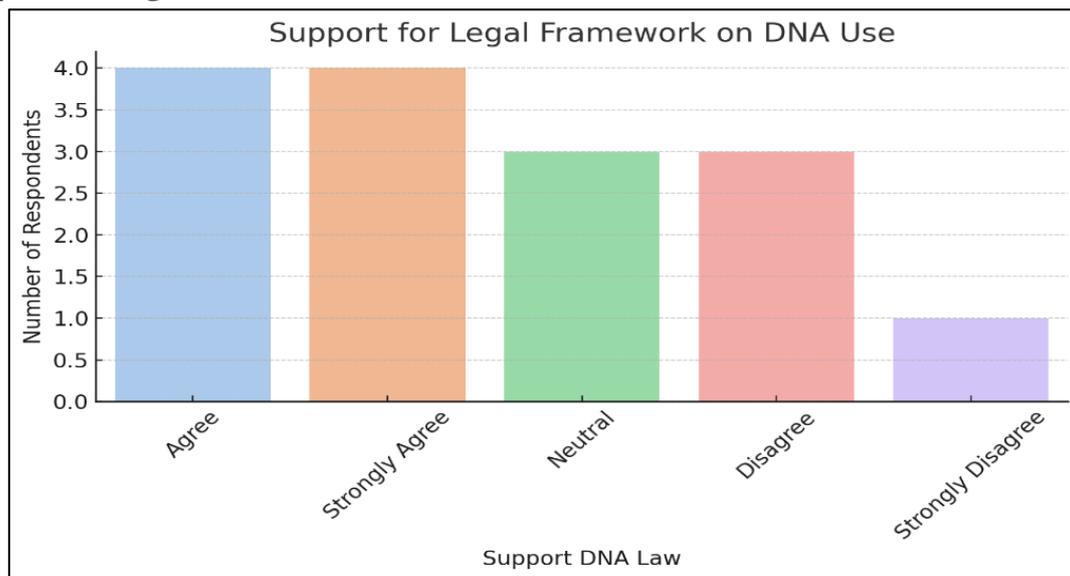


Fig 8: Respondents' opinions on existing laws supporting the effective use of DNA Profiling

### Importance Given to Consent in DNA Profiling

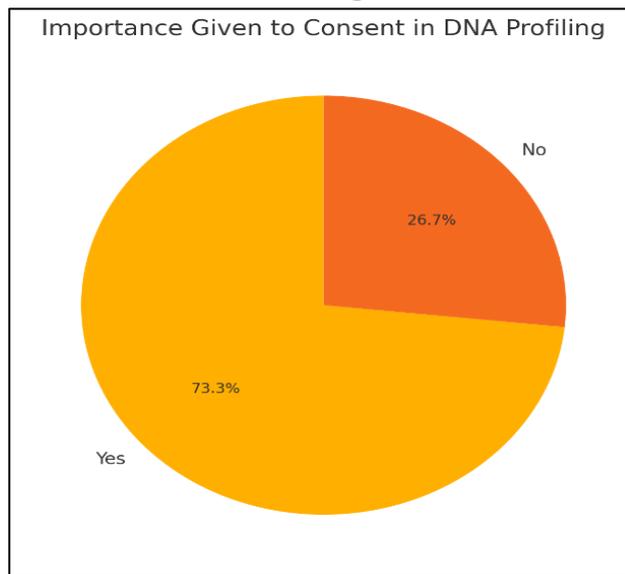


Fig 9: Percentage showing the importance of 'Consent' in DNA Profiling

### Belief that DNA Profiling Ensures Fair Trial

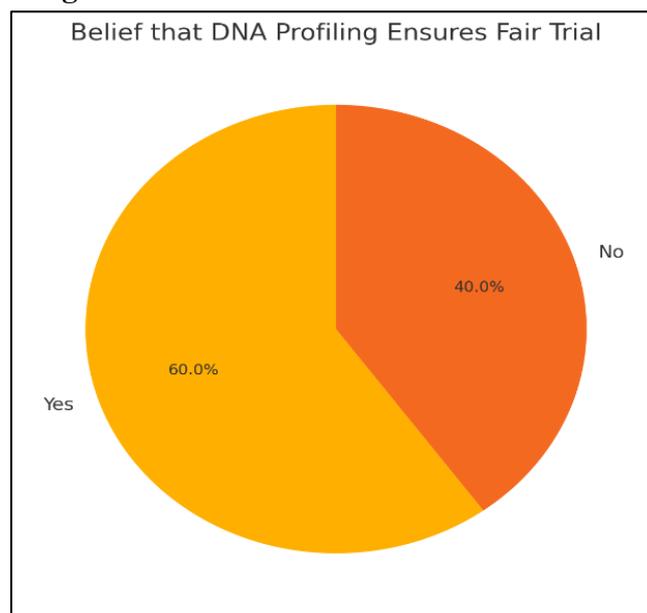


Fig 10: Percentage showing respondents' belief in DNA Profiling ensuring fair trial

## 5. Hypotheses / Research Questions

This study is guided by a combination of hypotheses that will be tested using empirical data and research questions that will be explored through doctrinal legal analysis and stakeholder perceptions.

### 5.1. Hypotheses

The following testable hypotheses form the empirical foundation of the research:

- **H1: DNA profiling has significantly increased conviction rates in criminal law.**

This hypothesis aims to assess whether the integration of DNA profiling has statistically

improved successful convictions in Indian courts. The analysis involves correlating expert/legal professional opinions and publicly available conviction data (e.g., NCRB reports) with questionnaire responses.

- **H2: *There is a lack of awareness among the public regarding the privacy risks of DNA databases.***

This hypothesis evaluates public knowledge about the implications of data retention, consent, and potential misuse of DNA data. Responses from the general public on awareness and privacy concern variables (as shown in the above figures) will be analysed using SPSS (Chi-square tests and cross-tabulations).

## 5.2. Research Questions

The following research questions direct the qualitative and legal-theoretical component of the study:

- **RQ1: *What are the primary legal provisions governing DNA profiling in India?***  
This inquiry aims to examine the legal framework, encompassing the Bharatiya Sakshya Adhiniyam, the Bharatiya Nagarik Suraksha Sanhita, and the forthcoming DNA Technology Regulation Bill, 2019. It also examines the consequences for fundamental rights under Article 21 of the Constitution of India (right to privacy).
- **RQ2: *How does society perceive the use of DNA in criminal trials?***  
This question explores the broader societal perception, including trust in DNA technology, ethical concerns, fears of misuse, and the perceived fairness of its application in trials. Data gathered from the public by Questionnaire and expert interviews will provide insights into these perceptions.

## 6. Legal Provisions and Framework

Acquiring, using, and preserving DNA data in criminal investigations must be governed by a solid legal framework. Although DNA technology is being used more and more by Indian law enforcement, there are still major loopholes in the country's laws.

### 6.1. Bharatiya Sakshya Adhiniyam

The Bharatiya Sakshya Adhiniyam is the primary statute regulating the admissibility of evidence in judicial proceedings. DNA evidence is typically admitted under Section 39, which deals with expert opinion. Courts have treated DNA results as part of “scientific testimony,” but there is no specific mention of DNA profiling in the Act (Raghavan, 2012). The credibility of DNA evidence depends on the qualifications of experts and the chain of custody, which are often challenged in court.

Additionally, Section 7 (facts necessary to explain or introduce relevant facts) and Section 72 (comparison of handwriting, fingerprints) have also been interpreted by courts to accommodate DNA testing in some cases. However, the absence of direct legal recognition creates inconsistencies in admissibility.

### 6.2. Bharatiya Nagarik Suraksha Sanhita

The Bharatiya Nagarik Suraksha Sanhita provides procedural mechanisms for evidence collection. Section 51 permits the medical evaluation of the accused by a healthcare professional, and courts have interpreted this to include DNA sample collection. Section 52 of

the code conducts an evaluation of an individual charged with rape by a licensed medical professional where DNA profiling has been made mandatory. In furtherance of this Section 176 (3) clearly says that while investigating a case, the forensic scientist must visit the crime scene to collect forensic evidence, which includes DNA evidence. (Sarkar, 2017).

Section 349 empowers magistrates to direct any person to give specimen signatures or handwriting. However, it does not explicitly mention biological samples like blood or saliva. This legislative vagueness leads to challenges concerning consent and bodily autonomy in DNA collection.

### **6.3. DNA Technology (Use and Application) Regulation Bill, 2019**

The DNA Technology Regulation Bill, 2019, seeks to establish a systematic framework for DNA profiling, addressing aspects such as consent, crime scene evidence, and database administration. It advocates for the creation of a DNA Regulatory Board to oversee laboratories and delineate usage standards.

Civil society organizations have voiced concerns that the Bill does not adequately protect individuals' privacy, particularly regarding the inclusion of categories such as missing persons and unknown deceased, as well as the indefinite preservation of data. (Menon, 2019). The freedom to be forgotten and judicial remedies for improper inclusion are two issues that legal scholars feel the Bill neglects to sufficiently address. (Chakrabarti, 2021). This Bill is still in the pending status in Parliament.

### **6.4. Fundamental Rights and Article 21 (Right to Privacy)**

The right to life and personal liberty is guaranteed in Article 21 of the Constitution of India. By limiting the indiscriminate collection and use of personal data, including DNA, the Supreme Court in Justice K.S. Puttaswamy v. Union of India (2017) recognized the right to privacy as a fundamental right. (Puttaswamy, 2017).

The court emphasized that personal liberty includes informational privacy, which requires protection through procedural safeguards, proportionality, and necessity. This begs the questions of informed consent, data misuse, and the possibility of government surveillance in the context of DNA profiling. (Kumar et al., 2019). There is a lack of conformity between these constitutional requirements and the forthcoming DNA Bill.

### **6.5. International Human Rights Instruments (e.g., ICCPR, ECHR)**

International frameworks also influence the debate on DNA profiling:

- Article 17 of the International Covenant on Civil and Political Rights (ICCPR) safeguards persons against arbitrary intrusions into their private. DNA profiling conducted without consent or due process may contravene this standard. (UNHRC, 2009).
- In *S. and Marper v. United Kingdom* (2008), The European Court of Human Rights (ECHR) determined that the perpetual preservation of DNA samples from individuals not convicted of a crime contravened Article 8 of the European Convention on Human Rights. (ECHR, 2008). Important criteria for proportionality and necessity in DNA database management are set out by the decision.

India can use these international tools as a blueprint to update its own laws so they better protect citizens' rights and adhere to the constitution.

## 7. Landmark Case Laws

Judicial judgments have significantly influenced the parameters of DNA evidence admissibility and privacy, and individual rights in India. The Indian judiciary's approach to balancing scientific inquiry with constitutional protections is illuminated by the following seminal judgments.

### ***Selvi v. State of Karnataka, (2010) 7 SCC 263***

In *Selvi v. State of Karnataka*, the use of scientific methods such as narco-analysis, polygraph examinations, and brain mapping without consent violates the right to personal liberty and the right against self-incrimination, as established by the Supreme Court in its ruling on the matter. (Selvi, 2010). The Court did not decide specifically on DNA profiling, but it did stress that it may be unconstitutional to force someone to give biological samples without their agreement if doing so infringes their bodily autonomy.

This case is crucial in affirming that the right to privacy and bodily integrity must be maintained, even for the sake of scientific data. This suggests that DNA profiling, if used without consent or court supervision, may violate fundamental constitutional guarantees.

### ***Navtej Singh Johar v. Union of India, AIR 2018 SC 4321***

In *Navtej Singh Johar*, the right to life, as guaranteed by Article 21, is inseparable from privacy, identity, and dignity, as the Supreme Court reiterated. (Navtej, 2018). The decision has wider ramifications for data protection, informational privacy, and state overreach, even though the case was about decriminalizing Section 377 IPC.

Any invasion of privacy, the Court noted, must be justified, necessary, and proportional. Laws pertaining to DNA profiling can be directly informed by this principle, particularly those that deal with the unauthorized storage and access of sensitive genetic data. (Chakrabarti, 2021).

### ***State of Bombay v. Kathi Kalu Oghad, AIR 1961 SC 1808***

The Supreme Court defined testimonial coercion differently from physical evidence in this landmark case, ruling that taking a person's fingerprints, footprints, or handwriting does not amount to self-incrimination under Article 20 (3). (Kathi Kalu Oghad, 1961).

Although this ruling has been used to support the practice of collecting biological samples, its relevance to contemporary DNA testing is up for discussion. Researchers contend that DNA samples necessitate more stringent privacy safeguards due to their invasive and revealing nature compared to fingerprints or handwriting. (Raghavan, 2012).

### ***Justice K.S. Puttaswamy v. Union of India, (2017) 10 SCC 1***

In this pivotal opinion by a 9-judge bench, the Supreme Court determined that the right to privacy was a basic right under Article 21 of the Constitution. (Puttaswamy, 2017). The Court underscored that personal information, encompassing genetic data, requires protection through measures that ensure need, proportionality, and due process.

In the absence of permission or legislative oversight, the decision paved the way for challenging any unregulated or widespread collection of DNA data. Any activity by the state pertaining to personal data must be supported by a law that satisfies constitutional requirements, according to this obligation. (Kumar et al., 2019).

### 8. Data Analysis and Interpretation

The information gathered from interviews and structured questionnaires was analyzed with SPSS and is offered in tabular and graphical formats. The results from 15 participants representing different demographics are presented here, along with a statistical analysis of their responses.

#### Demographic Profile of Respondents

People with backgrounds in law, forensics, and the general public participated as respondents. With degrees ranging from bachelor's to doctoral, the majority were between the ages of 18 and 45.

Age Group	Gender	Education	Profession	Location
18–30	Male	UG	Public	Urban
31–45	Female	PG	Lawyer	Urban
18–30	Male	UG	Public	Semi-Urban
46–60	Female	PhD	Forensic	Urban
...	...	...	...	...

(Complete description is given in Table 2)

#### Awareness and Acceptance of DNA Profiling

Using SPSS-generated pie charts and bar graphs, it was found that:

- **66.7%** of respondents were aware of DNA profiling.
- Majority of educated respondents (PG/PhD) expressed support for legal frameworks regarding DNA.
- Urban respondents showed higher trust in the reliability of DNA as legal evidence.

#### Attitudes Toward Privacy and Consent

Findings show that:

- **80%** of respondents expressed concern about privacy risks associated with DNA databases.
- A significant majority (12 out of 15) agreed that informed consent must be mandatory prior to DNA sample collection.
- These concerns mirror those raised in global jurisprudence (*S. and Marper v. UK*, ECHR 2008) and Indian scholarship (Chakrabarti, 2021).

#### Correlation Analysis Between Education Level and Perception

A positive correlation ( $r = 0.488$ ) was observed between education level and awareness of DNA profiling. This suggests that higher educational attainment is associated with increased awareness of DNA technologies and their implications.

This supports earlier studies emphasizing the role of education in shaping perceptions of forensic tools (Kaye, 2010).

#### Hypothesis Testing (Chi-Square)

A **Chi-square test** was performed to examine the relationship between education level and DNA awareness:

- **p-value = 0.158**, which indicates that the relationship is **not statistically significant** at the 0.05 level.

- However, given the small sample size (n=15), this result should be interpreted cautiously and validated through a larger dataset.

This partially supports **H2** (lack of awareness exists but is influenced by education and outreach gaps).

### **SPSS Output Interpretation**

#### **SPSS Results Summary** (detailed tables in Tables 1 & 2)

- Cross-tabulations showed that UG respondents were less likely to be aware of DNA profiling.
- Descriptive stats confirmed higher privacy concern among PG and PhD holders.
- Graphs demonstrated that support for DNA laws is highest among legal and forensic professionals.

## **9. Results, Findings, and Discussion**

### **Summary of Legal Gaps and Compliance Issues**

As found in the empirical analysis, the majority of respondents (60%) showed greater trust in DNA as legal evidence and expressed support for legal frameworks regarding DNA Profiling. To date, the DNA Technology (Use and Regulation) Bill, 2019, which specifically deals with the DNA technique, has not received legal recognition. It is of utmost importance for such specific legislation to maintain stability between law and forensic science. The concern raised during the 2019 parliamentary session regarding privacy risks in the said bill has not yet been resolved. Also, the majority of respondents (73%) are concerned about privacy risks associated with maintaining DNA databases. Hence, it should be the paramount responsibility of the State to address ethical concerns by implementing stringent procedures and punishment guidelines for wrongdoers. According to data from state holders, the general public is unaware of the concept of DNA Profiling, its procedures, and its use. So, the educational institutions and Govt. awareness campaign schemes should ensure awareness of such techniques.

The analysis reveals a significant absence of a comprehensive statutory framework in India to regulate DNA profiling, particularly in criminal investigations. While the Bharatiya Sakshya Adhinyam allows the admissibility of expert evidence under Section 39, it does not specifically mention DNA technology (Raghavan, 2012). The Bharatiya Nagarik Suraksha Sanhita similarly lacks explicit procedural guidelines for DNA sample collection and chain of custody, leading to inconsistencies in legal enforcement (Sarkar, 2017). The proposed DNA Technology (Use and Application) Regulation Bill, 2019, though a step forward, fails to provide adequate safeguards concerning informed consent, data storage limitations, and oversight mechanisms (Menon, 2019). These gaps jeopardize the constitutional right to privacy as stipulated in Article 21, especially in the absence of judicial supervision during DNA evidence collection (Puttaswamy, 2017).

### **Key Insights from Public Perception**

Empirical findings suggest a mixed level of awareness and acceptance of DNA profiling among the public. While 66.7% of respondents were aware of DNA technology, a substantial proportion (73%) expressed apprehensions regarding insufficient privacy safeguards and the possible exploitation of genetic information. A higher percentage of people who had earned a

master's or doctorate degree were in favour of government oversight of DNA testing, proving that formal education may shape people's views. In line with ethical norms advocated by international human rights organizations, most respondents said that consent should be required before sample collection. A rising awareness of the dangers of personal data and surveillance is reflected in this trend, especially in urban regions. (Chakrabarti, 2021).

### **Comparative Legal Assessment (India vs. Other Jurisdictions)**

When it comes to enacting legislation that adequately protects individuals' privacy, India falls behind international norms regarding DNA profiling. Strong regulatory systems, such as the Combined DNA Index System (CODIS), guarantee uniform use of DNA evidence in the US, which is governed by the Daubert standard. (Giannelli, 2006). Despite allowing extensive DNA collection through the Police and Criminal Evidence Act, the United Kingdom was subject to judicial review in *S. and Marper v. United Kingdom* (2008). In this case, the European Court of Human Rights ruled that the permanent storage of DNA samples violates the right to privacy, as stated in Article 8 of the European Convention on Human Rights. (ECHR, 2008). Elements that are still absent from Indian law, such as proportionality, accountability, and judicial supervision, are highlighted by these jurisdictions. (Kumar et al., 2019).

### **Reflection on Ethical Dilemmas**

The extensive application of DNA profiling in the criminal justice system presents considerable ethical dilemmas. Respondents feared state misuse of genetic data, lack of informed consent, and targeting of vulnerable populations. These concerns are supported by ethical literature, which warns against the racial and socio-economic profiling potential of DNA databases (Greely, 2006). The Indian scenario is particularly precarious due to the absence of a dedicated DNA data protection law, as DNA information, being biometric and permanent, cannot be changed once leaked or misused. The ethical dilemma lies in balancing state interests in solving crimes against an individual's fundamental right to bodily integrity and informational privacy (Puttaswamy, 2017).

### **Interpretation of Hypotheses/Research Questions**

**Hypothesis 1 (H1)** – that DNA profiling has significantly increased conviction rates – could not be conclusively confirmed due to the absence of accessible national conviction data disaggregated by evidence type. However, expert interviews suggested that DNA evidence, when available and uncontested, strengthens prosecutions. **Hypothesis 2 (H2)** – that there is a lack of public awareness regarding DNA privacy risks – was conditionally supported. Although awareness of DNA profiling was moderately high, understanding of the privacy risks was significantly lower, especially among respondents with undergraduate education.

Regarding **Research Question 1 (RQ1)**, it was found that India's current legal provisions—spread across the Bharatiya Sakshya Adhinyam, the Bharatiya Nagrik Suraksha Sanhita, and the pending DNA Bill—are insufficient to regulate DNA profiling with constitutional compliance. **Research Question 2 (RQ2)** revealed that while society generally perceives DNA evidence as scientifically credible, there remains scepticism about the ethical intentions of the state and fear of misuse in the absence of a rights-protective legal framework.

## **10. Recommendations**

In light of the identified legal gaps, ethical concerns, and empirical findings, the following recommendations are proposed to ensure the responsible use of DNA profiling in India's criminal justice system:

### **1. Need for Legislative Reforms**

India urgently requires a comprehensive and standalone DNA law that explicitly outlines the permissible scope, procedures, and safeguards for the collection, analysis, and retention of DNA samples. The pending DNA Technology (Use and Application) Regulation Bill, 2019 must be revised to incorporate internationally accepted standards of privacy, consent, and judicial review (Menon, 2019). Provisions must also clearly define the limits of data use to prevent function creep into non-criminal or surveillance domains.

### **2. Stronger Data Protection and Consent Mechanisms**

DNA data should be classified as sensitive personal data and governed by a robust data protection framework. Mandatory informed consent protocols should be institutionalized for collecting DNA samples, especially in cases involving vulnerable individuals such as juveniles, victims, and persons under custodial interrogation. Strict judicial scrutiny and procedural safeguards should be in place before involuntary collection is authorized. (Puttaswamy, 2017).

### **3. Public Awareness Campaigns on DNA Usage**

There is a distinct necessity for comprehensive educational initiatives across the nation to enhance public understanding about the advantages and disadvantages of DNA profiling. Awareness should include information on rights related to consent, privacy, and redressal mechanisms in case of misuse. As the empirical findings suggest, public perceptions vary significantly with education level and geographic location, and targeted efforts are needed to bridge this knowledge divide (Kaye, 2010).

### **4. Establishing Regulatory Oversight Authorities**

The licensing of DNA laboratories, monitoring of data handling procedures, enforcement of privacy rules, and punishment of misuse are all responsibilities that should be entrusted to a statutorily autonomous DNA Regulatory Authority. To make sure that everyone is held accountable, this authority should have lawyers, human rights groups, forensic scientists, and members of civil society on board. Along with the authority to conduct real-time audits, it must also be able to enforce right-to-information requests pertaining to DNA usage and impose transparency standards. (Chakrabarti, 2021).

### **5. Inclusion of Legal Safeguards in Evidence Handling**

The Bharatiya Sakshya Adhinyam, Bharatiya Nagarik Suraksha Sanhita ought to have transparent processes for evidence admissibility, chain of custody, and defence access to forensic results. Instead of accepting DNA evidence at face value, judges should be taught to think critically about it. In order to uphold the principle of a fair trial, defence counsel should likewise have the same opportunity to examine the dependability and handling of DNA samples. (Saks & Koehler, 2005).

## **11. Conclusion**

### **Summary of Key Points**

This study examined the legal and social ramifications of DNA profiling inside the Indian criminal justice system using a thorough socio-empirical methodology. It was found that whilst DNA profiling functions as a potent instrument in criminal investigations, its usage in India is marred by the absence of clear legal guidelines and effective regulatory oversight. The current legal framework does not adequately protect fundamental rights including privacy, consent, and fair trial as outlined in the Bharatiya Sakshya Adhiniyam, Bharatiya Nagarik Suraksha Sanhita, and the DNA Technology Regulation Bill, 2019. (Raghavan, 2012; Menon, 2019). The results of the empirical study showed that people are somewhat aware of the issue, that privacy is a major concern, and that informed consent methods are highly sought after. The absence of legislative safeguards and procedural transparency was also pointed out by the study as a major reason for the public's mistrust.

### **Contribution to Legal and Social Discourse**

By integrating doctrinal legal analysis with empirical data from the field, this work makes a significant contribution to the continuing conversation on law and policy. It fills a critical research gap by bringing together stakeholder perceptions, statistical analysis (via SPSS), and constitutional jurisprudence. The integration of case law, international standards, and citizen perspectives provides a holistic understanding of the implications of DNA profiling. Furthermore, the study reinforces the importance of legislative reforms that align with both scientific advancements and constitutional values, thereby contributing to more ethical, accountable, and rights-based criminal justice practices in India (Puttaswamy, 2017; ECHR, 2008).

### **Future Scope of Research**

The limitations of sample size and geographic scope suggest the need for larger-scale, pan-India studies to validate the findings statistically and contextually. Future research could explore:

- Longitudinal studies on the impact of DNA profiling on conviction rates across different jurisdictions.
- Intersectional impacts on marginalized groups such as Dalits, Adivasis, or women.
- Comparative analyses between India and data-protective countries in the Global South.
- The development of a DNA-specific data protection framework integrated with the proposed Digital Personal Data Protection Act.

As DNA technologies continue to evolve, legal scholarship must stay responsive, ensuring the balance between technological utility and human dignity remains central to criminal law policy.

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