

SEXUAL ASSAULT, FORENSIC INVESTIGATION, AND LEGAL SYSTEM IN PAKISTAN: A REVIEW

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(Received, 17th March 2023, Revised 13th October 2023, Published 21st November 2023)

Abstract *Sexual assaults are horrific crimes and major human rights violations everywhere, particularly against women and children. According to statistical surveys around the globe, the occurrences of sexual assaults are more common in developed countries. According to different survey reports published in The Nation, almost 11 cases are reported every 24 hours in Pakistan. Besides this high occurrence rate of rape cases, many cases go unreported. Conviction rates are surprisingly as low as 0.5% due to multiple factors like the unfamiliarity of victims with the legal procedures and basic human rights, the social pressure created by the families of victims, time-consuming and challenging legal processes, worry about retaliation from the attacker etc. With the prevalence of modern scientific technologies and trends in the World, modern and improved technologies and techniques like DNA testing and DNA profiling are being used in Pakistan also, even with the limited availability of full-fledged forensic labs. The need of the hour is to spread awareness and to enhance the literacy rate because more than 60 million people lack knowledge about basic human rights and the legal procedures regarding assault cases that they must follow in case of any unfortunate happenings.*

Keywords: Sexual Assaults, Sexual Harassments, Sexual Violations, Rape Laws, Islamic Laws, Forensic Examination, Forensic Protocols, Forensic Investigations, Crime Scene Investigations, Medico-legal Assessments

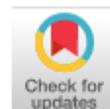
Introduction

As a global issue, sexual assaults have seriously threatened human rights and society. This horrific act is not only confined to women, but children, males, and transgender are vulnerable to its impact. Literature shows the negative effects of sexual abuse on victim's mental and physical health. There is also an increased risk of sexually transmitted diseases, suicidal ideation, depression, and sexual dysfunction. The crimes of sexual misconduct, physical abuse, threats, and rape are all included under the umbrella phrase "sexual violence". Regardless of the perpetrator's relationship with the victim, the WHO defines sexual violence as "Any sexual act/attempt to commit a sexual activity, or another act aimed towards a person's sexuality using coercion, in any setting (Organization, 2019)." According to the WHO, one in five woman might have experienced sexual assault (SA) at some point in their lives worldwide (Garcia-Moreno & Watts, 2011). In the US, this trauma affects 1.4% of males and 18.3% of women during their lifetimes (Watts et al., 2017). Similar statistics have been seen in Australia, where 17% of women and 4% of males younger than 18 have been sexually assaulted (Ross, 2021). It is an established reality that in Pakistan, the situation concerning sexual misconduct is also alarming. According to an estimate conducted by National

Crime Data, about 16.8% of women among 100,000 are sexually abused (Arif et al., 2014). Another study cited by Mazhar (2018) showed that 80% of women in their daily lives experience harassment in Pakistan. So, many organizations for human rights, activists, and social media have been actively involved in facing the issues of harassment in public and educational places as well as in hospitals; however, addressing the particular issue of street harassment has been least notified (Ahmed et al., 2021). Such cases are increasing every year and are serious threats to civilized societies. The actual number of these abuse instances is still missing as they are not reported under the social pressure created by victims' families (Fontes & Plummer, 2010). The current study aims to supplement the scant existing literature on sexual harassment of both men and women in open places as well as at the domestic level in Pakistan and to look at how victims of such harassment differ based on their gender throughout Pakistani cities.

1. Domestic Violence

Another violence that persists in third-world countries and also in some developed countries is 'Domestic violence'. Domestic assault against women can take many forms, including physical acts like beating, torturing, or slapping; psychological abuse such controlling behavior; economic abuse or demands;



and social isolation. It can even be a forced sexual activity (Zakar et al., 2016). According to Ferdoos (2005), women in Pakistan are not supposed to leave their houses alone to visit hospitals, marketplaces, or other public institutions. Different social backgrounds of the husband and wife, arguments, low literacy levels among spouses, particularly among women, unemployment among women, poverty, addiction among men, ignorance of women's rights, protracted, sluggish legal processes, misunderstandings about religion, and traditional social norms are some of the primary triggers of domestic abuse in Pakistan.

In Pakistan, a rural health facility conducted a cross-sectional study of 490 randomly chosen women of reproductive age, finding that 65% of the respondents were victims of domestic abuse (Tariq et al., 2014). Ironically, if a victim of physical or sexual abuse speaks forward, she is treated with contempt and is perceived as having lost her and her family's dignity. In Pakistani society, many rape incidents go unreported to avoid being written off as worthless (*Tackling Violence against Women.*).

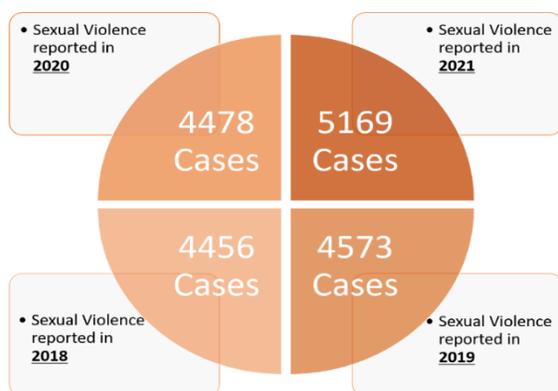


Figure 1: Illustration depicting the factual numbers based on sexual violence over the last five years (2017-2021) in Karachi, Pakistan (*Map: Rapes Reported in Karachi so Far in 2021 - Archives - SAMAA.*).

The current study aims to supplement the scant existing literature on sexual harassment of both men and women in open places in Pakistan and to look at how victims of such harassment differ based on their gender throughout Pakistani cities.

2. Gender-based Violence

Women are sexually harassed because of the gendered character of the economic and educational systems, where men have traditionally held power over them. In Sindh and Baluchistan, traditional school of thought link a family's honor to women's bodies. To uphold this honor, men think they have the right to control and influence the sexuality and way of life of women. Men, therefore, limit women's freedom of movement to uphold their honor through sociocultural standards. Women must protect their virginity and chastity since their bodies symbolize their families'

honor (Mumtaz, 2003). A woman who has an illicit relationship endangers not only the rights of others to her body but also the patriarchy-based social structure. Whether a woman is guilty or accused of engaging in an illicit sexual relationship is irrelevant regarding matters of honor. Since this mentality is narrowed and those people think that only "blood cleanses honor," the lady must be put to death if she brings the family into disgrace (Shehrbano et al., 2018) (Khan, 2020).

3. Sexual Harassment at Public Places

In a male-dominated society like Pakistan, harassment is usual incidence, and victims are forced not to take any legal action. A recent Gallup survey (2017) shows that 1 in 4 urban Pakistani women reported being stalked by men while traveling to their homes, workplaces, and markets. Nearly, 34.5% of men and 39.6% of women reported harassment in the transportation area, while 19.2% of women and 32.4% of in the university's open spaces, men were the targets of sexual harassment. While 49% women along 16.5% of men reported sexual harassment happening on the streets. However, information regarding parks showed less percentage of such cases i.e. only 11.1% of males and 13.7% of women were said to be abused were in parks (Imtiaz & Kamal, 2021).

3.1 Reported Assault Cases

Sexual harassment in Pakistan is becoming a common practice and is an alarming situation. The most recent and internationally questioned sexual assault cases are Layyah Gang Rape (2014), Zainab Ansari Rape Case (2018) ("Zainab Murder: Riots in Pakistan's Kasur after Child Rape and Killing," 2018), Motorway Rape Case (2020) (*Pak Woman Gang-Raped by Robbers in Front of Her Children on a Motorway: The Tribune India.*), Usman Mirza's sexual assault on a couple (2021) (*Pakistan: Couple Harassment Case - Human Rights News, 2021.*), and Noor Mukadam's Murder Case (2021) (*Noor Mukadam Murder Case: A Timeline, n.d.*). And very recently, a girl was raped in Margalla Hills Hiking trails in July 2023 (*Woman Raped at Margalla Hills' Hiking Trail in Islamabad: FIR - Pakistan - DAWN.COM.*). These cases brought attention to gender inequality and child protection in Pakistan and sparked inquiries about sexual harassment and its rising standard.

SA's are considered one of Pakistan's most serious crimes. The possible penalties are either the death penalty or a mandatory minimum of 10 years in prison, together with a significant fine. Scientific evidence such as DNA tests are utilized to prosecute rape cases. Only 4000 out of 22,000 cases filed from 2015 to 2020 were heard in court. This shows that Pakistan's exceptionally low conviction rate, particularly regarding sexual assaults, is the main factor contributing to the prolonged prosecution of such cases (RANK & JANG.). In Pakistan, at least 11

rape crimes are recorded every 24 hours, and 22,000 cases have been reported in the last six years, according to "The Nation". Recent data on rape and sexual assault shows that these crimes increased from October 2020 to October 2021.

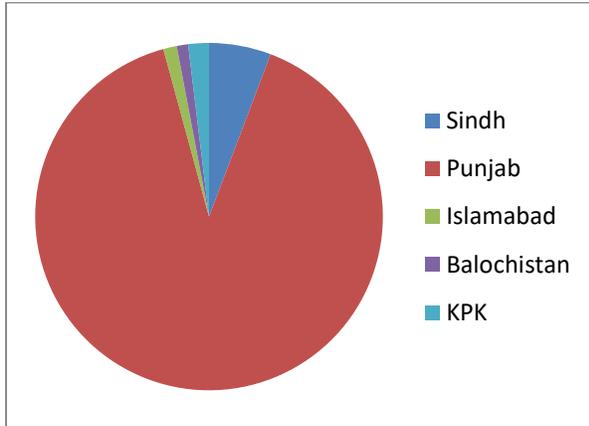


Figure 2: A provincial report on sexual violence observed from October 2020 to October 2021, out of these 351 cases involved adults, 685 children and rest were trans-genders.

Compared to the actual number of events, the number of documented rape cases is probably only the tip of the iceberg. The exact prevalence is unknown since victims do not report because of social stigma, worry about retaliation from the attacker, and time-consuming and challenging legal processes (*Data: One Year of Rape Cases in Pakistan - The Current.*). To ensure a safe atmosphere, the Pakistani government also established 1000 special courts for violence against women in 2019 (*Pakistan to Set up Special Courts to Tackle Violence against Women.*). These courts were specifically set to serve women and give them justice and honor.

3.2 Rape Categories

3.2.1 Stranger rape, the Archetypical rape, is the most well-known type of rape, in which the victim and offender are completely unfamiliar with one another. The concept of a "real" sexual assault as a violent stranger rape, as per rape myth research, is a heteronormative, male-dominated cultural heritage, and rape myth acceptance in society plays a part in the judicial injustice in sexual offenses (Andersen, 2007).

3.2.2 Acquaintance rape is engagement in sexual activity with a person "by force or threat of force; against her will and without her will." "Friendship or dating" Familiar rape is a rape in which the perpetrator and victim are acquainted. Some people like the term "survivor" over "victim" (Persson & Dhingra, 2022).

3.2.3 Date rapes are coerced sexual encounters between dates, as well as other sexual acts of violence, such oral sex, forced kissing, coerced touching, and the use of psychological pressure as a method of coercion (Moore, 2011).

4. Rape Myths and Beliefs

Rape myths are those myths that exonerate the perpetrator while blaming the victim. Female precipitation, which holds the victim directly responsible for the rape, is the most common rape myth. Female precipitation is the idea that the victim contributed to the rape in some way, for example, by engaging in dangerous behavior (like drinking), dressing inappropriately, or acting in general (Edwards et al., 2011). Another widespread misconception about rape is that men can't control their sexual urges. In a more subtle sense, the idea that men can't control their sexual urges makes women accountable for avoiding rape while also placing the guilt for the crime squarely on the shoulders of the perpetrator. If he can't control his sexual urges, she should avoid provoking him. Male sexuality and female precipitation should be proportionate to the relationship between the victim and the offender because rape myths—aside from male pathology—tend to function more strongly in circumstances where the rapist and the victim have previously been romantically involved. A stronger attribution of feminine precipitation and male sexuality is more likely from closer relationships, such as being engaged or dating, than from farther connections. (e.g., acquaintance and stranger rapes) (Russell & Hand, 2017).

5. Anti-Sexual Assault Laws in Pakistan

5.1 The Offence of Zina (Enforcement of Hudood) Ordinance, 1979

Under President Zia ul Haq's leadership, Pakistan created a set of regulations called the "Hudood Ordinances" to comply with the injunctions of Islam. When the Ordinances entered into effect in February 1979, they were primarily focused on the crimes of theft, adultery, defamation, and alcohol consumption. The "Offence of Zina (Enforcement of Hudood) Ordinance 1979" was created to address the zina infraction. Another offence included by this Ordinance was rape, often known as zina bil Jabr (Imran, 2005). Section 6 of the Ordinance defined zina bil Jabr and its penalty as:

- 1) "A person is said to have committed zina-bil-Jabr if he engaged in sexual activity with a woman or man, as the case may be, to whom they are not legally wed, under any of the following conditions:
 - a) against their will;
 - b) without their consent;
 - c) with their consent, but only after inducing fear of harm or death in the victim; Or
 - d) if the victim gives their permission and the offender is aware that the relationship is invalid because the victim considers the offender to be someone else to whom the victim is or believes herself or oneself to be legally wed.

The legislators assigned the same punishment to both zina and rape charges.

Section 8 of the Ordinance then went on to specify the kind of proof needed to establish zina and zina bil Jabr, as follows:

One of the following forms must be used as proof of Zina or zina bil Jabr subject to hadd:

- a) Before a court with appropriate jurisdiction, the accused confesses to committing the crime; or
- b) at least four Muslim adult male witnesses who, following the rules of tazkiyah al-shuhood, are truthful and abstain from grave sins (kabair), provide testimony as eyewitnesses to the penetration act required for the crime: Provided, the eyewitnesses may not be Muslims if the accused is a non-Muslim.

Negative effects were experienced by those who suffered by the unlawful application and abuse of the Zina Offence Ordinance. The portions of the Pakistan Penal Code that dealt with sexual offences were effectively removed by the Offence of Zina (Enforcement of Hudood) Ordinance (Imran, 2005).

5.2 Protection of Women Act, 2006

End of 2006 saw the adoption of the Protection of Women (Criminal Laws Amendment) Act. General Pervez Musharraf (in office from 1999 to 2008) took the initiative to change the Offence of Zina Ordinance of 1979. A "Commission of Inquiry for Women" report was published in 1997. All five Hudood Ordinances were studied and adjustments were suggested by the National Commission on the Status of Women in 2003. The Hudood Ordinances were thoroughly investigated by the Council of Islamic Ideology's Legal Committee beginning in 2006, and on June 27, 2006, the committee recommended that they must be revised. The Protection of Women Act, which Pakistan's National Assembly passed in December 2006, was the result of this process. This law was created to protect women facing charges under the Hudood Ordinance of 1979 by offering them protection from abuse and preventing victimization.

For instance, the Hudood Ordinances were repealed, and the criminal code's sections 365B, 367A, 371A, and 371B took their place. The rape sub-heading now includes the Pakistani criminal code sections 375 and 376. It was no longer necessary for rape victims to cite four pious Muslim men as witnesses to support their claims. Circumstantial evidence won't be considered in cases anymore, and rape victims won't be accused of zina. The 2006 Act further revised the Qazf Ordinance of 1979 by removing subsections (3) and (4) of sections 14 and 15 (Mehdi & Niazi.).

5.3 Criminal Law (Amendment) (Offences Relating to Rape) Act, 2016

To make rape a more serious offence, this legislation also altered the Pakistan Penal Code (PPC) of 1860, the Code of Criminal Procedure (CrPC) of 1898, and the Law of Evidence of 1984. By amending section 55 of the PPC, rape-related offences are now non-

commutable. Section 376 of the PPC has been amended to provide for life in prison or the death penalty in cases of rape of a youngster by a person who is physically or mentally impaired. It continued by saying that the perpetrator would receive the same penalties and fines if he worked for the government. It was also against the law to reveal the names of rape victims. A new section 53A was introduced to the CrPC after section 53, stating that a registered medical officer may examine a person who has been charged with rape, an unnatural crime, or sexual abuse or who has been accused of trying to commit rape, an unnatural crime, or sexual abuse under sections 376, 377, or 377B of the PPC (Jatoi).

Section 154 of the Code of Criminal Procedure has recently been amended to require the presence of any female police officers or female family of the victim while the investigating officer records the victim's declaration. A female police officer must also be present to submit a FIR for incidents of a similar nature. The police officer is expected to tell the victim of her right to legal counsel and give her a list of lawyers on the Provincial Bar Council who offer free legal assistance under the new section 161A inserted to the CrPC. A registered female physician must also examine the female victim as soon as the crime is reported in cases where rape, unnatural offence, or sexual abuse—or the attempted commission of rape, unnatural offence, or sexual abuse—is being investigated under sections 376, 377, or 378 of the Pakistan Penal Code. If these steps are taken, women will have support and won't feel alone, encouraging them to report such crimes.

Perhaps the most significant amendment is the new section 164B of the Criminal Procedure Code, which stipulates that a DNA test can only be conducted with the victim's or her legal heirs' approval and calls for the investigating officer to send DNA samples to a lab as soon as possible. In addition to ensuring that the victim is treated appropriately, this section ensures sufficient evidence in a rape case to acquit, or convict a defendant without a shadow of a doubt. Furthermore, it stipulates that such evidence can only be acquired if there are good reasons to think a medical test will produce proof. This law aims to protect a person's right to privacy by ensuring it is not violated (Qaisrani & Liaquat, 2018). The proposed law suggests a sentence of up to three years in prison for individuals who refuse to fully investigate allegations under section 166 (2) of the Pakistan Penal Code, which handles the issue of public official misconduct. Section 186 adds to this by punishing anyone who obstructs an official's investigation or obstructs an investigation with a three-month to one-year prison sentence and a monetary fine (Zubair et al.).

5.4 Amendments in rape laws act (2020) major changes

The Criminal Law (Amendment) Ordinance, 2020 (hereafter PPC) has significantly changed the Pakistan Penal Code. In Section 375 of the Penal Code, the definition of rape has been revised to consider the different ways that rape can currently be committed. The idea of penetration and insertion has been expanded to encompass several different ways to calculate them. The factors that might taint the victim's consent have also been strengthened and clearly defined. Section 375A, which only addresses the offence of gang rape, has been added. This is what the newly added section says: "Where a person is raped by one or more individuals acting as a group or in furtherance of a common intention, each of those individuals shall be guilty of the crime of gang rape and shall be punished with death, or with life in prison, or with and a fine."

The Penal Code's Section 376 outlines the penalties for rape. The convicted rapist can have previously been given the death penalty or a term of at least 10 years and up to 25 years in prison. The sentence can now be carried out for the remainder of the convict's natural life because this section has been modified.

A new section 376B of the PPC is introduced by the ordinance, which is significant. As per Section 376B:

Regardless of the applicable punishment, anyone found guilty of a violation of Sections 375, 375A, or 376 may be sentenced to chemical castration through a court order: -

- (1) In the case of a repeat offender of a section 375 infraction, or
- (2) in extraordinary circumstances concerning the first recorded offence of section 375.

The act further explains chemical castration as:

- a) When a person is rendered incapable of engaging in sexual activity for any time, as defined by the

Table 1. Description of well-established forensic laboratories situated in Pakistan

Forensic Laboratory	Location	Year of Establishment	No. of Cases solved
The National Forensic Science Agency (NFSA)	Islamabad	2002	2500/2600 Cases
Punjab Forensic Science Agency (PFSA)	Lahore	2012	36954/44417 Cases
Forensic Science Laboratory and Institute of Forensic Science	Peshawar	2017	1734/2242 Cases

Another DNA laboratory was set up at the National Forensic Science Agency (NFSA) in 2006 with the collaboration of People of China. Since then, the above-discussed cases have benefited from forensic testing performed by the DNA Laboratory (Mangi, 2021).

6.1 Forensic Protocols & Crime Scene Investigation

The data collection and evaluation of evidences is a mandatory step for productive criminal examination.

court, by administering medications supplied by a notified medical board, the procedure is formally announced by rules drafted by the Prime Minister (Bari, 2022).

6. Establishment of Forensic laboratories

All across the world, in the criminal court system, forensic science is essential. In developed countries, detectives and forensic scientists are using the most recent methods of criminal investigation to reduce the crime rate. While in Pakistan, The National Economic Council's Executive Committee approved the National Forensic Science Agency (NFSA) in 2002 to operate as a separate entity with different departments. The main goals of NFSA were to develop more forensic labs across Pakistan and offer training and educational facilities. The different working departments include DNA and serology, latent fingerprints, polygraph, narcotics, trace chemistry, toxicology, computer forensics, and questioned documents. Some of the well-established forensic laboratories are listed in table 1.

However, no laboratory has been built despite the Sindh Forensic Science Agency Act passed in the province in August 2017 (*Need for Forensic Laboratories in Sindh Greater than Ever*, 2017.). A Sindh DNA testing centre in Jamshoro offers forensic and research DNA testing. In addition, the Sindh government is working to create a forensic DNA testing lab at Karachi University.

(<https://www.researchgate.net/publication/326750125>).

Similarly, in the Baluchistan Province in August 2015, a law establishing the Baluchistan Forensic Science Agency was approved, but construction is still awaited.

This puzzle cannot be solved without help of forensic science. Well-developed protocols help the forensic scientist gather appropriate biological material at crime scene and evaluate it further. Some of these parameters include keeping the crime scene safe, maintaining witnesses' investigations for verification, testimonies of the crime sight, finding all proofs and storing all evidence.

The forensic investigating method can be employed by first responders, medical investigators, crime scene

investigators, spies, and other experts involved in a particular case. The forensic investigative procedure ensures the credibility of the inquiry and the evidence while allowing each team member to participate to the investigation (Tiry et al., 2022). The study of forensic

DNA may provide a sample of evidence to the victim or suspect, changing how the interrogation proceeds. To compare the DNA from the proposed scene of the crime sample to the profiles created from the proof sample, this special intrinsic quality of DNA is used.

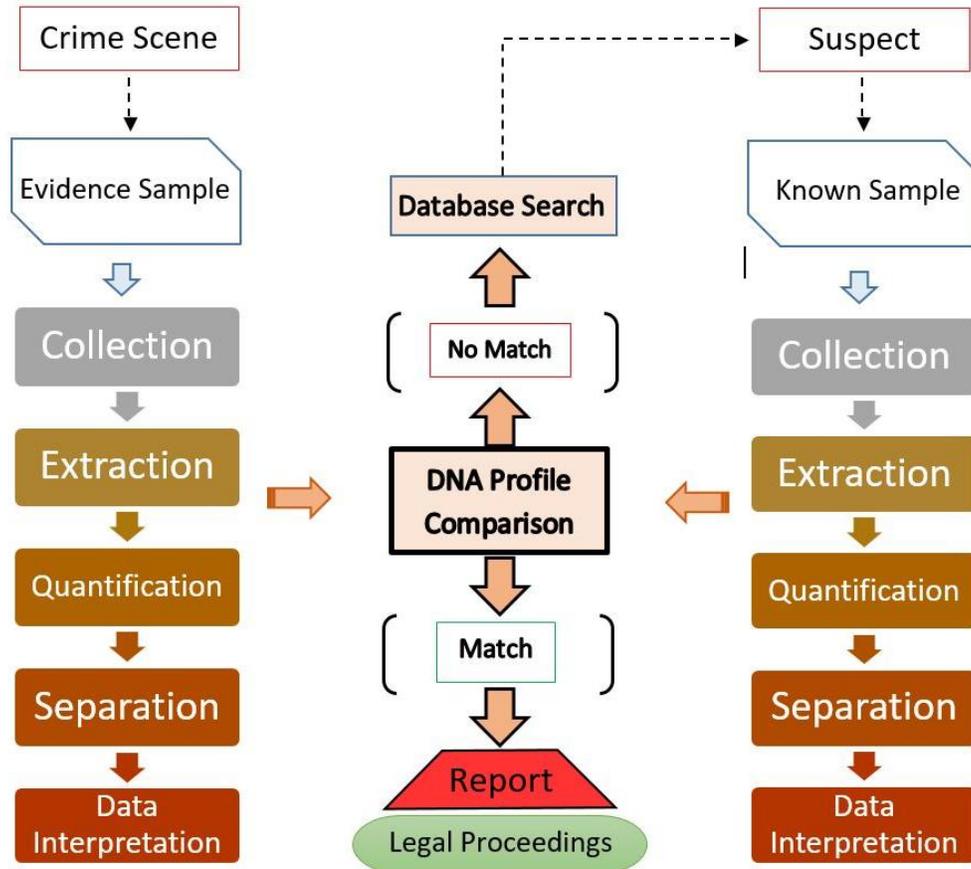


Figure 3: Overview of steps involved in DNA Testing DNA analysis needs differentiation between two samples in decision making under uncertainty.

6.2 Categories of Forensic Evidences

Gathering and evaluation of a wide variety of evidence is essential to a productive criminal investigation. When dealing with evidence, forensic scientists adhere to a set of rules and categorize it in several different ways. The necessary steps are shown in figure 3 to validate the evidence in criminal inquiry.

6.3 Knowledge of police regarding forensic protocols

The prosecution, identification and conviction of sex offenders is the main goal of creating a national DNA intelligence database (Shaikh & Ahmed, 2023). Establishing a national forensic DNA database will

relieve the strain on the medico-legal system, including government hospitals, police departments, and court hearings. Due to a lack of forensic procedural knowledge, abilities, resources, and a national database, police investigators have to face difficulties. Forensic investigators can get better findings by using DNA databases, protecting biological evidence, and being able to influence political pressure. Police investigators can solve many complicated crimes cases by developing a better understanding of forensic procedures involved in inquiry and using proper resources, training and fundings, etc (Mateen & Tariq, 2019).

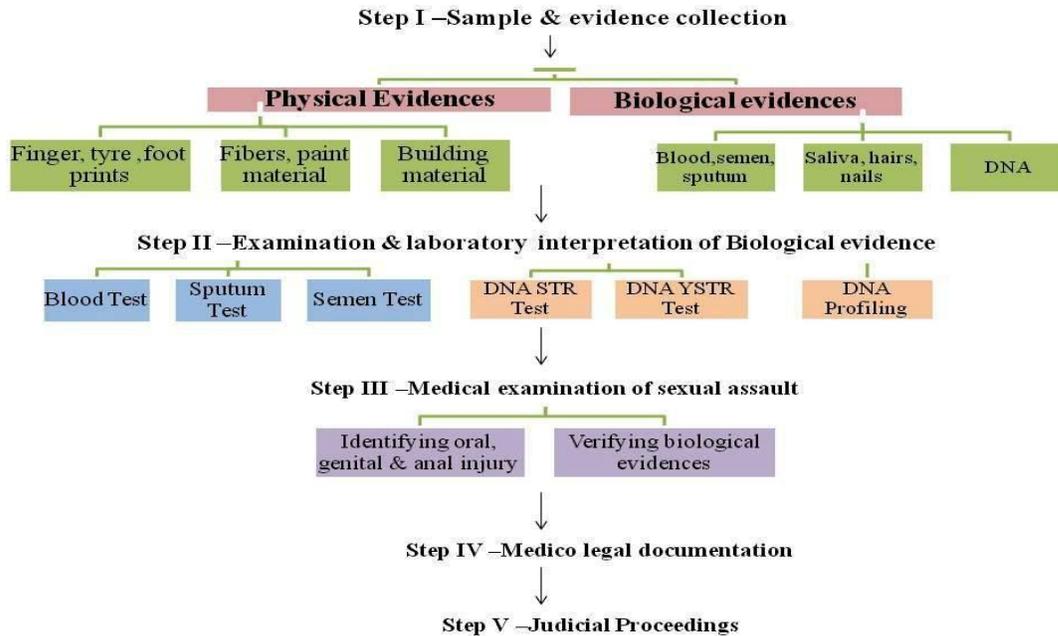


Figure 4. Summary of steps involved in data collection to get authentic evidence for legal proceedings. The mitochondrial DNA, nuclear short tandem repeats, or STR, and YSTR DNA testing or profiling is frequently performed in forensic analysis to get confident evidence.

6.4 Standards of Medico legal Examination

The manual for Standard Operating Procedures for Medico-legal Examination of Women Victims of Violence is one of the most complete resources available for medico-legal examiners. It is a thorough paper with complete instructions for the medical-legal examiner (Rasool & Rasool, 2020). So, only doctors designated as an MLO or CMO are legally permitted to evaluate both the victim and the suspect in a medical environment. Unfortunately, neither trained nor authorized paramedical staff frequently performs these inspections instead of doctors. Sexual behavior's circumstances are frequently not accurately documented; for example, inconsistencies in the facts have been discovered in police investigations and medicolegal reports. Whereas the location of pertinent biological fluid on any object can be found during a victim's forensic interrogation which offered as evidence and is very important (Hassan et al., 2007).

6.5 Legal course of action in Pakistan

Nevertheless, Pakistan's courts must adhere to the law because there is no specific judicial procedure that deals only with DNA evidence. DNA evidence has been available under Articles 59 and 164 of the QSO (Qanun-e-Shahadat Order). According to the previous principles, expert opinion on subjects like science and art is acceptable proof, whereas the latter acknowledges the various techniques made possible by advances in science and technology. Under the current legal procedure framework, a technician specializing in analyzing DNA evidence is known as a professional whose proof or opinions are accepted

in court. This legal framework is analogous to the one governing the admissibility of medical estimates, which suggests that DNA is a distinct type of medical evidence and that a DNA specialist is comparable to a doctor. We might not fully realize DNA's potential if we simply analyze it within this framework. The difference between medical estimation and DNA proof is that the latter accurately identifies the culprits while the former does not. It would be more reasonable to look into it from several legal angles. As we will see, the courts have not commented on the formation of the law, and much doubt exists (Munir et al., 2021) (Shaikh & Ahmed, 2023).

7. Lack of defense and Security during the Prosecution

Throughout their careers, the plaintiff, defendant, prosecutor's attorney, and court personnel will all run into security issues. Police officials and lawyers are targets of the most significant security threats. High-profile or terrorism-related police cases can have significant effects. Witnesses face significant security risks as well. In Pakistan's cities, the issue is noticeably worse. By testifying, witnesses endanger their own lives and their surrounding people. Because of this, witnesses decline to give testimony, especially in cases involving street crime. Unfortunately, the government hasn't done anything to ensure the protection and security of witnesses, as seen by the statute on witness defense being only partially or almost entirely unenforceable (Sellers, 2008).

Conclusion

The government's priorities should include expanding forensic labs, specialized facilities, and national DNA

[Citation Raza, M.S., Ahad, A., Nawaz, R., Ahmad, M., Hassan, J.U., Mehmood, U. (2023). *Sexual assault, forensic investigation, and legal system in Pakistan: a review.* Biol. Clin. Sci. Res. J., 2023: 465. doi: <https://doi.org/10.54112/bcsrj.v2023i1.465>]

repositories. These approaches have expensive expenses and little administrative and political viability. However, these alternatives continue to be the most important ways to improve the quality of services provided to victims of sexual assault, the speed at which cases are investigated, and the justice system in general.

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List of Abbreviations

SA: Sexual Assaults
 NFSA: National Forensic Science Agency
 PFSA: Punjab Forensic Science Agency
 STR: Short Tandem Repeats
 CMO: Chief Medical Officer
 MLO: Medico-legal Officer
 CrPC: Code of Criminal Procedure
 PPC: Pakistan Penal Code
 QSO: Qanun-e-Shahadat Order

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Funding

Not applicable

Conflict of Interest

Regarding conflicts of interest, the authors state that their research was carried out independently without any affiliations or financial ties that could raise concerns about biases.



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