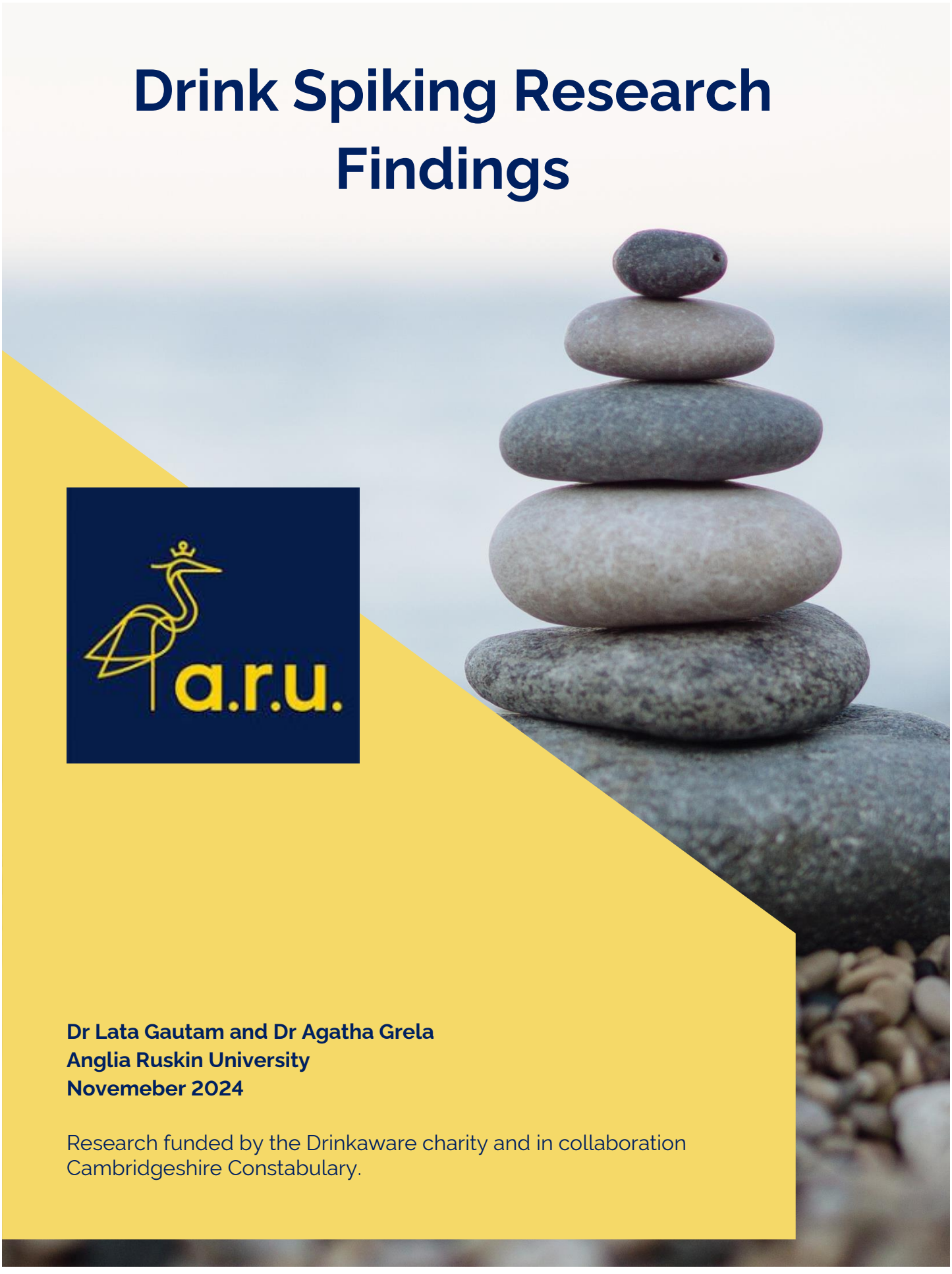
Drink Spiking Research Findings



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Evidence based research on drink spiking

Background

Drink spiking, the act of introducing drugs or substances, including alcohol, into beverages or food to incapacitate individuals for various malicious purposes, including sexual assaults, theft, pranks, or abuse, has become a concerning societal issue. In the UK, reports of increased incidents of drink spiking, particularly in house parties, as well as cases of 'needling,' a relatively new phenomenon emerging since 2021, have gained attention.

Needling involves the covert injection of substances — ranging from illicit drugs to pharmaceutical compounds — into individuals without their knowledge or consent, posing additional significant risks to their health and safety.

In response to this pressing social and scientific challenge, our investigation delved into following five critical dimensions:

- **Study 1** Two national surveys (Drinkaware Monitor 2022 and 2023) on the prevalence of drink spiking/needling, as collected from self-reported incidents, encompassing individuals' perceptions, personal experiences, the subsequent impact, and their inclination towards reporting such occurrences to authorities or others and reasons behind their decisions of reporting or not.
- **Study 2** Examination of initiatives implemented by various establishments and venues to combat drink spiking/needling.
- **Study 3** Evaluation of the efficacy of commercially available drink testing kits.
- **Study 4** Analysis of drinks collected from night-time venues using drink testing kits and Gas Chromatography – Mass Spectrometry (GC-MS).
- **Study 5** Analysis of urine samples obtained from Cambridgeshire Constabulary using two methods, firstly by using commercially available presumptive testing methods, followed by GC-MS confirmation of results.

This report provides an in-depth overview of our key findings. Studies received relevant ethical approval from the Faculty Research Ethics Panel under the terms of ARU's Research Ethics Policy.

Keywords: Drink spiking, needling. chemical submission, drugging, drink testing kits

Evidence based research on drink spiking

Study 1 – Survey based research on drink spiking

We have incorporated drink spiking-specific questions into 'The Drinkaware Monitor' survey (collected by YouGov) and meticulously analysed the gathered data. In 2022, we received responses from 6,318 individuals, and in 2023, the number rose to 10,473 participants. The 2022 survey centered on the respondents' knowledge, perception, and understanding of drink spiking and needling. We also delved into their experiences of drink spiking and/or needling (without a time limit, i.e. at any point in their lives), whether they reported the incidents to the police (if not, to whom, if anyone), familiarity with the perpetrator, interactions with law enforcement (including barriers to reporting), physical and mental health impacts, seeking medical assistance, and the likelihood of reporting based on the alleged offence type of drink spiking/needling.

In 2023, we introduced time-bound questions, specifically inquiring whether participants had experienced drink spiking or needling incidents within the past year. We investigated the subsequent events following these incidents, exploring participants' awareness of appropriate actions to take if someone they know encounters such situations.

Key findings from The Drinkware Monitor survey, 2022 (N = 6,318)

1. More than twice as many respondents understood the term 'drink spiking' (91.1%, n = 5,758) as compared to needling (41.4%, n = 2,615).
2. After being drugged (n = 748), in most cases (55.1%) no additional crime occurred. However, when the additional crime occurred, this included not only prank (8.4%), and harassment (3.5%) but also rape (4.0%) and sexual assault cases (8.4%).
3. Contrary to popular belief, a significant proportion of male respondents (n = 299) reported rape (4.3%) and sexual assault (6.0%) and were also subjected to more theft/robbery (5.0%), pranks (15.4%) and blackmail (2.0%) than female respondents (2.4%, 3.8% and 0.7%, respectively).
4. Of the respondents who did not report the incident to the police (89.7%, n = 671), approximately half said they did not think that there was any point. Instead, 64.0% of men and 72.9% of women confided in someone else. Almost a quarter (23.6%) of women and almost a third (30.4%) of men did not tell anyone.
5. 14.0% (n = 105) of the respondents who thought they had been drugged reported that the drugging resulted in physical or mental health issues. These included emotional and psychological scars with which some participants are still struggling to cope, after many decades of having the experience. Psychological scars also include suicidal thoughts.
6. The perpetrator was unknown to the survivor in 70.6%. of the cases (Table 1). However, if known (n = 187), they are more likely to be an acquaintance (23.5%)

than co-worker/workmate (15.0%) or partner/ex-partner (8.6%). Although participants from the LGBTQ+ community reported it was most likely to be a co-worker/workmate (24.5%) and a stranger (37.6%). Respondents from Black heritage only answered 'no' or 'prefer not to say' to knowing the perpetrator.

7. A number of themes have been identified when analysing perceptions of vulnerability to being drugged (Figure 1). Most responses (69.2%) indicated that the vulnerability of falling victim to drink spiking/needling was linked to the victim and the way they behaved, being of a certain age (primarily being young) and/or what they did (e.g. leaving drink unattended, being alone, being intoxicated). The victim being intoxicated was the most suggested vulnerability to drugging (53.6%). A relatively low number of respondents indicated that the responsibility for drugging lays within the perpetrator (8.8%), and some highlighted the responsibilities of the society (1.2%). The main perceived factor contributing to possibly being drugged, which was outside of the victim's control, was the presence of crowds (12.0%).

Table 1. Breakdown of responses to the question of knowing the perpetrator by alleged offence type with the three most selected options.

Offence type	Offender known?/ %		When yes, 3 most selected options
	No	Yes	
Rape (n = 30)	23.3	66.7	Acquaintance (40.0%) Partner/Ex-partner (25.5%) Friend (15.0%)
Sexual assault (n = 63)	50.8	44.4	Acquaintance (42.9%) Stranger or Friend (14.3%) Relative (10.7%)
Theft/ Robbery (n = 26)	80.8	19.2	Relative (40.0%) Co-worker/Workmate or Stranger (20.0%)
Blackmail (n = 9)	22.2	77.8	Relative or Co-worker/Workmate (33.3%) Stranger or Partner/Ex-partner (16.7%)
Harassment (n = 26)	34.6	53.8	Acquaintance (35.7%) Stranger (28.6%) Partner/Ex-partner (21.4%)
Intimidation (n = 20)	30.0	60.0	Co-worker/Workmate (20.0%) Relative or Stranger or Partner/Ex-partner (10.0%) Acquaintance (5.0%)
Prank (n = 63)	46.0	50.8	Friend (34.4%) Co-worker/workmate (21.9%) Relative (18.8%)

Nothing happened (n = 412)	81.1	16.3	Acquaintance or Friend (28.4%) Other (13.4) Co-worker/workmate or Stranger (9.0%)

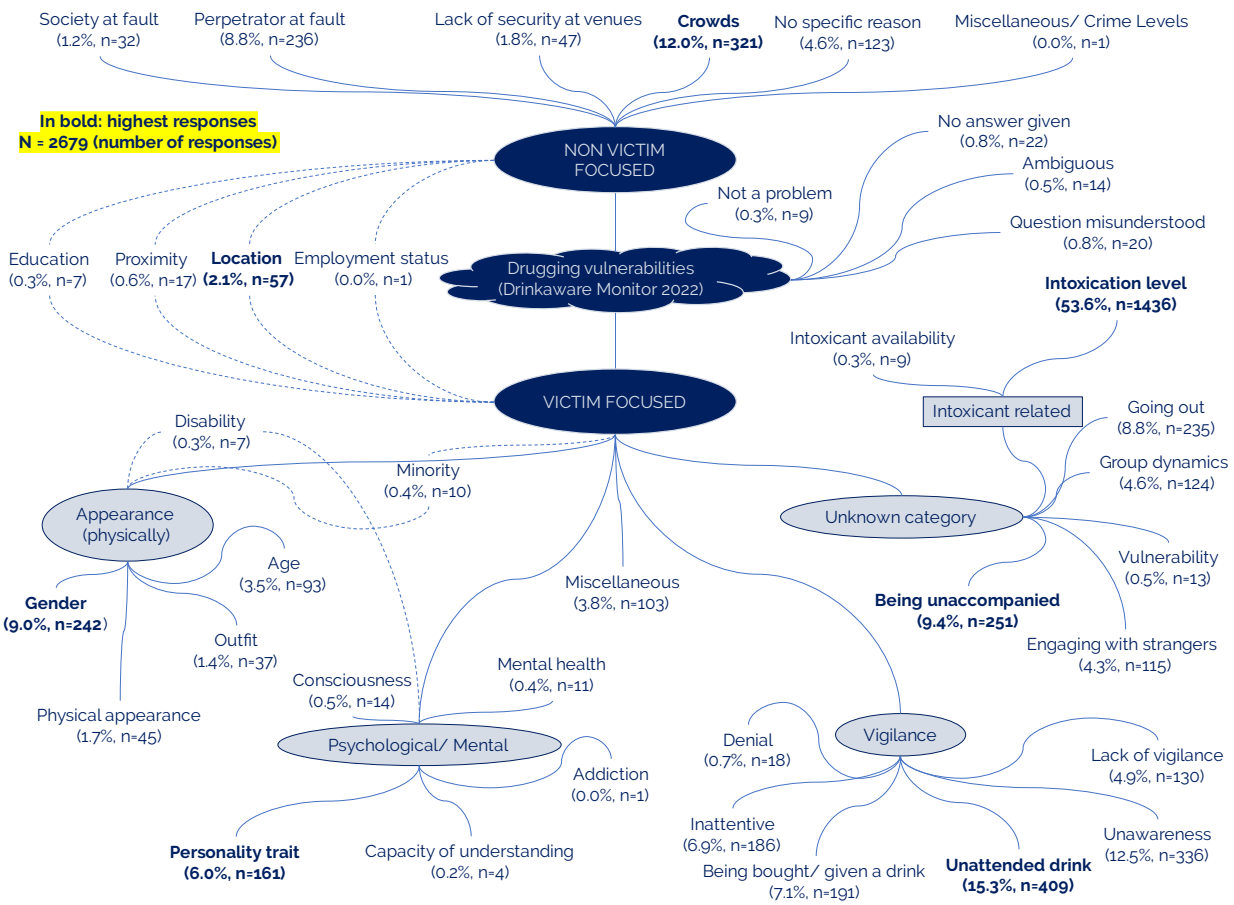

Figure 1. Survey respondents' perceptions of what makes a person vulnerable to drugging were analysed, but only those who had not been drugged were asked this question. The data was coded using keywords and phrases, which were then grouped into larger categories. Any ambiguous answers were reviewed and standardised by a second team member.

Key findings using both surveys

1. 2.2% (231 out of 10473) of participants of the 2023 survey have reported that they had been spiked within the last year and 11.3% (711 out of 6318) of the 2022 participants reported being spiked in their life-time. 0.7% (71 out of 10473) of the 2023 survey participants thought they had been needled in the previous year, compared to 1.4% (89 out of 6318) of the 2022 survey participants reporting being needled in their life-time.
2. There were about eight times more drink spiking cases reported (n = 711) in comparison to needling (n = 89) when participants were asked whether they have

ever been a victim of drink spiking. In the last year, the number of drink spiking cases were three times more (spiking n = 231; and needling n = 71).

3. For every three women who were spiked, two men were spiked based on the 2022 survey. This number changed to almost equal split (2.3% women and 2.1% men) in the last year.
4. The trend of where drink spiking occurs remains the same in 2023 with more incidents taking place in bars (40.7% vs 45.3% in 2022) and clubs (28.9% vs 34.2% in 2022) than anywhere. However, female respondents are slightly more likely to become victims of drink spiking in clubs (36.9%) than in bars (32.8%). The trend of needling has changed slightly with clubs (23.9% vs 27.0% in 2022) and bars (21.1% vs 14.6% in 2022). However, in the 2023 survey needling was reported to have allegedly happened at family events (20.7%) in as many cases as in bars (21.0%).
5. Contrary to popular belief, drink spiking and needling is not limited to night-life venues but is also prevalent in private settings. For example, as per the 2023 survey, 15.6% of the needling cases were reported to have had happened at a private home (Table 2).

Table 2. Breakdown of places where the alleged drugging took place by drugging type and year of survey. Highlighted in blue are the most selected options.

Venue type/ Setting	Alleged drink spiking cases (%)		Alleged needling cases (%)	
	2022 (n = 711)	2023 (n = 231)	2022 (n = 89)	2023 (n = 71)
Club	34.2	28.5	14.1	**24.3**
Bar	**45.3**	**40.8**	**26.6**	21.0
Private home	8.7	8.6	12.2	15.6
Social event	12.8	19.0	13.4	18.8
University/ College	5.1	9.7	12.0	17.7
Family event	2.4	3.6	9.3	20.7
Work	3.6	7.2	3.6	16.9
Other	4.2	4.1	5.2	6.1

* 2022 survey: experience of drink spiking EVER; 2023 survey: experience of drink spiking IN THE LAST YEAR

Key findings from 2023 survey (N = 10,473)

1. The needling incidences at colleges and universities have risen to 18.8% (13 out of 71) from 12.0% (11/89) reported in the 2022 survey.
2. When asked if they knew what to do in cases of drinks spiking (N = 10,473), more respondents declared they did (36.4%, n = 3,811), as compared to knowing what to do in cases of needling (21.3%, n = 2,231). This is comparable to findings of the 2022 survey where 25.3% (n = 1,407) knew what to do in cases of

drugging[1] (question was asked to participants who were not drugged, n = 5,570).

[1] The question in the 2022 survey was about drugging, whereas in the 2023 survey it was divided between drink spiking and needling.

Evidence based research on drink spiking

Study 2 – Initiatives introduced to reduce drink spiking and needling incidences

An online survey tool was distributed in Autumn 2022 for one month to all 299 alcohol-serving venues in Cambridgeshire, inquiring about reported cases of drink spiking incidents in their establishments since October 2021, as well as whether these incidents were subsequently forwarded to the police. Additionally, we investigated whether these venues had implemented any initiatives aimed at addressing the rise in drink spiking incidents.

Key findings – Out of the surveyed night-time venues, we received 30 responses (with 28 valid responses), constituting 10.0% of the total. Half of these venues (50.0%) were aware of drink spiking incidents occurring within their premises. Alarmingly, only seven venues proactively reported such incidents to the police, while six establishments noticed an increase in drink spiking since October 2021. The majority of venues expressed concern regarding this issue (Figure 2). Consequently, it is imperative for relevant organisations to provide these venues with appropriate support to address and mitigate drink spiking incidents.

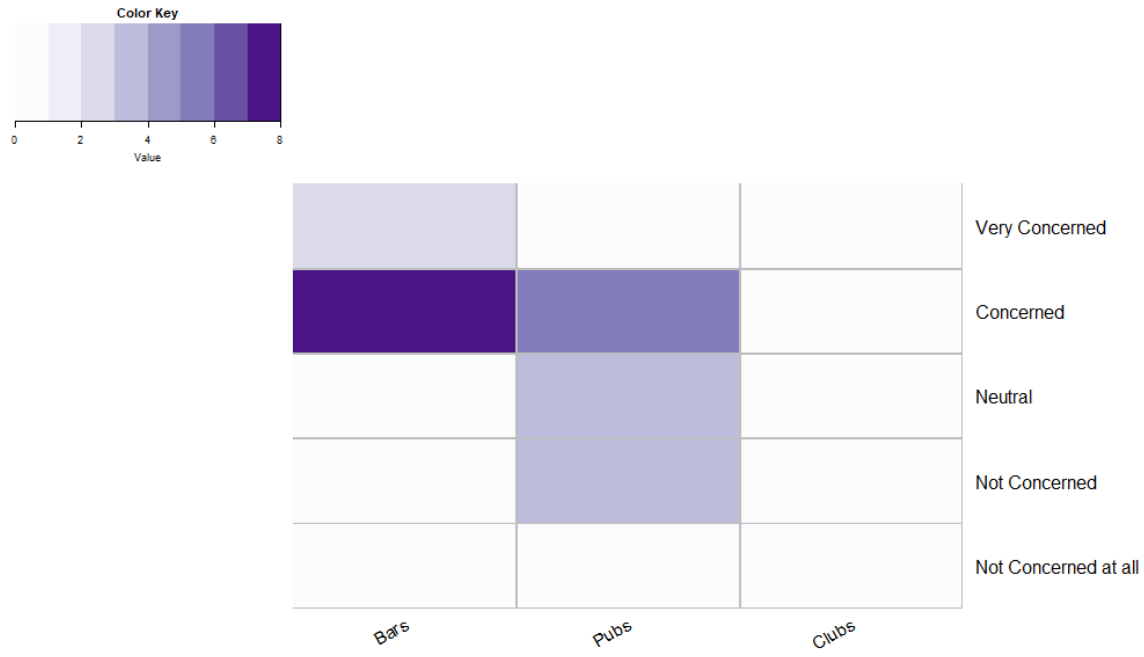

Figure 2. Concern levels of drink spiking happening within the premises (the darker the colour, the more venues have selected that answer; N = 28).

When asked about prevention measures adopted by venues, 18 out of the 28 employed more than one preventative measure: CCTV emerged as the predominant one (67.9%), followed by the introduction of schemes such as 'ask for Angela' and regular staff training and CPD (64.2% both) (Figure 3). Measures like anti-spiking protections and entry searches were comparatively less used (14.3% and 10.7%,

respectively). These measures might have helped the venues notice incidents of drink spiking taking place and subsequently reporting these cases to the police (Figure 4). The effectiveness of any of these methods in preventing or reducing spiking incidents has not been researched before, therefore further studies need to be conducted.

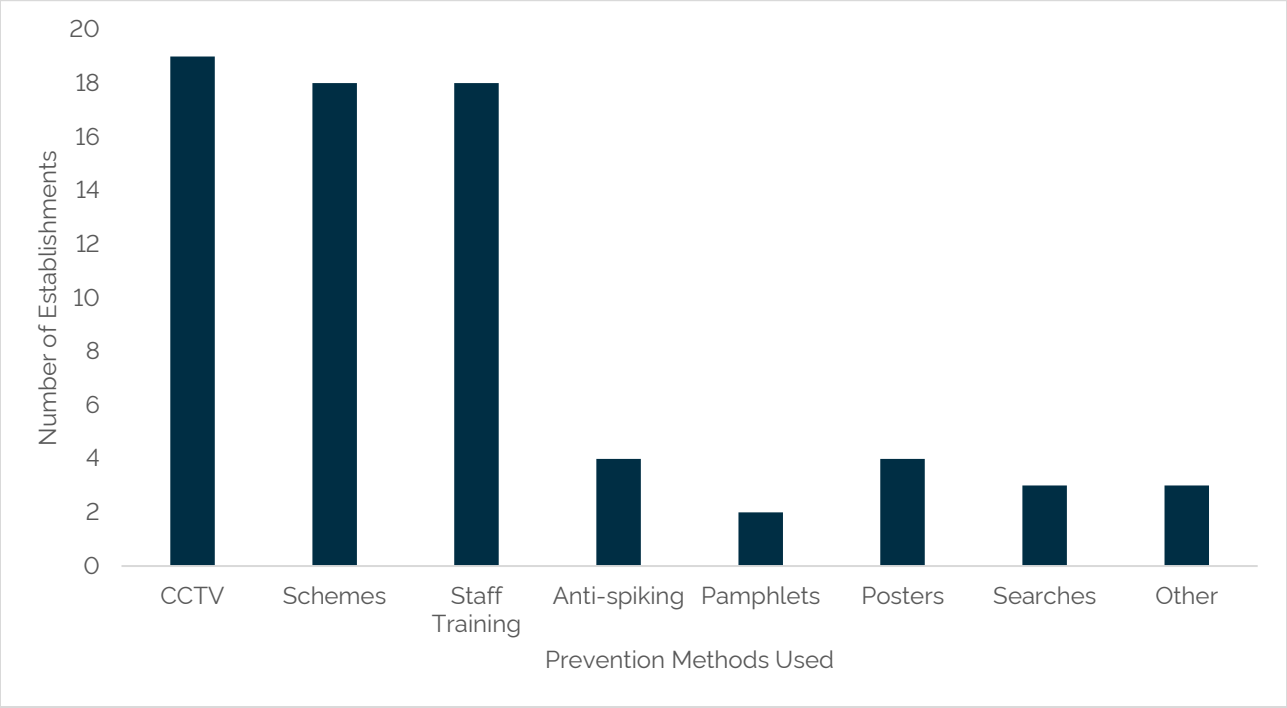

Figure 3. Preventative measures in place (venues selected multiple answers). 'Scheme' here refers to initiatives like 'Ask for Angela,' and 'anti-spiking protections' refers to products such as drink covers. Those who selected the 'other' category specified measures such as (i) having drink testing kits, (ii) frequent discussion of this topic with staff, and (iii) 'one drink served per person rule on 'bar service' event nights, most nights are table service and therefore monitored by waiting staff'.

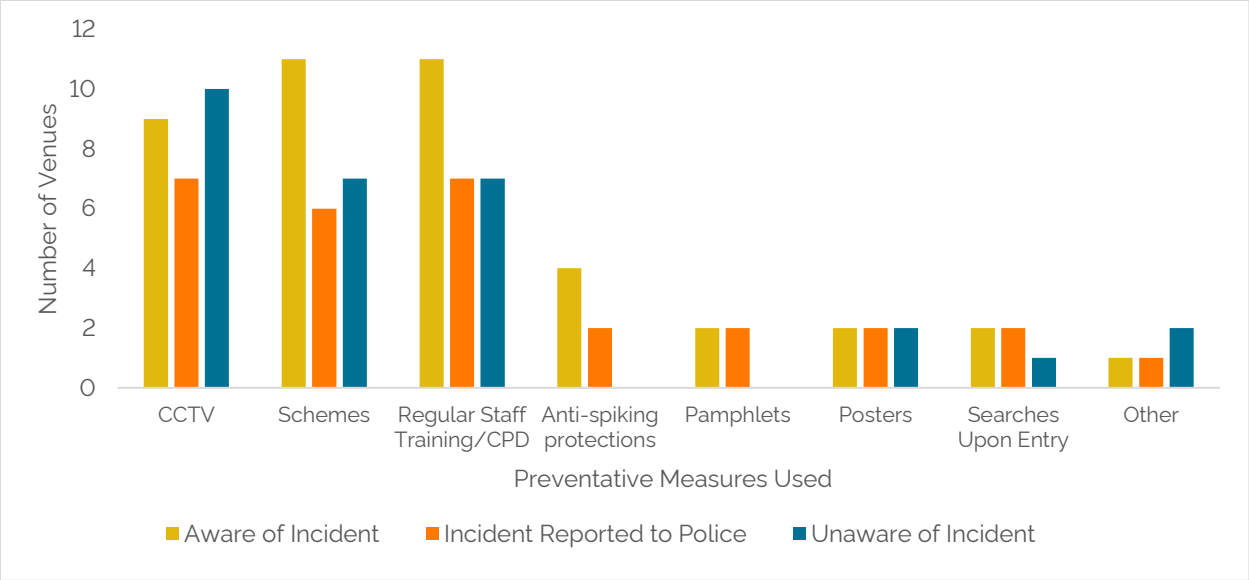

Figure 4. Awareness of drink spiking incidents at the venues, including incidents reported by the venues to the police and the preventative measures employed.

Regarding the survey findings, all respondents using anti-spiking protections (n = 4) reported instances of drink spiking within their venues. Similarly, among the three venues conducting entry searches (Figure 3), two reported having observed drink spiking incidents despite this measure (Figure 4). Without knowing when these measures were introduced, it is not possible to assess their effectiveness or determine whether they have impacted the number of incidents. Based on the survey results, venues which had implemented CCTV, schemes such as *Ask for Angela* and provided regular staff training, seemed to be more aware of drink spiking incidents in their venues and were more likely to report the incidents to the police (Figure 4). These findings highlight the most popular prevention measures in place, underscoring the need for further large-scale research, as this proof-of-concept study was based in Cambridgeshire only.

We conducted a search of grey and peer-reviewed literature, including government reports, to identify initiatives available in 2022. We asked which of these initiatives (Table 3) were known to the venues and the most known are the following: National Pubwatch (100%), Ask for Angela (92.9%), Welfare and Vulnerability Engagement Training (50.0%), and Drinkaware Nightlife Crew (46.4%).

Table 3. Awareness of each of the prevention initiatives. In some cases, an initiative was selected to have been implemented but not selected for awareness, resulting in implementation rate above 100%.

Initiative	Awareness of initiative, n = 28 (%)	Implementation rate (n = awareness of initiative, %)
National Pubwatch	28 (100)	20 (71.4)
Ask for Angela	26 (92.9)	20 (76.9)
Welfare and Vulnerability Engagement training	14 (50.0)	15 (107.1)
Drinkaware Nightlife Crew	13 (46.4)	5 (38.5)
CPL Learning	11 (39.3)	7 (63.6)
Use of posters freely available such as those by the BII	11 (39.3)	7 (63.6)
Women's Night Safety Charter	6 (21.4)	3 (50.0)
Night Time Industries Association	5 (17.9)	3 (60.0)

We have also asked about barriers for not implementing these initiatives. The main reason being their unsuitability for the venue, followed by costs and time constraints.

The only 'Other' response mentioned: "*We have never been supplied with posters etc. and since it has never seemed a problem we have not sought them out*".

Evidence based research on drink spiking

Study 3 – Evaluating the Efficacy of Drink Spiking Detection Kits

Drugs commonly reported in drink spiking, such as GHB, benzodiazepines, ketamine, and alcohol, cause sedation and amnesia. These drugs are quickly eliminated from the body, making them hard to detect in urine and blood samples, especially if there is a delay in reporting. The sedative effects and amnesia often lead to delayed reporting, which further reduces the chances of detection.

A promising solution has emerged in the form of testing kits, providing a rapid and straightforward method to ascertain whether a drink has been spiked with specified drugs (Table 4). These kits come in two varieties available on the market:

(i) **Colour-based kits**: These kits induce a colour change via a chemical reaction in the presence of the target compound.
(ii) **Immunoassay kits**: This type of kit operates by utilising antibodies that release a dye upon attaching to the target molecule.

Manufacturers and distributors of these kits claim that they provide immediate results (within 10 minutes, Table 4), potentially empowering individuals to protect themselves against drink spiking. These kits are only presumptive tests and cannot confirm the presence of a drug, due to the possibility of false positives and negatives. However, they can indicate whether a drink has been spiked and tentatively identify the drug(s) that the test kit is designed to detect (e.g. Xantus wristband is designed to test for GHB).

The effectiveness of these kits depends on their reliability, high specificity (true negatives) and sensitivity (identify true positives) among other factors such as ease of use and affordability. These kits should detect concentrations below usual spiking levels, especially considering GHB's synergistic effects when mixed with alcohol. Tests should not result in false negatives to prevent individuals from unknowingly consuming spiked beverages. Conversely, false positive results may lead to unwarranted accusations against businesses/venues.

Method - In this phase of our research, we explored commercially available drink testing kits, purchased them, and conducted laboratory tests following the manufacturers' recommendations. The kits tested included three colour-based testing kits (CT1, CT2 and CT3 –anonymised) and two immunoassay-based testing kits (IAT1 and IAT2 – anonymised), each claiming to detect individual drug or a combination of drugs (Table 4) at potential spiking concentrations. GHB sodium salt, diazepam, lorazepam as free base and ketamine hydrochloride were used in this study.

Evidence based research on drink spiking

Colour test kits are available only for GHB or GHB and ketamine, whereas immunoassay testing kits offer a wider range of drug detection options. For comparison of results, we used kits capable of testing for GHB, ketamine, and benzodiazepines in this research.

Key findings – The colour-based tests used in this research exhibited a degree of subjectivity and included contradictory and confusing instructions. CT1 and CT3 are coloured testing strips. The instructions stated that if either test strip shows a red or blue spot, 'do not drink', which contradicted the reference colour change shown on the strip itself. The CT3 test strip used in this research also presented other challenges. The strip's small surface area made it difficult to compare the colour change with the initial strip colour.

Unlike the CT1 and CT3 strips, CT2 exclusively tests for GHB in drink samples. According to the disclaimer provided with the product, the testing spot turns from green to blue within 2 minutes when GHB is present, however, we observed an immediate colour change. The disclaimer also states that if the wristband gets wet from rain or water, the test field will react with water and change to blue as a safety feature. However, this issue should not arise when water is mixed with other liquids, as per the disclaimer. Therefore, they have specified that water itself cannot be tested with this wristband.

Colour test exemplar results are shown in Table 5, and immunoassay kit results are in Table 6. We observed false positive results with colour testing kits when used with water and some other beverages, prompting us to test the specificity of the studied kits. CT1 results showed the highest false positives (97.1% on the yellow side of the strip and 25.7% on the pink side), followed by 80.0% false positives for the GHB test within the IAT1 with only 15.4% false positives for CT2 (sample size were significantly different therefore direct comparison cannot be made). The higher false positives could be linked to the drink's colour, subjectivity in colour interpretation, and a lack of contrast with the expected colour change. In addition, colour blindness could also impact the interpretation of the results. Please note that CT3 kits were not used for specificity studies. In comparison to the colour tests, immunoassay-based testing kits showed lower false positives (ketamine – 11.4%, benzodiazepines – no false positives from IAT1 to 2.9% false positives for IAT2).

Table 4. Drink testing kits, drugs tested for, and all relevant information obtained from instructions from the manufacturers and their websites (date checked 05/08/2024).

Mechanism	Test kits	Test panel for	Preliminary positive	Invalid & negative results	Limitations stated	Detectable level and other
Immunoassay	IAT1 (4 drugs panel)	GHB, Ketamine, Phencyclidine, Benzodiazepines	GHB- light purple to dark purple in 10 mins Coloured line appears next to C (control line) but no other line appears next to T (test line) in 5 minutes	Invalid - C line fails to appear Negative – Coloured lines appear next to C and T	Drinks must be non-oily, or non-dairy, and less than 25% alcoholic, pH 5-9, no odour or fungus in the drink	GHB = 10,000 ng/mL Ketamine = 1,000 ng/mL Phencyclidine = 50 ng/mL Benzodiazepines (e.g. Oxazepam) = 300/600 ng/mL
	IAT2 (urine testing but the test can also be used for testing drinks)	Benzodiazepines (21 listed)	Coloured line appears next to C but no line appears next to T in 5 minutes	Invalid – no lines appear or one line appears next to T Negative – Coloured lines appear next to C and T	Adulterants such as bleach and alum in urine may produce erroneous results Will not work in straight shots, such as vodka.	Accuracy 99%. Sensitivity - 200ng/mL (Oxazepam, Diazepam) Detectable limits for other Benzodiazepines provided
Colour based	CT1	Ketamine and GHB	Coloured circle appear on either side of the strip.	Not specified	Not specified	Minimum standard dosage

			Colour shown in the test strip is different to the text included. (time not specified)			
	CT3		Pink patch turns blue, or the yellow patch turns orange (time not specified)	Not specified	Not specified	Detectable level – not specified
	CT2	GHB only	Spot will turn from green to blue in 2 minutes.	Light yellowish/ greenish	Pure water or rain turns test field blue but the test works normally with water based drinks.	Not specified but says 98.2% reliability

Evidence based research on drink spiking

Table 5. Exemplar results showing false positive, and positive with their respective drugs using colour testing kits.

Testing Kits	WKD without drugs	True positives in WKD	
CT1	**False positive** - pink changed to light blue and yellow changed to slight range.	**Ketamine positive** - The colour changed from yellow to orange.	**GHB positive** - The colour changed from pink to slight blue, but it may not be specific enough to rule out a false negative or even to consider it as a positive result under varying lighting conditions.
CT3	Difficult to interpret results due to small surface area	**Ketamine positive** – The colour changed from yellow to orange but for GHB, the colour changed from pink to slight blue, but it may not be specific enough to rule out a false negative or even to consider it as a positive result under varying lighting conditions. The small surface area also adds to the difficulty here.	
CT2	**False Positive** – Turning slight blue leading to confusion.	**GHB Positive** – Green to blue but not enough to rule out a false negative or even to consider it as a positive result under varying lighting conditions.	

Table 6. Exemplar results showing false positive, and positive with their respective drugs using immunoassay-based kits tested with WKD with and without spiking in our laboratory.

Testing Kits	Negative control - WKD	Positive control
IAT2	**Negative results** - presence of two lines	**Positive results** – only one line present. Diazepam and lorazepam were tested. This test is only for benzodiazepines.
IAT1	**Negative results** – presence of two lines, excluding GHB which was a false positive (GHB strip is still a colour-based test).	**Positive results -** only one line present for ketamine and benzodiazepines (diazepam and lorazepam) with light purple for GHB. PCP was not tested in this research.

Overall summary

Given the number and type of drugs associated with drink spiking, one cannot simply test for a drug or a few and claim their drink is safe. This may result in a false sense of security for the intended users. The colour testing kits are only available for GHB and ketamine, the colour change is not as strong as indicated by the manufacturers and is even more problematic to interpret in poor lighting settings or for coloured beverages. The interpretation of the results could also be impacted if the user is colour-blind. Overall, the colour-based testing kits have lower specificity and higher false positive results, including GHB tested in the 4-drug panel IAT1. Therefore, our view is that these tests are not effective or reliable enough as testing methods for spiked drinks.

In contrast, immunoassay kits, such as IAT2 and IAT1 (for ketamine and benzodiazepines), show significantly fewer false positives compared to colour tests. Although there are kits available that can detect more drugs, they are typically expensive. Furthermore, the immunoassay kits display their negative/positive results opposite to that of COVID and pregnancy testing kits which the user might be more familiar with, and therefore can cause confusion in a drink spiking scenario.

Study 4 - Analysis of Drinks Collected From Night Time Venues

One way of monitoring prevalence of drink spiking and associated drugs used, is analysing drink samples. To do that, Cambridgeshire Constabulary acted as a gatekeeper and contacted the venues on our behalf. Out of those contacted, six venues replied and expressed interest in taking part in this study. Finally, four venues agreed to participate. Samples were collected between December 2023 and January 2024.

Method

Sample collection – Samples of drinks were collected from various night-time venues across Cambridgeshire during agreed dates and times by visiting the venues. These samples comprised leftover drinks from glasses ready for washing. In total, 236 samples were collected and analysed using presumptive testing and GC-MS methods. Duplicate samples were prepared for GC-MS analysis. Our sample collection efforts aimed to encompass periods including Christmas time, university welcome week in January, and payday.

Sample analysis - The drinks obtained from the venues were initially tested using presumptive kits: IAT2, CT1 and CT2 (Table 7); randomly selected five samples were also analysed by IAT1 (Table 8). Subsequently, samples which tested positive using any two of the presumptive kits underwent instrumental analysis (n = 162). Our analytical method allows for detection of 39 drugs and pharmaceutical compounds from different classes (amphetamines, cathinones, cocaine, opiates, GHB, ketamine and benzodiazepines). Alcohol was not included in this study.

Results - For IAT2, a larger volume of the sample was needed to dip the strip for 10-15 seconds until the liquid reached the wavy lines on the test strip. The strip was then placed on a flat surface and the results were read after 5 minutes. Consequently, samples with small volumes could not be tested with this kit. IAT2, which exclusively tests for benzodiazepines, consistently produced clear negative results, corroborating the GC-MS findings. In contrast, both colour-based tests — CT1 (which tests for ketamine and GHB) and CT2 (which tests for GHB only) — yielded false positives, consistent with the results reported in Study 3 of our research. The drugs studied in this research, including GHB, ketamine and benzodiazepines, were not detected by GC-MS analysis (Table 7). However, we did detect substances such as caffeine (e.g. SN29 and SN119) and glycerol in SN95, indicating that the studied drugs were likely to have been detected at spiking concentrations if they were present. Identification of these compounds relied on preliminary matches with the NIST database.

Table 7. Exemplar results for drinks collected from night-time venues in Cambridgeshire tested using various presumptive tests and GC-MS. P indicates positive and N indicates negative results.

Samples	IAT2	CT1	CT2	GC-MS
SN 6	N	**P**	**P**	N
SN 29	N	**P**	**P**	N
SN 142	N	**P**	**P**	N
SN 119	Not tested due to limited sample	N	**P**	N
SN 95 (red drink)		Inconclusive - coloured drink		N
				N
SN 77		**P**	**P**	N
SN 81	N	**P**	**P**	N
SN 222	N	**P**	**P**	N
SN 235	N	**P**	**P**	N

Table 8 shows results from drinks that were also tested with IAT1. This test yielded positive results for GHB but negative for ketamine and benzodiazepines. IAT2 and CT2 also showed negative results whereas CT1 showed positive results for two out of five samples tested. These findings further support our view that colour-based methods are unreliable. The results from the colour tests could be attributed to the subjective nature of colour interpretation, as only a slight colour change was observed with positive tests (Table 5).

Table 8. Comparison of IAT1 results with other presumptive testing methods and GC-MS. P indicates positive and N indicates negative results.

Samples	IAT2	CT1	CT2	IAT1	GC-MS
SN194	N	N	N	**Positive results for GHB**	N
SN210		N			
SN226		**P**			
SN227		**P**		Negative for ketamine and benzodiazepines	
SN236		N			

* CT1 is expected to detect the presence of GHB and ketamine; CT2 only GHB.

Overall findings – In conclusion, the drink samples analysed in this research tested negative for all 39 drugs (excluding alcohol) and pharmaceuticals. Additionally, as stated in Study 3, the colour testing methods used were again found to be unreliable, as they produced false positives.

Study 5 - Analysis of Urine Samples Collected From Survivors of Alleged Drink Spiking

Urine is one of the most commonly analysed toxicology sample. It plays a crucial role in forensic toxicology, aiding in the detection and quantification of various substances present in the body. Immunoassays are used for screening analysis and analytical techniques such as GC-MS are used for confirmation. This process provides valuable information regarding the presence of drug(s) in an individual's system at the time of urine collection. However, delays in reporting and the time elapsed since sample collection to analysis may introduce potential issues.

Method

Ethics approval – This research received ethics approval from the Faculty Research Ethics Panel under the terms of ARU's Research Ethics Policy, December 2022 (ETH2223-0025). As such, this research complies with the Human Tissue Act (HTA), 2004.

Sample collection – Urine samples were collected from consenting participants who had reported to Cambridgeshire Constabulary that they suspected their drink had been spiked. These samples were collected at the time of reporting and stored in a freezer by Cambridgeshire Constabulary. Only samples considered to have no further evidential value were used in our research. Collection followed the standard protocol of Cambridgeshire Constabulary. All participants in our study are over the age of 18.

For us to use urine in this research, retrospective consent was obtained by police officers. 8 samples were finally collected and brought to the Anglia Ruskin University laboratory on 29 February 2024. These samples were subjected to the presumptive testing (IAT1 and urine testing cup, UC) and followed by sample preparation and analysis by GC-MS.

Presumptive testing kits

Table 9 summarises the cutoff levels for the drugs that UC can simultaneously detect. It also includes guidance on interpreting the results (i.e. preliminary positive, negative, and invalid). To our knowledge, this test kit offers the broadest simultaneous detection of drugs and pharmaceuticals. It can detect 13 different drugs/ drug classes and in some cases their metabolites. For example, the 'cocaine' test strip tests positive for cocaine and its three metabolites, and the 'benzodiazepine' test strip tests for 16 different benzodiazepines, including diazepam and flunitrazepam. However, a GHB test is not included. Both kits used in this study tested for benzodiazepines, ketamine, and phencyclidine, but only IAT1 included GHB testing (see Table 4 in Study 3).

Presumptive testing of negative urine samples - As a negative control, we tested our own urine samples (neither of us had been on medication for the past few months). These were analysed using UC (Table 9) and IAT1 (Table 4). Although the IAT1 kit is designed for drink testing, we used it on urine samples for this experiment, particularly because GHB testing is not possible with the urine testing cup.

A minimum of 30 mL of urine was transferred to the urine testing cup. The results were read after 5 minutes. One sample did not meet the 30 mL requirement, but all test strips in the cup were submerged in the available urine and yielded results. For IAT1, the cap was first removed, and, with arrows pointing towards the sample, the test panel was immersed vertically in urine for 10-15 seconds to the level of the wavy lines. Results were read in 5 minutes except for the GHB test, which required 10 minutes as shown in Table 4. GHB shows colour change (light purple colour at 10 µg/mL and dark purple colour at greater or equal to 50 µg/mL) therefore results need to be compared with the colour shown on the packaging.

Presumptive testing of urine samples

Urine samples were thawed at room temperature before being subjected to presumptive testing using commercially available testing kits/cups, in addition to pH measurement. Throughout the presumptive testing phase, urine samples were maintained at 18-20˚C. The same method as described for negative urine was followed.

Table 9. Interpretation guidelines for the urine testing cup.

Test kits	Cut off (ng/mL)	Negative & invalid	Preliminary positive	Limitations and other information
UC	Amphetamine (500) Barbiturates (300) Buprenorphine (10) Benzodiazepines (200) Cocaine (150) Synthetic marijuana (50) Ketamine (1000) Methamphetamine (500) Methadone (300) Opiates (2000) Phencyclidine (25) Propoxyphene (300) Tricyclic antidepressants (1000) Marijuana (50)	**Negative** – Red or pink line appears next to T1 or T2 under the drug name and another line appears next to C. **Invalid** – If no red or pink line appears on control line (C), the result is invalid.	If no red or pink line appears next to the T1 and T2 under the drug name, the sample may contain that drug. This means, it shows only one line next to C. Read results after 5 minutes	**Limitations** - Does not distinguish between drugs of abuse and certain medications. May result preliminary positive with prescription medications (e.g. tricyclic antidepressants, barbiturates, benzodiazepines, methadone, buprenorphine and opiates), even at therapeutic doses. **Other information –** Instruction provided includes summary of accuracy results, sensitivity, precision, and interference results.

GC-MS sample preparation

All urine samples (Table 10) were prepared using enzymatic digestion followed by liquid-liquid extraction under both acidic and basic conditions. The samples were analysed with and without derivatization, resulting in eight different results for each sample to maximise detection. These analyses were conducted using GC-MS.

Results interpretation

The urine testing cup and IAT1 indicated the absence of compounds these test kits are designed to detect in all samples tested. Upon analysis by GC-MS, none of the 39 drugs included in this study were detected (Table 10). However, among the 8 samples analysed, sertraline (an antidepressant) and its metabolites were detected in one sample. The remaining seven samples showed the presence of caffeine and its metabolites. Sample six contained paracetamol and its metabolite. Additionally, cotinine (nicotine metabolite) and aspirin metabolites were detected in one instance. Identification of these compounds relied on preliminary matches with the NIST database, as they were not part of our initial screening method.

Table 10. Presumptive testing and GC-MS results from urine samples (March 2024).

SN	Time between collection and analysis	IAT1	Urine cup	GC-MS results (tentative based on NIST)
S1	15 months	Negative for the drugs and pharmaceuticals that can be tested by these kits.		Caffeine
S2				Caffeine and its metabolites, metabolites of aspirin
S3	8 months			Caffeine
S4	Unknown			Caffeine and its metabolites
S5				Paracetamol, **sertraline** and its metabolites
S6				Paracetamol, caffeine and metabolites of nicotine
S7 & S8	15 months			Metabolites of caffeine

From the date of sample submission to the police until the analysis in March 2024, four of the samples were stored for over two years. For three samples, the submission dates are unknown, and one sample was analysed within one year. If the survivors' drinks were spiked, potential reasons for non-detection of drugs used in the study include any of the points below or their combination:

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1. Drugs and metabolites may have been cleared from the body due to delays in reporting, and the time between the incident and sample submission is unknown to the researchers.
2. Drugs and metabolites may have degraded due to the extended duration of sample storage.
3. The drugs may fall outside the scope of what can be detected by both the presumptive test and the GC-MS method used in this research.
4. The concentration of drugs and metabolites may be below the detection limit of the methods used.

Sertraline and its metabolites were detected in one sample. Sertraline is an antidepressant called 'selective serotonin reuptake inhibitor' (SSRI), which differs from tricyclic antidepressants, the latter being detected by the urine test cup. However, sertraline was not among the 39 drugs included in our testing method, so this finding is based solely on the NIST database. Sertraline is commonly prescribed for conditions such as depression and panic attacks. According to the NHS (UK), consuming alcohol while taking sertraline may cause sleepiness.

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Conclusions

Our comprehensive investigation into drink spiking and needling has shed light on several crucial aspects of this societal issue. Through national surveys, we uncovered the prevalence of drink spiking and needling, with an increase in incidents reported over the past year, including in college/university environments. Our findings also highlight the underreporting of drink spiking/ needling to authorities, with many survivors opting to confide in someone else rather than contacting the police, citing various reasons for their reluctance.

Furthermore, our examination of initiatives implemented by nightlife venues in Cambridgeshire revealed a mixed response to addressing drink spiking incidents, with a lack of consistency in reporting to the police and varying levels of preventive measures in place. Despite the implementation of measures like CCTV and entry searches, the effectiveness of these strategies in deterring drink spiking remains uncertain.

Additionally, our evaluation of commercially available colour-based drink testing kits revealed limitations in their reliability and effectiveness, raising concerns about their ability to accurately detect spiked beverages and provide a false sense of security to users. Furthermore, these kits are limited to testing only for GHB and ketamine. In contrast, immunoassay-based tests, while more reliable, are more expensive but can test for a wider range of drugs.

Our analysis of drink samples from night-time venues, as well as urine samples collected from survivors of alleged drink spiking incidents, did not show presence of studied drugs and pharmaceuticals. The drugs included in this research were carefully selected based on their properties and likelihood of being used in spiking cases. Alcohol, also considered a drug, was not investigated in this research.

Various factors such as the timeline from alleged incident to urine sample collection and the length of sample storage before analysis may have contributed to the degradation of compounds, leading to negative results. This demonstrates the challenges in detecting and confirming instances of drink spiking through conventional testing methods.

Overall, our findings underscore the complex nature of the issue of drink spiking and the need for multifaceted approaches involving public awareness, collaboration with establishments, and advancements in detection methods to address this growing concern effectively.

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Recommendations For Further Work

This is the first comprehensive research on the topic, exploring every possible aspect of drink spiking from public perception, and their experiences, to the analysis of drink and urine samples, as well as including the assessment of available testing kits. We have also explored initiatives introduced by nightlife venues and their reporting of these incidents to the police. Given our established partnerships with a range of stakeholders, including Drinkaware, police and nightlife venues, our research group is uniquely positioned to continue leading these efforts.

Drawing upon the insights gained from our research, we have the following recommendations for future work. They encompass both the continuation of ongoing efforts and the exploration of innovative, strategic approaches to take a pioneering role in addressing this issue.

1. Addressing drink spiking requires enhancing detection methods. Advanced technologies like QTOF (Quadrupole Time-of-Flight) offer rapid screening without complex sample preparation, vastly improving detection capabilities. QTOF can simultaneously analyse over 1000 analytes, effectively detecting drink spiking compounds in both drinks and urine samples. Therefore, investing in advanced instrumentation, like QTOF, might provide further scientific evidence on drink spiking cases.

2. Conducting longitudinal studies to track the prevalence of drink spiking and needling over time, allowing for a better understanding of trends and changes in occurrence rates using the Drinkaware Monitor survey.

3. Conducting a comprehensive longitudinal study on nightlife venues across the country is imperative to gain deep insights into the efficacy of interventions and initiatives aimed at combating drink spiking. This study will not only provide invaluable data on the prevalence of drink spiking and needling but also facilitate the monitoring of incidents reported to law enforcement agencies.

4. Investigating effectiveness of prevention measures implemented by alcohol-serving venues, including CCTV, entry searches, and staff training programmes. Research could explore the impact of these measures on reducing incidences of drink spiking and improving victim support as well as reporting mechanisms.

5. Exploring strategies to improve victim support services and encourage reporting of drink spiking incidents to authorities. Research could examine the

barriers to reporting, develop interventions to address these barriers, and evaluate the impact of enhanced support services on reporting rates and victim outcomes.

6. Investigating broader public health implications of drink spiking and needling, including the psychological, physical, and social consequences for survivors. Research could assess the long-term health effects of drug exposure through drink spiking and evaluate the cost-effectiveness of interventions aimed at prevention and support.

By addressing these areas of research and development, we can advance our understanding of drink spiking and needling, identify effective strategies for prevention and support, and ultimately work towards reducing the incidence and impact of this harmful behaviour on individuals and communities.

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