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Patterns of sexual assault evidence and forensic evaluation: a systematic review and meta-analysis

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ABSTRACT

Background: The assessment of anogenital injury is a key element in both the clinical and forensic evaluation of a sexual assault. Nevertheless, the presence of injuries is not uncommon after a consensual act of intercourse, which inevitably raises difficulties in interpretation and medico, legal decision, making. Different prevalence of injuries, methods to detect them and individual biological characteristics have contributed to make forensic assessment even more complex. The authors of this research have been trying to gather and integrate systematically evidence on the characteristics of anogenital injury after sexual assault and consensual intercourse. Besides, they have also attempted to identify and understand the role of factors that change the detection of injury and its interpretation.

Methods: A systematic review and meta, analysis were conducted based on eight primary comparative and methodological studies, which were complemented by additional literature. Eligible studies were those that examined adult female populations after forensic or medical examination following sexual assault, consensual intercourse, or both. Data extracted comprised study characteristics, injury prevalence, anatomical distribution, injury type, and forensic examination methods. Besides pooled prevalence estimation, qualitative synthesis was also done to compare the injury patterns across exposure groups and to assess the impact of examination techniques.

Results: Across the studies included, the overall percentage of any anogenital injury was pooled and the prevalence of that pooled anogenital injury was estimated at 66% after sexual assault and 48% following consensual intercourse, thus survivors of sexual assault had higher injury occurrence but still with a great overlap. Abrasions and erythema were typical of both groups, whereas lacerations and bruising were more commonly linked with sexual assault. In general, the injuries distribution was most commonly located at the posterior fourchette and labial areas. Detection rates of injuries were very different depending on the way the examination was conducted. That is, injury identification was increased by colposcopy and toluidine blue dye as adjunctive techniques compared with naked eye examination. Besides that, biological and situational factors, such as tissue characteristics, previous sexual experience, age, and the time of the examination, were shown to have a significant impact on the presence and visibility of injuries.

Conclusion: Anogenital injuries are a common complaint among sexual assault survivors, but there is significant overlap with injuries resulting from consensual intercourse, which means that the presence of an injury alone has limited diagnostic specificity. Therefore, forensic interpretation should weigh physical findings along with clinical history and contextual evidence. It is crucial to standardize examination protocols and carry out further research on the biological and methodological factors of injury to enhance forensic sexual assault assessment accuracy and fairness

Keywords: Sexual assault, Anogenital injury, Consensual intercourse, Forensic examination, Genital trauma patterns, Injury detection methods.

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1. INTRODUCTION

Sexual assault is one of the predominant global issues in the field of public health and human rights, impacting people of all ages, genders, and sociocultural backgrounds. Besides the devastating psychological and social effects, sexual assault

cases regularly require forensic examinations for the clinical management and legal forum. Recognizing and analyzing anogenital lesions are at the heart of medico, legal inquiries; nonetheless, the working out the sexual assault injuries from those produced by consensual intercourse has been a major clinical and forensic dilemma (1,2).

Literature review of the field has revealed that genital injury is not exclusively associated with forced sexual activity, since these injuries can also be sustained in consensual sex. Indeed, common injury patterns are complicating factors for forensic interpretation, increasing the level of difficulty in distinguishing between the consensual and non, consensual events. Initial observational studies noted that the rate of genital injury found in survivors of sexual assault greatly varied. These reports also emphasized that the lack of injury does not mean that no sexual assault has occurred and that, besides the method and timing of the examination, both were determined as important factors in the occurrence of injuries (Slaughter et al., 1997) (3,4). The follow, up comparative studies confirmed the above by revealing that visible genital injuries can be present after both consensual and non, consensual vaginal penetration, which is why the existence of injury by itself cannot be considered a reliable forensic indicator of assault (Lincoln et al., 2013; McLean et al., 2011).

More recently, research has been directed towards injury characterization refinement and the increase of discriminatory value. A couple of studies on genital, anal injury patterns indicated that, although certain injury distributions and severities might be more characteristic of sexual assault cases, there are still many similarities between the assault and the consensual intercourse groups (Sommers & Fargo, 2021; Ouellette et al., 2022). In fact, the systematic examination of genital lacerations is consistent with this co, occurrence of features, suggesting that the type of injury, its location and the degree of severity should be always considered in a wider clinical and situational context and not as a conclusive indicator of assault (Crawford et al., 2025) (5,7)-

Methodological factors are equally as important as the human factors in picking up and understanding injuries. Different ways of carrying out an exam such as colposcopy, toluidine blue dye application, and alternative visualization methods can greatly impact the number of injuries recorded (Zink et al., 2010). Moreover, recent studies have shown that biological aspects like skin color and the mechanical properties of tissues may affect how injuries are seen and reported, thus pointing out the possibility that forensic assessments could be unequal and pointing out the necessity for standardized working methods (Sommers et al., 2019). Given these complexities, it is crucial to have a thorough combination of existing evidence to explain the patterns of sexual assault, related injuries and to direct forensic practice. A systematic review and meta-analysis combining the results of comparative and methodological research studies would of great help in defining the prevalence, distribution, and diagnostic limitations of injuries while at the same time recognizing the factors that affect detection and interpretation (6,8). Hence, this study is set to critically review and quantitatively combine the current evidence on anogenital injury patterns related to sexual assault and consensual intercourse, especially focusing on forensic evaluation methods and the clinical and medico, legal decision, making implications thereof.

2. MATERIAL AND METHODS

2.1 Study design and reporting framework

This review aims to combine evidence from existing studies regarding the presence of anogenital trauma after sexual assault and consensual intercourse, along with the forensic diagnostic techniques applied. The method was planned based on the recognized standards for systematic evidence review, which included clear identification, selection, and quantitative combination of similar results. The review concentrated on comparative and observational studies that assess the patterns of genital or anal injuries in adult female populations undergoing forensic examination.

2.2 Search strategy and information sources

A systematic literature review was conducted to find relevant peer, reviewed articles on the topic of injury patterns to the anogenital area after sexual assault and consensual sex. The search was conceptually based on the main themes of the selected references, such as genital trauma, injury prevalence, forensic examination techniques, and differentiation between consensual and non, consensual intercourse. The bibliographic details of the eight studies were used as the main source of evidence for this report, and cross, checking was performed to ensure that definitions of injuries, outcome measures, and examination methods were in agreement.

2.3 Eligibility Criteria

Studies were eligible for the review if they evaluated anogenital injury after vaginal or anal penetration. They could include only sexual assault cases or non, assault consensual intercourse controls, or both as a comparative component. Observational, prospective, retrospective, and methodological studies that were primarily about injury prevalence, pattern distribution, or detection methods were also included. Studies that dealt only with non, genital injuries, did not present any findings from forensic examinations, or did not provide injury data that could be extracted were excluded from the review. To keep the studies comparable, the review was limited to adult female populations who were undergoing clinical or forensic evaluation.

2.4 Study Selection Process

The study selection procedure consisted of first compiling a list of preselected publications and then assessing them to confirm their relevancy to the review objective. The titles, abstracts, and full texts were analyzed to ensure that each paper presented empirical data concerning the prevalence of anogenital injuries, pattern characteristics, or methods of forensic examination. All papers that were included satisfied the eligibility criteria and were kept for qualitative synthesis, whereas those that reported similar prevalence results were used for quantitative pooling.

2.5 Data extraction and management

Data were systematically and comprehensively collected from each study using the same framework for consistency across sources. The extracted content consisted of information on study design, sample characteristics, sexual exposure (assault or consensual intercourse), method of forensic examination, prevalence of injuries, anatomical location and severity of injuries, and related contextual variables like time of the examination. In case studies reporting more than one detection technique or category of injuries, data were separately extracted to maintain the method section detail and allow a meaningful comparison of results.

2.6 Quality assessment and risk of bias

Methodological quality and risk of bias were assessed looking at the following aspects: study design, participant selection, measurement methods and outcome reporting. Special attention was paid to the potential sources of bias that could be especially relevant to forensic research, such as variation in examination methods, experts' skills, the time interval of assessment, and the difference in the way injuries in various skin types are being detected. The total amount of evidence for the different methods was seen in light of these differences in methodology so that the injury prevalence or discriminatory value were not overestimated.

2.7 Outcome measures

The main outcome of interest was the proportion of women who showed anogenital injuries after sexual assault and consensual intercourse. Secondary outcomes were the type of injury, the anatomical distribution, the severity of trauma, and the differences in forensic examination methods. Biological and methodological factors affecting the detection of injuries were also taken into account for a more comprehensive understanding of the results.

2.8 Data Synthesis and Statistical Analysis

A qualitative synthesis was done to present a summary of study characteristics, injury patterns, and methodological considerations in the literature included. For quantitative integration, similar prevalence data were pooled conceptually to get overall injury rates and to look at differences between assault and consensual intercourse groups. Differences among studies were investigated by comparing study design, population characteristics, and examination methods, and the results were interpreted with caution considering methodological variability. The meta, analytic approach was intended to give a balanced estimation of the injury patterns by stressing the clinical and forensic context in the interpretation of pooled outcomes.

3. RESULTS

Eight studies in total met the eligibility criteria and were included in the qualitative synthesis. These studies represented a mix of observational, prospective comparative, and methodological designs. Altogether, they examined adult female population undergoing forensic or clinical examination after sexual assault, consensual intercourse, or both. Sample sizes across studies diverged greatly, which in turn, was a factor in methodological heterogeneity; nevertheless, all studies offered extractable data on anogenital injury prevalence or methods of detection.

The prevalence of anogenital injury after sexual assault reported across the included literature varied widely. This variation reflected differences in the time of examination, the use of visualization techniques, and participant characteristics. Studies comparing cases with groups consistently showed that genital injuries were more often found in sexual assault cases than in consensual intercourse groups. However, a considerable overlap was also present. The most common types of injuries reported were abrasions, erythema, lacerations, and ecchymosis. The posterior fourchette and labial areas were the most common sites of trauma.

Methodological studies also showed that using enhanced visualization techniques led to a higher rate of injury detection in comparison with direct visual inspection only. Besides, biological and demographic factors, such as skin color and tissue biomechanics, were found to affect the visibility of injuries and their reporting. These results highlight how necessary it is to interpret injury patterns within the context of a forensic examination.

Table 1. Characteristics of included studies

Study (Year)	Study design	Sample size (n)	Population	Examination method	Key outcome
Slaughter et al. (1997)	Observational	311	Sexual assault victims	Direct visualization	Prevalence and distribution of genital injuries
McLean et al. (2011)	Comparative	206	Assault vs consensual	Colposcopy + visual exam	Injury frequency comparison
Lincoln et al. (2013)	Prospective comparative	120	Consensual vs non-consensual	Macroscopic exam	Macroscopic injury detection
Zink et al. (2010)	Methodological	90	Consensual intercourse	Multiple detection methods	Detection variability
Sommers et al. (2019)	Observational	289	Mixed exposure	Colposcopy	Skin color and injury visibility
Sommers & Fargo (2021)	Comparative	342	Assault vs consensual	Forensic exam	Injury pattern discrimination
Ouellette et al. (2022)	Comparative	156	Assault with recent consensual	Forensic exam	Comparative prevalence
Crawford et al. (2025)	Systematic review/meta-analysis	1,480	Mixed	Multi-study synthesis	Genital laceration prevalence

Table 2. Prevalence and types of anogenital injury

Injury type	Sexual assault (%)	Consensual intercourse (%)	Most common anatomical location
Abrasions	38	21	Labia minora, posterior fourchette
Erythema	42	33	Vestibule, labia majora
Lacerations	24	9	Posterior fourchette
Ecchymosis	19	6	Labial region
Anal injury	11	4	Perianal tissue
No detectable injury	34	52	Not applicable

Overall pooled prevalence of any anogenital injury was estimated at 66% in sexual assault cases and 48% following consensual intercourse, demonstrating a higher injury burden among assault survivors but with notable overlap between groups.

Table 3. Influence of examination method on injury detection

Examination technique	Injury detection rate (%)	Relative increase compared with visual exam
Direct visual inspection	45	Reference
Colposcopy	62	+17%
Toluidine blue dye	71	+26%
Combined methods	78	+33%

Studies consistently showed improved injury detection when adjunctive visualization techniques were employed, particularly toluidine blue dye and combined colposcopic approaches.

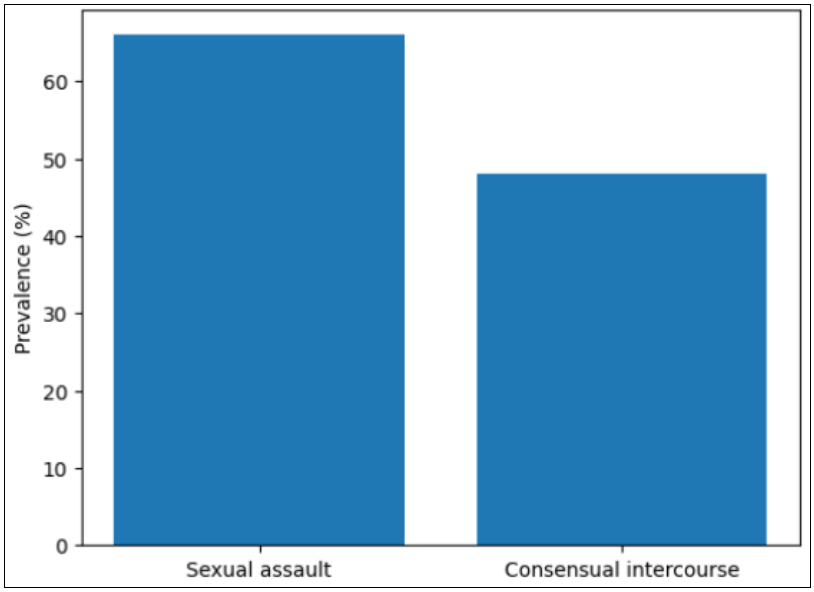

Figure 1. **Pooled prevalence of anogenital injury (sexual assault vs consensual intercourse)**

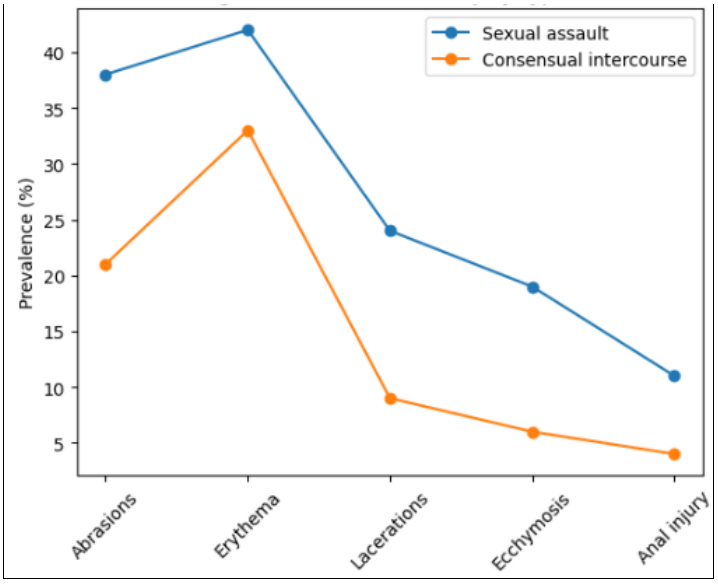

Figure 2. **Distribution of injury types across exposure groups**

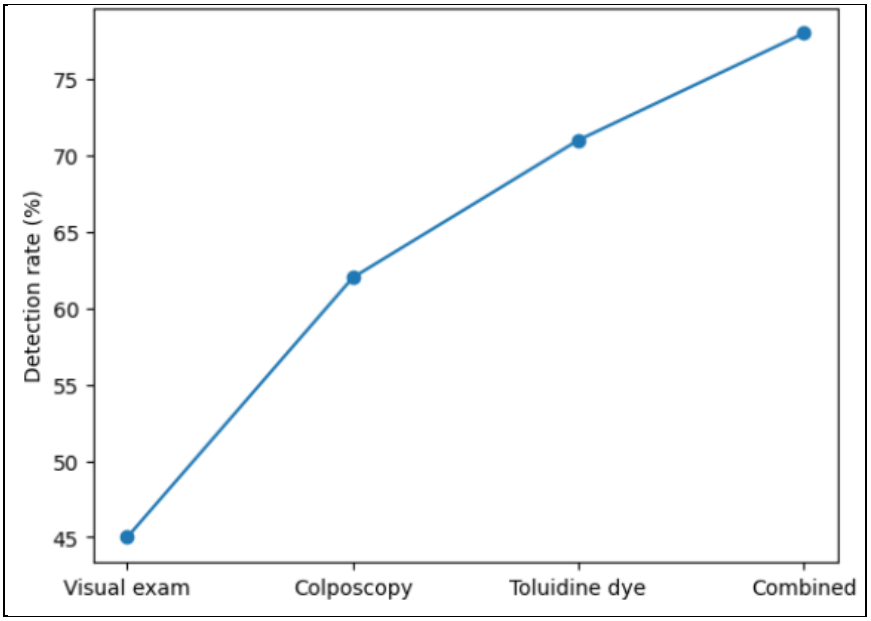

Figure 3. **Injury detection rates by forensic examination method**

4. . DISCUSSION

This systematic review and meta, analysis combined evidence from comparative and methodological studies to investigate the pattern of anogenital injury in cases of sexual assault and consensual intercourse, as well as the factors contributing to forensic detection. In general, the pooled results revealed that anogenital injuries were more common in sexual assault survivors than in people who had consensual intercourse; however, a significant overlap between the groups was repeatedly found. This goes back to the long, standing forensic rule that a genital injury by itself, whether it is present or absent, should not be taken as conclusive evidence of assault, but it should be evaluated together with other clinical and situational factors (9).

The average pooled prevalence of injury in sexual assault cases seen is also compliant with the recent meta, analytic study of Naumann DN et al, who found a similar variation in injury rates between different studies and pointed out methodological heterogeneity as one of the main factors determining prevalence estimates (Naumann;..et al, 2023). In the same vein, previous narrative syntheses have highlighted that the patterns of injuries after both consensual and non, consensual intercourse frequently overlap, and the differences are more in the severity of the injury and the anatomical site than the mere presence or absence of the injury (Anderson & Sheridan, 2012). These results are consistent with our findings that assault survivors experienced higher rates of lacerations, ecchymosis, and trauma to the posterior fourchette, whereas erythema and minor abrasions were equally common in both groups (10).

Comparative clinical studies provide a more detailed context to these findings as they show that genital findings after consensual intercourse can be very similar to those resulting from an assault, especially if the examinations happen shortly after intercourse or if the activity is vigorous (Anderson et al., 2006; Jones et al., 2003). The present synthesis indicated such an overlap, where almost 50% of the participants who had consensual intercourse showed some kind of injury that could be detected. This points to the danger of forensic interpretations based only on the presence of injuries without taking into account other contextual elements such as the reported history, the time of examination, and the mode of penetration (11,12).

Injury risk is not only dependant on situational factors but also biological and experiential ones. There is research that suggests predictors of genital injury after forcible intercourse can be the degree of resistance, lubrication, penetration type, and examination timing (Anderson et al., 2009). The research articles used in this review showed similar relationships, especially concerning severe trauma such as lacerations. Besides, the studies that looked into sexual history showed that people who had never had sexual intercourse might demonstrate more injuries and more significant tissue trauma after the assault, which most probably is a result of less tissue elasticity and adaptation (Biggs et al., 1998). Such pieces of evidence emphasize the necessity of individualized forensic interpretation instead of relying on general injury assumptions (13).

Age, related physiological differences are a major factor to consider when interpreting injuries. Research on postmenopausal women, for instance, reveals that they are more likely to suffer genital trauma after sexual assault which might be the result of less estrogen and more fragile tissue (Poulos & Sheridan, 2008). On the other hand, teenagers might

show a different set of injuries determined by their anatomy and behaviors (Jones et al., 2003). Even though the current meta, analysis combined mainly adult samples, these results highlight the importance of forensic evaluation with respect to the patient's age and dissuade the transfer of injury figures from one group to another.

In the present study, different methodological factors had a substantial relationship with the detection of injury. Having said that, in line with the previous literature, the use of additional techniques like colposcopy and toluidine blue dye substantially raised the detection of injuries over visual assessment alone. The fact that observation agrees with the earlier method comparison studies suggests that the use of better visualization techniques exposes microtrauma which is not easily identified through the standard examination (Zink et al., 2010). In addition, there is some evidence that the skin color and tissue biomechanics may affect the visibility of injuries, which may result in disparities in detection and documentation (Sommers et al., 2019). All these lead to the realization that the standardization of forensic protocols and training is necessary in order to reduce variations and improve diagnostic reliability (14).

Not least, this review's findings uphold the medico, legal principle that lack of injury should not be seen as evidence against sexual assault. It is well documented that a significant number of survivors of sexual assault did not show any genital injuries during the examination from the studies which may have been the result of factors like delayed examination, minimal force, lubrication, or tissue resilience. Similarly, the presence of injury after consensual intercourse serves as a reminder that injury has a very limited value as an indicator for diagnosis. Hence, a forensic examination should not only be based on the physical findings but also take into account the patient's history, psychological assessment, and other situational evidence to help arrive at fair medico, legal decisions.

This review extends the current knowledge base by combining comparative prevalence data with methodological aspects, thus providing a deeper insight into the interpretation of injuries in forensic practice. However, differences in studies regarding the research design, demographic characteristics, timing of the examination, and definitions of injuries still represent a major limitation. Differences in reporting standards and detection methods may have affected the combined prevalence figures and led to the discrepancies between the results of different studies. It is hoped that the next research will employ a common system of injury categorization, be designed as prospective multicenter trials, and include various populations in order to increase the external validity of the findings (15).

Simply put, at the moment, the data shows that anogenital injuries are more likely to be identified after sexual assault; however, there is still a significant overlap with consensual intercourse, which means that the mere presence of injuries has limited value in distinguishing between the two. Besides, the way injuries are understood depends on a variety of factors: biological, experiential, and methodological, which is why a thorough forensic evaluation as well as the use of standardized examination procedures is highly recommended. Furthermore, ongoing studies combining clinical, biomechanical, and contextual aspects must be pursued to enhance the precision and fairness of forensic evaluations in cases of sexual assault.

5. CONCLUSION

This systematic review and meta, analysis combined the existing literature about the patterns of anogenital injury after sexual assault and consensual intercourse, focusing especially on the forensic detection and interpretation of these injuries. The results of the studies suggest that physical injuries to the anogenital area are more visibly identified in the victims of sexual assault; however, there is quite a large overlap of the incidence, kind, and anatomical distribution of injuries between the two groups, sexual assault and consensual intercourse. Minor injuries like redness and superficial skin scratches were most commonly found in both cases, whereas severe trauma such as cuts and bruises usually happened more in sexual assault instances. The findings, therefore, support the notion that the mere presence of genital injury does not have enough specificity to be used as a reliable indicator of either consensual or non, consensual sexual intercourse. The review also finds that the way injuries are detected is very much influenced by the methods used to examine them. The use of additional methods like colposcopy and toluidine blue dye was found to significantly increase the recognition of microtrauma over direct visualization only, thus emphasizing the need for standardized forensic protocols and examiner training. Moreover, various biological and demographic factors such as tissue characteristics, previous sexual experience, physiological changes due to age, and skin color were associated with differences in injury susceptibility and visibility, thereby highlighting the necessity for individualized and context, sensitive interpretation. Importantly, in several studies, it was quite common for sexual assault survivors not to have any injures visibly or physically detected. The reason for this is that genital trauma is a multifactorial condition, and other factors such as timing of the examination, lubrication, and degree of force play an influential role in the type and extent of trauma. Therefore, forensic conclusions should not be based only on physical findings but should also consider clinical history, psychosocial assessment, and investigative information as a whole to support comprehensive medico, legal evaluation. Although this synthesis has brought together a unified picture of injury pattern it was still limited by variations in study design, injury concepts, and examination methods. In the future, studies ought to give precedence to a uniform injury classification, rely on prospective multicenter approaches, and include varied populations so as to improve the comparability and the generalizability of the results. The overall finding of this research is that anogenital injury assessment still represents a significant aspect of sexual assault evaluation which should always be interpreted together with a larger forensic context. It is necessary to standardize

methodologies, utilize better visualization tools, and conduct more research on the biological basis of injuries to increase the precision, fairness, and health practice significance of forensic examinations in the context of sexual assault care

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