Anogenital injury following sexual assault and consensual sexual intercourse: a systematic review and meta-analysis

David N. Naumann,[a,b,*] Louise Morris,[c] Douglas M. Bowley,[b] Tracy-Louise Appleyard,[d] Julie Cumming,[e] and Deborah Wardle[e]

[a]Institute of Inflammation and Ageing, University of Birmingham, Edgbaston, Birmingham B152TT, UK
[b]Department of Trauma and Emergency General Surgery, University Hospitals Birmingham NHS Foundation Trust, Birmingham, UK
[c]Department of Paediatric Surgery and Urology, Alder Hey Children's Hospital, Liverpool, UK
[d]Women's and Children's Division, North Bristol NHS Trust, Southmead Hospital, Bristol, UK
[e]NHS Education for Scotland, 3rd Floor, 2 Central Quay, 89 Hydepark Street, Glasgow, UK

eClinicalMedicine
2023;65: 102266

Published Online xxx
https://doi.org/10.1016/j.eclinm.2023.102266

Summary

Background Sexual violence is a grave human rights violation and a serious global public health challenge. Rates of reporting of sexual violence and subsequent passage of cases through the criminal justice system are poor all over the world. The presence or absence of anogenital injury following sexual assault may influence survivors in their willingness to report a crime, and law enforcement officers and jurors in their decision making regarding the laying of charges and/or conviction of offenders. The aim of this systematic review was to compare rates of identification of anogenital injury (AGI) in women following sexual assault and consensual sexual intercourse using the same examination techniques.

Methods In this systematic review and meta-analysis, Medline, Embase and Google Scholar were searched for relevant studies (in any language, with no age or sex criteria) published between February 25, 1993, and February 25, 2023, that directly compared AGI between individuals after either sexual assault or consensual sexual intercourse. Abstracts, conference proceedings, and case reports were excluded. The primary outcome of interest was any form of detected AGI. The Mantel-Haenszel method was used for meta-analysis using random effects modelling to determine the risk ratio (RR) of AGI between sexual assault and consensual sexual intercourse. Quality assessment was undertaken using the Newcastle–Ottawa scale tool. The I^2 statistic was used to determine heterogeneity among studies. An I^2 >75% was considered high heterogeneity. Funnel plots were used to assess the risk of publication bias, by determining any visually apparent asymmetry. This analysis is registered with PROSPERO, CRD42023402468.

Findings We included 10 studies, accounting for 3165 study participants. All participants were female. AGI was detected in 901 (48%) of 1874 participants following sexual assault and 394 (31%) of 1291 participants following consensual sexual intercourse. Meta-analysis of all included studies demonstrated that the presence of AGI was significantly more likely for participants following sexual assault than consensual sexual intercourse (RR 1.59 (95% CI 1.21, 2.09); $p < 0.001$). There was a significant heterogeneity among studies and funnel plots suggest that this RR may be an over-estimation. Subgroup analysis including only high-quality studies showed no significant difference between groups.

Interpretation Although AGI was significantly more likely to be detected after sexual assault than consensual sexual intercourse, more than half of survivors of sexual assault have no detectable injuries. The presence of AGI, therefore, does not prove there has been sexual violence and absence of injury does not refute that sexual assault has occurred.

Funding The University of Birmingham.

Keywords: Rape; Sexual assault; Non-consensual; Anogenital injury; Forensic

*Corresponding author. Institute of Inflammation and Ageing, University of Birmingham, Edgbaston, Birmingham B152TT, UK.
E-mail address: d.n.naumann@bham.ac.uk (D.N. Naumann).

Research in context

Evidence before this study

Previous studies have investigated the incidence of anogenital injury following sexual violence, and others have also investigated injuries following consensual sexual intercourse. However, there has been no synthesis of all the available data to compare injuries between rape survivors and those who consented. We aimed to synthesise all such data in the past 30 years and conduct a meta-analysis.

Added value of this study

This is the first synthesis of data (including >3000 participants) to show that although anogenital injury was significantly more likely in non-consensual than consensual sexual activity, there were both survivors of rape with no identified injuries and those following consensual intercourse with detectable injuries.

Implications of all the available evidence

The presence or absence of anogenital injuries is frequently used as evidence in court. This is the first synthesis of evidence to show that—although anogenital injury was detected at significantly higher frequencies after sexual assault than after consensual sexual intercourse—the presence of anogenital injury does not prove there has been sexual assault, nor does absence of injury disprove sexual violence.

Introduction

Sexual violence (SV) is a grave human rights violation and a serious global public health concern.[1] SV inflicts considerable harm on the mental and physical well-being of survivors, their families and communities, imposes high demands on the criminal justice system, and has detrimental social, economic, political, and cultural implications.[2] SV is common; in the year to September 2022 there were 70,633 rapes and nearly 130,000 other sexual offences recorded by police in England and Wales alone.[3] National Crime Survey data suggest that fewer than one in six female survivors of sexual assault by rape or penetration and fewer than one in five male survivors (aged 16–59 years) report the assault to the police.[4] The 'conversion' rate from reporting of an incident to decision to charge is lower still; in England & Wales for April–June 21, the percentage of cases that resulted in a criminal charge (out of all adult rape cases recorded) was 0.6%.[5]

The presence or absence of anogenital injuries (AGI) and their interpretation is usually a subject of intense focus in cross-examinations, with higher rates of prosecution and conviction for cases with injuries documented.[6–8] There is some evidence that women may be less willing to engage in the criminal justice system if there is absence of AGI following rape.[9] This may be due to the belief that they will be discredited in the absence of detectable injuries,[10] a belief perpetuated by the persistence of rape myths and stereotypes within society internationally.

As reported almost 40 years ago,[11] AGI may occur after consensual sexual intercourse (CSI) and sexual assault (SA) may not be associated with injury, therefore, the presence of AGI does not 'prove' that there has been SA, and importantly absence of injury does not refute that a SA has occurred.[12] In current legal proceedings this is frequently stated, but there has not yet been a large scale synthesis of data to support this statement. The aim of this study was to undertake a comprehensive review of the literature to compare prevalence of AGI in women following SA and CSI using the same examination techniques, to better inform those who evaluate forensic evidence in criminal proceedings.

Methods

Search strategy

Standard systematic review and meta-analysis methodology was used according to the PRISMA guidance[13] (Prospective Register of Systematic Reviews PROSPERO; reference number CRD42023402468). Two authors used OVID SP to systematically search Medline and Embase, and further searches were done using the PubMed version of Medline and Google Scholar. Studies in any language were included. Search terms defined the participants ("rape", "sexual assault", "non-consensual"), controls ("consensual", "voluntary"), and the outcome ("trauma", "injury", "genital", "genito-anal", "ano-genital"). Combinations of terms and spellings were used, and the Boolean operators "AND" and "OR" were used for all searches. As an additional method for study inclusion, manual searches through reference lists and tables in relevant articles were done to identify relevant studies. Abstracts and conference proceedings were excluded due to the probability of redundant or incomplete data. Case reports were excluded since these would not allow a comparison required for meta-analysis. Citations were collated, duplicates removed, and full texts obtained using EndNote V20.5 (Thomson Reuters). The final search was performed on 25th February 2023.

Definitions of sexual violence

For this study, we defined two groups for comparison: sexual assault (SA), and consensual sexual intercourse (CSI). Appreciating each study defined its own eligibility criteria, and legal definitions notwithstanding, we use SA in this text to mean any non-consensual sexual contact with the anogenital area of the survivor, and CSI

as the same sexual contact but with the consent of the participants.

Eligibility criteria

All studies that compared anogenital examination findings of participants following SA with participants after CSI in the last 30 years were eligible for inclusion (i.e., published between February 25th, 1993 and February 25, 2023). There is recognised heterogeneity among studies that might make meta-analysis difficult.[14] This includes differences in both study design and analysis of data. Therefore, to make the fairest comparison, studies were not eligible for inclusion if they only included one of these groups (i.e., *only* SA or *only* CSI). The rationale for this exclusion is that one study that only includes participants with SA may not be comparable to another study that only includes participants with CSI due to different techniques for examination, examiners, and definitions. Inclusion of only comparison studies ensures the highest probability of uniformity of these factors between groups. It was anticipated that there could be no randomised controlled trial data for the current research question. Therefore, observational studies which compared anogenital examination findings for individuals following SA and CSI were eligible for inclusion. Case reports and series with <10 participants were excluded. No age or gender criteria were applied for inclusion; data from study participants were extracted regardless of age, including both pre-pubertal and post-menopausal participants.

Data extraction

Data were extracted by two authors and discrepancies re-examined and resolved by consensus. Data included study details (design, year, journal), methodology (eligibility criteria, selection of participants, number of participants, techniques for examination, cohort matching, timing of assessment), and outcomes (definitions, types and numbers). Although data were extracted *verbatim* from the studies, the ethnicity categories "Caucasian" and "other" were considered problematic and replaced with the words "White" and "not specified" when summarised in the current review.

Outcomes

The outcome of interest was the presence of AGI (defined as any genital, anal or perineal injury detected using the techniques described in each study). Since there is not an agreed, universal definition of genital trauma,[15] the presence of this outcome was taken *verbatim* from the included studies and no additional interpretation was made by the review authors. The main outcome measure was dichotomous by design (no AGI/AGI) since this is the benchmark at which the results of forensic examination might be presented for cases of sexual assault.

Assessment of bias

The Newcastle–Ottawa scale was used to assess the risk of bias.[16] This scale was designed to help authors assess the quality of non-randomised studies in their presentation of systematic review findings. Such an exercise helps with the interpretation of the overall findings in the context of the quality of the research within included studies. This scale includes assessment of the selection of the study group populations: the survivors of SA and a comparison group of consenting participants, comparability of the cohorts on the basis of the design or analysis, and the assessment of the outcome of interest. A scoring system was used with a maximum of 9 points. Adapted definitions are illustrated in Supplementary Table 1. Two authors (DNN, LM) agreed on these definitions, which were adapted from the original source[16] to fit the criteria for study inclusion. These two authors independently scored the studies. Any discrepancies were re-examined together to reach consensus.

Statistical analysis

Risk ratios (RR) and 95% confidence intervals (95% CI) were used for the dichotomous outcome measure, according to the original numeric data. This represented the risk of an event (AGI) in the SA group compared to the CSI group (i.e., an RR >1 represents a greater risk of AGI in the SA group). The Mantel-Haenszel (M–H) method was used for the meta-analysis, with significance determined using χ^2 analysis. Forest plots were used to provide a graphical representation of this meta-analysis technique, with the RR and 95% CI displayed for all included studies next to each other, and an overall RR and 95% CI shown as a diamond for the synthesis of all studies. The I^2 statistic was used to determine heterogeneity among studies. This represents the percentage of the total variability in effect sizes among studies that is attributable to heterogeneity in data (i.e., between-study variability). A I^2 of >75% was considered to be high heterogeneity. An Euler diagram was used to illustrate the outcome in both groups. Planned subgroup analysis was undertaken to include only studies that scored as "*good*" according to the Agency for Healthcare Research and Quality (AHRQ) standards after assessment of bias using the modified Newcastle–Ottawa scoring system. A funnel plot was also used to assess the potential for publication bias or small-study effects by displaying the relationship between effect size of individual studies and precision (represented as standard error). In this graphical representation, asymmetry demonstrates the likely presence of publication bias.

Role of the funding source

The funder(s) of the study had no role in study design, data collection, data analyses, interpretation, or writing of the report.

Results

Study selection

The systematic search yielded 1401 results after duplicates were removed; 45 abstracts had potential for inclusion, and after the full texts were screened, 10 original studies were eligible for inclusion[17–26] (Fig. 1).

Study characteristics

The 10 included studies were published from 1997 to 2022 in the USA, UK, Australia, Denmark and Thailand. Although some authors described "case–control" studies, these were all cohort studies according to standard definitions, with the outcome of interest (AGI) occurring after either SA or CSI. There were 3165 study participants, all were women (no male data was reported in any studies). There were 1874/3165 (59%) survivors of SA. Study periods ranged from 1 to 9 years for SA participants. Study characteristics are summarised in Table 1, and participant characteristics are summarised in Table 2. Characteristics of sexual contact are summarised in Supplementary Table 2.

Examination techniques

Table 1 summarises examination techniques used for assessment of AGI. All studies reported naked eye examinations of the external genitalia, eight used magnification, and six used toluidine blue. Eight studies included examination of the internal genitalia; six used colposcopy to augment the examination. Four studies included anal examination; two included anoscopy when considered necessary by the examining clinician. All studies reported that the examiners were experienced in conducting forensic examinations following sexual assault. Study definitions of findings that were recorded as injury are detailed in Supplementary Table 2 *verbatim*. All studies included lacerations/tears, abrasions and bruises (or equivalent terms) in their definition of injury; half also included redness/colour change and swelling/oedema.

Selection of participants

Methods for identifying cohorts of sexual assault survivors and consensual sexual intercourse participants in

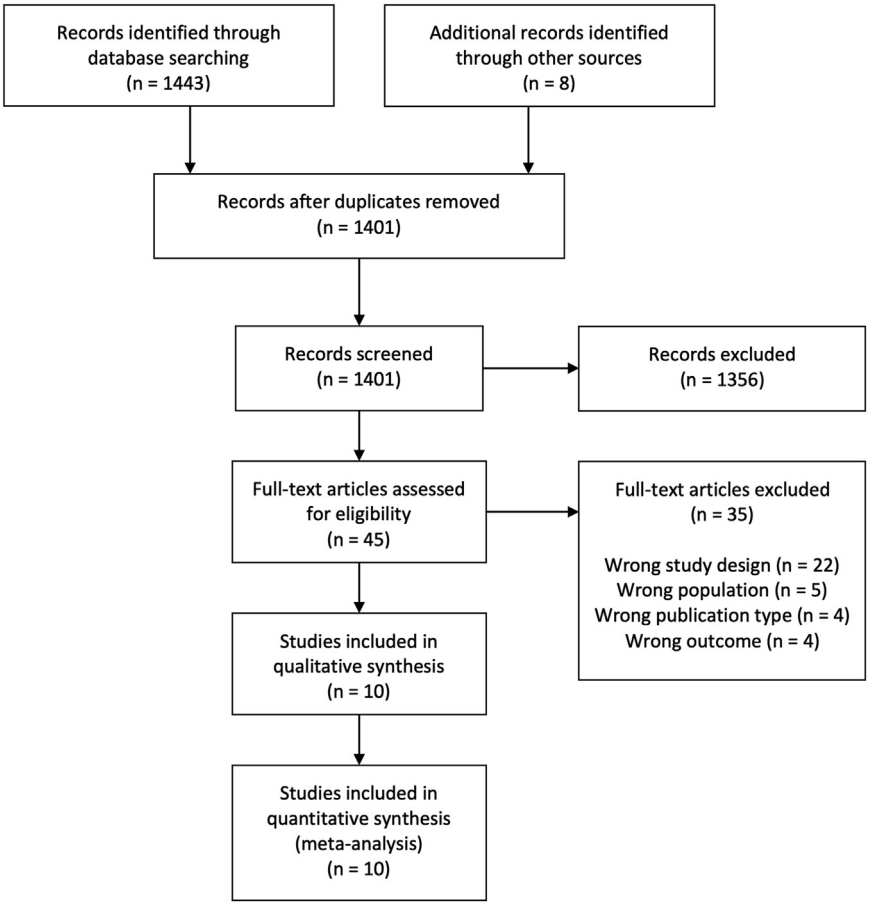

Fig. 1: PRISMA flow diagram for the identification, screening and inclusion of studies.

Year	Study	Country	Timescale	Population included	Specific exclusions	Examiners	Anatomy examined and technique	Findings categorised as anogenital injury
1997	Slaughter et al	USA	9 years	Females: post pubertal	–	Suspected abuse response team forensic examiners	Genital (external and internal) and anal: visual examination, colposcopy, photography ± anoscopy of 11 anatomical sites	Tears, ecchymosis, abrasions, redness, swelling
2003	Jones et al	USA	4 years	Females: adolescent (13–17 years)	"if the history of the assault was inconsistent because of intoxication or psychosocial issues"	Forensic sexual assault nurse examiners	Genital (external and internal) and anal: Visual examination, toluidine blue, colposcopy, photography ± anoscopy of 10 anatomical sites	Lacerations, erythema, abrasions, ecchymosis, edema
2006	Anderson et al, A	USA	1 year (SA), 3 months (CSI)	Females: healthy, non pregnant, post-menarchal	Postmenopausal women	Sexual assault nurse examiner	Genital (external and internal): Visual examination, toluidine blue, colposcopy and photography of 7 anatomical sites	Tears, ecchymosis, abrasions
2009	Anderson et al, B	USA	3.5 years	Female: adult (18–40 years), non pregnant, having menstrual periods, no prior hysterectomy	Postmenopausal women Non-English speakers	Forensic nurse examiners	Genital (external and internal): Visual examination, toluidine blue, urethral catheterisation, colposcopy and photography of 8 anatomical sites	Tears, ecchymosis, abrasions, redness, swelling
2011	Larkin et al	USA	21 months	Females: adult (18–46 years), sexually active, current partner, non pregnant, not currently menstruating, no current gynaecological infection, inflammation or injury	Postmenopausal women Non-English speakers	Sexual assault response team forensic examiners	Genital (external): Visual examination, toluidine blue and colposcopic photography (external only)	Swelling, colour change, tissue injury in the labia minora or posterior fourchette, hymenal injury, toluidine blue uptake
2011	McLean et al	UK	5 years (SA), 2 years (CSI)	Females: Adult (18+ years)	–	Forensic physician	Genital (external): Visual examination with magnified light source	Bruises, abrasions, lacerations
2013	Lincoln et al	Australia	6.5 years	Females: adult (18–45 years), no other episode of vaginal penetrative sex in previous 72 hours	Women with pigmented skin Sex workers	Forensic examiners (SA), general practitioners (CSI)	Genital (external and internal): Visual examination without magnification of 12 anatomical sites	Bruises, abrasions, lacerations
2013	Astrup et al	Denmark	2 years (SA), 2 months (CSI)	Females: adolescent (15–17 years) and adults	Unaccompanied minors; assault survivors with "psychological issues such as psychiatric disease, mental retardation or severe intoxication"	Experienced registrars	Genital (external and internal): Visual examination, toluidine blue, colposcopy and photography of 7 anatomical sites	Laceration, abrasion, contusion/haematoma/bruise
2021	Sommers et al	USA	4 years	Females: adult (21+ years) no recent genital injury, no current heavy menses	Transmen, transwomen Non-English or Spanish speakers	Forensic nurse examiners	Genital (external and internal) and anal: visual examination, toluidine blue, colposcopy and photography of 9 anatomical sites	Tears, ecchymosis, abrasions, redness, swelling
2022	Suttipasit et al	Thailand	6.5 years	Females: adolescent (<18 years), post menarchal, no other episode of vaginal or anal penetrative sex in prior 120 hours	"Having abnormal sexual or body growth, that is, hormonal abnormality"	Forensic trained physicians	Genital (external, internal only if puberty beyond Tanner Stage 2) and anal: visual examination of 10 anatomical sites	Abrasion, contusion/bruise, laceration

SA: sexual assault; CSI: consensual sexual intercourse.

Table 1: **Study characteristics for studies comparing injuries between sexual assault survivors and participants following consensual sexual intercourse.**

Year	Study	Number of participants		Participant identification		Ethnicity of participants		Mean age (years)[a]		Age range (years)	
		SA group	CSI group	SA group	CSI group	SA group	CSI group	SA group	CSI group	SA group	CSI group
1997	Slaughter et al	311	75	Presentation for evaluation by SARC	Presentation for evaluation by SARC, Volunteers responding to advertisement	White 89% Black/Asian 3% Hispanic 8%	Not reported	24	25	11–85	13–48
2003	Jones et al	204	51	Presentation for evaluation by SARC	Presentation for evaluation by SARC	White 74% Not specified 26%	White 63% Not specified 37%	15.1 ± 1.6		13–17	
2006	Anderson et al, A	56	46	Presentation to ED with report of SA	Volunteers responding to advertisement	Black 21% White 66% Hispanic 9% Asian 4% Unknown 0%	Black 15% White 78% Hispanic 2% Asian 2% Unknown 2%	26.3 ± 10.3	29.3 ± 6.0	16–54	21–45
2009	Anderson et al, B	40	40	Presentation to ED with report of SA	Volunteers responding to advertisement	White 70% African American 28% Asian 0% Pacific Islander 0% Hispanic 0% Not specified 2%	White 78% African American 8% Asian 2% Pacific Islander 2% Hispanic 8% Not specified 2%	26.5 ± 6.5	21.0 ± 3.6	18–39	18–39
2011	Larkin et al	185	50	Presentation to ED for police-authorised forensic examination	Volunteers responding to advertisement	African American 48% White 24% Hispanic 13% Asian 6% Unknown 10%	African American 34% White 50% Hispanic 3% Asian 7% Unknown 5%	25.5 ± 13.4	32.6 ± 8.1	18–46	19–48
2011	McLean et al	500	68	Presentation for evaluation by SARC	Volunteers responding to advertisement sent with invitation for cervical screening	White 93% Black 3% Asian 2% Not specified 2%	White 91% Black 2% Asian 4% Not specified 3%	30–45 most common age group	30–45 most common age group	18+	18+
2013	Lincoln et al	41	81	Presentation to hospital for forensic examination following report of SA to police	Presentation to GP with clinical or screening indication for genital examination (asked about vaginal penetrative sex in last 72 hours)	"Heavily pigmented" skin excluded "Some degree of skin pigmentation, described as 'brown' or 'olive' skin" 16% No skin pigmentation 83%		18–21 most common age	30–35 most common age	18–45	18–45
2013	Astrup et al	39	98	Presentation for evaluation by SARC	Volunteers responding to advertisement	Inuit descent 5% Middle Eastern descent 3% White 92%	White 100%	Median 26 (95% CI 23.4–29.4)	Median 23 (95% CI 22.3–23.7)	Not reported	
2021	Sommers et al	306	528	Presentation to ED with report of SA	Volunteers responding to advertisement	Black 24.5% Hispanic 1.0% Not specified 2.0% White 46.7% Unknown 25.8%	Black 28.8% Hispanic 41.1% Not specified 2.7% White 27.5% Unknown 0%	31.4 ± 10.0	32.6 ± 9.7	Not reported	
2022	Suttipasit et al	192	254	Presentation to hospital with report of SA	Girls who purported to consent to sexual activity, brought to hospital by parent/ guardian for forensic genital examination	Not explicitly stated; paper reporting from Thailand	Not explicitly stated; paper reporting from Thailand	Median 15 (IQR 13–16)	Median 14 (IQR 13–15)	10–18	10–18

ED: Emergency Department; SARC: Sexual Assault Referral centre; SA: sexual assault; CSI: consensual sexual intercourse. [a]±SD if available, or as stated.

Table 2: **Participant characteristics for included studies comparing injuries between sexual assault survivors and participants following consensual sexual intercourse.**

the included studies are summarised in Table 2, and definitions of consent are summarised in Supplementary Table 2. The majority of SA survivors were examined following a presentation to their Emergency Department or Sexual Assault Referral Centre (SARC). Two studies required "corroboration" of the assault by police investigation to qualify for inclusion in their SA group. The method for including participants following CSI varied across studies. Some studies used volunteers,[17,19,20,23,24,26] and others used participants presenting for gynaecological assessment[17,22] or routine cervical smears.[21] Two studies included participants who were under the age of consent for sex in that country, but who were described as *'willing participants'* and "*consented*" according to the authors' definitions.[18,25] One of these studies[17] also included in their CSI group participants who had attended with a report of sexual assault but *"later admitted to consensual intercourse (corroborated by police investigation)"*. One study paid their volunteers.[24] Three studies reported parity status of participants,[21–23] including one study that also discussed previous obstetric injury.[22] One reported a higher proportion of women in the SA group having had previous vaginal deliveries[23]; the remainder reported no significant difference in obstetric history between groups.[21,22] In terms of ethnicity, the majority of participants were reported as White in seven of the studies, but this was not the most common ethnicity in two of the studies.[20,24] One study specifically excluded women with "pigmented skin".[22]

Types of sexual contact

Supplementary Table 2 summarises the results for included studies in terms of the type of sexual act. In the majority of cases (but not all), this included penetration of the vagina and/or anus of the survivor/consenting participant by penis, finger or object, as well as use of condom or lubrication. Most studies specifically included female participants who had penetrative penile-vaginal sex in both the SA and CSI groups. However, some studies did not specify exact what type of sexual contact was eligible for inclusion in the SA group. The majority of studies reported findings from examinations that were conducted within 48 hours of reported SA or CSI. One study included survivors who were examined up to 120 hours after SA.[25] Two studies specifically ensured that the time interval was the same for each group.[20,26] In three studies the participants in the CSI group were examined earlier following intercourse than the SA group[17,19,24] while four studies had a longer time to examination for the consensual intercourse group.[21–23,25]

Quality of included studies

The Newcastle–Ottawa assessment for included studies is summarised in Supplementary Table 3. Three studies were rated as "good", one was "fair", and six were "poor". The studies at greatest risk of bias tended to score poorly on comparability, largely because of lack of controlling for differences between SA and CSI groups in terms of time to forensic clinical examination following sexual contact, with few studies controlling for any other differences between the groups. A funnel plot for the included studies showed asymmetry, which is consistent with the summary RR being overestimated, either due to publication bias (selective reporting), heterogeneity, or poor methodological design of lower quality studies[27] (Supplementary Fig. 1). Review of text in the included studies identified problematic statements that directly or indirectly question the credibility of women reporting sexual assault to clinical services or perpetuate rape myths and stereotypes (Supplementary Table 4). Presence of such statements in medical literature is concerning and contributes negatively to the quality of evidence available.

Primary outcome

AGI could be detected in 901/1874 (48%) of women following SA and 394/1291 (31%) following CSI. Meta-analysis of all included studies demonstrated that the presence of AGI was significantly more likely for participants following SA than CSI (RR 1.59 (95% CI 1.21, 2.09); $p < 0.001$); heterogeneity among studies was large (I^2 = 85%; $p < 0.001$) (Fig. 2). Fig. 3 illustrates the mixture of AGI between SA and CSI study participants,

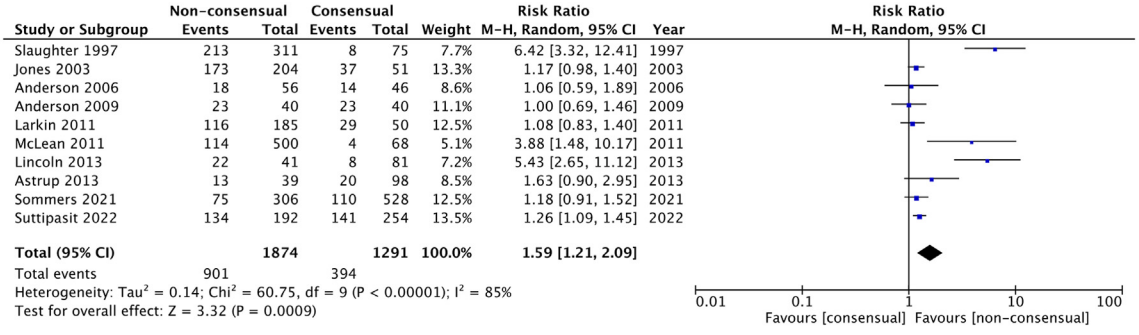

Fig. 2: Forest plot showing the risk ratios for anogenital injury following sexual assault (non-consensual) *vs* consensual sexual intercourse.

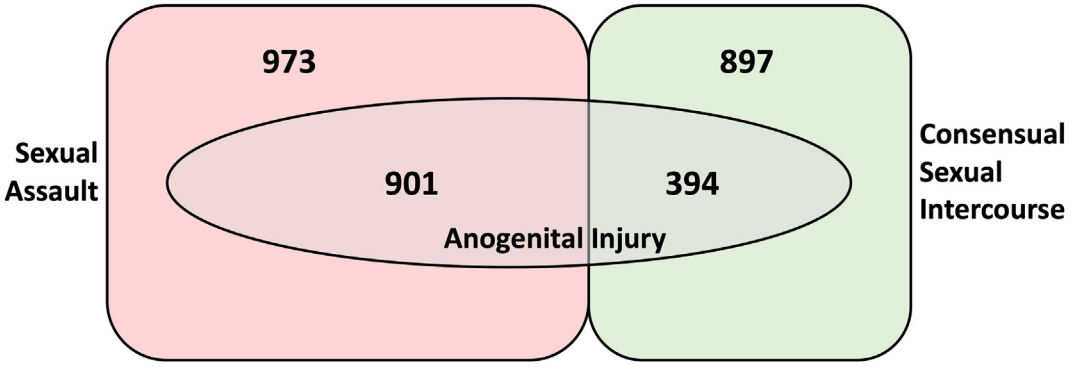

Fig. 3: Euler diagram illustrating the numbers of study participants who were either sexual assault survivors or had consensual sexual intercourse, and whether they had anogenital injuries on examination.

illustrating that more than half of rape survivors had no injuries and a conspicuous number of consenting participants had detectable injuries.

Subgroup analysis of AHRQ good studies

The three AHRQ good studies reported outcomes of 1149 participants; 531 were survivors of SA; 40% of SA survivors had AGI and 26% of participants having consensual sexual intercourse had AGI. There was no significant difference in the risk of AGI in these groups for this subgroup analysis (RR 1.10 (95% CI 0.94, 1.30); p = 0.25. Heterogeneity was very low in this analysis (I^2 = 0%) (Supplementary Fig. 2).

Discussion

AGI may occur during consensual and non-consensual sexual intercourse and neither presence nor absence of AGI proves that sexual assault has or has not occurred. This systematic review and meta-analysis included 10 studies with >3000 participants comparing identification of AGI between rape survivors and women after consensual sexual intercourse using the same examination techniques. It demonstrates that although AGI is significantly more likely following sexual assault (48% SA *vs* 31% CSI), both groups had a combination of cases in which AGI was detected and cases in which AGI was not detected. Moreover, this difference between groups may be an over-estimation, as reflected in the funnel plot and the subgroup analysis. Analysis of only high-quality studies showed no significant difference between these groups. Many of the studies attempted to identify specific locations, patterns, or constellations of injury that predicted the likelihood of CSI from the findings of the anogenital examination alone. Some attempted to develop systems of scoring anogenital findings to predict CSI. However, no pattern of injury, including absence of injury, can prove or disprove assault, nor provide evidence of consent.

The 2030 UN Agenda for Sustainable Development Goals (SDGs), adopted by member countries in 2015, calls for the elimination of violence against women and girls.[28] According to the UK Government's own figures, in 2019/2020, only 4% of sexual offences, and 2% of rape offences led to criminal charges/summons in the same year. A significant proportion of cases were closed with the outcome "*evidential difficulties, victim does not support action*".[29] Clinicians and other professionals involved in the care and support of assault survivors must be explicit in their reassurance of survivors, that lack of evidence of AGI in no way reduces the credibility of their account.

Numerous myths reinforce cultural attitudes towards reporting of sexual violence. One such myth is that physical violence (and thus injury) to be an inevitable accompaniment to rape: "*If a survivor doesn't physically fight back, you can't really say it was rape*",[30] or that without physical trauma one might be less inclined to believe that rape has occurred.[31] There are multiple strategies utilised by sexual predators that confound the likelihood of AGI. The use of coercion or intoxication appears much more common than use or threat of physical force. Fedina et al[32] recently reported <3% of survivors who disclosed rape or assault described the use or threat of physical force. Survivors may be subject to emotional manipulation to consent to sexual exploitation (coercion and/or grooming),[33,34] and/or to ingest intoxicants.[35] The likelihood of detection of physical injury will be further affected by the number of penetrative incidents and/or perpetrators, the nature and size discordance of the penetrating object, the use of lubricant and the time interval since the assault. Autonomic responses of vaginal lubrication in response to non-consensual sexual stimulation[36] may mitigate injury and the myth that non-consensual penetration will result in dry genital tissues and therefore increased chance of injury should be countered. We are dismayed to have identified statements which may perpetuate rape myths and stereotypes within the very studies which

provide the best available medical evidence on anogenital injury after sexual assault or consensual sexual intercourse (summarised in Supplementary Table 4). Two of the studies included in this review[18,25] including one published as recently as 2022, describes participants who met the criteria for child sexual abuse because they were below the age of consent but were categorised by the authors into "*willing*" and "*unwilling*" participants in sexual intercourse. We believe "willingness" in this cohort represents the effect of coercion and/or grooming.[34] We decry the use of '*willing*' to describe a child survivor of SA under any circumstance but particularly by health workers conducting research in this area. The medical community must not be complicit in undermining the credibility of survivors. It is vital that clinicians provide unambiguous, evidence-based messages to ensure that rape myths are refuted so that survivors can have increased confidence in the criminal justice system.

Prosecutors may use physical examination findings following sexual assault to make decisions about whether to proceed with charging and may present these findings in court as evidence. The results of our analysis indicate that allegations of rape should not be discredited based on the forensic medical examination alone. The evidence of wide variability in inter-rater agreement in the assessment of AGI[37,38] and our synthesis of data from the last 30 years demonstrating the considerable overlap in findings of AGI in CSI and SA (Fig. 3) must be taken into account.

Other investigators have addressed the evidence of AGI for women following SA or CSI by comparing studies that examined *only* SA or *only* CSI side by side.[39] However, comparing studies that may have used different examination techniques means that the studies may not necessarily be comparable. To our knowledge, we provide the first systematic review and meta-analysis that only includes studies of both SA and CSI. This was done to minimise the risk of bias from different examination techniques between studies. Studies included in this review still varied in their risk of bias, with considerable heterogeneity in both the meta-analysis and funnel plots. Studies that fit the eligibility criteria but were older than 30 years were excluded.[40–42] Overall, the level of evidence was low, but level 1 (randomised) evidence will never be available to answer the research questions addressed here.

Both studies and cohorts within studies varied on time to examination, which may have influenced the prevalence of injuries observed. In practice, it is difficult to control the time at which examination occurs after sexual assaults. Survivors respond individually to the trauma of sexual assault: some may seek immediate medical or police support, others may not feel able to seek this help until many hours, days, or weeks have passed. Many AGIs after sexual penetration are superficial, heal completely in a relatively short time and/or may not leave residual findings. Even studies with early examination had a large proportion of SA survivors without evidence of injury. The accuracy of recording of AGI will also depend on the experience of the clinician and the technique utilised to examine the survivor. It is possible that the data within included studies may overestimate the true prevalence of AGI since those with injuries may be more likely to present for examination. Furthermore, CSI groups in some studies included participants who recanted their allegation of SA[17] and/or participants who were minors,[18,25] both of whom could be misclassified. In both cases the data were extracted *verbatim* for the purpose of this systematic review, but these definitions are subject to criticism.

The current systematic review is limited by the level of evidence because random assignment to condition cannot be employed (and therefore level 1 evidence cannot be achieved). Due to the limited quality of the studies and their heterogeneity, there is remaining uncertainty over our ability to definitively report the overall "effect" of sexual assault on the incidence of AGI after SV. We cannot definitively state that all 3165 participants are unquestionably unique: two included studies are reported by the same author group and include a temporal crossover in their reported sexual assault survivor cohort.[19,26] The presence of non-anogenital injuries amongst participants was beyond the scope of the research question.

We did not find any studies that discussed the incidence of AGI in transwomen or post-surgical vaginas nor in men or people of other or non-binary genders. This may require further investigation in future studies that aim to increase the diversity of participants, especially since there is evidence that transwomen face high levels of sexual violence.[43] Few studies included participants of diverse ethnic backgrounds. One study which specifically excluded women with "pigmented skin" did so on the stated assumption that skin pigmentation influences the likelihood of injury detection.[22] Evidence suggests that Black women who are survivors of sexual assault have a reduced likelihood of detection of anogenital injury,[44,45] and that work is needed to ensure forensic sexual assault examiners are trained in examination of women with different skin tones. It is widely acknowledged that Black women bear a disproportionate burden of global health inequality,[46] and as a medical community we must reject racist stereotypes and ensure that all women can access proper support from appropriately trained clinicians.

This systematic review and meta-analysis included >3000 female participants from the last 30 years who were examined for AGI following consensual and non-consensual sexual intercourse using the same examination techniques. Although AGI was significantly more likely in non-consensual than consensual sexual activity (48% *vs* 31% respectively; RR 1.59 (95% CI 1.21, 2.09); $p < 0.001$) there were survivors of SA who had no identified anogenital injuries, and participants examined following consensual intercourse who had detectable AGI. Subgroup analysis for the highest quality

studies showed no significant difference between groups. The presence of anogenital injury does not prove there has been sexual assault, nor does absence of injury disprove sexual violence.

Contributors

The study was designed by DNN and DMB. DNN registered the protocol. DNN and LM accessed and verified the underlying data. Data extraction was undertaken by DNN and LM. Data analysis was undertaken by DNN and LM. The first draft of the manuscript was written by DNN, and LM, DMB, T-LA, JC, and DW provided data interpretation and revisions. The final manuscript was agreed by all authors.

Data sharing statement

Data from the current study can be made available upon reasonable request to the corresponding author.

Declaration of interests

We declare no competing interests.

Acknowledgements

Open access funding was provided by the University of Birmingham. The authors thank Joanne Thomson and the Defence Medical Library Services for their assistance in obtaining some of the full texts for this review, and Laura Pitman for legal/forensic advice.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.eclinm.2023.102266.

References

1 Sardinha L, Maheu-Giroux M, Stöckl H, Meyer SR, García-Moreno C. Global, regional, and national prevalence estimates of physical or sexual, or both, intimate partner violence against women in 2018. *Lancet*. 2022;399(10327):803–813.
2 Potter LC, Morris R, Hegarty K, García-Moreno C, Feder G. Categories and health impacts of intimate partner violence in the World Health Organization multi-country study on women's health and domestic violence. *Int J Epidemiol*. 2021;50(2):652–662.
3 Office for National Statistics (ONS), released 26 January 2023, ONS website, statistical bulletin, crime in England and Wales: year ending September 2022. https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/bulletins/crimeinenglandandwales/yearendingseptember2022#cite-this-statistical-bulletin.
4 Office for National Statistics (ONS), released 18 March 2021, ONS website, statistical bulletin, sexual offences in England and Wales overview: year ending March 2020. https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/bulletins/sexualoffencesinenglandandwalesoverview/march2020.
5 Criminal Justice System Scorecard Autumn 2021. For all crime and recorded adult rape offences. https://data.justice.gov.uk/pdf/Criminal%20Justice%20System%20Compact%20Scorecard%20-%20All%20Crime%20and%20Recorded%20Adult%20Rape.pdf.
6 Gray-Eurom K, Seaberg DC, Wears RL. The prosecution of sexual assault cases: correlation with forensic evidence. *Ann Emerg Med*. 2002;39(1):39–46.
7 Jewkes R, Christofides N, Vetten L, Jina R, Sigsworth R, Loots L. Medico-legal findings, legal case progression, and outcomes in South African rape cases: retrospective review. *PLoS Med*. 2009;6(10):e1000164.
8 Norfolk GA, White C. Interpreting evidence in court - the dangers and pitfalls. *J Clin Forensic Med*. 2006;13(4):160–161.
9 Fisher BS, Kaplan A, Budescu M, et al. The influence of anogenital injury on women's willingness to engage with the criminal justice process after rape. *Violence Vict*. 2013;28(6):968–983.
10 Huda T. "No signs of rape": corroboration, resistance and the science of disbelief in the medico-legal jurisprudence of Bangladesh. *Sex Reprod Health Matters*. 2022;29(2):2096186.
11 Cartwright PS, Moore RA, Anderson JR, Brown DH. Genital injury and implied consent to alleged rape. *J Reprod Med*. 1986;31(11):1043–1044.
12 Jina R, Jewkes R, Vetten L, Christofides N, Sigsworth R, Loots L. Genito-anal injury patterns and associated factors in rape survivors in an urban province of South Africa: a cross-sectional study. *BMC Womens Health*. 2015;15:29.
13 Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71.
14 Kennedy KM. Heterogeneity of existing research relating to sexual violence, sexual assault and rape precludes meta-analysis of injury data. *J Forensic Leg Med*. 2013;20(5):447–459.
15 McNair SM, Boisvert L. Prevalence of adult female genital trauma after acute sexual assault: the need for a universal definition of genital trauma. *J Forensic Nurs*. 2021;17(3):140–145.
16 Wells GASB, O'Connell D, Peterson J, Welch V, Losos M, Tugwell P. The Newcastle-Ottawa Scale (NOS) for assessing the quality of non-randomised studies in meta-analyses. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp; 2011. Accessed December 7, 2015.
17 Slaughter L, Brown CRV, Crowley S, Peck R. Patterns of genital injury in female sexual assault victims. *Am J Obstet Gynecol*. 1997;176(3):609–616.
18 Jones JS, Rossman L, Hartman M, Alexander CC. Anogenital injuries in adolescents after consensual sexual intercourse. *Acad Emerg Med*. 2003;10(12):1378–1383.
19 Anderson S, McClain N, Riviello RJ. Genital findings of women after consensual and nonconsensual intercourse. *J Forensic Nurs*. 2006;2(2):59–65.
20 Larkin HJ, Cosby CD, Kelly D, Paolinetti LA. A pilot study to test the differential validity of a genital injury severity scale, in development for use in forensic sexual assault examinations. *J Forensic Nurs*. 2012;8(1):30–38.
21 McLean I, Roberts SA, White C, Paul S. Female genital injuries resulting from consensual and non-consensual vaginal intercourse. *Forensic Sci Int*. 2011;204(1–3):27–33.
22 Lincoln C, Perera R, Jacobs I, Ward A. Macroscopically detected female genital injury after consensual and non-consensual vaginal penetration: a prospective comparison study. *J Forensic Leg Med*. 2013;20(7):884–901.
23 Astrup BS, Ravn P, Thomsen JL, Lauritsen J. Patterned genital injury in cases of rape–a case-control study. *J Forensic Leg Med*. 2013;20(5):525–529.
24 Sommers MS, Fargo JD. Discriminating between consensual intercourse and sexual assault: genital-anal injury pattern in females. *J Forensic Leg Med*. 2021;79:102138.
25 Suttipasit P, Sinlapamongkolkul P, Wongwittayapanich S. Comparative study of acute anogenital injury between consensual and nonconsensual postmenarche adolescents. *Am J Forensic Med Pathol*. 2022;43(2):126–141.
26 Anderson SL, Parker BJ, Bourguignon CM. Predictors of genital injury after nonconsensual intercourse. *Adv Emerg Nurs J*. 2009;31(3):236–247.
27 Sterne JAC, Sutton AJ, Ioannidis JPA, et al. Recommendations for examining and interpreting funnel plot asymmetry in meta-analyses of randomised controlled trials. *BMJ*. 2011;343:d4002.
28 United Nations Department of Economic and Social Affairs. Sustainable Development Goal 5: achieve gender equality and empower all women and girls. https://sdgs.un.org/goals/goal5.
29 HM Government. Tackling violence against women and girls. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033934/Tackling_Violence_Against_Women_and_Girls_Strategy_-_July_2021.pdf; 2021.
30 Payne DL, Lonsway KA, Fitzgerald LF. Rape myth acceptance: exploration of its structure and its measurement using the Illinois Rape Myth Acceptance Scale. *J Res Pers*. 1999;33(1):27–68.
31 Hine BA, Murphy AD, Churchyard JS. Development and validation of the male rape myth acceptance scale (MRMAS). *Heliyon*. 2021;7(6):e07421.
32 Fedina L, Holmes JL, Backes BL. Campus sexual assault: a systematic review of prevalence research from 2000 to 2015. *Trauma Violence Abuse*. 2018;19(1):76–93.
33 Snead AL, Babcock JC. Differential predictors of intimate partner sexual coercion versus physical assault perpetration. *J Sex Aggress*. 2019;25(2):146–160.
34 Winters GM, Jeglic EL, Kaylor LE. Validation of the sexual grooming model of child sexual abusers. *J Child Sex Abus*. 2020;29(7):855–875.
35 *Judgements on Regina vs. Mc.cCann, Sinaga & Shah*. London: Royal Courts of Justice S; 2020.

36 Levin RJ, van Berlo W. Sexual arousal and orgasm in subjects who experience forced or non-consensual sexual stimulation – a review. *J Clin Forensic Med*. 2004;11(2):82–88.
37 Sachs CJ, Benson A, Schriger DL, Wheeler M. Reliability of female genital injury detection after sexual assault. *J Forensic Nurs*. 2011;7(4):190–194.
38 Astrup BS, Lauritsen J, Thomsen JL, Ravn P. Colposcopic photography of genital injury following sexual intercourse in adults. *Forensic Sci Med Pathol*. 2013;9(1):24–30.
39 Song SH, Fernandes JR. Comparison of injury patterns in consensual and nonconsensual sex: is it possible to determine if consent was given? *Acad Forensic Pathol*. 2017;7(4):619–631.
40 McCauley J, Guzinski G, Welch R, Gorman R, Osmers F. Toluidine blue in the corroboration of rape in the adult victim. *Am J Emerg Med*. 1987;5(2):105–108.
41 McCauley J, Gorman RL, Guzinski G. Toluidine blue in the detection of perineal lacerations in pediatric and adolescent sexual abuse victims. *Pediatrics*. 1986;78(6):1039–1043.
42 Lauber AA, Souma ML. Use of toluidine blue for documentation of traumatic intercourse. *Obstet Gynecol*. 1982;60(5):644–648.
43 Hawkey AJ, Ussher JM, Liamputtong P, et al. Trans women's responses to sexual violence: vigilance, resilience, and need for support. *Arch Sex Behav*. 2021;50(7):3201–3222.
44 Sommers MS, Zink T, Baker RB, et al. The effects of age and ethnicity on physical injury from rape. *J Obstet Gynecol Neonatal Nurs*. 2006;35(2):199–207.
45 Rechtin C, Rossman L, Jones JS, Wynn B. 294: the effects of skin pigmentation on the detection of genital injury from sexual assault: a population-based study. *Ann Emerg Med*. 2009;54(3):S92–S93.
46 Dayo E, Christy K, Habte R. Health in colour: black women, racism, and maternal health. *Lancet Reg Health Am*. 2023;17:100408.