

1 **What about drug checking? Systematic review and netnographic**
2 **analysis of social media**

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6
7 **Abstract**

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9 Drug checking services have been operating worldwide as a harm reduction tool in
10 places like festivals and nightclubs. A systematic review and netnographic analysis
11 were conducted to explore the public's perception of drug checking. Although public
12 perceptions of drug checking had not previously been evaluated in the literature, some
13 positive and negative perceptions were captured. From Twitter, a total of 1316 tweets
14 were initially identified. Following the removal of irrelevant tweets, 235 relevant tweets
15 were identified of which about 95% (n = 223) tweets were in favour and about 5% (n
16 = 12) were not in favour of drug checking as a harm reduction intervention. Tweets
17 perceived the service as part of effective law reform, public health intervention that
18 serves in raising awareness and countering the role of the internet, initiative to prevent
19 harm and/ or potentially deaths, help in identifying novel trends related to drugs,
20 enabling a scientific basis to capture data, reducing harm from risky drugs or risky
21 consumption, reducing the economic and social burden on society and preventing
22 young people from having criminal records and punitive fines. Drug checking was
23 perceived to support engagement with treatment services and support individuals in
24 making more informed decisions. Tweets against drug checking focussed on the
25 concerns over the quality of drug checking particularly with false positive results, which
26 may lead to punitive outcomes, discrimination and prejudice. The present study
27 showed that Twitter can be a useful platform to capture people's perceptions on drug
28 checking.
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31 **Keywords**

32 Drug checking, Drug screening, Drug testing, Pill testing, Harm Reduction, Twitter
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51 **Introduction and Background**

52 The growing increase in the severe harm caused by the use of illicit drugs places
53 immense pressure on healthcare services [1-3]. As part of a public health initiative to
54 tackle the harms associated with drug use, drug checking services (also known as
55 drug or pill testing) have been made increasingly available worldwide as part of a harm
56 reduction approach [4-5]. In 2017, a global review identified 31 drug checking services
57 operating across 20 countries [6].

58 Various drug checking models have been established. These include on-site (also
59 known as front-of-house testing) drug checking services such as The Loop, which is
60 commonly found in nightlife economy like nightclubs and at festivals [7-8]. "Front-of-
61 house testing" allows "face-to-face interactions and real-time exchange of information"
62 between service users and service providers [5, 9-11]. Other models include off-site
63 services such as the Welsh Emerging Drugs & Identification of Novel Substances
64 (WEDINOS) project, a service that is funded by the Welsh Government. It allows
65 submission of drug samples whereby individuals are provided with information on the
66 chemical profile and harm reduction advice in addition to samples submitted from
67 various organisations, services and nightlife economy venues from across the UK [12-
68 13]. Another example of off-site services is MANDRAKE (Manchester Drug Analysis
69 and Knowledge Exchange), which works in partnership with local police and other
70 stakeholders in Manchester (UK), providing analytical results alongside harm
71 reduction interventions in the city-centre [14]. Self-checking drug testing is another
72 delivery method, which individuals can employ to assess their own products, and have
73 been perhaps most commonly utilised to reduce the risk of fatal overdoses from potent
74 drugs such as fentanyl derivatives [15-20].

75
76 The Drug Information and Monitoring System (DIMS) in the Netherlands is perhaps
77 the longest running drug checking service [6]. DIMS have successfully operated their
78 services for over 20 years [6, 10, 21], and have acted as a pharmacovigilance arm,
79 which feeds into the European Early Warning System [22]. Following the Dutch
80 initiative, other drug checking services began to set up across Europe, including
81 CheckIt in Austria and WEDINOS in the UK. These drug checking services share
82 common goals: reducing harm and inadvertent overdoses and pre-mature deaths [23-
83 24]. DanceSafe was founded in 1998, in the United States. It provided a harm
84 reduction service to the nightlife and electronic music community [7, 10]. More recently
85 in the UK, The Loop introduced a "front-of-house" service known as Multi-Agency
86 Safety Testing (MAST) to festivalgoers since 2016, which has claimed a 95%
87 reduction in drug-related hospital admissions and identified numerous samples that
88 were miss-sold [8].

89 In the UK, the first Home Office-licensed pharmacist-led drug checking service, within
90 a drug and alcohol service, was piloted in 2019 in North Somerset. The pilot checked
91 drug samples and provided holistic harm reduction interventions using a multi-
92 disciplinary approach [25]. However, unlike the UK and the Netherlands, where drug

93 checking services are supported by government bodies and/ or through controlled
94 drug licenses, other countries are often restricted as a result of national laws and
95 regulations [6, 10, 21, 26]. In some services, where possession of drugs may be an
96 offence, drug checking services' staff would ask the service user to conduct the testing
97 themselves [27-28]. These services are dependent upon volunteer harm reduction
98 organisations, where analysts may not have sufficient training [29]. Thus, despite the
99 increasing use of drug checking services in a variety of settings, they may not be
100 widely accepted and may be perceived as encouraging drug use [30-31]. Limited
101 studies have been conducted to explore acceptability of drug checking whether the
102 service was provided by specialised services or undertaken by the drug user [4, 19-
103 20, 32]. An evaluation of DIMS has been undertaken to assess whether service
104 provision has increased drug use. Evaluation results showed that drug use has
105 remained unchanged since the initial set up of the service in 1992 in the Netherlands
106 [33].

107 Due to the limited published literature available on the general public's perception of
108 drug checking, in this research, we aimed to explore this further via social media.
109 "Social media mining" may provide some understanding of the acceptability of the use
110 of drug checking services within a harm reduction context and potential for use in a
111 wide range of settings. The growing popularity of social media in recent years has
112 provided a platform for users and suppliers to interact and communicate and is
113 frequently used by providers of drug checking services to communicate findings,
114 particularly pertaining to substances, which carry significant levels of risks if
115 consumed.

116 A netnographic method, where qualitative data is obtained from information that is
117 already publicly available can be used to identify the needs and decision influences of
118 online consumer groups [34]. "Social media mining" has been shown to be an effective
119 public health tool that can support disease surveillance, pharmacovigilance
120 particularly with respect to behavioural medicines, etc. [35]. However, "Social media
121 mining" can be limited by technical literacy and subjective analysis [35]. In fact, many
122 research papers have used social media as a source of big data that is generated by
123 users [35- 46]. This approach has been used to explore various aspects of substance
124 misuse via Twitter [38-46]. Unlike other social media platforms such as Facebook,
125 Twitter's Application Programming Interface (API) is easily and openly accessible,
126 allowing large publicly made available datasets to be retrieved [47]. Twitter users
127 create posts known as "tweets", which are limited to 280 characters and reports having
128 326 million monthly active users in 2018 [48] with 500 million tweets posted daily [49].
129 Re-tweets are posts re-tweeted by other users. Furthermore, the creation of
130 "Hashtags" allows tweets to be categorised [50], which is useful for classifying major
131 themes and current understanding trends.

132 By using Twitter, user-generated data has been commonly collected manually or via
133 a web crawler [36]. The duration of data collection in various studies varied from seven

134 days up to a year [39, 44]. Some of these research papers collected tweets, whilst
135 others identified social circles of main users [39, 41]. The number of tweets varied with
136 the popularity of the topic. For example, 2100 tweets were collected about the use of
137 prescription drugs in just seven days [44]. This is in comparison 2.3 million tweets
138 collected over six months on diversion of prescription medicines [40].

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140 To our knowledge, there are no published papers to date, which explored the public's
141 perception of drug checking or drug testing via Twitter.

142

143 **Aims**

144 The aim of this study was to explore the public's perception of drug testing as a harm
145 reduction intervention in the literature and via Twitter.

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147 **Methodology**

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149 The public's perceptions of drug testing as a harm reduction intervention was explored
150 in the literature. Engagement in discussions related to drug testing was investigated
151 by collecting real-time data using a netnographic methodology via Twitter.

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153 **Literature Review**

154 A literature review was carried out using the scientific databases PubMed, Scopus and
155 Google Scholar using the PRISMA guidelines (Preferred Reporting Items for
156 Systematic Reviews and Meta-Analyses) [51] (Figure 1). The search was completed
157 during 2019 and the following search terms were used: "public perception" AND "drug
158 testing" OR "drug checking" OR "drug screening" OR "pill testing"; a combination of all
159 four search terms: "drug testing" AND "drug checking" AND "drug screening" AND "pill
160 testing". All types of publications up until 18th July 2019 were included. Articles that
161 were not written in English were excluded from this study. Duplicate articles were
162 removed using Zotero V.5.0.69. A grey literature search was also conducted on
163 Google to explore the public's perception of drug testing at festivals using the same
164 search terms.

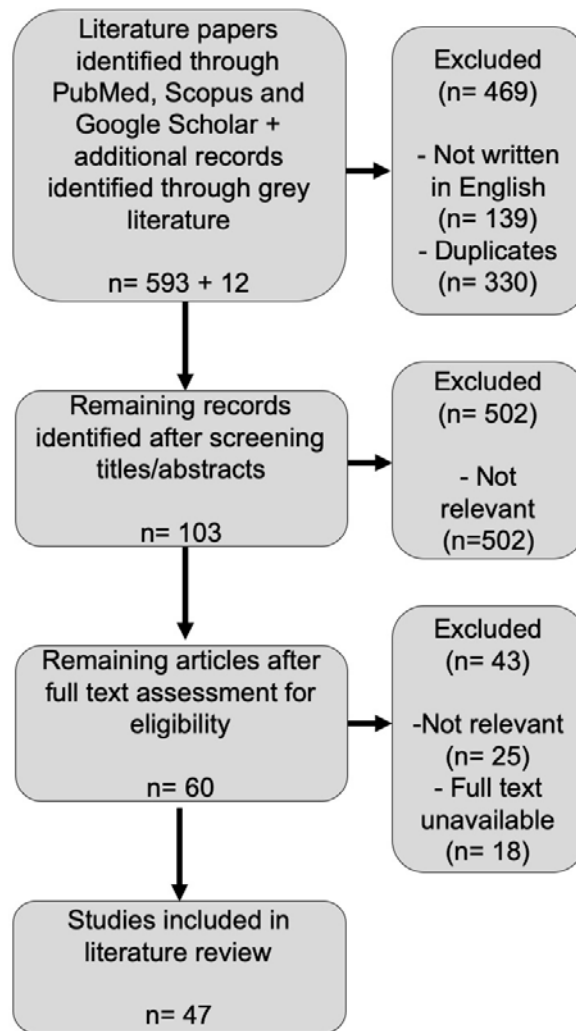


Figure 1: PRISMA flow chart

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Twitter Data

RapidMiner Studio (2018) V.9.0. (Germany), a data-mining software, was employed to extract tweets over a one-month period (23rd October 2018 - 23rd November 2018) from Twitter users as outlined in Figure 2. A "Search Twitter" operator was selected to allow access to Twitter and establish a connection with a Twitter account. The following keywords were individually searched: "drug testing", "drug checking", "drug screening" and "pill testing", with separate connections being established. Access tokens were then produced, which provided authentication and allowed RapidMiner to connect to the Twitter account.

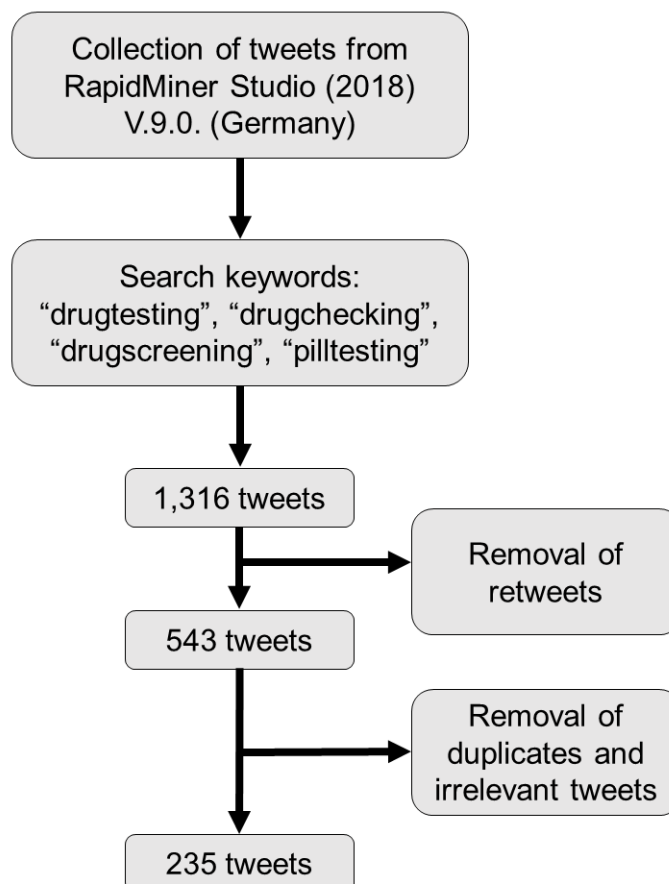


Figure 2: A schematic flowchart outlining the process of extracting tweets from the data mining software RapidMiner Studio (2018) V.9.0. (Germany).

Method optimisation and data cleaning

Following the initial set up, additional parameters were added (e.g. exclude non-English tweets) to restrict the search and ensure relevance of the original tweets as highlighted in Table 1. Raw data were then imported into a Microsoft Excel (2018) spreadsheet (Table 2). The software could only identify tweets that were most recent or popular (up to 10 days). This led to old tweets being automatically deleted from the spreadsheet as more recent tweets became available. As a result, new spreadsheets had to be created daily in order to keep the data intact and ensure tweets were being obtained through the software. Due to a large volume of raw data generated, RapidMiner was used to clean the dataset e.g. remove retweets and duplicates. For this purpose, a second spreadsheet was created with reposted tweets (re-tweets) removed, undertaken using the same parameters described in Table 2 with the addition of “(-rt)” after each keyword. Tweets related to workplace drug testing were not aligned with the objectives of this study and hence, were also removed.

202 Table 1: Outline of searches for tweets and additional search restrictions
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Parameter	Description	Search Restrictions
Search Query	The term that should be searched	drugtesting, drugscreening, drugchecking, pilltesting
Result Type	The preferred search result type	Recent or popular
Limit	The limit on the number of tweets to return	1,000
Language	Specifies the language of the query	English

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Table 2: Output data generated on a Microsoft Excel (2018) spreadsheet

Parameter	Description
Created-At	Date and time tweets were created
From-User	Username of Twitter account holder
From-User-Id	Username Id of Twitter account holder
To-User	User of which tweet is directed to
To-User-Id	User Id of which tweet is directed to
Language	Language of tweet
Source	Source of tweet
Text	Tweet created by user
Geo-Location-Latitude	Geographical location and latitude of the tweet
Retweet-Count	Number of re-tweets
Id	Id of tweet

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210 Re-tweets, duplicated and irrelevant tweets were excluded and manually removed
 211 from the data set. The dataset collected from raw data was manually compared to
 212 clean data, to ensure no tweets were missed during removal of re-tweets. Keywords
 213 and phrases were also searched within the document using the sidebar search to
 214 confirm the removal of duplicated tweets. Keywords were manually identified assigned
 215 and themes were analysed by searching for common words or phrases present within
 216 the tweets. A colour coding system was then used to categorise these tweets to their
 217 relevant themes. The Excel spreadsheet was manually reviewed by IM and
 218 independently reviewed by AG to ensure appropriate tweets had been identified.
 219 Categorisation was then independently reviewed, the findings were discussed and no
 220 differences were identified.

221 In this study, original tweets were only included. Re-tweets may indicate that a user is
222 in favour of a tweet. They were however removed from the dataset as there is no clear
223 indication whether the tweet is, in fact, an opinion of the tweeter. For example, some
224 users may choose to re-tweet a tweet, which resonates with their followers, but this
225 may not represent their personal opinion. Duplicates were also removed from the
226 dataset. Duplicates differ from re-tweets as users may duplicate an original tweet by
227 re-writing the same tweet. Organisations may also use this method by tweeting the
228 same tweet multiple times during the day to increase the chances of followers viewing
229 the tweet. The latter is not considered a duplicated as they have been tweeted by
230 different users and hence, were not removed from the dataset.

231

232 **Results**

233

234 *Literature Review*

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236 Search results from Scopus and PubMed identified a total of 139 papers. The search
237 from Google Scholar identified 923 papers. Seventeen published papers over the
238 period 2015 - 2019 were identified as relevant. Duplicate articles were removed and
239 relevant papers were identified resulting in 47 papers. Due to the limited published
240 data available on the public's perception of drug testing at festivals in the UK;
241 therefore, a grey literature search was conducted on Google to provide an overview
242 of the public's perception of drug testing at festivals in the UK.

243 The literature review identified two main authors Barratt and Brunt who have carried
244 out comprehensive global evidence reviews to compare various drug checking
245 services [52]. The literature review also showed the lack of benchmarking to evaluate
246 these services [52]. It has also showed mixed views relating to perceptions of drug
247 checking services. Some views expressed that these services were found to positively
248 influence users' behaviour and allow informed decisions to be made [8, 53-54], whilst,
249 others expressed their concerns about the potential of these services to encourage or
250 endorse drug use [8-10, 55-57]. Limited studies have been conducted in the UK to
251 explore the public's perceptions of drug checking in the UK [8, 25]. A number of
252 research papers explored various aspects of substance misuse on Twitter [38-42, 44-
253 46], however, none of them explored the public's perceptions on drug checking.

254

255 *Twitter*

256 This research explored the views and perceptions of the general public using real-time
257 data collected employing a netnography method, where data was collected from
258 Twitter. Themes "in favour" or "not in favour" of drug checking were identified from
259 keywords, hashtags and full tweets.

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261 A total of 1316 tweets were initially identified. Following the removal of retweets, 543
262 original tweets were identified: 274 tweets on drug testing, 50 on drug screening, 50

263 on drug checking and 169 on pill testing. Following the removal of duplicates and
264 irrelevant tweets (n = 56), 235 relevant tweets were identified of which about 95% (n
265 = 223) tweets were in favour and about 5% (n = 12) were not in favour of drug testing
266 as a harm reduction intervention. The most common keyword that attracted relevant
267 tweet was “pill testing”.

268

269 Keywords were identified to explore a user’s behaviour and the emotions they are
270 trying to convey. For example, positive emotions are often associated with words such
271 as “good” and “amazing” whereas negative emotions are associated with words such
272 as “bad” and “poor” [58]. Examples of positive sentiments identified within the tweets
273 include “*pleased*”, “*happy*” and “*grateful*”. Negative sentiments identified. Include “*sad*”
274 and “*disappointing*”.

275

276 Results from the present study are in good agreement with findings from other twitter
277 studies:

278

279 *“Of 87 respondents 53% supported #pilltesting at all youth music events in Australia,
280 46% supported pilltesting at GroovinTheMoo and 1% opposed pill testing
281 <https://t.co/Mci67vjX8e>”*

282

283 **Tweets in favour of drug checking listed various benefits of those services
284 including raising awareness and countering the role of the internet:**

285

286 *“having that discussion face-to-face with health professionals means more young
287 people can stay safe and healthy”.*

288

289 *“This is about listening to experts & giving people non-judgmental info about their
290 #drugs that will prevent overdose & save lives”.*

291

292 *“Impact of speaking with a professional on dangers of drugs, without fear of
293 persecution”.*

294

295 *“it is overseen by medical professionals with expertise in drug overdose, with forensic
296 chemists performing the analysis on lab grade kit, & peer groups providing context”.*

297

298 **Tweets identified in favour of drug checking highlighted tweeter’s opinions
299 that drug checking could prevent harm and/ or potentially deaths:**

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301 *“After significant struggle>80 countries allowed legal needle syringe programs to
302 reduce HIV spread among & from people who inject drugs as less worse option.
303 #Pilltesting another less worse option compared to more deaths & hospital admissions
304 of young people at music events”.*

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306 *“Tragedy averted by naloxone by paramedics”.*

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"I'd much prefer to see benefit of doubt go to trying to save lives, prevent hospital admissions of young people than go to theoretical concerns maybe this/that. Let's get on with it!"

"Pill testing would be beneficial to save lives & expenses. Whilst having drug tested, users could've been educated on dosage to reduce OD."

"Save lives first, questions later #PillTestingSavesLives #pilltesting #votereason!"

"There are concerns Premier Berejiklian's policy of ramping up police operations and refusing to adopt harm minimisation measures such as pill testing will lead to the loss of more young lives. #sydneydruglawyers #pilltesting #musicfestivals #drugpossession <https://t.co/SCgdBbkHvt>"

"What we know is that at the #Canberra trial - yes, just one the one so far - at least two potentially fatal substances were identified. Punters threw them out".

#PillTesting won't end all harm, but it can make a real difference. We can keep more young lives safe. #Greens <https://t.co/7TD0OwKdml>"

"I'm tired of #pilltesting debate. If there's still doubt where should that benefit of doubt go? I'd much prefer to see benefit of doubt go to trying to save lives, prevent hospital admissions of young people than go to theoretical concerns maybe this/that. Let's get on with it!"

In this study, a number of tweets highlighted that drug checking helps engaging people in services and capturing individuals who are not in treatment, influences and alters their drug-taking behaviours and habits:

"Offering #drugchecking at services provides an opportunity to engage with young people who may otherwise never present to a traditional drug service. Looking forward to seeing @profhrs work on #prevention and #briefintervention at festivals #nationaldrugsforum2018 <https://t.co/q7mNsPk1oC>"

Some views see that drug checking being part of drug policy:

Harm minimisation, supply reduction and demand reduction = effective drug law reform. The Federal Government's own Drug Strategy backs this approach. #pilltesting <https://t.co/kX50IzHHNr>"

"Possession of illicit drugs is still illegal (it's kind of implied in the word ??), and #pilltesting doesn't change that."

351 *#PillTesting offers users opportunity to know from responsible figures that*
352 *drugs/substances could be dangerous, without fear of persecution. Mostly, 'Fear of*
353 *persecution' has never been a reason to stop indulging in addictive behaviour".*

354

355 *"This is not endorsing drug use, just like injection rooms & needle exchanges".*

356

357 **Opinions in the present study highlighted that drug checking can support**
358 **individuals in making more informed decisions:**

359

360 *"They are told the contents so they can make a more informed, safer decision. No*
361 *ticks. #PillTesting saves lives, a good thing".*

362

363 *"That's the evidence pill testing shows, pills with known harmful contents are thrown*
364 *out & not taken. Need #pilltesting to learn the contents".*

365

366 **Some tweets shared outcomes of drug checking services:**

367

368 *"Pills with known content are thrown and not taken".*

369

370 *"Benschop et al. clearly shows that where #pilltesting is offered, consumers use less*
371 *drugs, & use fewer varieties".*

372

373 *"Sharing knowledge and information for young people on what to do if test is positive".*

374

375 **Tweets in favour of drug checking also highlighted the fact that with**
376 **decriminalisation or not, people will continue to take drugs and hence, harm**
377 **reduction as exemplified by drug checking is key:**

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379 *"drug use will always prevail"*

380 *"young people will continue to take drugs"*

381 *"people have and will always use drugs".*

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383 *"We know young people consume recreational drugs both inside and outside major*
384 *music events".*

385

386 *More work must also be done to ensure on-site and offsite #pilltesting services are*
387 *realised".*

388

389 *"I don't support decriminalisation of illegal drugs but I do support #PillTesting People*
390 *will always take drugs & studies show that if you test pills & tell users what's mixed*
391 *with the drug i.e. bleach-draino-ketamine-petrol ect the majority will throw them away*
392 *#BetterThanDeath"*

393

394 *"Pilltesting policy is in transition from contentious to widely supported & unremarkable.*

395 *Think about it the other way: knowing young people will continue to take drugs at music*
396 *events, what are the arguments for ensuring those drugs are untested?”.*

397

398 **Tweets in favour of drug checking have sometimes included a harm reduction**
399 **message to potential drug users. These included:**

400

401 *“if you’re taking a #drug obtained anywhere other than a pharmacy, get it tested”.*

402

403 *“Discard if you can, don’t use alone, take a test shot, have naloxone nearby”.*

404

405 *“Test your drugs! Spread the word- everyone needs to know that #harmreduction tools*
406 *are available! #drugchecking can save lives of your friends and loved ones. Check for*
407 *#fentanyl and other adulterants- test it before you ingest it! #testit*
408 *<https://t.co/Vo4QOxVSDD> <https://t.co/aeXv3Fo4nT>”*

409

410 **In the present study, tweets highlighted barriers where drug checking may not**
411 **be legal in some countries e.g. Sydney.**

412

413 *“She said those handling illicit substances as part of a pilltesting service could be liable*
414 *to prosecution under current laws”.*

415

416 **Views not in favour of drug checking perceived drug checking as a way to**
417 **legalise all drugs without educating on harms from drugs or how to deal with**
418 **peer pressure, which leads to more arrests for under 18 years of age.**

419

420 *“Hi! I respectfully disagree!??Im from #Michigan & it thrived with jobs until they began*
421 *#DrugTesting. I tested 99% on the tests to work at GMC and the ONLY test I failed*
422 *was for #Cannabis. Also a friend just bought a house & got fired due to random test.*
423 *Resulted in #Suicide ??”*

424

425 *“Look how often field drug tests send innocent Georgians to jail*
426 *<https://t.co/V9e1UcJWVC> #drugtests #drugtesting”.*

427

428 *“#Pre-employment #drugtesting can limit turnover, by detecting which applicants are*
429 *likely to miss work, raise insurance premiums, have performance issues, and*
430 *ultimately have a higher separation rate.*

431 *<https://t.co/kYAo8gfjQt>”.*

432

433 *“You get what you pay for and a \$2 drug test is almost too good to be true. Sad that*
434 *innocent people had to pay the price. Hopefully they can right some wrongs.*

435 *#drugtesting..... police used faulty drug testing tool that sent people to jail.*

436 *<https://t.co/MtPz74WhjO> <https://t.co/5Zjer5xrAA>”.*

437

438

439 **Discussion**

440 This is the first paper to explore public’s perceptions of drug testing as a harm
441 reduction intervention. Engagement in discussions related to drug testing was
442 investigated by collecting real-time data using a netnographic methodology via Twitter.

443 This research explored people’s perceptions and views about the use of drug checking

444 services as a harm reduction tool in settings such as festivals and nightclubs. From
445 the literature, some studies have explored the design features of a publicly accepted
446 service: in Australia, Barratt et al. (2018) found that 94% of people would use on-site
447 drug checking services located at festivals or clubs; however, they would not use the
448 service if there was a likelihood of arrest. Recently, Alex Ross-King, 19 years old,
449 overdosed on MDMA and lost her life as a result of trying to avoid being arrested at
450 the Fomo music festival in Parramatta (New South Wales, Australia) [59]. This finding
451 is consistent with other studies where research suggested that users are receptive
452 towards using drug checking services [55, 60], however, obstacles to using these
453 services include fear of being detained by the police, loss of privacy, criminalisation
454 and loss of anonymity [16, 60]. Furthermore, users may choose not to use these
455 services unless they were using a new substance, batch and/ or dealer [61].

456 Published views from the public of drug testing at festivals in the UK showed mixed
457 perceptions of drug checking [62-64]:

458 *“There were two people killed yesterday, so if [The Loop’s work] stops two people*
459 *dying. It has to be a good thing”.*

460 *“It just gives you peace of mind. I know tomorrow I’ll be alright rather than worrying*
461 *about what’s in my drugs”.*

462 *“Legalise and regulate them. That’ll make people much safer”.*

463 *“Drug testing services offer an illusion of safety...drugs are illegal because they are*
464 *unsafe and that is the message that the police ought to be giving”*

465 Views in favour of drug checking at festivals showed that the public considers drug
466 checking services at festivals as being important in preventing deaths and reducing
467 harm to users. Many in favour of drug checking services, appreciated the service being
468 provided and the potential reduction in harms that they may have otherwise
469 experienced. Some believed that the government should not be responsible for
470 providing funding for drug checking services and feel that it would be more appropriate
471 to place stricter regulations and legislation in place instead. Some also expressed the
472 contradiction between having a drug checking service inside festivals despite the
473 presence of police whose priority is to prevent drugs from entering festivals in the first
474 place [62-64]. This finding shows that although the public appreciates the service,
475 clearer guidelines on the legal aspects of taking drugs in the festival environments is
476 required. This would also provide further assurance to users who may want to use
477 drugs to use services like The Loop or ACT GTM Pill Testing Service (Australia)
478 without the fear of prosecution or criminalisation [65].

479 In addition to the general public’s perceptions of drug testing, politicians and the wider
480 scientific community may have contradicting views [31]. Prof. Alison Ritter, Director of

481 the Drug Policy Modelling Program at the National Drug and Alcohol Research Centre
482 (NDARC), and Andrew Leibie, a scientist with Safework Laboratories and a member
483 of the International Association of Forensic Toxicologists have both expressed
484 arguments for and against drug testing, respectively [31]. Arguments for drug testing,
485 as described by Prof. Ritter debated that drug testing has been shown to influence
486 market trends and the life of a drug in the illicit drug market. It has indirectly informed
487 drug makers to avoid harmful adulterants, influenced people's behaviour to reduce/
488 stop drug use, enabled access to care and support, and represented an invaluable
489 source of information on drug use. In contrast, arguments against drug testing, as
490 described by Leibie, focussed on the reliability and accuracy of onsite testing
491 techniques [31]. Following a public Hearing in New South Wales (NSW) concerning
492 an inquest into the death of six patrons of NSW music festivals, the Magistrate Harriet
493 Grahame, Deputy State **Coroner recommended the trialling of 'pill testing' to**
494 **reduce drug-related harms and enhance public health and safety** [66].
495

496 Given the limited knowledge on the public's perceptions on drug checking
497 interventions, Twitter was employed as a platform to enhance the understanding of
498 tweeters' opinions via opinion mining or sentiment analysis [67].
499

500 The size of the dataset of relevant tweets that was collected was limited compared to
501 other studies where data was also collected from the Twitter platform. This is possibly
502 because the topic explored in the present study is relatively novel and is of concern to
503 a limited population (mostly festivalgoers). To enhance the understanding of a
504 tweeters' opinions, opinion mining or sentiment analysis or stance detection were used
505 to determine whether the opinion is positive, negative or neutral [67]. Sentiment
506 analysis is a useful tool in analysing behaviour; however, there are challenges
507 associated with this method as it may not be suitable for tweets using informal
508 language, misspellings, slangs and symbolic forms of words [68]. The analysis of
509 sentiments does not necessarily indicate an individual's views on drug testing i.e.
510 whether the user is in favour of drug testing or not in favour. For example, in the
511 following tweet: *"Supporting #pilltesting won't just reduce risks for young people*
512 *attending music events, but also save money & win votes"*, the sentence represents
513 factual opinion and expressed explicitly as written. Conversely, stance detection
514 determines favourability towards a target [69] i.e. if a person is in favour or not in favour
515 of drug testing. Various software and algorithms are available to classify tweets. In this
516 research, the software was not used to explore a user's tweet. Once tweets were
517 collected using each of the keywords, the favourability of an opinion was manually
518 examined and assigned a category (i.e. in favour or not in favour). The process was
519 independently reviewed.
520

521 Results from the present study are in good agreement with findings from other twitter
522 studies. Relevant tweets highlighted the public's perceptions of drug checking. They
523 also highlighted the role of the media in influencing the acceptance of drug checking.
524 Tweets in favour of drug checking acknowledged that drug checking: is a part of

525 effective law reform, a public health intervention and an enabler of trust with the
526 political system. Tweets perceived drugs as “a health issue and not a crime” and that
527 “prohibition may lead to drugs being cut and mixed”.

528

529 Tweets identified in favour of drug checking highlighted tweeter’s opinions that drug
530 checking could prevent harm and/ or potentially deaths, and that helping to save a life
531 is of greater importance than not using drug checking at all. This view is broadly in line
532 with international developments in drug legislative reforms, which are receiving
533 increasing support for drug checking and other harm reduction interventions [1, 10,
534 70]. This is also in line with previous findings demonstrating evidence of harm
535 reduction through drug checking [1, 8, 54].

536

537 Drug checking advocates promoted the evidence-base underpinning drug testing
538 arguing that it deters rather than promotes drug use [31, 54, 65, 71-72]. In Australia,
539 Butterfield et al. (2016) highlighted that drug checking services enabled the monitoring
540 of emerging psychoactive substances, inform decision-making related to the
541 management of symptoms of toxicity and promote access to treatment [27]. Drug
542 checking services have also been described as early detection systems and effective
543 monitoring tools [30, 73]. In addition to individuals being provided with harm reduction
544 advice, drug checking services allow a greater understanding of recent drug trends
545 and monitoring of drug supply, particularly in relation to Novel/ emerging Psychoactive
546 Substances (NPS) [3, 30, 73].

547

548 In the present study, some tweeters stated that drug checking helps identifying trends
549 e.g. identification of harmful adulterants/ identification of harmful adulterants,
550 identifying counterfeit products such as e-liquid preparations, enabling a scientific
551 basis to capture data, identifying drugs that may have potential therapeutic effects e.g.
552 use of psilocybin for the treatment of treatment resistant depression. Other perceived
553 benefits from tweets also include harm reduction awareness; harm reduction from
554 risky drugs; reduction of risky consumption; reduction of the economic and social
555 burden on society; preventing youths from having criminal records and punitive fines;
556 reducing the use of sniffer dogs.

557

558 Furthermore, there is potential for users’ behaviours to be positively influenced by
559 these services: findings from a supervised consumption site (SCS) in Canada found
560 that drug users were more likely to reduce their drug dose when results were positive
561 for fentanyl [19]. Additionally, a study, which looked at the use of self-checking fentanyl
562 test strips found that users were five times more likely to change their drug use
563 behaviour when fentanyl was identified [20]. At festivals, Measham (2018) reported
564 that users are likely to dispose of their drugs if found to be harmful or potentially
565 containing a lethal substance and that 21.3% of people consequently chose to dispose
566 of their substances. Similarly, Australia’s first ‘pill testing’ trial at Grooving the Moo
567 (GTM) in 2018, reported that 42% would change their drug use as a result of the
568 intervention and 18% would either dispose of the drugs or were uncertain as to what

569 they would do [53]. However, the effectiveness of harm reduction advice provided at
570 places like festivals may be challenging as users are already likely to be under the
571 influence of substances before using the service [10]. For example, during The Loop's
572 pilot study, 62.9% of service users had an alcoholic drink and 43% had already
573 consumed other drugs other than alcohol before using the service [8] potentially
574 impacting upon the level of engagement and ability to provide informed consent. A
575 study by Saleemi et al. (2017) found that festivalgoers whose samples tested negative
576 for MDMA at a rave were less likely to consume their drug products. In this case, the
577 true content was communicated to the users who made more informed decisions
578 regarding the intake of the samples [54].

579
580 Drug checking provides people with information on the content of their products, which
581 they usually would not otherwise know when substances are obtained illicitly [10, 74].
582 In the absence of this information, users may be misinformed, taking substances that
583 they did not intend on taking or consuming drugs with unclaimed contaminants, which
584 puts them at an increased risk of harm [75]. Although drug checking services do not
585 condone the use of drugs, and outline that not consuming drugs is the safest option,
586 the fact that users have already obtained drugs with the intention to use should be
587 taken into consideration [9]. For this reason, some services also provide individuals
588 with advice and information on how harms can be reduced [5, 10, 76].

589
590 Compilation of information from various drug checking services enable timely public
591 health alerts to be escalated, shared and communicated when samples are likely to
592 be associated with potential significant risk of harm, for example, due to their relative
593 high strengths or unclaimed toxic adulterants [77-78]. For example, in 2015, DIMS
594 issued public warnings over "Superman" pills, which were sold as ecstasy and have
595 been shown to contain 170 mg of para-methoxy-metamphetamine (PMMA), a highly
596 toxic compound that is produced instead of MDMA if the precursor 4-methoxy-PMK
597 (4-methoxy piperonyl methyl ketone) is erroneously/ intentionally employed instead of
598 PMK (piperonyl methyl ketone) [77]. In the UK, the same pills caused the death of four
599 young people where no drug checking service was available [10]. Previous research
600 has also identified notable levels in pills with relatively high purity as well as harmful
601 cutting agents [53]. Intelligence UK seizure data over the period 2017 'quarter 4' to
602 2018 'quarter 3' showed that the average purity of cocaine was ca. 80% and was
603 commonly cut by benzocaine, caffeine, phenacetin, creatine, paracetamol, boric acid,
604 lactose, lidocaine, and/or levamisole [79]. In contrast, amphetamine had a very low
605 average purity (ca. 11%) over the same period and was found to be cut with caffeine,
606 glucose, lactose and/or creatine. For ecstasy, over the same period, the average purity
607 of the powders/crystals was 87% and the average amount in tablets/capsules was 153
608 \pm 9 (median = 156 mg/ tablets/capsules) [79]. The identification of drugs is also
609 important for new emerging health threats, in particular potent, highly harmful and
610 difficult to detect fentanyl derivatives [80]. Only a small number of drug checking
611 technologies are able to detect a small number of fentanyl analogues [15]. Drug

612 checking services have been available at supervised consumption site (SCS) to
613 prevent fatal overdoses from drugs such as fentanyl derivatives [17-18].

614
615 Tweets highlighted the need for drug checking due to the increasing access of drugs
616 to people of all ages and the potential for criminalisation. Call have been made to
617 encourage drug checking innovations in order to find ways to improve the detection of
618 challenging and potentially lethal fentanyls.

619
620 Many barriers were perceived to implementing drug checking. A survey, which
621 explored the views of more than 2,300 young Australians aged 16-25 years, found that
622 over 82% were in support of 'pill-testing' as it allowed them to make informed decisions
623 [81]. Despite increasing support within the drug-taking community for drug checking
624 and associated positive outcomes [1], such services have limitations and barriers to
625 wider implementation such as appropriate funding and obtaining relevant licences/
626 political support. Additionally, there were concerns that drug checking may encourage
627 illicit drug use and criminality [8-10, 55-57]. On the other hand, there is often a stigma
628 associated with individuals who consume drugs, which can pose as a barrier for those
629 wanting to seek [25].

630
631 There have been concerns that dealers may misuse drug testing information such as
632 information about the purity of sample to promote their products [10]. Kerr & Tuper
633 (2017) argued that even if this is the case, drug checking services can "shift and
634 stabilise" the drug market since dealers would want to ensure their products are not
635 harmful and users can make better informed decisions rather than being patronised
636 by the dealers. However, a study by Bardwell et al. (2019) found that dealers may use
637 drug checking technology to reduce the risk of harm by providing improved information
638 to customers [16]. Saleemi et al. (2017) found that less than 60% of users, whose
639 samples tested positive for MDMA reported that they may still not consume it. It was
640 suggested that this group may not have been the users themselves, but rather friends
641 of users or dealers.

642
643 In the present study, tweets against drug checking focussed on the concerns over the
644 quality of drug checking particularly with false positive results, which may lead to
645 punitive outcomes, discrimination and prejudice. Communicating the content of
646 substances is at the heart of these services. However, this depends on the available
647 expertise, funding and detection techniques. There can be significant associated costs
648 of specialised analytical equipment and expertise required to facilitate such services
649 and limitations in being able to deliver timely, highly accurate and precise results [8-
650 10, 55-57, 82].

651
652 Tweets collected in the present study identified some gaps and made some proposals
653 to reduce harms from drugs. These include: the need to evaluate the drug checking
654 services, need to improve drug checking technologies to face challenges caused by
655 new trends e.g. opioid crisis, call for an open science approach discussing the

656 practicalities of implementing drug checking, calls to transform drug policy, need for
657 education on harm reduction, drug education prior to events where drug consumption
658 is inevitable, raising awareness, calls for an ethical Charter with insights focussed on
659 success specific to local jurisdictions, calls to regulate drugs e.g. in a limited way for
660 example via prescription for +21, then over-the-counter at pharmacies, sharing drug
661 checking results amongst stakeholders, learning from alcohol policies as alcohol is
662 also a drug [83].

663

664 The present study is a brief overview and findings suggest that the public are generally
665 in favour of drug testing, particularly the use of drug checking services in places like
666 festivals where drug deaths can be prevented, and education can be provided to
667 people who would not otherwise seek help or support for their recreational use. The
668 positive response from drug checking services trialled at places like The Loop and
669 GTM demonstrate the sense of trust and ability to enter a non-judgemental
670 environment where users can seek advice without being criminalised or prosecuted
671 for their actions [8, 53]. Therefore, such services may support improve engagement
672 with drug treatment services and enable more people to access appropriate help and
673 support.

674

675 In October 2018, a Trans-Tasman Charter was signed between Australia and New
676 Zealand in which the two countries collaborated to develop drug checking services at
677 events, festivals and other suitable locations [11]. This new initiative demonstrates the
678 significance of drug checking services, where services are now expanding and being
679 of importance in other parts of the world outside of Europe. Although harm reduction
680 approaches such as drug checking is not aimed at eliminating the use of illicit
681 substances, the benefits of reducing harm and minimising risks continue to be
682 appreciated by the public. Therefore, suggest continued work to explore public
683 perception as this develops/expands internationally.

684

685 **Limitations**

686

687 The analysis of tweets using isolated words or sentences may introduce bias due to
688 the subjectivity of its nature. The tweets sample size was limited in comparison to other
689 Twitter studies where larger samples were obtained. This is due to the limited number
690 of search terms, the duration and season of data collection, and the exclusion of re-
691 tweets. Other studies collected a high number of tweets due to the use of a large
692 number of search terms [84], data collection of a long period of time (e.g. a year) [85],
693 and the use of original tweets as well as re-tweets [86]. In our study, we have analysed
694 only those tweets circulated in autumn, where the summer season would have been
695 a more appropriate season for festivals. A further limitation of this study was that the
696 software was unable to highlight the exact geographical location of these tweets and
697 hence, our findings are not generalisable and cannot be representative of views of the
698 UK. In this study, views of users with private accounts were not captured.

699

700 **Conclusions**

701 The literature review revealed mixed opinions towards drug checking with some
702 promoting them as significant influence for a change in behaviour towards drug use,
703 whilst others perceiving them as promoting drug use. From Twitter, views in favour of
704 drug checking suggested that it would be an overwhelmingly useful strategy in
705 reducing drug-related harms and saving lives. Overall, significantly more tweets were
706 in favour of drug checking; however further research is required into the views of the
707 UK public. Tweets in favour of drug checking perceived the service as a part of
708 effective law reform, a public health intervention that serves in raising awareness and
709 countering the role of the internet, preventing harm and/ or potentially deaths, helps in
710 identifying novel trends related to drugs, enables a scientific basis to capture data,
711 reduces harm from risky drugs or risky consumption, reduces the economic and social
712 burden on society and prevents youths from having criminal records and punitive fines.
713 Drug checking was perceived to positively influence users' behaviours, supports
714 engagement with treatment services and supports individuals in making more
715 informed decisions. Tweets against drug checking focussed on the concerns over the
716 quality of drug checking particularly with false positive results, which may lead to
717 punitive outcomes, discrimination and prejudice. The present study showed that
718 Twitter can be a useful platform to capture people's perceptions and main factors
719 influencing people's perceptions on drug checking/ testing.

720

721 **List of abbreviations**

722 API: Application Programming Interface

723 DIMS: Drug Information and Monitoring System

724 GTM: Grooving the Moo

725 MANDRAKE: Manchester Drug Analysis and Knowledge Exchange

726 MAST: Multi-Agency Safety Testing

727 MDMA: 3,4-methylenedioxymethamphetamine

728 NPS: New Psychoactive Substances

729 PMMA: paramethoxymetamphetamine

730 PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

731 SCS: Supervised Consumption Site

732 WEDINOS: Welsh Emerging Drugs & Identification of Novel Substances Project

733

734 **Declarations**

735

736 ***Ethics approval and consent to participate***

737 Not applicable

738

739 ***Consent for publication***

740 Not applicable.

741

742 ***Availability of data and materials***

743 The datasets used and/or analysed during the current study are available from the corresponding author
744 on reasonable request.

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Competing interests

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Authors' contributions

AG conceived the paper, the main conceptual ideas and the proof outline. IM led on writing the initial draft and the data collection from Twitter under the supervision of AG. RG Contributed to the categorisation of the tweets. RG and FS reviewed the paper and supported the work overall. All authors reviewed and contributed to the writing of the paper.

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789 **References**

- 790 1 Groves A. "Worth the test?" Pragmatism, pill testing and drug policy in Australia. *Harm Reduct*
791 *J.*, **2018**,15(1):1–13.
- 792 2 Oute, J., Nygaard-Christensen, M., Lindholst, C., Thomsen, K.R., Boelskifte, L., Elmholdt,
793 E., Hesse, M., Kolind, T. Literature Review of Drug Checking in nightlife – Methods, Services,
794 and Effects, **2018**. [https://www.sst.dk/-/media/Udgivelser/2019/Engelsk-version-](https://www.sst.dk/-/media/Udgivelser/2019/Engelsk-version-Litteraturgennemgang-om-stoftest-i-nattelivet.ashx?la=da&hash=38C42CFA74BB5A333B024F3B127440D55538BF29)
795 [Litteraturgennemgang-om-stoftest-i-](https://www.sst.dk/-/media/Udgivelser/2019/Engelsk-version-Litteraturgennemgang-om-stoftest-i-nattelivet.ashx?la=da&hash=38C42CFA74BB5A333B024F3B127440D55538BF29)
796 [nattelivet.ashx?la=da&hash=38C42CFA74BB5A333B024F3B127440D55538BF29](https://www.sst.dk/-/media/Udgivelser/2019/Engelsk-version-Litteraturgennemgang-om-stoftest-i-nattelivet.ashx?la=da&hash=38C42CFA74BB5A333B024F3B127440D55538BF29)
797 (Accessed December 29, 2019).
- 798 3 United Nations Office on Drugs and Crime (UNODC). World drug report 2018. Analysis of
799 drug markets. Vienna. **2018**.
800 https://www.unodc.org/wdr2018/prelaunch/WDR18_Booklet_3_DRUG_MARKETS.pdf
801 (Accessed December 29, 2019).
- 802 4 Sherman SG, Morales KB, Park JN, McKenzie M, Marshall BDL, Green TC. Acceptability of
803 implementing community-based drug checking services for people who use drugs in three
804 United States cities: Baltimore, Boston and Providence. *Int J Drug Policy*, **2019**, 68:46–53.
- 805 5 Winstock AR, Ramsey J. Drug checking and pill testing – what it can and cannot do and why
806 it matters. Global Drug Survey, **2017**. [https://www.globaldrugsurvey.com/past-](https://www.globaldrugsurvey.com/past-findings/gds2017-launch/drug-checking-and-pill-testing-what-it-can-and-cannot-do-and-why-it-matters/)
807 [findings/gds2017-launch/drug-checking-and-pill-testing-what-it-can-and-cannot-do-and-why-](https://www.globaldrugsurvey.com/past-findings/gds2017-launch/drug-checking-and-pill-testing-what-it-can-and-cannot-do-and-why-it-matters/)
808 [it-matters/](https://www.globaldrugsurvey.com/past-findings/gds2017-launch/drug-checking-and-pill-testing-what-it-can-and-cannot-do-and-why-it-matters/) (Accessed June 23, 2019).
- 809 6 Barratt M, Kowalski M, Maier L, Alison R. Global Review of Drug Checking Services 2017.
810 Drug Policy Model Progr Bull No 24, **2018**.
811 [https://ndarc.med.unsw.edu.au/sites/default/files/ndarc/resources/Global%20review%20of%](https://ndarc.med.unsw.edu.au/sites/default/files/ndarc/resources/Global%20review%20of%20drug%20checking%20services%20operating%20in%202017.pdf)
812 [20drug%20checking%20services%20operating%20in%202017.pdf](https://ndarc.med.unsw.edu.au/sites/default/files/ndarc/resources/Global%20review%20of%20drug%20checking%20services%20operating%20in%202017.pdf) (Accessed March 23rd,
813 2020).
- 814 7 DanceSafe. About Us, **2019**. <https://dancesafe.org/about-us/> (Accessed May 27, 2019).
- 815 8 Measham FC. Drug safety testing, disposals and dealing in an English field: Exploring the
816 operational and behavioural outcomes of the UK's first onsite 'drug checking' service. *Int J*
817 *Drug Policy*, **2018**, 67, 102-107.
- 818 9 Alcohol and Drug Foundation (ADF). Drug checking: a harm reduction strategy, **2018**
819 <https://adf.org.au/insights/drug-checking-a-harm-reduction-strategy/> (Accessed December
820 1st, 2018).
- 821 10 Brunt T. Drug checking as a harm reduction tool for recreational drug users: opportunities
822 and challenges, **2017**.
823 [http://www.emcdda.europa.eu/system/files/attachments/6339/EuropeanResponsesGuide20](http://www.emcdda.europa.eu/system/files/attachments/6339/EuropeanResponsesGuide2017_BackgroundPaper-Drug-checking-harm-reduction_0.pdf)
824 [17_BackgroundPaper-Drug-checking-harm-reduction_0.pdf](http://www.emcdda.europa.eu/system/files/attachments/6339/EuropeanResponsesGuide2017_BackgroundPaper-Drug-checking-harm-reduction_0.pdf) (Accessed March 23rd, 2020).
- 825 11 Pill Testing Australia. TRANS TASMAN Charter for pill testing, **2019**.
826 <https://pilltestingaustralia.com.au/trans-tasman-charter/> (Accessed September 15th,
827 2019).
- 828 12 Harm Reduction Wales. Annual report 2017-2018, **2018**.
829 http://www.wales.nhs.uk/sitesplus/documents/888/Philtre_Annual_Report_2018_FINAL.pdf
830 (Accessed December 1st, 2019).
- 831 13 Welsh Emerging Drugs & Identification of Novel Substances Project (WEDINOS). WEDINOS
832 - About Us, **2018**. http://www.wedinos.org/about_us.html (Accessed December 23rd, 2018).
- 833 14 Sutcliffe Research Group. MANDRAKE- Manchester drug analysis and knowledge exchange,
834 **2018** <https://www.sutcliffe-research.org/mandrake/> (Accessed January 11th, 2019).
- 835 15 Bardwell G, Kerr T. Drug checking: a potential solution to the opioid overdose epidemic?
836 *Subst Abuse Treat Prev Policy*, **2018**,13:20.
- 837 16 Bardwell G, Boyd J, Arredondo J, McNeil R, Kerr T. Trusting the source: The potential role of
838 drug dealers in reducing drug-related harms via drug checking. *Drug Alcohol Depend*,
839 **2019**,198:1–6.
- 840 17 Barry CL. Fentanyl and the Evolving Opioid Epidemic: What Strategies Should Policy Makers
841 Consider? *Psychiatr Serv*, **2017**, 69(1):100–3.
- 842 18 Laing MK, Tupper KW, Fairbairn N. Drug checking as a potential strategic overdose response
843 in the fentanyl era. *Int J Drug Policy*, **2018**, 62:59–66.
- 844 19 Karamouzian M, Dohoo C, Forsting S, McNeil R, Kerr T, Lysyshyn M. Evaluation of a fentanyl
845 drug checking service for clients of a supervised injection facility, Vancouver, Canada. *Harm*
846 *Reduct J*, **2018**, 15(1):46.

- 847 20 Peiper NC, Clarke SD, Vincent LB, Ciccarone D, Kral AH, Zibbell JE. Fentanyl test strips as
848 an opioid overdose prevention strategy: findings from a syringe services program in the
849 Southeastern United States. *Int J Drug Policy*, **2019**, 63:122–8.
- 850 21 Barratt MJ, Kowalski M, Maier LJ, Ritter A. Profiles of drug checking services in 2017. *Drug*
851 *Policy Model Progr Bull No* 24, **2018**.
852 [https://ndarc.med.unsw.edu.au/sites/default/files/ndarc/resources/Profiles%20of%20drug%20](https://ndarc.med.unsw.edu.au/sites/default/files/ndarc/resources/Profiles%20of%20drug%20checking%20services%20in%202017.pdf)
853 [Ochecking%20services%20in%202017.pdf](https://ndarc.med.unsw.edu.au/sites/default/files/ndarc/resources/Profiles%20of%20drug%20checking%20services%20in%202017.pdf) (Accessed March 23rd, 2020).
- 854 22 European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) and Europol (2007),
855 Early-warning system on new psychoactive substances — operating guidelines, EMCDDA
856 Risk assessments, Publications Office of the European Union, Luxembourg. 2007.
857 http://www.emcdda.europa.eu/system/files/publications/449/EWSguidelines2_98082.pdf
858 (Accessed March 23rd, 2020).
- 859 23 Hungerbuehler I, Buecheli A, Schaub M. Drug Checking: A prevention measure for a
860 heterogeneous group with high consumption frequency and polydrug use - evaluation of
861 zurich's drug checking services. *Harm Reduct J*, **2011**, 8(1):16.
- 862 24 Tupper KW, McCrae K, Garber I, Lysyshyn M, Wood E. Initial results of a drug checking pilot
863 program to detect fentanyl adulteration in a Canadian setting. *Drug Alcohol Depend*, **2018**,
864 190:242–5.
- 865 25 The Pharmaceutical Journal (PJ). First Home Office-licensed street drug-testing clinic
866 opens, **2019**, Vol 302, No 7923, DOI: 10.1211/PJ.2019.20206219
- 867 26 EMCDDA. An inventory of on-site pill-testing interventions in the EU in cooperation with.
868 Lisbon, **2001**. [file:///C:/Users/Amira.Guirguis/Downloads/pill_testing_report%20\(3\).pdf](file:///C:/Users/Amira.Guirguis/Downloads/pill_testing_report%20(3).pdf)
869 (Accessed March 23rd, 2020).
- 870 27 Butterfield RJ, Barratt MJ, Ezard N, Day RO. Drug checking to improve monitoring of new
871 psychoactive substances in Australia. *Med J Aust*, **2016**, 204(4):144–5.
- 872 28 Lefkovits, Z.G. A Pill too Hard to Swallow? A Public Health and Legislative Consideration of
873 Methods to Reduce Drug-Related Harm in the Victorian Party Scene: On-site Pill Testing,
874 Market Monitoring and Publication of Publication of Police Drug Seizure Data. Parliament of
875 Victoria, Melbourne, Australia, **2016**. <https://www.ncbi.nlm.nih.gov/pubmed/27469086>
876 (Accessed March 23rd, 2020).
- 877 29 Camilleri AM, Caldicott D. Underground pill testing, down under. *Forensic Sci Int*, **2005**,
878 151(1):53–8.
- 879 30 Schroers A. Drug checking: monitoring the contents of new synthetic drugs. *J Drug Issues*,
880 **2002**, 32(2):635–46.
- 881 31 Thomas, M. The pros and cons of pill testing. Parliament of Australia: Australia, **2018**.
882 Available at:
883 [https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Libra](https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/FlagPost/2018/May/The_pros_and_cons_of_pill_testing)
884 [ry/FlagPost/2018/May/The pros and cons of pill testing](https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/FlagPost/2018/May/The_pros_and_cons_of_pill_testing) (Accessed September 13th,
885 2019)
- 886 32 Barratt MJ, Bruno R, Ezard N, Ritter A. Pill testing or drug checking in Australia: acceptability
887 of service design features. *Drug Alcohol Rev*, **2018**, 37(2):226–36.
- 888 33 Uitemark, J. and Cohen, P. A clash of policy approaches: The rise (and fall?) of Dutch
889 harm reduction policies towards ecstasy consumption. *Int J Drug Policy*, **2005**, 16: 65-
890 72, 66.
- 891 34 Kozinets R V. The Field Behind the Screen: Using Netnography for Marketing Research in
892 Online Communities. *J Mark Res*, **2002**, 39(1):61–72.
- 893 35 Paul, M.J., Sarker, A., Brownstein, J.S., Nikfarjam, A., Scotch, M., Smith, K.L. and Gonzalez,
894 G. Social media mining for public health monitoring and surveillance. In: *Biocomputing 2016: Proceedings of the Pacific symposium*; World Scientific Publishing Co. Pte Ltd: Big Island,
895 United States, **2016**; (pp. 468-479).
- 896 36 Cameron, D., Smith, G.A., Daniulaityte, R., Sheth, A.P., Dave, D., Chen, L., Anand, G.,
897 Carlson, R., Watkins, K.Z. and Falck, R. PREDOSE: a semantic web platform for drug abuse
898 epidemiology using social media. *J biomed inform*, **2013**, 46(6), pp.985-997.
- 899 37 Chary, M., Genes, N., McKenzie, A. and Manini, A.F. Leveraging social networks for
900 toxicovigilance. *J Med Toxicol*, **2013**, 9(2), pp.184-191.
- 901 38 Cavazos-Rehg, P.A., Krauss, M., Fisher, S.L., Salyer, P., Grucza, R.A. and Bierut, L.J. Twitter
902 chatter about marijuana. *J Adolesc Health*, **2015**, 56(2), pp.139-145.
- 903 39 Hanson, C.L., Cannon, B., Burton, S. and Giraud-Carrier, C. An exploration of social circles
904 and prescription drug abuse through Twitter. *J med Internet Res*, **2013**, 15(9), p.e189.

- 906 40 Kalyanam, J., Katsuki, T., Lanckriet, G.R. and Mackey, T.K. Exploring trends of nonmedical
907 use of prescription drugs and polydrug abuse in the Twittersphere using unsupervised
908 machine learning. *Addict behav*, **2017**, 65, pp.289-295.
- 909 41 Katsuki, T., Mackey, T.K. and Cuomo, R. Establishing a link between prescription drug
910 abuse and illicit online pharmacies: analysis of Twitter data. *J medl Internet Res*, **2015**,
911 17(12), p.e280.
- 912 42 Sarker, A., O'Connor, K., Ginn, R., Scotch, M., Smith, K., Malone, D. and Gonzalez, G.
913 Social media mining for toxicovigilance: automatic monitoring of prescription medication
914 abuse from Twitter. *Drug Saf*, **2016**, 39(3), pp.231-240.
- 915 43 Scott, K.R., Nelson, L., Meisel, Z. and Perrone, J. Opportunities for Exploring and Reducing
916 Prescription Drug Abuse Through Social Media. *J Addict Dis*, **2015**, 34(2-3), p.178.
- 917 44 Shutler, L., Nelson, L.S., Portelli, I., Blachford, C. and Perrone, J. Drug use in the
918 Twittersphere: a qualitative contextual analysis of tweets about prescription drugs. *J Addict*
919 *Dis*, **2015**, 34(4), pp.303-310.
- 920 45 Shutler, L., Perrone, J., Portelli, I., Nelson, L.S. and Blachford, C.R. Prescription opioids in
921 the Twittersphere: a contextual analysis of tweets about prescription drugs. *Ann Emerg*
922 *Med*, **2013**, 62(4), p.S122.
- 923 46 Thompson, L., Rivara, F.P. and Whitehill, J.M. Prevalence of marijuana-related traffic on
924 Twitter, 2012–2013: a content analysis. *Cyberpsychol Behav Soc Netw*, **2015**, 18(6),
925 pp.311-319.
- 926 47 Ahmed, W., Bath, P. and Demartini, G. Chapter 4 Using Twitter as a Data Source: An
927 Overview of Ethical, Legal, and Methodological Challenges. In: *The Ethics of Online*
928 *Research. Advances in Research Ethics and Integrity (2)*; Woodfield, K., Ed.; Emerald:UK,
929 **2017**; pp. 79-107. ISBN 978-1-78714-486-6.
- 930 48 Twitter. Q3 2018 Earnings Report, **2018**, 1–14. [https://investor.twitterinc.com/static-](https://investor.twitterinc.com/static-files/5ce969d2-a97f-49ef-ae10-577b81f6efee)
931 [files/5ce969d2-a97f-49ef-ae10-577b81f6efee](https://investor.twitterinc.com/static-files/5ce969d2-a97f-49ef-ae10-577b81f6efee) (Accessed March 23rd, 2020).
- 932 49 Omnicore. Twitter by the numbers: stats, demographics, & fun facts, **2018**
933 <https://www.omnicoreagency.com/twitter-statistics/> (Accessed November 27th, 2019).
- 934 50 Schultz D, Jolly S. Automatic Tweet Hashtag Categorization, **2010**
935 https://courses.media.mit.edu/2010fall/mas622j/Projects2010/SunnyJolly_DanSchultz.pdf
936 (Accessed November 9th, 2019).
- 937 51 Moher, D., Liberati, A., Tetzlaff, J. & Altman, D. G. Preferred reporting items for systematic
938 reviews and meta-analyses: the PRISMA statement. *PLoS Med*, **2009**, 6, e1000097.
- 939 52 Kerr, T. & Tupper, K. Drug checking as a harm reduction intervention: Evidence Review
940 Report. Vancouver, Canada: British Columbia Centre on Substance Use, 2017.
941 [https://www.bccsu.ca/wp-content/uploads/2017/12/Drug-Checking-Evidence-Review-](https://www.bccsu.ca/wp-content/uploads/2017/12/Drug-Checking-Evidence-Review-Report.pdf)
942 [Report.pdf](https://www.bccsu.ca/wp-content/uploads/2017/12/Drug-Checking-Evidence-Review-Report.pdf) (Accessed March 14th, 2020).
- 943 53 Makkai T, Macleod M, Vumbaca G, Hill P, Caldicott D, Noffs M, et al. Report on Canberra
944 GTM Harm Reduction Service. New South Wales: Harm Reduction Australia, 2018.
945 <https://www.drugsandalcohol.ie/29513/> (Accessed March 14th, 2020).
- 946 54 Saleemi S, Pennybaker SJ, Wooldridge M, Johnson MW. Who is “molly”? MDMA adulterants
947 by product name and the impact of harm-reduction services at raves. *J Psychopharmacol*,
948 **2017**, 31(8):1056-1060
- 949 55 Day N, Criss J, Griffiths B, Gujral SK, John-Leader F, Johnston J, et al. Music festival
950 attendees' illicit drug use, knowledge and practices regarding drug content and purity: a cross-
951 sectional survey. *Harm Reduct J*, **2018**, 15(1):1.
- 952 56 Faunce T, Byrne S, Gock A, Cowling A, Faunce T. Australia's first official illicit pill testing at
953 canberra groovin' the moo music festival: legal hurdles and future prospects. *J Law Med*,
954 **2018**, 26(54).
- 955 57 The Loop. Equipment, **2018**. <https://wearetheloop.org/equipment/> (Accessed January 11th,
956 2019).
- 957 58 Liu B. Sentiment Analysis and Opinion Mining Morgan & Claypool Publishers. Lang Arts
958 Discip, **2012**, 167. internal-pdf://0744994148/Sentiment Analysis and Opinion Mining.pdf
959 (Accessed March 14th, 2020).
- 960 59 The Guardian. Festival overdose victim took multiple pills before event 'to avoid police
961 detection', **2019a**. [https://www.theguardian.com/australia-news/2019/jul/08/festival-](https://www.theguardian.com/australia-news/2019/jul/08/festival-overdose-victim-took-multiple-pills-before-event-to-avoid-police-detection)
962 [overdose-victim-took-multiple-pills-before-event-to-avoid-police-detection](https://www.theguardian.com/australia-news/2019/jul/08/festival-overdose-victim-took-multiple-pills-before-event-to-avoid-police-detection) (Accessed March
963 14th, 2020).
- 964 60 Sande M, Šabić S. The importance of drug checking outside the context of nightlife in
965 Slovenia. *Harm Reduct J*, **2018**, 15(1):2–9.

- 966 61 Chinet L, Stéphan P, Zobel F, Halfon O. Party drug use in techno nights: A field survey among
967 French-speaking Swiss attendees. *Pharmacol Biochem Behav*, 2007, 86(2):284–9.
- 968 62 Evans M. Anti-drug campaigners slam plans to introduce drug testing tents at music festivals,
969 **2017**. [https://www.telegraph.co.uk/news/2017/05/21/anti-drug-campaigners-slam-plans-](https://www.telegraph.co.uk/news/2017/05/21/anti-drug-campaigners-slam-plans-introduce-drug-testing-tents/)
970 [introduce-drug-testing-tents/](https://www.telegraph.co.uk/news/2017/05/21/anti-drug-campaigners-slam-plans-introduce-drug-testing-tents/) (Accessed July 4th, 2019).
- 971 63 Edwards M. Inside the UK's First City Centre Drug Testing Facility, **2018**.
972 [https://www.vice.com/en_uk/article/59qdw/inside-the-uks-first-city-centre-drug-testing-](https://www.vice.com/en_uk/article/59qdw/inside-the-uks-first-city-centre-drug-testing-facility)
973 [facility](https://www.vice.com/en_uk/article/59qdw/inside-the-uks-first-city-centre-drug-testing-facility) (Accessed July 4th, 2019).
- 974 64 Waldron J, Mokrysz C, Grabski M, Freeman T, Measham F. Just say “know” to drugs: can
975 testing facilities make festivals safer?, **2017**. [https://www.theguardian.com/science/sifting-](https://www.theguardian.com/science/sifting-the-evidence/2017/aug/10/just-say-know-to-drugs-can-testing-facilities-make-festivals-safer)
976 [the-evidence/2017/aug/10/just-say-know-to-drugs-can-testing-facilities-make-festivals-safer](https://www.theguardian.com/science/sifting-the-evidence/2017/aug/10/just-say-know-to-drugs-can-testing-facilities-make-festivals-safer)
977 (Accessed March 14th, 2020).
- 978 65 The Conversation. Testing festival goers’ pills isn’t the only way to reduce overdoses. Here’s
979 what else works, **2019**. [https://theconversation.com/testing-festival-goers-pills-isnt-the-only-](https://theconversation.com/testing-festival-goers-pills-isnt-the-only-way-to-reduce-overdoses-heres-what-else-works-118827)
980 [way-to-reduce-overdoses-heres-what-else-works-118827](https://theconversation.com/testing-festival-goers-pills-isnt-the-only-way-to-reduce-overdoses-heres-what-else-works-118827) (Accessed March 14th, 2020).
- 981 66 Grahame, H. Inquest into the death of six patrons of NSW music festivals. Findings of
982 Magistrate Harriet Grahame, Deputy State Coroner. New South Wales State Coroner’s
983 Court, Lidcombe: Australia, **2019**.
984 [http://www.coroners.justice.nsw.gov.au/Documents/Redacted%20findings%20in%20the%20](http://www.coroners.justice.nsw.gov.au/Documents/Redacted%20findings%20in%20the%20joint%20inquest%20into%20deaths%20arising%20at%20music%20festivals%20including%20annexures%20-%208%20November%202019.pdf)
985 [joint%20inquest%20into%20deaths%20arising%20at%20music%20festivals%20including](http://www.coroners.justice.nsw.gov.au/Documents/Redacted%20findings%20in%20the%20joint%20inquest%20into%20deaths%20arising%20at%20music%20festivals%20including%20annexures%20-%208%20November%202019.pdf)
986 [%20annexures%20-%208%20November%202019.pdf](http://www.coroners.justice.nsw.gov.au/Documents/Redacted%20findings%20in%20the%20joint%20inquest%20into%20deaths%20arising%20at%20music%20festivals%20including%20annexures%20-%208%20November%202019.pdf) (Accessed March 14th, 2020).
- 987 67 Martín-Wanton T, Pons-Porrata A, Montoyo-Guijarro A, Balahur A. Opinion Polarity Detection
988 Using Word Sense Disambiguation to Determine the Polarity of Opinions, **2010**.
989 [https://www.researchgate.net/publication/221539778_Opinion_Polarity_Detection_-](https://www.researchgate.net/publication/221539778_Opinion_Polarity_Detection_-_Using_Word_Sense_Disambiguation_to_Determine_the_Polarity_of_Opinions)
990 [_Using_Word_Sense_Disambiguation_to_Determine_the_Polarity_of_Opinions](https://www.researchgate.net/publication/221539778_Opinion_Polarity_Detection_-_Using_Word_Sense_Disambiguation_to_Determine_the_Polarity_of_Opinions) (Accessed
991 March 14th, 2020).
- 992 68 Bindal N, Chatterjee N. A Two-Step Method for Sentiment Analysis of Tweets. *Int Conf Inf*
993 *Technol*, **2016**, 218–24.
- 994 69 Mohammad SM. Sentiment Analysis: Detecting valence, emotions, and other affectual states
995 from text. *Natl Res Counc Canada*, **2015**, 1.
- 996 70 House of Commons. Health and Social Care Committee. 2019. Drugs policy. First report of
997 session 2019. UK: Parliamentary Copyright House of Commons, **2019**.
- 998 71 Hendrie, D. Toxicologists throw support behind pill testing ahead of major festival weekend.
999 newsGP, **2019**. [https://www1.racgp.org.au/newsGP/professional/toxicologists-throw-support-](https://www1.racgp.org.au/newsGP/professional/toxicologists-throw-support-behind-pill-testing-ah)
1000 [behind-pill-testing-ah](https://www1.racgp.org.au/newsGP/professional/toxicologists-throw-support-behind-pill-testing-ah) (Accessed March 14th, 2020).
- 1001 72 The Guardian. NSW's resistance to pill testing will drive dealers to sell 'more dangerous
1002 drugs', ACT warns, **2019b**. [https://www.theguardian.com/australia-news/2019/jan/23/nsws-](https://www.theguardian.com/australia-news/2019/jan/23/nsws-resistance-to-pill-testing-will-drive-dealers-to-sell-more-dangerous-drugs-act-warns)
1003 [resistance-to-pill-testing-will-drive-dealers-to-sell-more-dangerous-drugs-act-warns](https://www.theguardian.com/australia-news/2019/jan/23/nsws-resistance-to-pill-testing-will-drive-dealers-to-sell-more-dangerous-drugs-act-warns)
1004 (Accessed March 14th, 2020).
- 1005 73 Giné CV, Vilamala MV, Measham F, Brunt TM, Bücheli A, Paulos C, et al. The utility of drug
1006 checking services as monitoring tools and more: A response to Pirona et al. *Int J Drug Policy*,
1007 **2017**, 45:46–7.
- 1008 74 Ventura M, Noijen J, Bücheli A, Isvy A, van Huyck C, Martins D, et al. Drug Checking Service
1009 Good Practice Standards. Health Programme of the European Union, **2013**.
1010 http://newip.safenightlife.org/pdfs/standards/NEWIP_D_standards-final_20.12-A4.pdf
1011 (Accessed March 14th, 2020).
- 1012 75 Guirguis A, Corkery JM, Stair JL, Kirton SB, Zloh M, Schifano F. Intended and unintended
1013 use of cathinone mixtures. *Hum Psychopharmacol Clin Exp*, **2017**, 32(3):1–17.
- 1014 76 Komesaroff PA, Lloyd-Jones DM. Pill testing warrants assessment in careful pilot
1015 programmes. *Intern Med J*, **2019**, 49(4):419–21.
- 1016 77 EMCDDA. Recent changes in Europe’s MDMA/ecstasy market. Vienna, **2016**.
1017 <http://www.emcdda.europa.eu/system/files/publications/2473/TD0116348ENN.pdf>
1018 (Accessed March 14th, 2020).
- 1019 78 Harm Reduction International (HRI). Drug-checking services, **2018**.
1020 <https://www.hri.global/files/2019/03/25/drug-checking-2018.pdf> (Accessed May 23rd, 2019).
- 1021 79 Daily S. Class A – National drugs intelligence bulletin. Q3 2018. Teddington, UK: LGC
1022 Group, **2019**.
- 1023 80 EMCDDA. European drug report 2019: trends and developments. 2019.
1024 [http://www.emcdda.europa.eu/system/files/publications/11364/20191724_TDAT19001ENN_](http://www.emcdda.europa.eu/system/files/publications/11364/20191724_TDAT19001ENN_PDF.pdf)
1025 [PDF.pdf](http://www.emcdda.europa.eu/system/files/publications/11364/20191724_TDAT19001ENN_PDF.pdf) (Accessed March 14th, 2020).

1026 81 Lancaster K, Ritter A, Matthew-Simmons F. *Young people's opinion on alcohol and other*
1027 *drugs issues*. Australian National Council on Drugs, Australia, **2013**.
1028 82 Sage C, Michelow W. *Drug checking at music festivals: A how-to guide*. Nelson, BC, Canada:
1029 ANKORS, **2016**.
1030 83 Pharmaceutical Society of Australia. Minimising harm from illicit drug use through pill testing
1031 and drug checking position statement, **2019**. [https://www.psa.org.au/pharmacists-support-](https://www.psa.org.au/pharmacists-support-pill-testing/)
1032 [pill-testing/](https://www.psa.org.au/pharmacists-support-pill-testing/) (Accessed March 14th, 2020).
1033 84 Chan B, Lopez A, Sarkar U. The canary in the coal mine tweets: Social media reveals public
1034 perceptions of non-medical use of opioids. *PLoS One*, **2015**,10(8):1–10.
1035 85 Rose SW, Jo CL, Binns S, Buenger M, Emery S, Ribisl KM. Perceptions of menthol cigarettes
1036 among twitter users: Content and sentiment analysis. *J Med Internet Res*, **2017**, 19(2):1–16.
1037 86 Glowacki EM, Glowacki JB, Wilcox GB. A text-mining analysis of the public's reaction to the
1038 opioid crisis. *J Subst Abuse*, **2017**, 39(2): 129-133.
1039