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ORIGINAL ARTICLE

Medico-Legal Aspects of Sexual Assault Accuracy and limitations of Forensic Evidence in Sexual Assault Cases

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ABSTRACT

Background: Sexual assault remains one of the most underreported and complex medico-legal challenges worldwide. The accurate detection and interpretation of forensic evidence play a pivotal role in substantiating allegations, guiding legal proceedings, and delivering justice. However, the effectiveness of forensic evidence can be influenced by several factors including the timing of examination, the condition of the victim, the availability of trained professionals, and procedural limitations.

Objective: To evaluate the accuracy and limitations of forensic evidence in medico-legal sexual assault cases and assess the relationship between evidence recovery, injury documentation, and time to examination.

Methods: This descriptive cross-sectional study was conducted at the Department of Forensic Medicine, Bacha Khan Medical College Mardan, and Allama Iqbal Medical College Lahore, Pakistan, from January 2022 to March 2023. A total of 70 medico-legal cases of alleged sexual assault were reviewed. Data were extracted on demographic details, time of presentation, types of forensic evidence collected, presence of physical injuries, and DNA test outcomes. Descriptive statistics were used to analyze the data.

Results: The majority of victims were females (75.7%), with adolescents (13–18 years) representing the most affected group. A significant portion of cases (54.3%) presented within 24 hours of assault. Semen was detected in 44.3% of cases, spermatozoa in 32.9%, and a DNA match with the alleged perpetrator was found in 37.1% of cases. Genital injuries were present in 41.4% of victims. However, 55.7% of cases showed no biological evidence, often due to delayed reporting, hygiene measures, or procedural errors.

Conclusion: While forensic evidence can significantly aid in the investigation of sexual assault cases, it has inherent limitations. Early examination, proper evidence collection, and multidisciplinary collaboration are critical for maximizing the utility of forensic findings. A victim-centered, evidence-informed, and context-sensitive approach is essential for ensuring justice in sexual assault investigations.

Keywords: Sexual assault, forensic evidence, medico-legal, DNA analysis, injury documentation, limitations.

INTRODUCTION

Sexual assault represents a profoundly traumatic experience that transcends individual suffering and echoes as a broader public health and human rights concern. It encompasses a spectrum of non-consensual sexual acts that may involve coercion, physical force, threats, psychological manipulation, or the use of substances to incapacitate the victim[1]. The medico-legal dimension of sexual assault is critically important, as it directly interfaces with the healthcare system, the legal and judicial framework, forensic science, and societal response mechanisms. The role of forensic medicine in such cases is not limited to documentation and evidence collection, but extends to ensuring justice, supporting victims through expert testimony, and preventing miscarriage of justice through scientific scrutiny[2].

In cases of alleged sexual assault, the survivor's body becomes a critical crime scene, making forensic medical examination a cornerstone in the investigative process. The forensic evaluation seeks to uncover and collect physical, biological, and trace evidence that can establish the occurrence of an assault, identify the perpetrator, and support the legal prosecution[3]. This involves meticulous documentation of injuries, collection of bodily fluids for DNA analysis, preservation of trace evidence such as fibers or hair, and examination of clothing. Each step in this chain requires a high degree of scientific precision, ethical consideration, and sensitivity to the survivor's physical and psychological condition[4].

However, despite remarkable advances in forensic science and DNA technology, several limitations and challenges continue to affect the reliability and interpretation of forensic evidence in sexual assault cases. Biological evidence may be absent in cases where the perpetrator used a condom, or where the victim has showered or changed clothes prior to examination[5]. Genital injuries may not always be present, particularly in cases involving non-violent or delayed reporting. Conversely, the presence of sperm or semen may not necessarily indicate non-consensual intercourse, particularly in cases involving known perpetrators or ongoing relationships. Such ambiguities underscore the difficulty in establishing definitive conclusions solely based on forensic evidence[6].

Moreover, the complex nature of consent in sexual assault cases further complicates medico-legal analysis. Unlike other violent crimes, the legal determination of sexual assault often hinges not only on physical evidence but also on the interpretation of psychological, behavioral, and contextual factors[7]. This places immense importance on comprehensive medical history, detailed interviewing, and trauma-informed care. Unfortunately, in many regions, the lack of trained forensic examiners, inconsistent protocols, and inadequate infrastructure hinder the delivery of high-quality medico-legal services[8].

Legal systems across the world increasingly depend on forensic evidence as a pillar of objectivity in criminal investigations. However, there exists a risk of over-reliance or misinterpretation, especially when forensic findings are presented without adequate clinical or contextual background[9]. Courts and juries may place disproportionate weight on DNA results, unaware of the nuances and limitations inherent in their collection and interpretation. Likewise, the absence of injuries or forensic findings may lead to unjust dismissal of the survivor's testimony, contributing to underreporting and secondary victimization[10].

This study aims to explore in depth the medico-legal aspects of sexual assault with a special focus on the accuracy and limitations of forensic evidence. It evaluates the strengths and weaknesses of biological, physical, and trace evidence, highlights procedural challenges in evidence collection and preservation, and discusses the legal implications of forensic interpretations[11]. The

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article also emphasizes the importance of a multidisciplinary, survivor-centered approach that integrates medical, legal, and psychosocial dimensions to ensure justice and compassionate care. In doing so, it seeks to inform and guide forensic practitioners, healthcare providers, legal professionals, and policymakers toward more effective handling of sexual assault cases within the medico-legal framework[12].

MATERIALS AND METHODS

Study Design and Setting: This was a descriptive, cross-sectional study conducted at two prominent forensic centers in Pakistan: the Department of Forensic Medicine, Bacha Khan Medical College, Mardan, and the Department of Forensic Medicine, Allama Iqbal Medical College, Lahore. Both institutions are major medico-legal units that provide services for sexual assault survivors in their respective catchment areas. The aim of the study was to evaluate the accuracy and limitations of forensic evidence in cases of alleged sexual assault by analyzing real-world medico-legal case files and laboratory findings.

Study Duration and Sample Size: The study was conducted over a period of 15 months, from January 2022 to March 2023. A total of 70 medico-legal sexual assault cases were selected for inclusion in the study. These cases were drawn from the official medico-legal records maintained by the forensic departments during the study period. Only those cases with complete documentation, including physical examination findings and forensic evidence reports, were included.

Inclusion and Exclusion Criteria: The inclusion criteria comprised all individuals irrespective of age or gender who presented to the forensic departments with a complaint of sexual assault and underwent complete medico-legal examination during the defined period. The selected cases had to have full documentation, including collection of biological or trace forensic samples and relevant laboratory testing. Exclusion criteria included cases with incomplete medico-legal reports, refusal of forensic examination by the survivor, or withdrawal of consent. Cases with follow-up visits were also excluded to avoid duplication; only the first documented visit was considered for analysis.

Data Collection Process: Data collection was carried out retrospectively through a detailed review of medico-legal registers, physical examination reports, and forensic laboratory results. A structured data extraction tool was developed to ensure uniformity in data collection across both sites. The data extracted included demographic details of the victim (age, sex, marital status), time interval between the alleged assault and the forensic examination, types of forensic evidence collected (biological samples such as vaginal swabs, semen, saliva, and blood), documentation of injuries (genital and extra-genital), and the presence or absence of physical findings. Other relevant observations such as the condition of clothing, victim hygiene before examination, and challenges in collecting or preserving evidence were also documented. In some cases, DNA analysis and toxicology screening were available and included in the review.

Forensic Evaluation and Evidence Documentation: Each case underwent a standardized forensic examination conducted by trained medico-legal officers and forensic medical specialists. Biological samples were collected using sterile techniques and stored in accordance with standard operating procedures. Trace evidence such as fibers, hairs, and foreign materials were preserved and sent for analysis. Injuries were meticulously documented, photographed (where permissible), and assessed for consistency with the reported history. All forensic samples were submitted to designated forensic science laboratories for further analysis, and DNA profiling reports were reviewed when available.

Ethical Considerations: Given the sensitive nature of the subject, the study was conducted with strict adherence to ethical standards. Approval was obtained from the Institutional Review Boards (IRBs) of both Bacha Khan Medical College and Allama Iqbal Medical College. As this was a retrospective review, no direct contact with patients was made. All case data were anonymized and kept confidential, in compliance with ethical guidelines and the principles of the Declaration of Helsinki.

Statistical Analysis: The data were entered into SPSS version 26.0 for statistical processing. Descriptive statistics were used to summarize categorical variables such as age groups, gender distribution, types of forensic evidence collected, and the presence of physical injuries. Continuous variables such as time interval from assault to examination were analyzed using means and standard deviations. Associations between the presence of forensic findings and key factors such as delay in examination or injury presence were evaluated using chi-square tests. A p-value of less than 0.05 was considered statistically significant for inferential interpretation.

RESULTS

The findings from this cross-sectional analysis of 70 medico-legal cases of alleged sexual assault evaluated at the Department of Forensic Medicine, Bacha Khan Medical College, Mardan, and Allama Iqbal Medical College, Lahore, from January 2022 to March 2023 revealed critical insights into victim demographics, time of presentation, types and outcomes of forensic evidence collection, and observed limitations in forensic accuracy. All results are presented in detailed paragraphing with respective tables cited appropriately.

Demographic Distribution of Victims: Out of the 70 cases included in the study, the majority of victims were females, constituting 75.7% (n = 53), whereas 24.3% (n = 17) were male victims. A wide age range was observed, with victims as young as 7 years and as old as 46 years. The mean age was 17.8 ± 6.2 years, with adolescents (13–18 years) being the most commonly affected group, accounting for 38.6% (n = 27) of the total cases. Children aged 7–12 years followed, comprising 20% (n = 14). The young adult group (19–25 years) made up 17.1% (n = 12), while 26–35 years accounted for 12.9% (n = 9), and those above 35 years made up 8.6% (n = 6). This distribution is shown in Table 1.

Table 1: Demographic Distribution of Victims

Age Group (years)	Number of Cases	Percentage (%)
7–12	14	20.0
13–18	27	38.6
19–25	12	17.1
26–35	9	12.9
>35	6	8.6
Total	70	100.0

Time Interval Between Assault and Examination: The time lag between the alleged assault and the forensic examination was an important variable affecting evidence recovery. Out of the 70 cases, 21 cases (30%) were examined within 12 hours, while 17 cases (24.3%) presented between 12–24 hours. Another 15 victims (21.4%) reported between 24–48 hours, and 17 cases (24.3%) presented after 48 hours. It was observed that positive forensic findings, particularly semen detection and DNA matching, were significantly higher in cases examined within the first 24 hours. In contrast, the likelihood of recovering viable biological evidence diminished substantially beyond the 48-hour mark. The distribution is detailed in Table 2.

Table 2: Time Interval Between Assault and Medico-Legal Examination

Time Interval	Number of Cases	Percentage (%)
<12 hours	21	30.0
12–24 hours	17	24.3
24–48 hours	15	21.4
>48 hours	17	24.3
Total	70	100.0

Types and Frequency of Forensic Evidence Collected: In all 70 cases, a complete medico-legal examination was conducted, with a variety of forensic samples collected based on the circumstances. The most commonly collected samples were vaginal or anal swabs, along with saliva, semen stains, and blood

samples. Biological evidence was collected in 66 cases (94.3%), whereas trace evidence including clothing fibers, hair, and lubricant residues was documented in only 12 cases (17.1%).

Regarding findings, semen was presumptively detected in 31 cases (44.3%) using chemical and microscopic analysis. Spermatozoa were observed under microscopy in 23 cases (32.9%). Moreover, DNA analysis yielded a conclusive match with the alleged perpetrator in 26 cases (37.1%). However, in 39 cases (55.7%), no biological evidence was detected, often due to delayed presentation, bathing, or clothing changes by the victim prior to examination. These results are presented in Table 3.

Table 3: Forensic Evidence Recovery and Analysis Results

Forensic Finding	Number of Positive Cases	Percentage (%)
Semen detection (presumptive)	31	44.3
Spermatozoa on microscopy	23	32.9
DNA match with alleged suspect	26	37.1
Trace evidence recovered	12	17.1
No biological evidence found	39	55.7

Injury Documentation and Physical Examination: The documentation of injuries revealed that genital injuries were present in 29 cases (41.4%), and extra-genital injuries were observed in 12 cases (17.1%). In contrast, no visible injuries were recorded in 29 cases (41.4%). The absence of injuries was particularly frequent in younger children and adults with delayed reporting, highlighting the limitation of relying solely on physical signs to substantiate the occurrence of sexual assault.

Injury presence was strongly correlated with early reporting (<24 hours) and in cases where force or resistance was described. However, in cases of drug-facilitated or non-violent coercive assaults, injuries were often minimal or absent. These findings are detailed in Table 4.

Table 4: Distribution of Physical Injuries Documented in Victims

Type of Injury	Number of Cases	Percentage (%)
Genital injuries present	29	41.4
Extra-genital injuries	12	17.1
No visible injuries	29	41.4
Total	70	100.0

Limitations Observed in Forensic Findings: Several practical and procedural limitations were identified during the review of these medico-legal cases. First, delayed reporting significantly reduced the probability of obtaining meaningful forensic evidence. As shown in Table 2, 24.3% of victims presented after 48 hours, resulting in degradation of biological samples. Second, post-assault hygiene measures, such as bathing, changing clothes, or urination, were reported in 22 out of 70 cases (31.4%), compromising the sample quality.

Moreover, in 10 cases (14.3%), there were deficiencies in sample labeling, storage, or chain-of-custody documentation. In some instances, absence of trained staff led to improper swab technique or inadequate injury documentation. Despite these limitations, 26 cases (37.1%) still yielded positive DNA matches, underlining the importance of meticulous evidence handling and early examination.

Overall, the results show that while forensic evidence can play a crucial role in supporting sexual assault allegations, its accuracy is highly dependent on timely reporting, proper evidence handling, and survivor cooperation. However, its absence does not rule out assault, and it must be interpreted within the broader medico-legal and psychological context.

DISCUSSION

The present study offers a detailed exploration of the medico-legal, clinical, and forensic dimensions of sexual assault cases, focusing particularly on the accuracy and limitations of forensic evidence. By analyzing 70 medico-legal cases from two major forensic departments in Pakistan Bacha Khan Medical College, Mardan, and Allama Iqbal Medical College, Lahore this study provides insight into how forensic findings are influenced by various temporal, procedural, and clinical factors[13, 14].

One of the key findings was the predominance of female victims (75.7%) and the higher vulnerability of adolescents aged 13–18 years. This is consistent with global data, which show that females, especially minors and adolescents, are at a higher risk of sexual victimization. The high percentage of child and adolescent victims underscores the need for sensitive, age-appropriate forensic practices and legal protections[15].

The analysis of the time interval between assault and medico-legal examination revealed a critical pattern: cases reported within 12–24 hours had significantly higher chances of yielding positive forensic findings, including semen detection, spermatozoa, and DNA matches[16]. This aligns with existing literature suggesting that biological evidence such as semen or epithelial cells is most reliably detected within the first 24 to 48 hours post-assault. In contrast, delayed presentation (>48 hours) substantially reduced the likelihood of detecting viable evidence. This observation supports the urgent need for immediate reporting and rapid forensic response systems[17].

Injury documentation played an important corroborative role in about 58.6% of cases. However, the absence of physical injuries in 41.4% of cases reiterates a crucial medico-legal principle: absence of injury does not imply absence of assault[18]. Many assaults, particularly those involving coercion without physical force, drug-facilitation, or assaults on children, may not leave visible injuries. The findings echo those of previous studies that have emphasized the limited diagnostic specificity of genital injuries in determining assault versus consensual intercourse, especially among adults[19].

The limitations of forensic evidence, as revealed in this study, were multifactorial. First, delayed reporting led to the natural degradation of biological samples. Second, victims often engaged in hygiene practices such as bathing or changing clothes before examination, which reduced the chances of recovering trace evidence[20]. Third, logistical and administrative challenges such as unavailability of trained forensic professionals, inadequate evidence kits, or errors in maintaining the chain of custody further compromised the quality and reliability of the evidence[21].

Another important observation was the overdependence of legal stakeholders on DNA evidence for prosecution. While DNA matches were confirmed in 37.1% of cases, the legal system must recognize that a negative result does not disprove the survivor's claim, especially when reporting is delayed. Courts must also consider the psychological trauma, behavioral changes, and detailed victim narratives, particularly in cases where forensic findings are negative or inconclusive[22].

This study also highlights the disparity in evidence collection quality between well-resourced institutions and peripheral centers. The two study centers are tertiary-level institutions; however, many sexual assault evaluations in Pakistan occur at rural hospitals where forensic infrastructure is lacking. There is an urgent need to develop national protocols, increase the number of trained Sexual Assault Examination Officers (SAEOs), and standardize evidence collection kits across the country[23].

CONCLUSION

This study concludes that forensic evidence is an essential but not definitive component of sexual assault investigations. Its accuracy is closely linked to the timing of examination, victim cooperation, procedural quality, and examiner expertise. While biological evidence such as semen, spermatozoa, and DNA can strengthen the medico-legal case, its absence does not disprove assault, especially in delayed or non-violent cases.

The results emphasize the importance of early medico-legal intervention, standardized forensic protocols, and holistic, survivor-centered care in improving the evidentiary strength and legal outcomes in sexual assault cases. Courts and prosecutors must

interpret forensic findings in conjunction with clinical, psychological, and circumstantial evidence, rather than in isolation.

To improve outcomes, it is recommended that forensic and healthcare systems invest in rapid response mechanisms, nationwide training programs for examiners, and digital systems for timely forensic reporting. Ultimately, justice for survivors depends not solely on laboratory findings but on a multidisciplinary, ethical, and evidence-informed approach that respects the dignity and voice of the victim.

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