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DNA transfer through nonintimate social contact

S. Jones [a,*], K. Scott [a], J. Lewis [b], G. Davidson [c], J.E. Allard [d,1], C. Lowrie [e,1], B.M. McBride [f], L. McKenna [f], G. Teppett [g], C. Rogers [h], N. Clayson [i], A. Baird [j,1]

[a] SPA Forensic Services, Nelson Street, Aberdeen, Scotland AB24 5EQ, United Kingdom
[b] Cellmark Forensic Services, 16 Blacklands Way, Abingdon Business Park, Abingdon, Oxfordshire OX14 1DY, United Kingdom
[c] Cellmark Forensic Services, Unit B1, Buckshaw Link, Ordnance Road, Buckshaw Village, Chorley, Lancashire PR7 7EL, United Kingdom
[d] Forensic Science Service Ltd, 109 Lambeth Road, London SE1 7LP, United Kingdom [1]
[e] LGC Forensics, Building 3, Drayton Manor Business Park, Coleshill Road, Tamworth B78 3GL, United Kingdom
[f] Forensic Science Laboratory, Garda Headquarters, Phoenix Park, Dublin 8, Ireland
[g] SPA Forensic Services, Rushton Court, 3 West Victoria Dock Road, Dundee, Scotland DD1 3JT, United Kingdom
[h] SPA Forensic Services, Pitt Street, Glasgow, Scotland G2 4JS, United Kingdom
[i] SPA Forensic Services, 11 Howden Hall Road, Edinburgh, Scotland EH16 6TF, United Kingdom
[j] Forensic Science Northern Ireland, 151 Belfast Road, Carrickfergus, County Antrim, Northern Ireland BT38 8PL, United Kingdom

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ABSTRACT

The UK and Ireland Association of Forensic Science Providers' (AFSP) Body Fluid Forum (BFF) set out to assist in the interpretation of sexual offence cases where semen is absent on vaginal swabs but female DNA is present on penile swabs or male underwear, and the issue to be addressed is whether or not sexual intercourse occurred. This study aims to investigate the frequency and amount of female DNA transferred to the penis and underwear of males following staged nonintimate social contact with females and to compare the findings with the amount of female DNA transferred to the penis and subsequently to the underwear of a male who had engaged in unprotected sexual intercourse with a female. In this study, no matching female DNA was detected on the inside front of the 44 items of male underwear used in this research following staged contact of a nonintimate nature and subsequent secondary transfer to the penis. After sexual intercourse, full profiles matching the female participant were found on the inside front of the males underwear with maximum peak heights in the range between 1898 and 3157 rfu. It was possible to demonstrate that DNA can occasionally transfer to the waistband and outside front of underwear worn by a male following staged nonintimate social contact. Data obtained in this study suggest that a matching female DNA profile below a peak height of 1000 rfu on the waistband of a male's underwear might be explained by nonintimate social contact with secondary transfer of female DNA from the male's hands.

1. Background

Forensic science has long since had an important role in the investigation of sexual offences. The identification of semen on intimate swabs taken from the complainant, together with DNA analysis to establish the possible source, has proven invaluable in such cases. Often the scientist is also asked to evaluate the findings and give an opinion of the significance of the results in light of the prosecution and defence accounts. Where the issue to be addressed relates to whether or not sexual intercourse occurred at a particular time, then the presence of semen on intimate swabs can often provide support for an assertion that sexual intercourse did take place. However, how do we address the issue of whether sexual intercourse has occurred if no semen is found on the intimate swabs taken from the complainant? The member organisations of the Association of Forensic Science Providers Body Fluid Forum have casework data which shows that semen is found in around 35% of submitted sexual offence cases with intimate swabs each year [2,3]. Advances in forensic science have led to increased sensitivity in DNA analysis; it is now routine practice to obtain DNA profiles from surfaces and objects which have merely been touched or handled [4]. This together with improved methods for DNA recovery from fabric surfaces [5] has given forensic practitioners greater opportunity to investigate sexual offences in the absence of semen on intimate swabs by examining penile swabs and male underpants for the presence of female DNA. Finding female DNA on such exhibits from a male suspect who denies having had any contact with the female can show a possible link between these individuals. However, it is possible for a person's DNA to be detected on surfaces when that person has not had direct contact with the item or individual. In these circumstances, their DNA may have been transferred via an intermediary surface (secondary or multiple transfers) such as someone else's hands [6,7]. Given this, in those allegations where the complainant and suspect are known to have been in

* Corresponding author.
E-mail address: sarah.jones@spa.pnn.police.uk (S. Jones).
[1] Formerly.

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contact with each other prior to the alleged incident, it is important to know whether or not findings support an allegation of sexual intercourse as opposed to nonintimate social contact.

The AFSP BFF has set out to investigate the frequency and amount of female DNA transfer to the penis and underwear of males following staged nonintimate social contact with females, and to compare the findings with the amount of female DNA transferred to the penis and underwear of a male following unprotected sexual intercourse with a female. These findings will assist in the interpretation of sexual offence cases where semen is absent on intimate swabs from the complainant and the issue to be addressed is whether or not sexual intercourse occurred.

2. Materials and methods

2.1. DNA transfer during nonintimate social contact—initial trial

Male participants took penile swabs from themselves following staged nonintimate social contact with a female and simulated urination, and the underwear the males were wearing at the time of the simulated urination was subsequently seized. DNA was recovered from the underwear, and DNA analysis of these samples together with DNA analysis of the penile swabs was carried out. The resulting DNA profiles were interpreted. This was an initial investigation to determine whether transfer and recovery could happen. As such, the conditions for this initial trial were set to maximise the chance of transfer and were not representative of the timescales encountered in casework. The underwear was not cross-linked.

The trial was carried out within eight BFF organisations. A total of ten male/female pairs completed the initial trial, and there were three repeats with each couple, giving a total of 30 data sets. The same male participant was used on two occasions with different females (9 males participated), and the same female participant was used on two occasions with different males (9 females participated). Male and female pairs were chosen on the basis of the least number of alleles shared and having had no recent intimate contact.

2.1.1. Prior to contact

The male participant showered and redressed wearing a new pair of 100% cotton briefs with no front opening and his own normal outer clothing. Both the male and the female participants then washed their hands.

2.1.2. Staged contact (primary transfer step)

The male participant touched the face of the female with his hands using a massaging motion over the cheeks and neck area for 2 min. The male and female participants then held hands continuously using a rubbing/massaging motion for 3 min. Throughout the 5 min of contact, the male and female spoke to each other. The female then left the room.

2.1.3. Immediately after contact (secondary transfer step)

The male participant simulated urination for about 30 s by undoing his trousers and removing his penis from his underwear over the waistband of the underwear. To maximise the likelihood of transfer, both hands were used to hold the penis before returning the penis back into the underwear and redressing. The male participant washed his hands and then walked around for a period of 5 min.

2.1.4. Sample collection

Wearing gloves, the male volunteer removed his underwear and then swabbed the shaft of his penis using a wet sterile cotton swab (moistened with deionised water) followed by a dry sterile cotton swab. The penile swabs were then frozen until they were submitted for DNA testing. The male participant put his underwear into a self-seal plastic bag, and this was then stored at room temperature until the underwear was sampled.

Sampling of the underwear and the subsequent DNA analysis was carried out by different scientists from those involved in the transfer experiments. The following five separate areas of the underwear were sampled for DNA analysis in laboratory conditions using mini-taping [5], applying the tape repeatedly to the surface of the underwear to ensure each entire area was sampled:

- Front waistband (inside and outside)
- Inside front panel
- Outside front panel
- Back inside
- Back outside

2.2. DNA transfer during nonintimate social contact—6-h time delay

Male participants took penile swabs from themselves following staged nonintimate social contact with a female and simulated urination, and the underwear that the males were wearing at the time was subsequently seized. In order to mimic a more realistic casework

Table 1
Male participant 1 and female participant 1 (initial trial)
Tables 1–7: results of underwear samples with female DNA detected.

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
Waistband	6* (9†)	72 79 109 180 227 289	289 (het)	0

* Number of alleles attributable to the female only and not accounting for shared alleles with the male.
† Number of female alleles accounting for those shared with male.

Table 2
Male participant 1 and female participant 1 (initial trial).

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
Waistband	11* (19†)	56 61 84 85 117 190 268 528 528 766 279	766 (het)	6

* Number of alleles attributable to the female only and not accounting for shared alleles with the male.
† Number of female alleles accounting for those shared with male.

Table 3
Male participant 1 and female participant 1 (initial trial).

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
Waistband	5* (9†)	92 100 113 141 180	180 (het)	1

* Number of alleles attributable to the female only and not accounting for shared alleles with the male.
† Number of female alleles accounting for those shared with male.

Table 4
Male participant 1 and female participant 2 (initial trial).

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
Waistband	14* (19†)	402 345 442 381 374 286 458 321 395 239 230 169 161 128	458 (hom)	13

* Number of alleles attributable to the female only and not accounting for shared alleles with the male.
† Number of female alleles accounting for those shared with male.

Table 5
Male participant 1 and female participant 2 (initial trial).

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
Waistband	14* (20†)	451 382 532 345 308 174 876 289 396 341 195 192 229 256	816 (hom)	0

* Number of alleles attributable to the female only and not accounting for shared alleles with the male.
† Number of female alleles accounting for those shared with male.

scenario, a delay of 6 h was introduced between the simulated urination (secondary transfer step) and the time that the penile swabs and underwear were collected.

Table 6
Male participant 2 and female participant 2 (6-h time delay).

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
Waistband	11* (17†)	75 33 161 62 87 98 154 112 59 58 70	161 (het)	1

* Number of alleles attributable to the female only and not accounting for shared alleles with the male.
† Number of female alleles accounting for those shared with male.

Table 7
Male participant 1 and female participant 3 (initial trial).

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
Front outside	1*	56	56 (het)	0

* Number of alleles attributable to the female only and not accounting for shared alleles with the male.

Table 8
Male participant 1 and female participant 1 (initial trial)
Tables 8–11: results of penile swab samples with female DNA detected.

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
shaft	5* (5†)	53 61 66 73 85	85 (het)	0

* Number of alleles attributable to the female only and not accounting for shared alleles with the male.
† Number of female alleles accounting for those shared with male.

Table 9
Male participant 1 and female participant 1 (initial trial).

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
shaft	1*	56	56 (het)	0

* Number of alleles attributable to the female only and not accounting for shared alleles with the male.

In this time delay trial, the shaft, coronal sulcus and glans of each male volunteer's penis was swabbed using the same wet and dry sampling method as the initial trial. In addition, the areas sampled from the underwear were from the front waistband (inside and outside) and the inside front panel. Apart from the time delay of 6 h, cross-linking the new underwear and the number of samples collected, the experimental design was exactly the same as the initial trial.

Table 10
Male participant 1 and female participant 1 (initial trial).

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
shaft	1*	51	51 (het)	0

* Number of alleles attributable to the female only and not accounting for shared alleles with the male.

Table 11
Male participant 1 and female participant 2 (initial trial).

Sample	No. of female alleles	Peak height of female alleles (rfu)	Max female peak height (rfu)	No. of unknown alleles
Shaft	4*	53 76 105 166	166 (hom)	0

† Number of female alleles accounting for those shared with male.
* Number of alleles attributable to the female only and not accounting for shared alleles with the male.

Although the introduction of this time delay was aimed at making this part of the trial more realistic to casework, the specific level of contact and speed of sample collection should be noted.

A total of fourteen male/female pairs completed this trial, one set of samples per pair, giving a total of 14 data sets.

2.3. DNA transfer during and subsequent to sexual intercourse

A male participant took penile swabs from himself following unprotected sexual intercourse with a female and the underwear he wore immediately after the intercourse was collected. Samples were subsequently recovered from the underwear.

One couple completed this trial on three occasions, abstaining from sexual intercourse for 7 days before the start of the trial and with a delay of 7 days between each subsequent intercourse event. The couple shared 7/20 alleles.

It is acknowledged that the timings involved in this trial maximise the likelihood of detection of female DNA on the penile swabs and underwear.

2.3.1. Prior to contact

The male participant showered and dried himself with a clean bathroom towel. As the couple were co-habiting, new bedding was used for each intercourse event.

2.3.2. Intercourse (primary transfer step)

The couple engaged in intimate contact with the penis being inserted into the vagina for approximately 2 min. Ejaculation did not occur.

2.3.3. Immediately after intercourse (secondary transfer step)

The male participant put on a new pair of cross-linked 100% cotton briefs with no front opening and his own trousers, and then remained active for 5 min without further contact with the female.

2.3.4. Sample collection

The method of sample collection and the areas of the penis and underwear sampled were the same as in the initial trial (Section 2.1.4).

2.4. DNA analysis

Wet and dry penile swabs from each area sampled were combined for the purposes of DNA analysis.

DNA analysis was carried out by several of the participating AFSP BFF organisations using their own DNA procedures. Twenty-eight cycles SGM+ DNA analysis was carried out on a 3100 Sequencer (Applied Biosystems). Each sample was run once. Genemapper software was used to analyse the DNA results. A reporting threshold of 25 rfu was used.

3. Results

Full details of matching female DNA detected in the underwear and penile swab samples for all of the trials are given in Tables 1–11.

3.1. DNA transfer during nonintimate social contact—initial trial

DNA matching the female participant was detected on underwear samples. Five occurrences of matching DNA were observed in

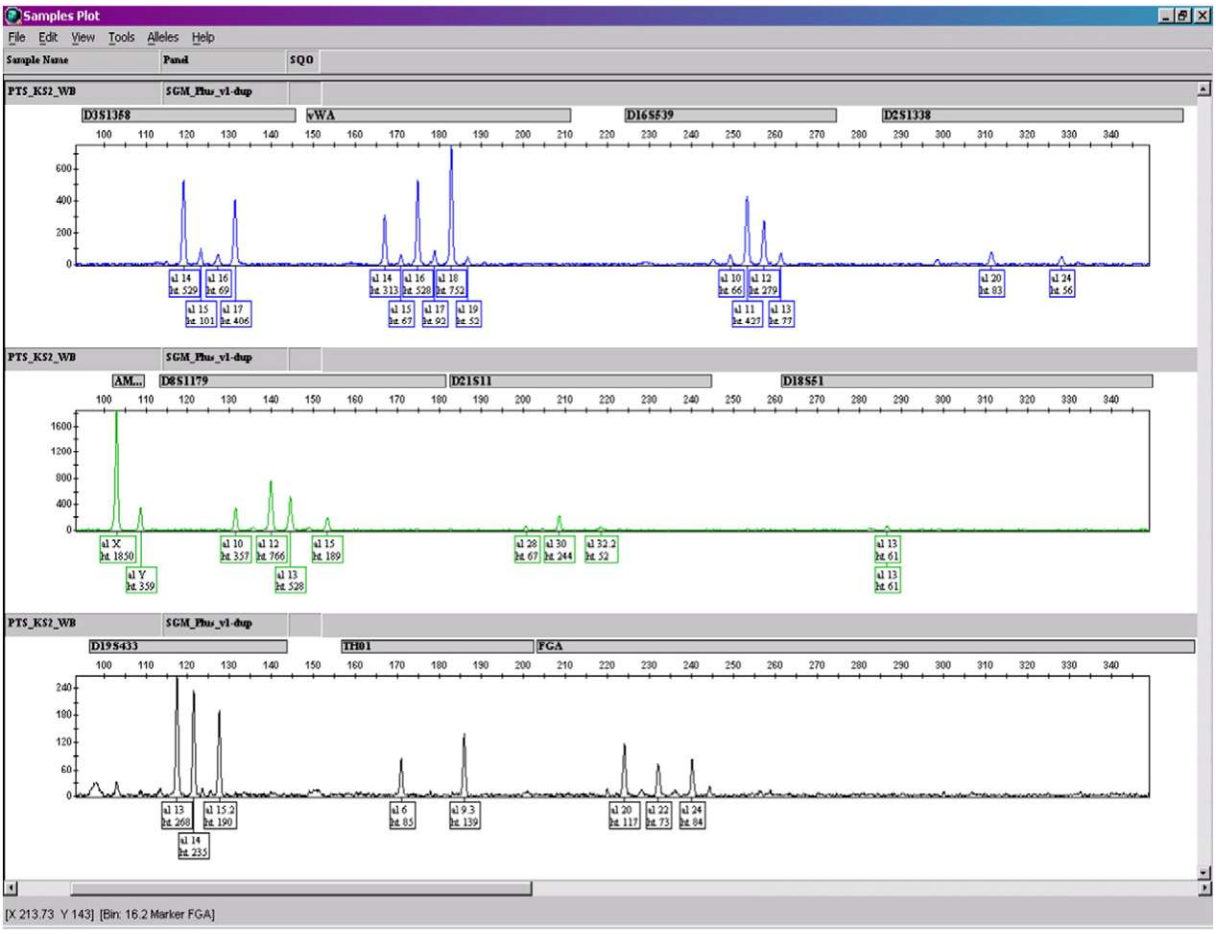

Fig. 1. Mixed DNA profile of waistband sample showing matching female DNA partial profile (peak heights as per Table 2).

waistband samples from the 30 times that this trial was carried out, and just one occurrence was observed in an outside front panel sample. No matching female DNA was detected in any samples from the inside front or back (inside and outside).

In the five waistband samples where matching female DNA was detected, the observations were as follows:

- All five samples gave partial female DNA profiles with a maximum peak height range of 180–816 rfu.
- In one sample, the DNA matching the female was found as a major contributing profile with 11 alleles attributable to the female. Fig. 1 shows the mixed DNA profile obtained from this sample.
- In two samples, the contributors were found as 1:1 mixtures (same male/female pairing in both samples) both male and female gave 14 alleles each (not accounting for shares alleles). Fig. 2 shows the mixed DNA profile obtained with one of these samples.
- In two samples, the female was the minor contributor (and gave 5 and 6 alleles, respectively, not accounting for shared alleles).

The only occurrence of matching female DNA detected on the front panel of the underwear seized was detected in one sample from the outside. This was present as a single allele (56 rfu) matching the female participant.

DNA corresponding to the DNA profile of the female participant was detected on four of the 30 penile shaft samples.

- On two of the samples, the female DNA was in the minor, contributing 4 and 5 alleles, respectively. The maximum peak heights were 85 and 166 rfu.
- On the other two samples, the matching female DNA was present only as a single allele.

No matching female DNA was detected on the other 26 penile shaft samples.

3.2. DNA transfer during nonintimate social contact—6-h time delay

From the 14 pairs of underwear, only one occurrence was observed of matching female DNA transfer. This was in a waistband sample and had a maximum peak height of 161 rfu. No matching female DNA was detected in any samples from the inside front in the 14 times that this trial was carried out.

No matching female DNA was detected on any of the penile shaft, coronal sulcus or glans samples collected in this trial.

3.3. DNA transfer during and subsequent to sexual intercourse

DNA matching the female participant was detected in all samples from the underwear collected in this trial (and visible staining was found in many areas sampled).

- All waistband samples gave a full profile matching the female participant. The maximum peak height range was 1386–3157 rfu.
- All inside front samples gave a full profile matching the female participant. The maximum peak height range was 1898–3157 rfu.

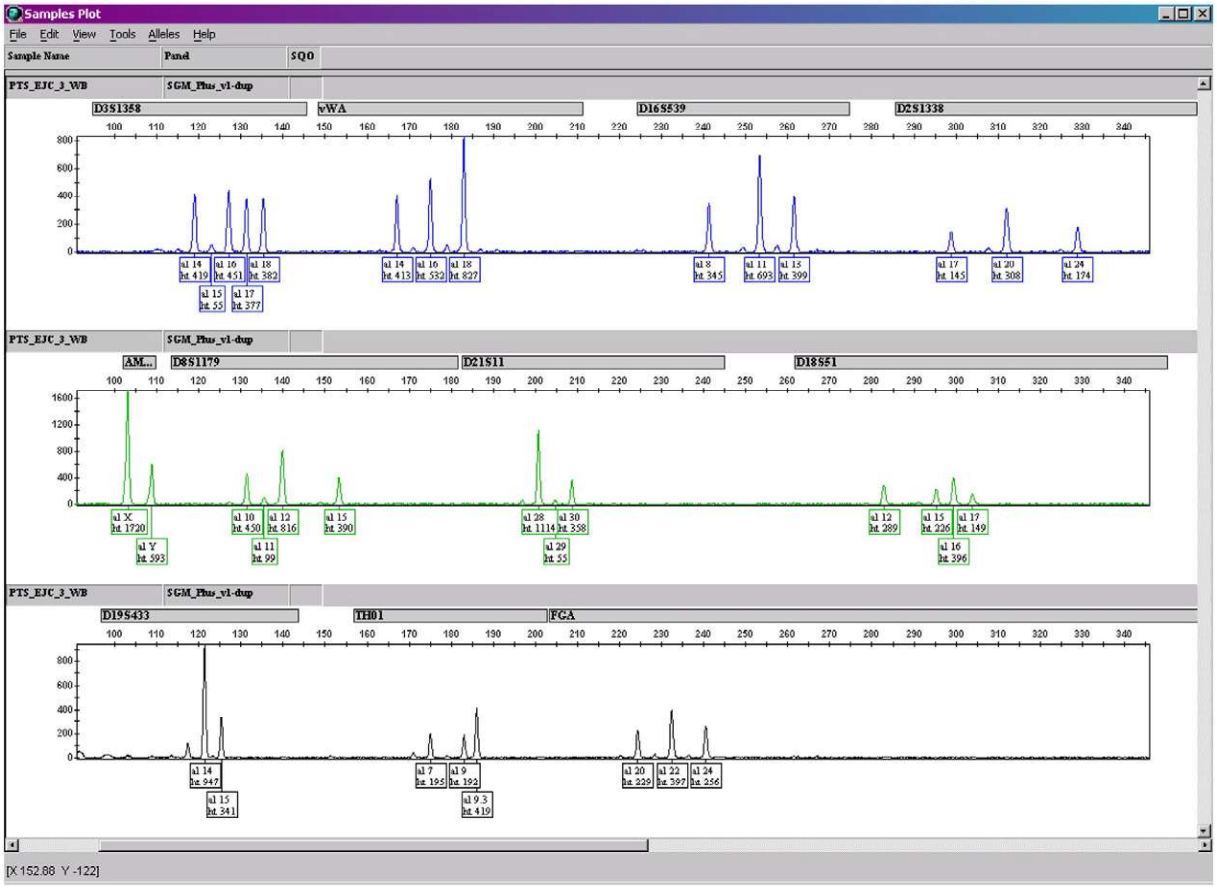

Fig. 2. Mixed DNA profile of waistband sample showing matching female DNA partial profile (peak heights as per Table 5).

- Full DNA profiles matching the female participant were also detected on all of the samples from the inside back, the outside front and the outside back.

Full DNA profiles matching the female participant were also detected on all of the penile shaft samples with a maximum peak height range of 958–5835 rfu.

4. Discussion

It has been documented that female DNA is detectable on the penis of a male following sexual intercourse after a period of 24 h has elapsed [8], and the Faculty of Forensic and Legal Medicine Guidelines [9] recommend sampling the penis within 3 days of an act of alleged sexual intercourse. In this study, no matching female DNA was detected on any of penile samples taken 6 h after the staged nonintimate social contact events. Even when swabs were taken immediately following the staged contact, female DNA was found at a relatively low level (up to a maximum peak height of 166 rfu). This contrasts with the high levels of female detected on penile samples taken after direct wet transfer during sexual intercourse (958–5835 rfu).

In this study, no matching female DNA was detected on the inside front of the 44 items of male underwear used in this research following staged contact of a nonintimate nature and subsequent secondary transfer to the penis (during simulated urination). In contrast, DNA matching the female participant was detected in this area of underwear worn following unprotected sexual intercourse. After sexual intercourse, full profiles matching the female participant were found on the inside front of the male's underwear with maximum peak heights in the range of between 1898 and 3157 rfu. This DNA was the result of a secondary transfer of female vaginal material via the penis. This is expected to have comprised a wet transfer of vaginal material (and visible staining was found on the underwear). The amount of DNA recovered from the inside front of the male's underwear following sexual intercourse could not be replicated by the indirect transfer of DNA from the type of nonintimate social contact described in this research.

Under the circumstances of this study, it was possible to demonstrate that DNA can occasionally transfer to the waistband and outside front of underwear worn by a male following staged nonintimate social contact. These results can assist the forensic expert when considering the examination strategy of male underwear in sexual offence cases, for example, when sampling for DNA, avoiding the waistband and other areas that depending on design of the underwear may have been touched by the suspect if the alternative proposition is social contact of the type described in this study. Alternatively, if DNA matching the female complainant is found on the waistband of a male suspect's underwear, the data obtained in this study suggest that depending on the time delay before the underpants are seized, a matching female DNA profile below 1000 rfu might be explained by nonintimate social contact with secondary transfer of female DNA from the male's hands.

This study does not take into account all of the factors that might affect transfer and persistence of DNA, such as the type of surface and nature of contact and the time between each transfer step [10]. The forensic expert should factor such considerations into any assessment of findings.

5. Conclusion

In this study, it was not possible to replicate the high levels of female DNA transferred from sexual intercourse by nonintimate social contact. DNA matching a female's DNA profile on the inside front of the suspect's underwear with no front opening greater than 1000 rfu, and/or on penile swabs greater than 200 rfu, would be expected to provide support for an allegation of sexual intercourse, even if the male and female concerned were alleged to have had nonintimate social contact of the type described in this study. These levels are conservative as it is clear from this study that as expected the amount of female DNA from this type of social contact decreases with a time delay prior to sample collection.

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