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Factors associated with trace evidence analysis and DNA findings among police reported cases of rape

Graduate thesis in Medicine

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Abstract

Background The medical examination after rapes has two main goals: to provide high-quality care for the victim and to collect evidence to be used in the crime investigation. Collected samples are sent for forensic analysis upon police request. However, little is known about how the police select cases to be submitted for analysis. Furthermore, few studies report the DNA findings and associated factors.

The aim of this study was to examine whether victim-, suspect- and assault characteristics, were associated with (1) forensic analysis of trace evidence, (2) detection of spermatozoa and (3) DNA match in police-reported cases of rape/attempted rape. In addition, we explored whether DNA findings were associated with police investigations and legal outcome.

Methods We conducted a retrospective, descriptive study based on police-reported rapes and attempted rapes of female victims (≥ 16 years of age) in Sør-Trøndelag Police District throughout 1997 – 2010. Police data were merged with information from the Sexual Assault Centre (SAC) at St. Olavs University Hospital, Trondheim, Norway. Altogether 324 cases were included. We applied Pearson's χ^2 tests for the analyses. Statistical significance was assumed when $p < 0.05$.

Results Among 324 victims (mean age $24.2 \pm SD 8.4$ years), swabs and/or clothes were collected from the victim in 299 cases, of which 135 were sent for forensic analysis. The police decision to analyze the forensic material was associated with a public venue ($p = 0.006$) and interval from assault to sampling < 24 h ($p = 0.033$). Trace evidence analyses could be evaluated in 129 of the cases, and were positive for spermatozoa in 79 cases. Among samples collected within 24 h, 90 % were positive for spermatozoa ($p = 0.003$). In addition, detection of spermatozoa was associated with a reported penetrative rape ($p = 0.006$).

The police requested forensic analyses of available trace evidence collected from the victim and/or the suspect (swabs and/or clothes) and/or the venue in 143 cases. The forensic analyses disclosed matching DNA profiles in 57 cases (40 %) and no matching DNA profiles in 50 cases (35 %), whereas 36 cases (25 %) were classified as “other”. DNA match was associated with absence of victim vulnerability factors ($p = 0.001$), victim being known to the suspect ($p = 0.013$) and a private venue of the assault ($p = 0.013$). In addition, interrogation of the suspect ($p < 0.001$), crime scene examination ($p = 0.013$) and the suspect admitting sexual contact ($p = 0.003$), were associated with a DNA match. A higher proportion of cases with DNA match were prosecuted in court ($p < 0.001$).

Discussion The police requests more analyses and detects spermatozoa in 90 % of the cases when the interval from assault to sampling is < 24 h. Spermatozoa is an evidence that gains further importance with the increased availability and progressive advances in DNA-profiling techniques. When there was a DNA match between the victim and the suspect, a higher proportion of the cases was taken to court. Nevertheless, DNA evidence should always be considered in the scope of other evidence.

Conclusions Our study provides descriptive data regarding trace evidence analyses and DNA findings and identifies potential factors that influence the analyses and DNA findings. These results may improve the quality of medico-legal care.

Keywords: Rape, Attempted Rape, Sexual assault, Victim, Suspect, Sexual Assault Centre, Medico-legal examination, Trace evidence, Medico-legal findings, Spermatozoa, DNA match

Sammendrag

Bakgrunn Den medisinske undersøkelsen etter en voldtekt har to hovedmål: å gi offeret helsehjelp av høy kvalitet og å innhente spor som kan brukes i politietterforskningen. Det er politiet som rekvirerer rettslig analyse av sporprøvene, men vi vet lite om hvordan politiet velger ut hvilke saker som skal analyseres. I tillegg er det få studier som rapporterer DNA-funn og assosierte faktorer.

Målet med studien var å undersøke om karakteristika ved fornærmede, mistenkte eller hendelsen er assosiert med (1) rettsgenetisk analyse av spormaterialet, (2) funn av sædceller og (3) DNA-match i politirapporterte voldtekter/voldtektsforsøk. I tillegg undersøkte vi om DNA-funn var assosiert med politiets etterforskningsarbeid og det rettslige utfallet.

Metode Vi gjennomførte en retrospektiv deskriptiv studie av politirapporterte voldtekter/voldtektsforsøk mot kvinner ≥ 16 år i Sør-Trøndelag Politidistrikt i perioden 1.1.1997 – 31.12.2010. Politiets saksdokumenter ble slått sammen med informasjon fra overgrepsmottaket på St.Olavs universitetssykehus i Trondheim. Til sammen ble 324 saker inkludert i studien. Vi anvendte Pearsons kji-kvadrattest i analysene. Signifikansnivået ble satt til $p < 0.05$.

Resultater Av de 324 sakene (gjennomsnittsalder $24.2 \pm SD 8.4$ år) ble det sikret vattpinneprøver og/eller klær fra fornærmede i 299 saker, hvorav 135 ble sent til Rettsmedisinsk institutt for analyse. Politiets avgjørelse om å sende sporsikringsmaterialet til analyse var assosiert med privat åsted ($p = 0.006$) og tid fra hendelse til sporsikring < 24 t ($p = 0.033$). Resultatet av sporanalysene kunne vurderes i 129 av sakene og sædceller ble påvist i 79 saker. Blant prøvene som ble sikret innen 24 t etter overgrepet, viste 90 % sædceller ($p = 0.003$). I tillegg var funn av sædceller assosiert med opplysning om en penetrativ voldtekt ($p = 0.006$).

Politiet rekvirerte rettsmedisinske analyser av tilgjengelig spormateriale sikret fra fornærmede og/eller mistenkte (vattpinner og/eller klær) og/eller åstedet i 143 saker. De rettsmedisinske analysene avdekket matchende DNA-profiler i 57 saker (40 %). I 50 saker (35 %) forelå det ingen matchende DNA-profiler, og 36 tilfeller (25 %) ble klassifisert som «annet». DNA-match var assosiert med fravær av sårbarhetsfaktorer hos fornærmede ($p = 0.001$), kjent overgriper ($p = 0.013$) og privat åsted ($p = 0.013$). I tillegg var avhør av mistenkte ($p < 0.001$), åstedsundersøkelse ($p = 0.013$) og det at mistenkte innrømmet seksuell kontakt ($p = 0.003$), assosiert med DNA-match. En høyere andel av sakene med DNA-match førte til tiltale ($p < 0.001$).

Diskusjon Politiet rekvirerer flere analyser og finner sædceller i hele 90 % av sakene når det er gått < 24 t fra hendelse til sporsikring. Sædceller er spor av stor rettsmedisinsk verdi, som ved hjelp av DNA-profilering og DNA-registeret kan få videre betydning. Selv om det foreligger DNA-match mellom fornærmede og mistenkte vil politiet og påtalemyndighetene alltid måtte veie DNA-bevis mot øvrige bevis i saken.

Konklusjoner Vår studie beskriver sporsikringsanalysene og DNA-funnene og identifiserer faktorer som potensielt kan virke inn på analysene og funnene. Resultatene kan bidra til å øke kvaliteten på rettsmedisinske prosedyrer.

Forord

I det 5. året på profesjonsstudiet i medisin er det satt av ett semester til å fordype seg i et medisinsk forskningstema. Under utplassering fattet jeg interesse for gynekologi og kom i kontakt med min veileder Cecilie. Hun arbeidet da med sin doktorgradsavhandling «Medisinske funn og rettslig utfall blant kvinner som har oppsøkt overgrepsmottaket ved St.Olavs Hospital, Trondheim, i periode 1997 – 2010», og åpnet opp for at jeg kunne skrive min hovedoppgave på samme datamateriale. Cecilies interesse og engasjement for kvinners helse, har gitt meg glede av og styrke til å forske for å bidra til å optimalisere forholdene for kvinner utsatt for seksuelle overgrep.

Jeg har gjennom arbeidet med hovedoppgaven og et tett samarbeid med min veileder, tilegnet meg uvurderlig kunnskap og erfaring med vitenskapelig skriving og forskningsmetodikk. Som lege er det nødvendig å søke vitenskapelig litteratur og holde seg faglig oppdatert.

Det er begrenset kunnskap om politiets og rettsvesenets bruk av medisinsk informasjon i den rettslige prosessen. Målet med studien var å undersøke om karakteristika ved fornærmede, mistenkte eller hendelsen er assosiert med sporsikringsanalyser og funn av sæd/DNA. I tillegg ønsket vi å se på om det var noen sammenheng mellom det rettslige utfallet av de anmeldte voldtektssaken og funn av DNA-match mellom fornærmede og mistenkte. Kunnskapen kan bidra til et bedre samarbeid mellom helsevesen og politi, for å optimalisere forholdene for voldtektsofre.

Hovedoppgaven presenteres som et utkast til en artikkel, med tanke på publisering i et medisinsk fagtidsskrift. Vi har i prosessen hatt samarbeidsmøter med politiet og presentert preliminaire funn. Jeg har fått akseptert et abstract med funn fra denne oppgaven for den 5. internasjonale konferansen for voldtektsofre (ICSoR 2016), og vil derfor formidle våre resultater i en muntlig presentasjon på engelsk i Stockholm i september.

Først og fremst vil jeg takke min veileder, førsteamanuensis Cecilie Therese Hagemann, for tett oppfølging, gode samtaler og givende veiledning. Jeg vil også takke professor Berit Schei, professor Kari Ormstad og forsker II Lise Eilin Stene for konstruktive og gode tilbakemeldinger. Til slutt vil jeg rette en stor takk til min familie som alltid stiller opp og støtter meg. Til min samboer Lars, du er min bauta. Og til vår sønn Lucas, du sprer uendelig med kjærlighet, glede og energi og får meg til å koble helt av.

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Abbreviations

CRF	Case Report Form
FMI	Institute of Forensic Medicine
Kripos	The National Criminal Investigation Service
REK	Regional Committee for Medical and Health Research Ethics
SAC	Sexual Assault Center
STPD	Sør-Trøndelag Police District

Introduction

Sexual assault is a prevalent, underreported and underprosecuted crime (2, 3). A national prevalence study reports a prevalence of 9.4 % (4). There has been a steady increase in the number of police-reported rapes in Norway, from about 400 per year during the 1990'ies to more than 1200 cases per year in 2014 (5, 6). In addition, about 1200 adult patients contact one of the Norwegian Sexual Assault Centre's (SAC's) each year, independent of police reporting (7). However, only one in ten rapes is reported to either police or health care (4, 8), see Figure 1. Among rape victims attending Nordic SAC's after rape, 50 – 70 % of cases are reported to the police, and vice versa (8-10). Despite increasing rates of police-reported rapes, the number of cases proceeding to prosecution (taken to court) is low and almost constant (11).

A SAC provides acute medical care to victims of sexual assaults and discloses medico-legal findings important for both the woman's health and legal interests. The forensic part of the examination aims to preserve possible DNA evidence (e.g. semen/spermatozoa, blood and epithelial cells) (12-14). Studies report that biological trace evidence is collected by medical staff in 54 – 91 % of the cases (8, 10, 15-17), typically including the victim's clothing, specimen samples such as hair and nail, and oral, vaginal, anal and body surface swabs (12, 18). The police collects trace evidence from the suspect and biological material from the venue. The forensic medical examination can provide crucial evidence in the investigation and prosecution of a rape (12, 19).

Traditionally, the analyses of trace evidence in police-reported rapes has been seen as a resource-demanding and not always a prioritized investigative step (20). The police is responsible for submitting the collected evidence to a forensic laboratory for analysis (12). However, studies disclose that more than 40 % of collected evidence is never submitted for analysis, hampering available forensic evidence to be used in the investigation and prosecution of the cases (12-14, 16). Two Scandinavian studies report that trace evidence are analyzed by the forensic lab in 51 – 57 % of the cases (8, 10). Nowadays, the police tends to request more analyses, but still much trace evidence is left behind at the SAC (10). Little is known about how the police selects cases to be submitted for analysis. Previous research has indicated that the police is considering contextual factors in this decision (13, 14, 21).

Primarily, the forensic laboratory determines whether semen and/or spermatozoa are present on the vaginal swabs or any of the other evidence items collected. If no semen/spermatozoa are detected, the analytical challenge is to detect other sources of biological material, commonly blood

or epithelial cells (22). Spermatozoa are an excellent source of DNA and may be of high forensic importance in a sexual assault case. Identifiable spermatozoa may survive for a long time, e.g., in the uterine cervix of fertile women up to 7 days and almost “forever” on dried clothing (23, 24). Detection of spermatozoa could prove a sexual contact, but more importantly, makes it possible to identify the suspect through DNA-profiling. However, DNA-profiling can only demonstrate whether the person’s DNA is present, and is alone not an evidence of rape (3). On the other hand, it is important to highlight that although the suspect’s DNA is not detected in trace evidence collected from the victim’s body, it does not exclude him as a suspect (9). In addition, the presence on a suspect’s skin (e.g., in swabs collected from finger or penis) or clothes of cells from the victim, may impact the proceeding of a rape case. Also, samples collected from the venue may contain biological evidence crucial to the crime investigation. DNA is an important tool for forensic investigation, helping to convict perpetrators and clear innocent subjects (25, 26). Today, improved analytical techniques and DNA-registers enhance the possibilities of detecting and interpreting DNA evidence.

From September 1, 2008, due to changes in the DNA Procedure Act, the DNA-register could be used in investigation and prosecution of criminal cases (27). Today, the National Criminal Investigation Service (Kripos) administrates the national DNA-register. The increasing number of crime perpetrators included in the DNA-register is valuable for the use of DNA-profiling in crime investigation (28). To our knowledge, no published literature has reviewed the overall results and experiences regarding the use of this register in Norwegian rape cases.

Spermatozoa have been detected in 35 – 59 % of the cases in several studies (8, 25, 29) and a DNA match with a suspect was achieved in 14 – 16 % of the cases in Scandinavia (8, 10). However, there is consistency in previous research that a low percent of the trace evidence analyses are positive in rape cases (30). This may be explained by late attendance at the SAC, hygienic measures undertaken after the rape, variations in vaginal flora, sexual dysfunction/non-ejaculation or use of condom by the suspect, and also use of spermicidal agents or oral contraceptives, or after digital penetration (25, 31, 32). It may also be due to the work of the health care and police system or poor sensitivity of the laboratory’s tests (15, 17).

Research focusing on medico-legal evidence in sexual assault is scarce. Studies published so far from SACs or police case series mostly focus on sociodemographic data and injuries. Only a few case series worldwide report the results of forensic analyses and describe factors associated with analyses of trace evidence and detection of spermatozoa and a DNA match.

The aim of this study was to examine whether certain victim-, suspect- and assault characteristics, were associated with (1) forensic analysis of trace evidence, (2) detection of spermatozoa and (3) DNA match in police-reported cases of rape/attempted rape. In addition, we explored whether DNA findings were associated with police investigations and legal outcome.

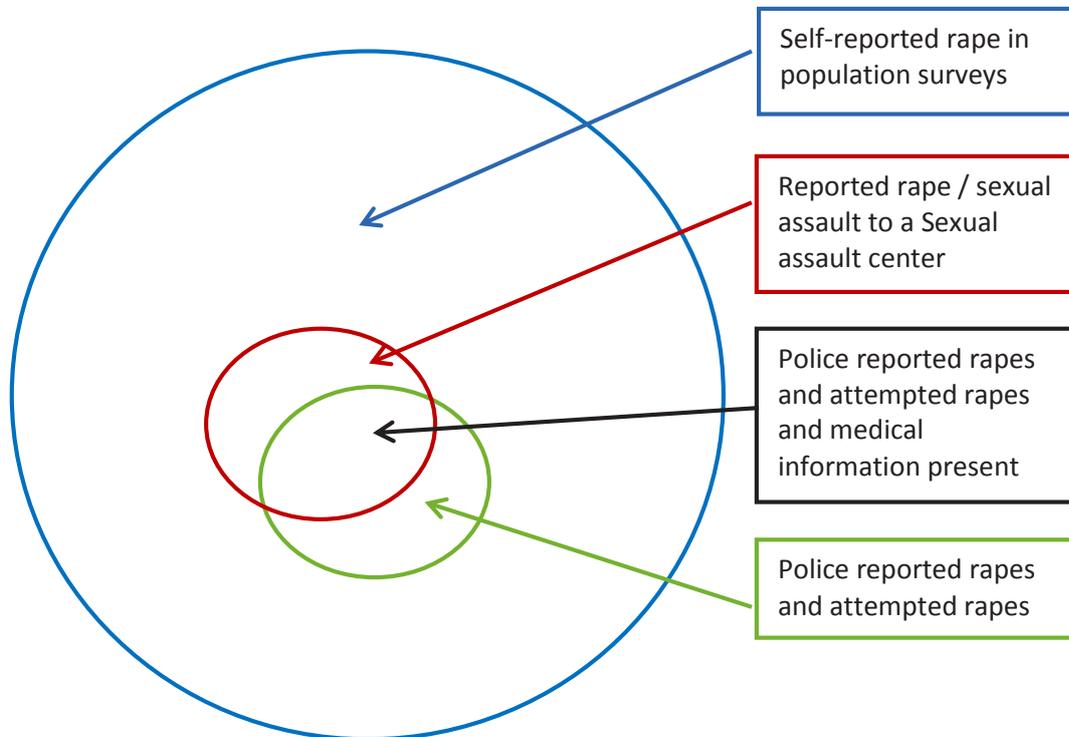


Figure 1 Theoretical model of the proportion of women who report in population surveys being subjected to rape, and those who report to a Sexual assault center (red) or to the police (green). Our study has conducted analysis of the police-reported cases with available medical information (black). (Not drawn to scale, modified after (1))

Material and Methods

Design and sample

We conducted a retrospective descriptive study based on police-reported cases of rape and attempted rape of female victims ≥ 16 years of age in Sør-Trøndelag Police District (STPD) between January 1, 1997 and December 31, 2010. Cases were selected based on the former Norwegian Penal Code (33). According to the law (Chapter 19, Section 192), rape was regulated as in the following abbreviated version; penetration of penis/finger/foreign object in vagina/anus, penis in mouth, masturbation, and coercion by means of violence, threats, or during impaired consciousness (10, 33). Attempted rape is also punishable, but was covered by another paragraph in the Norwegian Penal Code. Altogether 697 cases were reported during the study period. Cases were excluded according to Figure 2. Male victims ($n = 26$), minors (≤ 16 years of age, $n = 77$), unidentified victims ($n = 4$) and duplicate registrations ($n = 21$) were excluded, leaving a total of 569 cases eligible for the study. Further 10 patients from the SAC declined having their medical information used in the study. Medical information from the SAC at St.Olavs university hospital, Trondheim, Norway, was available in 324 of the cases. Details of the procedure are described elsewhere (9, 34-38).

Data collection and storage

Clinical, forensic, and laboratory information was extracted from the patients' records and the police files. For the period 1997 – 2003, information was fed manually into a paper-based registration form. For the period 2003 – 2010, the data was registered through a web-based data collection system (case report form, CRF). For this study, laboratory reports extracted from the police files (from the period 2003 – 2010) were converted into the web-CRF (Appendix 1). These web-CRF's were then merged with the rest of the data from the original project (9).

Variables

Victim characteristics were collected from SAC medical records and included age, origin, living situation, occupational status and vulnerability factors, as well as voluntary alcohol intake. Victim origin was classified as Western if stated as Western Europe, North America or Oceania, else classified as Non-Western. Self-reported alcohol intake in relation to the assault was categorized into none, < 5 , or ≥ 5 units of alcohol. The latter category included being clinically intoxicated. One alcoholic unit was defined as 12 g ethanol. Data regarding interval from assault to sampling were also collected from the hospital SAC.

Suspect- and assault characteristics, as well as investigational- and legal data were collected from the police records. Information reported by the victim was used in case of an unidentified suspect and from SAC records in case of missing information in the police files. Suspect characteristics included sex, age and (assumed) origin, the latter classified as for victim characteristics.

The type of sexual assault was defined as penetrative or non-penetrative. Penetration included both penile and foreign object penetration of anal, vaginal and oral orifices. Since one of the purposes of this study was to examine the prevalence of spermatozoa, penetration by a finger (contrary to the law) and sexual acts like forced masturbation, attempted penetration and touching up/fondling were defined as no penetration. The victim/suspect relationship was dichotomized into known and stranger. The suspect was defined as being known to the victim if he was a current or previous partner/husband/boyfriend, family member, acquaintance and casual acquaintance (known < 24 h). If the victim had never seen the suspect before he was categorized as a stranger. Physical violence was dichotomized into yes and no, the latter including verbal threats. Venue was defined as private, included the victim's, suspect's or other person's residence. Public venue, included any public indoor or outdoor location or a vehicle.

Investigational data included information on whether the police had interrogated the suspect and/or witnesses and whether they had inspected the venue, as well as information regarding admittance of sexual contact or rape/attempted rape. According to the Norwegian Administration of Justice Act, legal outcome was categorized into four main categories: charges filed; insufficient evidence; no suspect identified; and no crime/accusation withdrawn. In cases of more than one suspect, information regarding the most active suspect was used.

Detection of spermatozoa and a DNA match between victim and suspect, was based on laboratory reports from the FMI¹ (Institute of Forensic medicine, Oslo, Norway), available in the police records. These were all reviewed and re-coded. The results of trace evidence analyses were categorized as match, no match and other, for further descriptions see Table 4. To establish whether there is a DNA match between the victim and the suspect, the police requests forensic analyses of trace evidence collected on swabs and/or clothes collected from the victim (mostly at the SAC) and/or the suspect (collected by the police), as well as biological material from the venue (collected by the police). Identical DNA profiles recovered from an evidence sample (swabs/clothes/material from the venue) and from reference swabs collected from the victim or the suspect (by the police), was termed a DNA match. Cases classified as "other" regarding DNA

¹ Institute of Forensic Medicine (FMI) existed until 2011, thenceforth organized under National Institute of Public Health

match, included: no reference; no suspect; no tested material; too little DNA; and missing information. In case of discrepancy between police and medical record information, police files were regarded as gold standard.

Study approval

The study was approved by the Regional Committee for Medical and Health Research Ethics (REK-Midt) and the Norwegian Director General of Public Prosecutions² (through the Advisory Board on Secrecy and Reserch³).

Statistical analyses

Descriptive characteristics were reported by frequencies and proportions for the categorical variables, and by mean and SD for the continuous variables. Associations between the outcome variables: (1) analysis of trace evidence; (2) detection of spermatozoa; (3) DNA match and the independent categorical variables were analyzed using Pearson's χ^2 test. Fischer's Exact Test or Exact unconditional test were used as appropriate. Statistical significance was assumed when $p < 0.05$. Missing data were calculated but excluded when statistical tests were performed. Data analyses were performed using IBM SPSS Statistics for windows, version 22.0.

² Riksadvokaten

³ Rådet for taushetsplikt og forskning

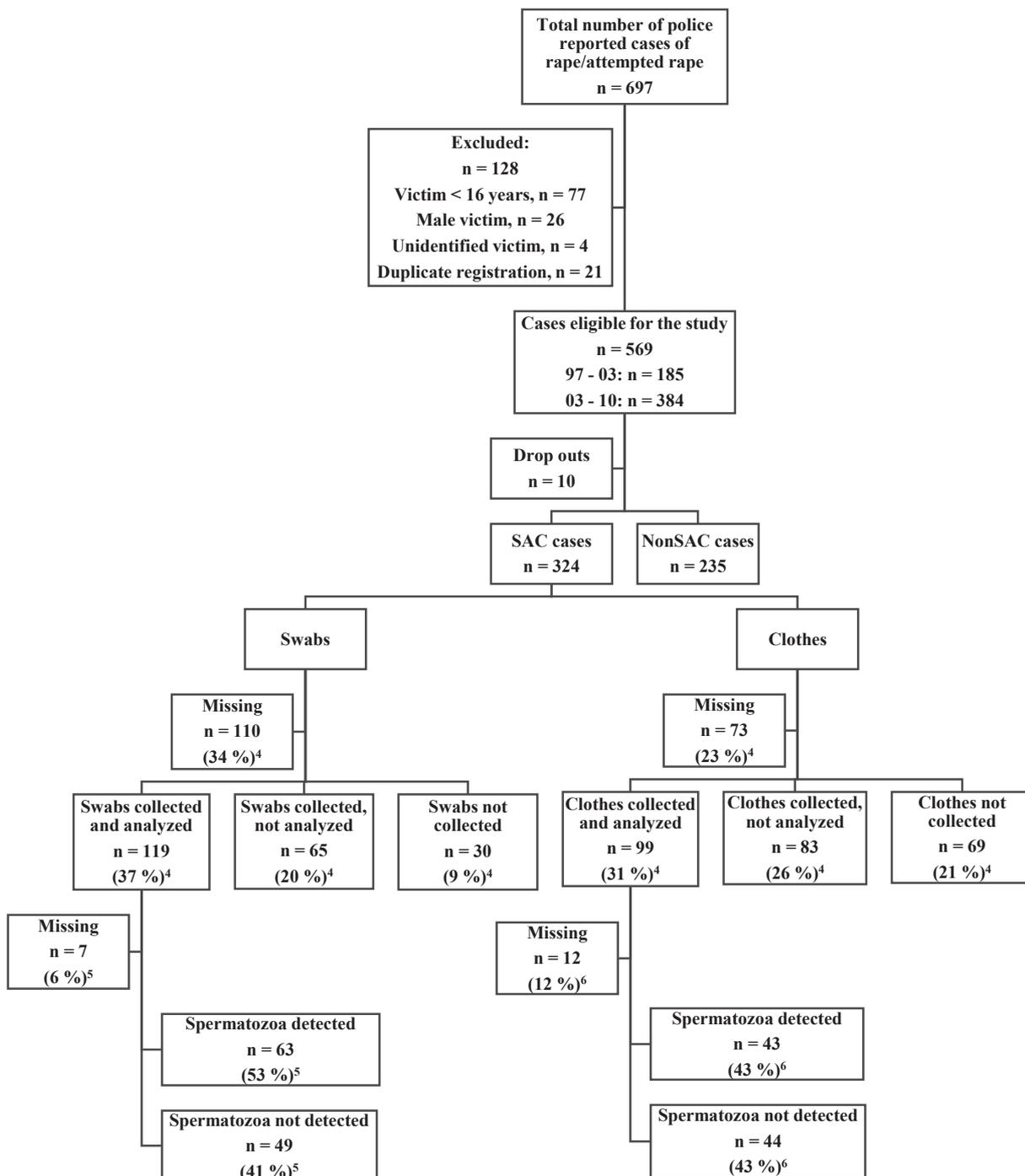


Figure 2 Flow chart of included and excluded police-reported cases of rape and attempted rape for the period 1997 – 2010 in Sør-Trøndelag police district. Presentation of trace evidence analyses and DNA test results from swabs and clothes collected from the victim. ^{4,5,6}

⁴ Percent of the 324 police-reported cases of rape/attempted rape with available medical information

⁵ Percent of the 119 cases of analyzed swabs collected from the victim

⁶ Percent of the 99 cases of analyzed clothes collected from the victim

Results

Descriptive information regarding victim characteristics among the 324 police-reported cases with medical record at the SAC is summarized in Table 1. The mean age was 24.2 (SD = 8.4), ranging from 16 to 59 years old. Most victims were single/separated/divorced 165 (51 %) and employed and/or students 219 (68 %). Regarding vulnerability, 131 (40 %) suffered from prior/current mental health problems or drug abuse. Based on self-reported data, 245 (76 %) of the victims had been drinking alcohol in relation to the assault, of whom 169 (52 %) had drunk more than five units of alcohol. The assailants were all men, with a mean age of 29.4 (SD = 9.6), ranging from 14 to 58 years old.

Table 1 Victim background characteristics

Characteristics	N = 324 (%)
Age in years, mean (SD)	24.2 (8.4)
Ethnicity	
Western	210 (65)
Non-Western	11 (3)
Living situation	
With parents/caregivers	80 (25)
Alone/Separated/divorced	165 (51)
With friends/family/partner/husband	48 (15)
Institution/Assisted living	13 (4)
Occupational status	
Employed/education	219 (68)
Unemployed	77 (24)
Vulnerability	
No	122 (38)
Physically or mentally disabled	32 (10)
Prior/current psychiatric history or drug abuse	131 (40)
Prior physical or sexual assault	38 (12)
Voluntary alcohol intake	
No intake	44 (14)
< 5 units	76 (24)
> 5 units	169 (52)

Among the 324 police-reported cases with available medical information, trace evidence in terms of swabs and/or clothes were collected from the victim in 299 cases (92 %): Both swabs and clothes were collected from the victim in 242 cases (81 %), only swabs in 46 cases (15 %) and only clothes in 11 cases (4 %). The police opted to send the collected trace evidence for analysis in 135 cases (45 %): Swabs and clothes were analyzed in 83 cases (61 %), only swabs in 36 cases (27 %) and only clothes in 16 cases (12 %). For further descriptions, see Figure 2.

Victim-, suspect- and assault characteristics related to the police decision to request analysis are described in Table 2. Analysis of trace evidence was associated with patient age being > 18 years ($p = 0.047$), a public venue ($p = 0.006$) and interval from assault to sampling being < 24 h ($p = 0.033$).

Table 3 describes victim-, suspect- and assault characteristics related to the finding of spermatozoa at the forensic laboratory. Trace evidence analyses could, for unknown reasons, be evaluated only in 129 of the 135 cases (96 %), and were positive for spermatozoa in 79 (61 %) of these cases. Spermatozoa were detected on both swabs and clothes in 27 cases (34 %), only on swabs in 36 cases (46 %) and only on clothes in 16 cases (20 %). Among samples collected within 24 h after the rape/attempted rape, 90 % were positive for spermatozoa ($p = 0.003$). In addition, there was an association between detection of spermatozoa and a penetrative rape ($p = 0.006$). Although not statistically significant, there was a trend towards more evidence of spermatozoa in cases with a private venue ($p = 0.082$).

A considerable amount of information was missing regarding detection of a DNA match between victim and suspect. Among the available trace evidence samples collected from the victim and/or the suspect (swabs and/or clothes) and/or the venue, 143 cases were sent for analysis at the FMI. The forensic analyses demonstrated matching DNA profiles in 57 cases (40 %), no matching DNA profiles in 50 cases (35 %), and finally 36 cases (25 %) were classified as “other”. The results and further details regarding the cases are presented in Table 4. A DNA match was associated with absence of victim vulnerability factors ($p = 0.001$), the victim being known to the suspect ($p = 0.013$) and a private venue of the assault ($p = 0.013$). In addition, interrogation of the suspect ($p < 0.001$), inspection of the venue ($p = 0.013$) and the suspect admitting sexual contact ($p = 0.003$), were associated with a DNA match. A higher proportion of cases with DNA match were prosecuted ($p < 0.001$).

In the absence of matching DNA profile between the collected evidence and reference samples from the victim and/or the suspect, 63 % of the victims reported mental health problems or substance abuse. Among the cases classified as “other”, no suspect was identified in 53 %, and the police did not inspect the venue in 44 % of the cases.

Key findings

- **Trace evidence was collected from the victim in 299 (92 %) of the cases**
- **The police requested analyses of available samples from the victim in 135 (45 %) of the cases**
- **Spermatozoa were detected in 79 (61 %) of the analyzed and evaluated cases**
- **Analysis of trace evidence and detection of spermatozoa were both significantly associated with interval from assault to sampling being < 24h.**
- **A DNA match between victim and suspect was detected in 57 cases (40 %)**
- **A higher proportion of cases with a DNA match were prosecuted**
- **A DNA match was associated with absence of victim vulnerability factors ($p = 0.001$)**

Table 2 Victim-, suspect- and assault characteristics by analysis of swabs and/or clothes collected from the victim in 299 police-reported cases of rape/attempted rape

Characteristics	Analyzed <i>n</i> = 135 (45 %) <i>n</i> (%)	Not analyzed <i>n</i> = 164 (55 %) <i>n</i> (%)	<i>p</i>
Victim characteristics			
Age, <i>n</i> = 299			
16 – 17 years	20 (15)	43 (26)	
18 – 24 years	67 (50)	75 (46)	
≥ 25 years	48 (36)	46 (28)	0.047
Vulnerability factors, <i>n</i> = 298			
No vulnerability factor	51 (38)	61 (37)	
Physical or cognitive disability	15 (11)	14 (9)	
Mental health problems/ substance abuse	50 (37)	72 (44)	
Previous sexual assault(s)	18 (13)	17 (10)	0.589
Occupation, <i>n</i> = 273			
Employed/education	96 (78)	105 (70)	
Unemployed	27 (22)	45 (30)	0.133
Suspect- and assault characteristics			
Suspect origin, <i>n</i> = 271			
Western	81 (66)	111 (75)	
Non-Western	42 (34)	37 (25)	0.099
Type of sexual assault, <i>n</i> = 253			
No penetration	18 (16)	19 (14)	
Penetration	98 (85)	118 (86)	0.712
Victim/suspect relationship, <i>n</i> = 293			
Known	107 (80)	125 (79)	
Stranger	27 (20)	34 (21)	0.795
Physical violence, <i>n</i> = 252			
No/Verbal	25 (22)	22 (16)	
Yes	90 (78)	115 (84)	0.249
Venue, <i>n</i> = 295			
Private	77 (58)	117 (73)	
Public	57 (43)	44 (27)	0.006
Time of day of assault, <i>n</i> = 289			
7 a.m. – 8 p.m.	(10)	24 (15)	
8 p.m. – 7 a.m.	119 (90)	133 (85)	0.168
Interval from assault to sampling, <i>n</i> = 297			
< 24 h	111 (83)	118 (72)	
> 24 h	23 (17)	45 (28)	0.033

Table 3 Victim-, suspect- and assault characteristics by detection of spermatozoa on analyzed swabs and/or clothes collected from the victim in 129 cases of police-reported rapes

Characteristics	Spermatozoa positive <i>n</i> = 79 (61 %) <i>n</i> (%)	Spermatozoa negative <i>n</i> = 50 (39 %) <i>n</i> (%)	<i>p</i>
Victim characteristics			
Age, <i>n</i> = 129			
16 – 17 years	12 (15)	8 (16)	
18 – 24 years	38 (48)	27 (54)	
≥ 25 years	29 (37)	15 (30)	0.730
Vulnerability factors, <i>n</i> = 128			
No vulnerability factor	29 (37)	19 (39)	
Physical or cognitive disability	10 (13)	5 (10)	
Mental health problems/ substance abuse	29 (37)	20 (41)	
Previous sexual assault(s)	11 (14)	5 (10)	0.883
Occupation, <i>n</i> = 117			
Employed/education	54 (78)	37 (77)	
Unemployed	15 (22)	11 (23)	0.880
Suspect- and assault characteristics			
Suspect origin, <i>n</i> = 188			
Western	46 (61)	30 (70)	
Non-Western	29 (39)	13 (30)	0.357
Type of sexual assault, <i>n</i> = 111			
No penetration	5 (7)	11 (26)	
Penetration	64 (93)	31 (74)	0.006
Victim/suspect relationship, <i>n</i> = 129			
Known	66 (84)	36 (74)	
Stranger	13 (17)	13 (27)	0.168
Physical violence, <i>n</i> = 110			
No/Verbal	12 (18)	12 (28)	
Yes	55 (82)	31 (72)	0.215
Venue, <i>n</i> = 128			
Private	51 (65)	24 (49)	
Public	28 (35)	25 (51)	0.082
Time of day of assault, <i>n</i> = 126			
7 a.m. – 8 p.m.	8 (10)	4 (8.5)	
8 p.m. – 7 a.m.	71 (90)	43 (92)	0.779 ⁷
Interval from assault to sampling, <i>n</i> = 128			
< 24 h	71 (90)	34 (69)	
> 24 h	8 (10)	15 (31)	0.003

⁷ Exact unconditional test

Table 4 Victim-, suspect- and assault characteristics and investigational- and legal data by detection of a DNA match between the victim and the suspect in 143 police-reported cases of rape

Variable	Match⁸, n = 57 (40), n (%)	No match⁹, n = 50 (35), n (%)	Other¹⁰, n = 36 (25), n (%)	p
Victim characteristics				
Age, n = 143				
16 – 17 years	15 (26)	5 (10)	6 (17)	
18 – 24 years	25 (44)	26 (52)	19 (53)	
≥ 25 years	17 (30)	19 (38)	11 (31)	0.279
Vulnerability factors, n = 142				
No vulnerability factor	26 (46)	13 (27)	13 (36)	
Physical or cognitive disability	11 (19)	2 (4)	3 (8)	
Mental health problems/ substance abuse	14 (25)	31 (63)	13 (36)	
Previous sexual assault(s)	6 (11)	3 (6)	7 (19)	0.001
Occupation, n = 132				
Employed/education	41 (77)	37 (79)	23 (72)	
Unemployed	12 (23)	10 (21)	9 (28)	0.766
Suspect- and assault characteristics				
Suspect origin, n = 132				
Western	37 (66)	34 (77)	20 (63)	
Non-Western	19 (34)	10 (23)	12 (38)	0.323
Type of sexual assault, n = 124				
No penetration	5 (10)	9 (21)	6 (19)	
Penetration	45 (90)	33 (79)	26 (81)	0.298
Victim/suspect relationship, n = 142				
Known	52 (91)	39 (80)	24 (67)	
Stranger	5 (9)	10 (20)	12 (33)	0.013
Physical violence, n = 122				
No/Verbal	11 (22)	8 (19)	5 (17)	
Yes	40 (78)	34 (81)	24 (83)	0.889
Location of assault, n = 142				
Private	42 (74)	23 (47)	19 (53)	
Public	15 (26)	26 (53)	17 (47)	0.013

Time of day of assault, n = 140				
7 a.m. – 8 p.m.	9 (16)	3 (6)	4 (11)	
8 p.m. – 7 a.m.	47 (84)	46 (94)	31 (89)	0.279
Interval from assault to sampling, n = 142				
< 24 h	51 (91)	39 (78)	31 (86)	
> 24 h	5 (9)	11 (22)	5 (14)	0.164
Investigational and legal data				
Interrogation suspect, n = 130				
Yes	56 (98)	33 (75)	15 (52)	
No	1 (2)	11 (25)	14 (48)	< 0.001
Interrogation witnesses, n = 143				
Yes	54 (95)	42 (84)	31 (86)	
No	3 (5)	8 (16)	5 (14)	0.179
Inspection of the venue, n = 142				
Yes	47 (83)	31 (63)	20 (56)	
No	10 (18)	18 (37)	16 (44)	0.013
Admits sexual contact, n = 100				
Yes	42 (76)	18 (58)	4 (29)	
No	13 (24)	13 (42)	10 (71)	0.003
Admits rape/attempted rape, n = 100				
Yes	1 (2)	0 (0)	0 (0)	
No	53 (98)	32 (100)	14 (100)	1.000 ¹¹
Legal outcome, n = 142				
Charges filed	20 (35)	4 (8)	5 (14)	
Insufficient evidence	35 (61)	27 (55)	10 (28)	
No suspect identified	1 (2)	13 (27)	19 (53)	
No crime/complainant withdrawn	1 (2)	5 (10)	2 (6)	< 0.001 ¹¹

⁸ DNA extracted from swabs and/or clothes from the victim matched the suspect's DNA profile in 40 cases. DNA extracted from swabs and/or clothes from the suspect matched the victim's DNA profile in 11 cases. Material collected from the venue matched the suspect's and the victim's DNA profile in 5 cases. In one case, abortion material matched the suspect's DNA profile.

⁹ 29 cases were coded as «no DNA match detected». In 21 cases DNA extracted from swabs and/or clothes from the victim mismatched the suspect's DNA profile. In case of no reference, DNA of an unknown male was detected in 20 cases. Too small amounts of DNA to give a conclusive DNA typing were extracted from the collected samples in 13 cases. In 2 cases information regarding the results of the DNA typing was missing. In 1 case no suspect and no material was tested.

¹¹ Fisher's Exact Test

Discussion

We found that trace evidence, in terms of swabs and clothes, was collected from the victim in 299 of the 324 cases (92 %), and analyzed in 135 of the 299 cases (45 %). In comparison, studies report that biological trace evidence is collected by medical staff in 54 – 91 % of the cases (8, 10, 15-17). While two Scandinavian studies report that trace evidence is analyzed by the forensic laboratory in 51 – 57 % of the cases (8, 10).

The presence of spermatozoa on swabs and/or clothes collected from the victim in this study (61 %) is higher than in several other studies. In two studies from Denmark and Finland respectively, spermatozoa were detected in 35 % (8) and 46 % (29). Only in a recently published study from Costa Rica, 59 % of the samples tested positive for spermatozoa (25). The high detection rate of spermatozoa in our study could be due to improved quality of evidence collection and increased sensitivity of modern laboratory techniques (3, 39).

A DNA match between victim and suspect was detected in 40 % of the cases, with the largest group of cases being swabs and/or clothes from the victim matching the suspect's DNA profile from the reference test. In two Scandinavian studies a DNA match between victim and suspect was found in 14 % (8) and 16 % (10) of the cases. Spermatozoa is a forensic evidence that gains further importance with the increased availability and progressive advances in DNA-profiling techniques and increased use of the DNA-register (2, 19). Hence, more analyses are expected to be performed (10). In addition, it will be possible to identify offenders in previously unsolved crimes. Among the cases classified as "other", a DNA profile of an unknown male was detected and entered into the DNA-register in 56 % of the cases. As a result, eventual future crimes performed by these same individuals, may later identify the suspects from some of the rape cases included in this study. Our material was updated until November 2012, and possible later detection of a suspect will therefore not be captured in the results presented above.

We found that the police's decision to request analysis of trace evidence material was significantly associated with a public venue of the assault. In contrast, spermatozoa are more often detected in case of a private venue. In addition, there was a higher proportion of matching DNA profiles in cases with a private venue. Prior research has indicated that the police considers victim and assault characteristics when deciding whether to request an analysis (13, 14). A US study suggested that the decision to submit forensic material for analysis frequently was dependent on the status of the suspect in the crime investigation and the perceived quality of the available evidence (21). This

selection might result in a loss of medical evidence, especially in cases where the suspect denies sexual contact (10). However, studies have shown that the offender seldom denies sexual contact with the victim in cases where trace evidence collection already has been performed (8, 15). In cases where there evidentiary is a question of consensuality (i.e. in case of a known suspect and a private venue), forensic analyses may not add relevant information (34), and a match does not necessarily lead to conviction (15). In a South African study, a DNA report more often led to an acquittal because the DNA profile did not match that of the suspect (15).

We found that the police requested more analyses and detected spermatozoa in as many as 90 % of the cases when the interval from assault to sampling was < 24 h. Early attendance after a penetrative rape makes it more likely to detect spermatozoa. In addition, when there is a longer interval from assault to sampling, there may be less remaining evidence and the police may question the victim's reliability. However, it is important to remember that spermatozoa may survive in the female genital tract for as long as 7 days (3, 19, 23), implying that evidence may be lost if the SAC has access for victims only up to 72 h post-assault.

Few studies have been able to combine victim background and assault characteristics, forensic medical examination, crime investigation and DNA results (10). In our study, more cases were prosecuted in case of a DNA match. However, almost 60 % of the cases with a DNA match were dismissed because of insufficient evidence. The increased discrepancy between the number of reported rape cases and those proceeding to prosecution, may reflect an increase in police-reported cases that are more challenging to the legal system. A DNA match was detected in a higher proportion of cases when the police had interrogated the suspect and inspected the venue, which may reflect that the police are putting more effort in cases being more likely to proceed. Also, a DNA match was detected in a higher proportion of cases when the victim reported no vulnerability factors. When there were no matching DNA profiles, 63 % of the victims reported mental health problems or substance abuse. It is important to underline the fact that the police requested analyses and detected spermatozoa in about the same proportion of cases independent of victims' vulnerability factors. A more in-depth or qualitative study may assess the impact of vulnerability factors and catch light on steps other than DNA match important for a case to proceed.

Few studies assess the impact of forensic evidence, and reported results are inconsistent. Most previous studies have focused on the impact of injuries on legal outcome; some report a significant association (40) others have found no such association (41-43). No studies have shown an association between sperm detection or DNA match and conviction (40-43). However, detection of DNA is potentially important and testing should be pursued. The possible DNA match is

difficult to interpret as a predictor for conviction, because its influence is reduced by (1) missing evidence collection, (2) collected evidence not being sent for laboratory analysis, and (3) missing reference samples from the suspect. Studies from both high and low/middle income countries report that DNA analyses was not yet the standard during the study period (39, 44), partly explaining why non-medical variables have shown such a strong influence on case outcome (18, 41). With the consistent availability of high-quality medical forensic examination and laboratory techniques, DNA analyses may gain more importance in determining case outcome than what the literature has traditionally found (2). Both an American and an Australian study have concluded that DNA evidence significantly increases the likelihood of case progression (2, 45).

Strengths and limitations

This study has several limitations. Firstly, it is important to highlight that this is a study of police-reported cases of rape/attempted rape. It is unknown whether a crime actually has taken place. Secondly, the results only pertain to victims of rape/attempted rape who report to police and present to the SAC in a Nordic setting. Thirdly, the nature of a retrospectively designed study means that information has not been collected in a research context using standardized CRFs. The reliability of the data is influenced by both the accuracy of the victims' and the suspects' self-reported descriptions, as well as the police officers' and the physicians' descriptions. Finally, some variables have a rather small effect size, which may make it difficult to determine significant associations. The amount of missing data may also bias the results. Additionally, it should be pointed out that statistical association does not imply a causal relationship. It is difficult to ascertain the direct effects of medico-legal findings on police and court decisions. For further methodological limitations see (34) and (9).

Despite the above-mentioned imitations, the exploration of this rather large study sample based on files from the police, SAC, and FMI, has contributed to filling a gap of knowledge on the impact of trace evidence analyses and DNA matching in the investigation of rape cases in a Norwegian police district. It is a strength to our study that we have merged information from three data sources and utilized available technologies for DNA-profiling, enabling us to present our DNA findings and associated factors. The long follow-up allows for a final legal conclusion.

Conclusions

Medico-legal examination and collection of trace evidence are important tools in the investigation and prosecution of rape cases. When there was a DNA match between the victim and suspect, a higher proportion of cases were taken to court. Nevertheless, DNA evidence should always be considered in the scope of other evidence and aspects of the police investigation and the work of the court (10). Our study has provided descriptive data regarding trace evidence analyses and identified potential factors influencing forensic analyses and DNA findings. The results may improve the quality of the health and police systems, enabling forensic evidence collection and analysis as well as DNA-profiling to realize its potential.

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Basert på lab-rapport fra Rettsmedisinsk

1. * Vattpinner tatt til sporsikring fra fornærmede
 - Nei
 - Ja, fra anogenitalt område
 - Ja, fra kropp utenom genitalia
2. Antall vattpinner totalt
3. Sædvæske (sure fosfater/PSA) påvist på vattpinnene tatt fra fornærmede?
 - Nei
 - Ja, fra anogenitalt område
 - Ja, fra kropp utenom genitalia
 - Ikke testet
 - Usikkert resultat
 - Annet
 - Uopplyst
4. Hvis annet, angi
5. Sædceller påvist på vattpinnene tatt fra fornærmede?
 - Nei
 - Ja, fra anogenitalt område
 - Ja, fra kropp utenom genitalia
 - Ikke testet
 - Usikkert resultat
 - Annet
 - Uopplyst
6. Sædvæske (sure fosfater/PSA) påvist på klær fra fornærmede?
 - Nei
 - Ja, på truse
 - Ja, på andre klær
 - Ikke testet
 - Usikkert resultat
 - Annet
 - Uopplyst
7. Hvis annet, angi
8. Sædceller påvist klær fra fornærmede?
 - Nei
 - Ja, på truse
 - Ja, på andre klær
 - Ikke testet
 - Usikkert resultat
 - Annet
 - Uopplyst
9. Hvis annet, angi
10. Vattpinner tatt til sporsikring fra mistenkte/siktede (I)?
 - Nei
 - Ja, fra anogenitalt område
 - Ja, fra kropp utenom genitalia
 - Kun referanseprøve tatt
 - Ikke aktuelt
11. Antall vattpinner totalt (mistenkte I)
12. Vattpinner tatt til sporsikring fra mistenkte/siktede (II)?

	<input type="checkbox"/> Nei <input type="checkbox"/> Ja, fra anogenitalt område <input type="checkbox"/> Ja, fra kropp utenom genitalia <input type="checkbox"/> Kun referanseprøve tatt <input type="checkbox"/> Ikke aktuelt
13.	Antall vattpinner totalt (mistenkte II) <input type="text"/>
14.	Vattpinner tatt til sporsikring fra mistenkte/siktede (III)? <input type="checkbox"/> Nei <input type="checkbox"/> Ja, fra anogenitalt område <input type="checkbox"/> Ja, fra kropp utenom genitalia <input type="checkbox"/> Kun referanseprøve tatt <input type="checkbox"/> Ikke aktuelt
15.	Antall vattpinner totalt, (mistenkte III) <input type="text"/>
16.	DNA-typing foretatt? <input type="checkbox"/> Nei <input type="checkbox"/> Ja, av vattpinner tatt fra fornærmede, anogenitalt område <input type="checkbox"/> Ja, av vattpinner tatt fra fornærmede, utenfor anogenitalt område <input type="checkbox"/> Ja, av vattpinner tatt fra mistenkte, anogenitalt område <input type="checkbox"/> Ja, av vattpinner tatt fra mistenkte, utenom anogenitalt område <input type="checkbox"/> Ja, av truse tatt fra fornærmede <input type="checkbox"/> Ja, av andre klær tatt fra fornærmede <input type="checkbox"/> Ja, av klær tatt fra mistenkte <input type="checkbox"/> Ja, av laken, sneip, kondom, blod eller annet fra åsted <input type="checkbox"/> Ja, fostervannsprøve/ abortmateriale <input type="checkbox"/> Annet <input type="checkbox"/> Uopplyst
17.	Hvis annet, angi <input type="text"/>
18.	DNA-match funnet? <input type="checkbox"/> Nei <input type="checkbox"/> Ja, vattpinner tatt fra fornærmede matcher mistenkte <input type="checkbox"/> Nei, vattpinner tatt fra fornærmede, annet mannlig DNA <input type="checkbox"/> Ja, vattpinner tatt fra mistenkte, fornærmedes DNA <input type="checkbox"/> Ja, fra truse tatt fra fornærmede, matcher mistenkte <input type="checkbox"/> Nei, fra truse tatt fra fornærmede, annet mannlig DNA <input type="checkbox"/> Ja, fra andre klær tatt fra fornærmede, matcher mistenkte <input type="checkbox"/> Nei, fra andre klær tatt fra fornærmede, annet mannlig DNA <input type="checkbox"/> Ja, av klær tatt fra mistenkte, matcher fornærmedes DNA <input type="checkbox"/> Ja, av laken, sneip, blod eller annet fra åsted, matcher fornærmedes og mistenktes DNA <input type="checkbox"/> Ja, fostervannsprøve/abortmateriale matcher mistenktes DNA <input type="checkbox"/> Nei, fostervannsprøve/ abortmateriale mismatches mistenktes DNA <input type="checkbox"/> Annet <input type="checkbox"/> Uopplyst <input type="checkbox"/> Ikke aktuelt
Andre opplysninger / Additional Information or Corrections	
<input type="text"/>	
<input type="button" value="Lagre svar / Save and view log"/> <input type="button" value="Tilbakestill skjema / Reset"/>	
Vis svarshistorikk / View log <input type="button" value="Print page"/>	