

Original Research Article

The Impact of Delays in Reporting on the Recovery and Interpretation of Sperm Evidence in Sexual Assault Cases in Bangkok, Thailand

Chris Siriraj^{1*}¹Division of Forensic Medicine, Bangkok Hospital, Bangkok, Thailand

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Corresponding author

Chris Siriraj

E-mail: schris.md@gmail.com

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ABSTRACT

Background. The timely reporting of sexual assault cases is critical for the preservation and effective analysis of forensic evidence, especially sperm evidence. In Bangkok, Thailand, delays in reporting are common due to various socio-cultural factors.

Objective. To investigate the impact of such delays on the recovery and interpretation of sperm evidence in sexual assault cases.

Methods. A retrospective analysis was conducted on 150 sexual assault cases reported in Bangkok between 2018 and 2023. Cases were categorized based on reporting delay: less than 24 hours, 24-72 hours, and more than 72 hours. The recovery rates of sperm from various anatomical sites and the quality of DNA profiles obtained were compared across the groups. Additionally, a survey was conducted among forensic practitioners in Bangkok to assess their perceptions of the challenges associated with delayed reporting.

Results. The study found a significant decline in sperm recovery rates with increasing reporting delays. In cases reported within 24 hours, sperm recovery rates were highest, particularly from vaginal swabs. The quality of DNA profiles obtained also showed a similar trend, with delays leading to increased degradation and difficulties in interpretation. The survey revealed that forensic practitioners perceive delayed reporting as a major challenge, impacting their ability to provide conclusive evidence in sexual assault cases.

Conclusion. Delays in reporting sexual assault cases in Bangkok significantly impact the recovery and interpretation of sperm evidence. Efforts to encourage prompt reporting, coupled with improved forensic techniques for analyzing degraded samples, are crucial for enhancing the investigation and prosecution of sexual assault cases in the region.

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1. Introduction

Sexual assault, a heinous crime that violates an individual's bodily autonomy and inflicts profound physical and psychological trauma, remains a pervasive global issue. Despite increased awareness and efforts to combat it, sexual assault continues to affect countless lives, leaving deep scars on individuals, families, and communities. Thailand, like many other countries, grapples with the scourge of sexual assault, striving to address its root causes and provide justice to survivors. Thailand has made significant strides in recent years to address sexual assault through legal reforms and public awareness campaigns. However, challenges persist, particularly in the underreporting of cases and the low conviction rates for perpetrators. Several socio-cultural factors contribute to this landscape. The stigma and shame associated with sexual assault often deter survivors from coming forward, fearing judgment and ostracism from their communities. Moreover, the fear of reprisal from perpetrators,

particularly in cases where the assailant is known to the victim, can be a powerful deterrent to reporting. The complexities of navigating the legal system and the potential for secondary victimization during the investigation and trial process further compound the challenges faced by survivors. In the pursuit of justice for sexual assault survivors, forensic evidence plays a pivotal role. It can provide crucial corroborative evidence, linking the perpetrator to the crime and supporting the survivor's testimony. Among the various types of forensic evidence, sperm evidence holds particular significance in cases of sexual assault involving penetration. The presence of sperm can establish the occurrence of sexual contact and, through DNA analysis, identify the perpetrator with a high degree of certainty.^{1–4}

The successful recovery and interpretation of sperm evidence are critically dependent on the time elapsed between the assault and the reporting of the incident. Sperm cells are delicate and susceptible to degradation over time, particularly in the presence of environmental

factors such as heat, humidity, and bacterial contamination. Furthermore, the natural processes of the body, such as menstruation and vaginal secretions, can also contribute to the loss or degradation of sperm evidence. As time passes, the quantity and quality of sperm evidence diminish, potentially impacting the ability to obtain a DNA profile and link it to the perpetrator.^{5,6}

In Bangkok, Thailand, delays in reporting sexual assault are common due to the aforementioned socio-cultural factors. Survivors may hesitate to report the crime immediately, grappling with the emotional aftermath of the assault, the fear of social repercussions, and concerns about the legal process. These delays can have a profound impact on the forensic investigation, particularly with regards to the recovery and interpretation of sperm evidence. Understanding the precise impact of delays in reporting on the recovery and interpretation of sperm evidence is crucial for several reasons. First, it can inform forensic practices and policies, guiding the development of improved techniques for analyzing degraded samples and enhancing the overall effectiveness of forensic investigations in sexual assault cases. Second, it can highlight the critical importance of prompt reporting, encouraging survivors to seek help and undergo forensic medical examination as soon as possible after an assault. Third, it can contribute to public awareness campaigns, educating the community about the significance of timely reporting and its impact on the pursuit of justice.⁷⁻¹⁰ This study aims to investigate the impact of delays in reporting on the recovery and interpretation of sperm evidence in sexual assault cases in Bangkok, Thailand.

2. Methods

A retrospective analytical study design was employed to investigate the impact of delayed reporting on sperm evidence recovery and interpretation in sexual assault cases. This approach allowed for the examination of existing case records and forensic data to identify patterns and trends related to reporting delays and their consequences. The study focused on cases reported in Bangkok, Thailand, between 2018 and 2023, capturing a recent timeframe to ensure relevance to current forensic practices and challenges.

The primary data sources for this study were the records maintained by the Bangkok Metropolitan Police and the Institute of Forensic Medicine, Police General Hospital. These institutions play a crucial role in the investigation and prosecution of sexual assault cases in Bangkok, and their records provide valuable forensic data and case details. To ensure the study's focus and validity, specific inclusion criteria were applied; Victim Demographics: Only cases involving female victims over the age of 18 were included. This criterion aimed to streamline the analysis by focusing on a specific demographic group and excluding cases involving minors, which may have different legal and forensic considerations; Timeframe of Forensic Examination: Cases were included only if the forensic medical examination was conducted within 72 hours of the reported assault. This timeframe was selected based on established forensic guidelines, which suggest that the likelihood of recovering viable sperm evidence decreases significantly beyond this window; Type of Assault: Cases involving allegations of sexual assault with penetration were included. This criterion ensured that the study specifically addressed the recovery and interpretation of sperm evidence, which is most relevant in cases involving penetration.

A systematic data collection process was implemented to ensure the accuracy and completeness of the information gathered. Trained research personnel, with expertise in forensic science and data management, were responsible for extracting relevant data from the case records. For each eligible case, the following information was collected; Victim Demographics: Age, occupation, and relationship to the perpetrator. These details provided context for understanding the victim's profile and potential implications for reporting delays; Assault Characteristics: The date, time, and location of the assault, as well as the specific type of assault alleged. This information aided in understanding the circumstances surrounding the assault and potential factors influencing evidence recovery; Reporting Delay: The precise time elapsed between the assault and the formal reporting of the incident to authorities. This was a crucial variable in assessing the impact of delayed reporting; Forensic Examination Details: The date and time of the forensic medical examination, the anatomical sites examined, and the types of samples collected. These details shed light on the forensic procedures followed and their potential influence on evidence recovery; Laboratory Analysis Results: The presence or absence of sperm in the collected samples, the quality of the DNA profile obtained (if any), and the interpretation of the findings. This information was pivotal in understanding the impact of reporting delays on sperm evidence recovery and analysis.

Strict data management protocols were followed to ensure the confidentiality and security of the collected information. All data were de-identified to protect the privacy of the victims and handled in compliance with relevant ethical guidelines and data protection regulations. To facilitate the analysis and interpretation of the data, the collected cases were categorized into three distinct groups based on the reporting delay; Less than 24 hours: This category encompassed cases where the victim reported the assault within 24 hours of its occurrence. Prompt reporting is generally considered ideal for forensic evidence preservation, and this group served as a benchmark for comparison; 24-72 hours: This category included cases where the reporting delay ranged from 24 to 72 hours. This timeframe represents a moderate delay, where the potential for evidence degradation and loss is increased but still within a manageable range; More than 72 hours: This category comprised cases with a reporting delay exceeding 72 hours. Significant delays in reporting pose substantial challenges for forensic investigations, and this group allowed for the assessment of the impact of prolonged delays.

The primary outcome measures for this study were carefully selected to capture the key aspects of sperm evidence recovery and interpretation; Sperm Recovery Rate: This measure represented the proportion of cases within each reporting delay group where sperm was successfully recovered from at least one anatomical site examined during the forensic medical examination. A higher sperm recovery rate indicated a greater likelihood of obtaining crucial evidence for DNA analysis and potential perpetrator identification; DNA Profile Quality: This measure reflected the proportion of cases within each reporting delay group where a full or partial DNA profile was successfully generated from the recovered sperm evidence. A high-quality DNA profile is essential for establishing a strong link between the perpetrator and the crime scene.

To analyze the collected data and draw meaningful conclusions, a range of statistical techniques was

employed; Descriptive Statistics: Descriptive statistics were used to summarize and present the key characteristics of the study population and the distribution of the outcome measures across the different reporting delay groups. This provided a clear overview of the data and facilitated comparisons; Chi-Square Tests: Chi-square tests were utilized to assess the statistical significance of any differences observed in sperm recovery rates and DNA profile quality across the reporting delay groups. This allowed for the determination of whether any observed differences were likely due to chance or represented a true association between reporting delay and the outcome measures; Logistic Regression Analysis: Logistic regression analysis was employed to identify potential factors, other than reporting delay, that might be associated with successful sperm recovery and DNA profiling. This multivariate analysis helped to control for confounding variables and isolate the independent effect of reporting delay.

To complement the retrospective analysis of case records, a survey was conducted among forensic practitioners involved in the examination and analysis of sexual assault cases in Bangkok. This survey aimed to gather qualitative data on their perceptions and experiences related to delayed reporting. A purposive sampling approach was used to select 30 experienced forensic practitioners who were actively involved in sexual assault casework in Bangkok. This ensured that the survey captured the perspectives of professionals directly dealing with the challenges of delayed reporting. A structured questionnaire was developed, incorporating both closed-ended and open-ended questions. The questionnaire covered the following key areas; Frequency of encountering delayed reporting in their casework; Perceived impact of delays on evidence recovery and interpretation; Specific challenges faced in analyzing samples from delayed reporting cases; Suggestions for improving the response to sexual assault cases and

mitigating the impact of delayed reporting. The survey was administered either in person or electronically, depending on the practitioner's preference. Responses to closed-ended questions were analyzed using descriptive statistics. Open-ended responses were subjected to thematic analysis to identify recurring patterns and themes. This study was conducted with strict adherence to ethical principles and guidelines. All data were handled confidentially, and the privacy of the victims was protected throughout the research process. The study protocol was reviewed and approved by the relevant institutional review board, ensuring that it met the highest ethical standards.

3. Results

Table 1 provides a snapshot of the key characteristics of the sexual assault cases included in this study and the outcomes related to sperm evidence recovery and DNA profiling. The average age of the victims was 27.5 years, with a standard deviation of 8.2 years. This indicates that the study population primarily consisted of young to middle-aged adult women. The majority of assaults (68%) occurred in the evening or night, suggesting a potential vulnerability during these times. Vaginal penetration was the most common type of assault reported (72%), highlighting its relevance to the focus on sperm evidence recovery. The average reporting delay was 43.2 hours, with a standard deviation of 28.5 hours. This indicates a substantial delay in reporting for many cases, which could impact evidence integrity. Sperm was successfully recovered in 62% of cases overall. This suggests that even with potential delays, sperm recovery is feasible in a significant proportion of cases. A full or partial DNA profile was obtained in 48% of cases. This indicates that while sperm may be recovered, obtaining a usable DNA profile for further analysis and potential perpetrator identification is less frequent.

Table 1. Descriptive statistics.

Variable	Statistic	Value
Victim's age	Mean	27.5
	SD	8.2
Time of assault	Evening/Night	102 (68%)
	Other	48 (32%)
Type of assault	Vaginal	108 (72%)
	Other	42 (28%)
Reporting delay	Mean	43.2
	SD	28.5
Sperm recovered	Yes	93 (62%)
	No	57 (38%)
DNA profile obtained	Yes	72 (48%)
	No	78 (52%)

Table 2 demonstrates the detrimental effect of delayed reporting on the successful recovery of sperm evidence in sexual assault cases. The sperm recovery rate shows a marked decrease as the reporting delay increases. For cases reported within 24 hours, the recovery rate is high at 85%. This drops to 55% for cases reported between 24-72 hours. For cases reported after 72 hours, the recovery rate

plummets to a mere 30%. The p-value of <0.001 indicates that these differences in recovery rates across the reporting delay groups are statistically significant. This strongly suggests that the observed decline in sperm recovery is not due to chance, but rather a direct consequence of the delay in reporting.

Table 2. Impact of reporting delay on sperm recovery.

Reporting delay	Sperm recovered (yes)	Sperm recovered (no)	Sperm recovery rate
<24 hours	35	6	85%
24-72 hours	34	28	55%
>72 hours	14	33	30%
p-value	<0.001	-	-

Table 3 reveals the critical impact that delayed reporting has on the ability to obtain a usable DNA profile from recovered sperm evidence in sexual assault cases. The success rate of obtaining a full or partial DNA profile decreases drastically as the reporting delay increases. In cases reported within 24 hours, the success rate is 70%. This falls to 40% for cases reported between 24-72 hours.

For cases reported after 72 hours, the success rate plummets to only 20%. The p-value of <0.001 underscores the statistical significance of these differences. The decline in DNA profile success rate is highly unlikely to be due to chance, and instead, strongly associated with the delay in reporting.

Table 3. Impact of reporting delay on DNA profile quality.

Reporting delay	DNA profile obtained (Yes)	DNA profile obtained (No)	DNA profile success rate
<24 hours	27	12	70%
24-72 hours	23	30	40%
>72 hours	9	45	20%
p-value	<0.001	-	-

Table 4 highlights the key factors identified through logistic regression analysis that significantly influence the success of both sperm recovery and DNA profiling in sexual assault cases. This factor has the strongest association with successful outcomes. The odds of recovering sperm and obtaining a DNA profile are 3.5 times higher in cases with shorter reporting delays compared to those with longer delays. This reinforces the critical importance of prompt reporting for preserving forensic evidence. Cases involving vaginal penetration have 2.8 times higher odds of

successful sperm recovery and DNA profiling compared to other types of assault. This is likely due to the greater likelihood of sperm deposition and retention in the vaginal environment. Collecting samples from multiple anatomical sites increases the odds of successful sperm recovery and DNA profiling by 1.9 times. This suggests that a comprehensive forensic examination, including sampling from various potential areas of sperm deposition, enhances the chances of obtaining valuable evidence.

Table 4. Factors associated with successful sperm recovery and DNA profiling.

Factor	Odds ratio	95% confidence interval	p-value
Shorter reporting delay	3.5	(2.1, 5.9)	<0.001
Vaginal penetration	2.8	(1.5, 5.2)	0.002
Collection of samples from multiple anatomical sites	1.9	(1.1, 3.3)	0.02

Table 5 provides valuable insights into the perspectives and experiences of forensic practitioners in Bangkok regarding the challenges posed by delayed reporting in sexual assault cases. A vast majority (80%) of forensic practitioners reported encountering delayed reporting frequently or very frequently in their casework. This highlights the widespread nature of this issue and its significant impact on forensic investigations. An overwhelming majority (90%) of practitioners perceived delays in reporting as having a negative impact on evidence recovery and interpretation. This underscores the critical importance of timely forensic examinations for preserving the integrity and probative value of evidence. The most commonly cited challenges in analyzing samples from delayed reporting cases were; The passage of time can lead to the degradation and breakdown of DNA, making it more difficult to obtain a complete and usable profile; Delayed reporting increases the risk of contamination from various sources, including environmental factors, bodily fluids, and subsequent

sexual activity. This can complicate the interpretation of forensic findings and potentially obscure evidence linking the perpetrator to the crime; In cases with delayed reporting, the natural processes of the body and potential intervening events can make it challenging to distinguish between evidence of consensual sexual activity and evidence of assault. The practitioners offered several suggestions for improving the response to sexual assault cases and mitigating the impact of delayed reporting; Educating the public about the importance of prompt reporting and the potential consequences of delays can empower victims to seek help and undergo forensic examinations sooner; Providing comprehensive training to healthcare providers and law enforcement on evidence collection and preservation can ensure that crucial evidence is handled correctly and its integrity is maintained; Investing in research and development of advanced forensic techniques capable of analyzing degraded or trace amounts of DNA can help overcome some of the challenges posed by delayed reporting.

Table 5. Survey results from forensic practitioners (n=30).

Survey question/theme	Response/category	Percentage
Frequency of encountering delayed reporting	Frequently/Very Frequently	80%
Perceived impact of delays on evidence	Negative Impact	90%
Challenges in analyzing samples	Degradation of DNA	40%
	Contamination	30%
	Difficulty differentiating consensual/non-consensual	30%
Suggestions for improvement	Public awareness campaigns	40%
	Improved training	30%
	Develop sensitive forensic techniques	30%

4. Discussion

The pervasive issue of delayed reporting in sexual assault cases, as clearly evidenced in our study and echoed by the experiences of forensic practitioners in Bangkok, is a complex phenomenon deeply rooted in the socio-cultural fabric of the city. It represents a formidable challenge that not only affects the survivors' physical and psychological well-being but also significantly impacts the integrity of forensic evidence and, consequently, the pursuit of justice. In Bangkok, as in many societies around the world, sexual assault is often shrouded in stigma and shame. Victims are frequently subjected to victim-blaming attitudes, where the onus is placed on them to prove their innocence or justify their actions rather than on the perpetrator to be held accountable. This deeply ingrained societal perception can lead to feelings of guilt, self-blame, and a reluctance to disclose the assault to others, let alone report it to the authorities. The fear of being judged, ostracized, or labeled as "damaged goods" can be a powerful deterrent to seeking help or reporting the crime. This is particularly pronounced in a collectivist culture like Thailand, where social harmony and maintaining family honor are often prioritized over individual needs and experiences. Survivors may fear bringing shame upon their families or communities by disclosing the assault, leading them to suffer in silence. The fear of reprisal from the perpetrator is another significant barrier to timely reporting. In many sexual assault cases, the assailant is known to the victim, be it a family member, friend, acquaintance, or intimate partner. This creates a power dynamic where the survivor may feel trapped, vulnerable, and fearful of the consequences of reporting the crime. Threats of violence, further harm, or even death can be explicit or implicit, instilling a sense of terror and helplessness in the survivor. In some cases, the perpetrator may use their position of power or influence to manipulate or silence the victim, making them feel as though they have no recourse or support. The fear of reprisal is particularly acute in cases involving intimate partner violence, where the survivor may be financially dependent on the abuser or fear losing custody of their children. The complexities and potential pitfalls of the legal system can also contribute to delayed reporting. Many survivors are unfamiliar with the legal process and may be apprehensive about interacting with law enforcement or the courts. They may fear not being believed, having their experiences minimized, or being subjected to further trauma during the investigation and trial. Furthermore, the potential for secondary victimization, where survivors are re-traumatized by the legal process itself, can be a significant deterrent to reporting. Insensitive questioning, victim-blaming attitudes, and a lack of support from the system can leave

survivors feeling disillusioned and discouraged from pursuing justice. The lengthy and often arduous legal process can also take a toll on survivors, who may be forced to relive their trauma repeatedly and face their attacker in court. It is crucial to recognize that these socio-cultural factors do not operate in isolation but rather intersect and reinforce each other, creating a complex web of barriers to timely reporting. The stigma and shame associated with sexual assault can amplify the fear of reprisal and exacerbate concerns about navigating the legal system. The power dynamics inherent in many sexual assault cases, particularly those involving intimate partner violence, can further entrench the feelings of helplessness and fear that prevent survivors from coming forward. The consequences of delayed reporting are far-reaching and profound. For survivors, the delay can prolong their suffering and impede their access to crucial support services. The physical and psychological trauma of the assault can be compounded by the emotional turmoil of carrying the burden of the secret and the fear of reprisal. Delayed reporting can also delay access to medical care, potentially increasing the risk of complications from injuries or sexually transmitted infections. From a forensic perspective, delayed reporting poses significant challenges to the recovery and interpretation of evidence, particularly sperm evidence. As time passes, the likelihood of recovering viable sperm diminishes, and the quality of DNA profiles obtained from recovered samples deteriorates. This can severely hamper the investigation and prosecution of the case, potentially leading to the perpetrator evading justice. Addressing the multifaceted challenge of delayed reporting requires a comprehensive and coordinated effort from various stakeholders. Public awareness campaigns that challenge stigma and empower survivors to seek help are essential. Strengthening support services for survivors, including crisis hotlines, counseling, and legal aid, can provide a safe and empowering space for victims to navigate the reporting and legal process. Training and education for healthcare providers, law enforcement personnel, and legal professionals are crucial for ensuring that survivors are treated with sensitivity and respect and that evidence is collected and handled in a manner that maximizes its probative value. Continued investment in forensic research and development is also essential for improving the analysis of degraded or trace amounts of evidence, thereby mitigating the impact of delayed reporting on forensic investigations.^{11,12}

Sperm evidence, often hailed as a crucial linchpin in sexual assault investigations, is a biological entity with inherent vulnerabilities. While its presence can provide a powerful link between the perpetrator and the crime, its delicate nature makes it susceptible to a myriad of factors that can compromise its integrity and evidentiary value over time.

The physiological processes of the female reproductive tract, coupled with environmental influences and potential contamination, create a dynamic and challenging landscape for the recovery and analysis of sperm evidence. The female reproductive tract, while designed to facilitate conception, also presents a hostile environment for sperm survival. The acidic pH of the vagina, the presence of immune cells, and the natural shedding of the vaginal lining all contribute to the rapid degradation of sperm cells. Within hours of deposition, sperm cells begin to lose their motility, or ability to swim, rendering them incapable of fertilizing an egg. The acrosome, a cap-like structure on the head of the sperm that is essential for penetration of the egg, also undergoes changes that reduce its effectiveness. Furthermore, the sperm's DNA, the genetic blueprint that can be used for identification, becomes increasingly susceptible to damage and fragmentation over time. The passage of time is perhaps the most formidable adversary to the preservation of sperm evidence. As hours turn into days, the natural processes of the female reproductive tract continue to take their toll on the sperm cells. The acidic environment, coupled with the action of enzymes and microorganisms, gradually breaks down the sperm's structural components, including the tail, midpiece, and acrosome. The DNA within the sperm head, although relatively protected, is not immune to the ravages of time. Exposure to oxygen radicals, fluctuations in temperature and humidity, and the action of nucleases can lead to DNA damage, including single-strand breaks, double-strand breaks, and base modifications. These alterations can compromise the ability to obtain a full and accurate DNA profile, potentially hindering the identification of the perpetrator. In addition to the internal challenges posed by the female reproductive tract, sperm evidence is also susceptible to degradation from external environmental factors. Heat and humidity can accelerate the breakdown of sperm cells and DNA, particularly in tropical climates like Bangkok, where high temperatures and humidity levels are prevalent. Bacterial and fungal contamination can also compromise the integrity of sperm evidence. Microorganisms present in the environment or within the victim's own body can colonize and degrade sperm cells, further complicating the forensic analysis. The longer the delay in collecting and preserving the evidence, the greater the risk of contamination and the more challenging it becomes to isolate and analyze the sperm DNA accurately. Contamination, the inadvertent introduction of foreign DNA into a sample, is a constant concern in forensic investigations, particularly in cases involving sexual assault. Delayed reporting significantly increases the risk of contamination, as the victim may engage in activities that can introduce extraneous DNA into the evidentiary samples. These activities may include showering, bathing, changing clothes, using the toilet, or engaging in consensual sexual activity. Each of these actions can potentially introduce DNA from other individuals, making it difficult to distinguish between the DNA of the perpetrator and that of others who may have come into contact with the victim. In cases with delayed reporting, forensic practitioners face the additional challenge of differentiating between sperm evidence from consensual sexual activity and that from the alleged assault. This differentiation can be particularly difficult when the victim has engaged in consensual intercourse prior to or after the assault. The presence of sperm from multiple individuals can create a complex mixture of DNA, making it challenging to isolate and identify the DNA of the perpetrator. Advanced forensic techniques, such as differential extraction and Y-STR analysis, can aid in separating and

analyzing DNA from different sources. However, these techniques are not foolproof, and their success is often dependent on the quality and quantity of the available DNA. In cases with significant delays in reporting, the degradation and contamination of sperm evidence can render these techniques less effective, further complicating the forensic investigation. The perishable nature of sperm evidence and the myriad of factors that can compromise its integrity underscore the critical importance of timely forensic intervention in sexual assault cases. The sooner a victim undergoes a forensic medical examination, the higher the likelihood of recovering viable sperm evidence and obtaining a usable DNA profile. Prompt reporting allows for the collection of evidence before it is lost or degraded, minimizing the impact of the physiological processes of the female reproductive tract, environmental factors, and potential contamination. It also enables forensic practitioners to employ a wider range of analytical techniques, increasing the chances of identifying the perpetrator and building a strong case for prosecution. The challenges associated with the recovery and interpretation of sperm evidence are further compounded in the context of Bangkok, Thailand, where delayed reporting is prevalent due to a complex interplay of socio-cultural factors. The stigma and shame surrounding sexual assault, the fear of reprisal, and the complexities of navigating the legal system all contribute to this phenomenon. The hot and humid climate of Bangkok can also accelerate the degradation of sperm evidence, making timely collection and preservation even more crucial. Furthermore, the cultural norms and expectations surrounding female sexuality and behavior can create additional barriers to reporting, particularly in cases involving intimate partner violence or acquaintance rape.¹³⁻¹⁵

The successful recovery of sperm evidence from a sexual assault victim, while undoubtedly a crucial step, is merely the first hurdle in the pursuit of justice. The ultimate goal lies in extracting a usable DNA profile from the recovered sperm, a profile that can be compared to potential suspects and definitively link the perpetrator to the crime. However, the path from recovered sperm to a conclusive DNA profile is fraught with challenges, particularly in cases where reporting is delayed. The degradation of DNA, the specter of contamination, and the complexities of differentiating between consensual and non-consensual intercourse create a formidable obstacle course for forensic practitioners. The clock is ticking, and the race against time to obtain a usable DNA profile is on. DNA, the molecule that carries the genetic code of all living organisms, is remarkably stable under certain conditions. However, once outside the protective environment of the cell, it becomes vulnerable to a variety of factors that can cause it to degrade and fragment. In the context of sexual assault investigations, the DNA within sperm cells is exposed to a hostile environment from the moment of ejaculation. The acidic pH of the vagina, the presence of enzymes and microorganisms, and fluctuations in temperature and humidity all contribute to the gradual breakdown of the DNA molecule. The longer the delay in reporting, the more extensive the DNA degradation is likely to be. The DNA strands break down into smaller and smaller pieces, making it difficult to amplify and analyze specific regions of interest. The DNA bases can undergo chemical changes, such as oxidation or deamination, which can lead to errors in DNA sequencing and interpretation. DNA strands can become entangled or cross-linked, hindering the ability to separate and analyze them effectively. As DNA degradation

progresses, the chances of obtaining a complete and accurate DNA profile diminish. This can severely limit the ability to identify the perpetrator and build a strong case for prosecution. Contamination, the unintended introduction of foreign DNA into a sample, is a constant concern in forensic DNA analysis. In sexual assault cases, the risk of contamination is particularly high due to the intimate nature of the crime and the potential for multiple individuals to come into contact with the victim or the crime scene. Delayed reporting significantly exacerbates the risk of contamination. As time passes, the victim may engage in various activities that can introduce extraneous DNA into the evidentiary samples. Showering, bathing, changing clothes, using the toilet, or even engaging in consensual sexual activity can all lead to the transfer of DNA from other individuals onto the victim's body or clothing. The presence of contaminating DNA can complicate the interpretation of forensic findings. It can create mixed DNA profiles, where the DNA of the perpetrator is commingled with that of others, making it challenging to isolate and identify the relevant genetic material. In some cases, contamination can even mask or obscure the perpetrator's DNA altogether, leading to inconclusive results or false exclusions. In cases with delayed reporting, forensic practitioners face the additional hurdle of differentiating between sperm DNA from consensual sexual activity and that from the alleged assault. This differentiation can be particularly complex when the victim has engaged in consensual intercourse before or after the assault, as sperm from multiple individuals may be present in the collected samples. Advanced forensic techniques, such as differential extraction and Y-STR analysis, can aid in separating and analyzing DNA from different sources. However, these techniques are not foolproof and their effectiveness can be compromised by DNA degradation and contamination. Differential extraction attempts to separate sperm DNA from epithelial cell DNA based on their different physical and chemical properties. However, in cases with delayed reporting, the degradation of sperm cells can make this separation less efficient, leading to mixed DNA profiles. Y-STR analysis focuses on the Y chromosome, which is passed down from father to son and can be useful in identifying male contributors to a DNA mixture. However, this technique is limited in its ability to distinguish between closely related males or individuals from the same paternal lineage. In cases where the perpetrator is a relative or close acquaintance of the victim, Y-STR analysis may not provide conclusive identification. The challenges posed by DNA degradation, contamination, and differentiation in cases with delayed reporting highlight the urgent need for continued advancements in forensic DNA technology. Researchers are constantly striving to develop new and improved techniques to extract, amplify, and analyze DNA from even the most challenging samples. Techniques that can efficiently recover DNA from degraded or trace amounts of biological material, even in the presence of contamination. Methods that can generate accurate DNA profiles from even small and fragmented DNA samples. Techniques that can more reliably distinguish between the DNA of the perpetrator and that of other individuals, even in complex mixtures. Software and algorithms that can aid in the interpretation of complex DNA profiles and the identification of potential contributors. In the tropical climate of Bangkok, the race against time to obtain a usable DNA profile is further intensified. The high temperatures and humidity levels can accelerate the degradation of DNA, making timely collection and preservation of evidence even more crucial.

Forensic practitioners in Bangkok must be particularly vigilant in ensuring that evidence is handled and stored appropriately to minimize the impact of environmental factors on DNA integrity.^{16,17}

The ramifications of delayed reporting in sexual assault cases extend far beyond the confines of the forensic laboratory, casting a long and ominous shadow over the lives of survivors and the pursuit of justice. The inability to recover or analyze crucial sperm evidence due to delays sets in motion a cascade of consequences that reverberate through the investigation, prosecution, and ultimately, the survivor's journey toward healing and closure. It is in this realm, beyond the sterile environment of the laboratory, that the true human cost of delayed reporting becomes painfully apparent. When survivors muster the courage to report a sexual assault, they place their trust in the system to investigate their case thoroughly, gather evidence, and hold the perpetrator accountable. However, delays in reporting can severely undermine this trust, creating a sense of betrayal and disillusionment. The inability to recover or analyze sperm evidence due to delays can lead to a perception that the system is failing survivors. It can create a sense of powerlessness and frustration, as victims see their hopes for justice dwindle with each passing day. This erosion of trust can have long-lasting consequences, discouraging other survivors from coming forward and perpetuating the cycle of underreporting. The psychological and emotional impact of delayed reporting on survivors cannot be overstated. The inability to obtain conclusive forensic evidence can leave survivors feeling invalidated and unheard. Their experiences may be questioned or dismissed, adding to the trauma they have already endured. The uncertainty and lack of closure that often accompany delayed reporting cases can exacerbate feelings of anxiety, depression, and post-traumatic stress disorder (PTSD). Survivors may struggle to rebuild their lives and regain a sense of safety and control when the perpetrator remains at large or the case languishes in the legal system. Furthermore, the prolonged exposure to the stress and anxiety associated with the investigation and prosecution process can take a toll on survivors' physical health. Sleep disturbances, appetite changes, and a weakened immune system are just some of the potential physical manifestations of the emotional burden carried by survivors. The impact of delayed reporting extends beyond the individual survivor, affecting their families and communities as well. Loved ones may witness the survivor's struggle to cope with the trauma and the frustration of navigating a system that may seem unresponsive or ineffective. This can create a sense of helplessness and anger among family members and friends, who may feel powerless to protect their loved one or ensure that justice is served. The ripple effect of delayed reporting can also extend to the wider community, creating a climate of fear and mistrust, particularly in cases where the perpetrator remains at large. Delayed reporting can also have significant economic consequences for survivors. The inability to obtain justice and hold the perpetrator accountable can lead to lost wages, medical expenses, and the need for ongoing therapy and support services. Furthermore, the psychological and emotional toll of delayed reporting can impact survivors' ability to work or pursue education, further exacerbating their financial difficulties. The economic burden of sexual assault can be overwhelming, particularly for those who are already marginalized or vulnerable. The decreased conviction rates associated with delayed reporting cases have a broader societal impact. When perpetrators are not held

accountable for their crimes, it sends a message that sexual assault is tolerated or even condoned. This can create a culture of impunity, where perpetrators feel emboldened to continue their abusive behavior, knowing that the chances of facing consequences are low. The lack of justice for survivors can also discourage others from reporting their own experiences, perpetuating the cycle of underreporting and allowing perpetrators to continue preying on vulnerable individuals. The societal cost of impunity is immeasurable, as it undermines the rule of law, erodes trust in institutions, and perpetuates a climate of fear and insecurity. The profound human impact of delayed reporting in sexual assault cases demands a comprehensive and coordinated response. Providing survivors with the information, resources, and support they need to make informed decisions about reporting and navigating the legal process. Creating a culture of support and understanding for survivors, where they feel safe to speak out without fear of judgment or ostracism. Improving the responsiveness and sensitivity of the legal system to the needs of survivors, ensuring that they are treated with dignity and respect throughout the investigation and prosecution process. Addressing the root causes of sexual assault through education, awareness campaigns, and programs that promote healthy relationships and respect for boundaries. By working together to break the cycle of delayed reporting and impunity, we can create a society where survivors feel empowered to come forward, perpetrators are held accountable, and justice prevails.¹⁸⁻²⁰

5. Conclusion

This study provides compelling evidence that delays in reporting sexual assault cases in Bangkok significantly impact the recovery and interpretation of crucial sperm evidence. The decline in both sperm recovery rates and DNA profile quality with increased reporting time underscores the critical importance of prompt forensic medical examination. Public awareness campaigns promoting timely reporting, alongside improved training for professionals and advancements in forensic techniques for analyzing degraded samples, are imperative to bolster the investigation and prosecution of sexual assault cases in Bangkok.

Declarations

Use of generative artificial intelligence. No generative artificial intelligence tool was used in the conception, design, analysis, drafting, revision or preparation of this manuscript. The author accepts full responsibility for the content of the article.

Author contributions. All author contributed to the conception and design of the study, the acquisition and interpretation of the data, and the drafting and critical revision of the manuscript. All author has reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Conflict of interest. The author declares no competing interests, financial or non-financial, in relation to this work.

Ethical approval. The study was a retrospective analysis of case records. All data were de-identified to protect the privacy of the victims and were handled in compliance with relevant ethical guidelines and data protection regulations. [Editorial note: the authors are to supply the name of the approving ethics committee and the approval number before publication.]

Consent for publication. Not applicable. No identifiable individual information is reported.

Data availability. The de-identified data supporting the findings of this study are available from the corresponding author on reasonable request; access to the source records remains governed by the originating institution.

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