Literature Review of Drug Checking in nightlife – Methods, Services, and Effects

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Colophon

This report is the product of a collaboration between the Danish Health Authority and researchers from the Centre for Alcohol and Drug Research (CRF) at the University of Aarhus.
The general study was managed and carried out by assistant professor, Jeppe Oute, CRF, University of Aarhus.
Assistant professor, Maj Nygaard-Christensen, CRF, University of Aarhus assisted with the literature search and the write-up of this report. The review of testing equipment and the analysis processes related to drug checking was supervised by associate professor, Christian Lindholst, department head at the Institute of Forensic Medicine, University of Aarhus.
Associate professor, Kristine Rømer Thomsen, assistant professor, Maj Nygaard-Christensen, scientific assistant, Line Boelskifte and trainee, ph.d. Else-Marie Elmholdt, CRF, University of Aarhus contributed to the quality assessment of the literature and the organization of the report.
Finally, a monitoring group including associate professor, Morten Hesse and professor Torsten Kolind, CRF, provided ongoing feedback on the literature review, problems pertaining to specific topics, and the write-up of the report.

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1.0 Reading Guidelines

To make it easier for the reader to navigate this report, this chapter gives a brief overview of the content of the individual chapters.

Chapter 2: Background
This chapter describes the aim and the background for this literature review of drug checking in nightlife. Additionally, drug checking is put into a broader historical context as the background for the report's research question.

Chapter 3: Methods
This chapter describes the literature search in three databases, PubMed, Web of Science, and Scopus. Furthermore, a flowchart of the search process is presented, followed by a summary of the findings of the search process as well as some critical reflections about the precision and shortcomings of the search process.

Chapter 4: Quality Assessment of Articles and Reports
In this chapter, a quality assessment of the articles and reports identified through the literature search is conducted. Based on this, a number of critical statements are made about the methodological and empirical weaknesses of the literature as well as contextual shortcomings.

Chapter 5: Findings
The result chapter should be read with the quality assessment of the literature in mind (chapter 4). The chapter presents the results of the literature review in relation to the following three aspects:

Testing equipment and analysis processes
The question of which testing equipment and analysis processes assessed in the literature about drug checking in nightlife is highlighted. Furthermore, knowledge is provided about the most commonly used drug tests in nightlife and descriptions of their reliability and price.

Content and Organization of Drug Checking Programs
The question of the content of previous and current drug checking programs and the organization of the programs are highlighted.

Positive and Negative Effects of Drug Checking Programs
First, the findings from the literature on possible positive effects of drug checking programs are reviewed, including the evidence for reductions in the number of poisonings, behavioral changes among users, and counseling in relation to drug checking, and how the programs contribute to national and international monitoring of drugs.

Next, the negative effects of drug checking programs as presented in the literature are described. Among other things, the question of whether drug checking contributes to the normalization of drug use is reviewed, including whether users consider their drugs 'pure' and hence, less dangerous, based on drug checking.

Chapter 6: Conclusion

The conclusion summarizes the general findings of the literature review, and conclusions on the three research questions are presented in a narrative form. The chapter concludes with some general perspectives on considerations and needs for further research based on this report.

Appendix 1

A diagram is included as an appendix, documenting the quality assessment presented in chapter 4. The diagram consists of an overview of the different types of articles and reports that were identified in the literature search and reviewed in the report. The appendix should also contribute to enhancing the transparency of the critical reservations about the credibility of the results found in the literature. Furthermore, the diagram gives the reader the ability to see the specific assessment of the quality of the individual articles and reports by the author, including the study's aim, methods, sample, main findings, and comments. It is recommended that the reader continuously consults the diagram when reading the quality assessment of the literature and the findings.

2.0 Background

Although several drug checking programs in nightlife are in existence in a few European countries, Canada, and Australia there is only limited systematic scientific knowledge about the methods used, the organization of the drug checking services and the effects of drug checking, including unwanted negative effects (Pirona et al., 2017). Following a debate about drug checking in nightlife in the media as well as politically, the Danish Health Authority conducted a professional assessment of drug checking programs in nightlife concluding that from a precautionary standpoint such programs could not be recommended. The assessment presumes that *initiation of new initiatives must always be founded on solid knowledge about the effect of the intervention, and that there are no negative or contrary effects* (Danish Health Authority, 2018).

On this background, the Danish Health Authority initiated a systematic review of the international research literature on drug checking among recreational drug users, including evaluations of such programs, documentation about the effects as well as a critical analysis of the quality of the documentation. This literature review will provide the basis for upcoming work by the Danish Health Authority on this issue.

2.1/ Introduction

'Drug checking (services)' or 'pill testing' includes testing drugs and giving the test results about the type of drug, purity, and concentration to the drug users. Drug checking has been used for some years in different European countries[1] both as a harm reduction approach and for monitoring (e.g. project TEDI 2011-2013). Drug checking programs are characterized in the literature as both "Front of the house pill testing" and "Back of house testing" (Makkai, 2018). The former refers to drug checking programs in nightlife or at festivals, often conducted by NGOs with the primary aim of reducing harm, i.e. minimizing harm related to drugs, e.g. poisonings and deaths, and starting a dialogue with and counseling users about the drugs and the risk of taking them. 'Back house' drug checking (Makkai, 2018) refers to tests of drug samples handed over for analysis both by drug users and routinely from the police. The primary aim of back house checking is to follow the development of the drugs on the drug market, to monitor the drugs on the market by the authorities, and on that basis to inform and act in case new and particularly potent drugs emerge, e.g. by sending out special warnings. Furthermore, this monitoring is used as the foundation for regulating new and dangerous drugs through the individual countries' policies and legislations, updating the current knowledge about the drugs for health professionals to ensure the most optimal intervention for the drug users, and finally assist the police in enforcing the laws in nightlife contexts of different countries based on exact knowledge about the drugs and their content (Makkai et al., 2018). In Denmark, as in other EU countries, drug monitoring is based on the information from forensic analyses not only contributing to the national monitoring but also to the European "early warning system." Since 1997, all EU member states have been obligated to carry out this monitoring and to exchange information about new psychoactive drugs.[2]

[1] The Netherlands 1992, Belgium 1993, Austria 1997, Spain 1997, Portugal 2001, Switzerland 2001, Wales 2009 (Brunt 2017)
[2] JOINT ACTION of 16 June 1997 adopted by the Council on the basis of Article K.3 of the Treaty on European Union, concerning the information exchange, risk assessment and the control of new synthetic drugs (97/396/JHA).

The first test of using drug checking in nightlife occurred in Western Europe in the 1990ies. It happened as a reaction to a new generation of young, recreational drug users and their escalating use of synthetic psychoactive drugs. The aim of drug checking was initially to obtain better knowledge about changes to the new drug market, knowledge about user groups as well as to contribute to harm reduction and prevention (Brunt, 2017; Brunt & Niesink, 2011; Kerr & Tupper, 2017). The first drug checking program was the Dutch drug information and monitoring system DIMS (Drug Information and Monitoring System) that was initiated by the Dutch government in 1992. In the following years, a smaller drug checking program (Modus Fiesta) was launched in Belgium, while both Austria (the mobile Check-it) and Spain (Asociación Hegoak Elkartea, Energy Control) launched drug checking initiatives during the period 1994-1997. Since 2000, more drug checking services have been added in Europe and globally (Barratt et al., 2018a; Brunt, 2017)

A new global review of existing drug checking programs estimated that there were more than 31 drug checking programs spread across 20 countries in 2017. These include both front and back house programs. Most of these were European but there were also related programs in USA, Australia, and New Zealand, among others (Barratt et al. 2018a). While these drug checking programs are often targeting younger, recreational users in nightlife and at festivals there has also been an interest in transferring the experiences of drug checking to more marginalized groups of drug users. This is particularly true in North America where the use of fentanyl and related deaths is described as a genuine epidemic (Kerr & Tupper, 2017: 10-11; Laing, Tupper & Fairbarn, 2018). Thus, in Canada a pilot drug checking program was initiated in 2016 in an injection room facility, where drug users, assisted by health professionals were given the opportunity to check their drugs followed by making the results available for everybody and not just the people using the injection room (Kerr & Tupper, 2017: 10-11).[3] However, generally, the vast majority of drug checking programs in nightlife are targeting recreational users and adjusted to checking the drugs related to the recreational drug use by youth, including drug use of the classic drugs MDMA, cocaine, and amphetamine (Kerr & Tupper, 2017: 22).

Most drug checking programs in nightlife are carried out in on-site labs (front house), where users can have their drugs checked right then and there. Specifically, the users hand over their purchased drugs and compound(s), purity, and, if possible, additives is/are identified. The user then receives the test results, sometimes within a few minutes but no later than after an hour. As the drug checking results are most often given to the user, it supports the user's ability to make a more informed decision in relation to taking the drug (Barratt et al., 2018). Other programs are only offered in stationary labs (back house) in relation to a preventative or health-related effort. A number of interventions offer a combination of mobile and stationary drug checking services (Barratt et al., 2018a).

In addition to checking the users' drugs, the aim of the drug checking programs is also to get in touch with the users, including youth that may be difficult to get in touch with in the treatment system (Fernandez-Calderon et al., 2018). Furthermore, the idea is to establish a framework for communicating and informing about 'safer use' of drugs, including ensuring that youths have the appropriate knowledge about risks of using drugs (Toumbourou et al., 2007).

[3] Similarly, drug checking was initiated in the injection room 'Skyen' in Copenhagen for the drug users using this facility.

Drug checking programs often take place in a legal grey zone (Barratt et al., 2018; Kerr & Tupper, 2017). For example, personnel in drug checking projects is not legally allowed to handle drugs that are submitted if drug possession is illegal (Lefkovits, 2016; Nicholas, 2006). In some places this is solved by letting users check their drugs themselves while others solve the problem through local agreements between police, health personnel, and nightlife operators (Butterfield et al., 2016b).

Thus, there are two general aims related to drug checking programs, harm reduction and monitoring. The aim of most drug checking programs in terms of harm reduction is to give advice and distribute information materials and possibly refer users to treatment or counseling (Barratt et al., 2018). The direct contact between user and personnel in drug checking programs may facilitate access to a 'hidden' user group (Gine et al., 2017), including first-time users and recreational users without any prior contact to prevention efforts. While the result of the drug test almost always is given to the individual user, the aim of these drug checks is also to share the results with a wider, potential user group. The English drug checking project, The Loop, mostly known for drug checking at festivals, sends out warnings to users on social media when harmful drugs or impurities have been identified (Makkai, 2018).

As mentioned, the aim may also be monitoring. Among other things, the Dutch DIMS wants to contribute to the knowledge about the recreational drug market, new drug trends, or changes in the compounds and the purity and strength of the drugs (Barratt et al, 2018b). The Trans-European Drug Information project (TEDI) produces and updates a database of new and particularly dangerous drugs on the European drug market at user level, based on input from participating drug checking programs (Brunt et al., 2017: 193; Kerr & Tupper, 2017).

However, the international literature points out that the established drug checking programs are difficult to compare, and that they may have positive as well as negative effects. The positive effects are related to the usefulness of monitoring changes on the drug market and reduce the harm related to drug use. On the other hand, there is an argument for a spill-over effect from drug checking that use of illegal drugs is normalized and legitimized by drug checking programs (Brunt et al., 2017).

For the review of the international literature on the use and the effects of drug checking in nightlife, the following research questions were formulated.

2.2/ The Research Questions of the Report

i) What kind of test equipment and analysis processes are presented in the literature about drug checking in nightlife? In addition, the report will focus on what drug testing methods are currently used for drug checking services as well as their validity, price and mobility.
ii) What is the content of previous and current drug checking programs, and how are they organized? The drug checking programs' testing methods and delivery of harm reducing counseling will be reviewed as well as monitoring of the drug market and drug use.

iii) What are the positive and negative effects of drug checking programs? The literature will be reviewed to find information about positive effects of harm reduction, e.g. reduction in the number of poisonings and deaths, behavioral changes among users and delivery of counseling in relation to drug checking, as well as how the programs contribute to national and international drug monitoring. Pertaining to negative effects, information about drug checking as a contributor to normalization of drug use will be reviewed, including whether users consider their drugs 'pure' and hence, less dangerous, based on the test.

3.0 Methods

To get an overview of the complete literature on drug checking in nightlife a *scoping review* (Pedersen, 2018) was conducted. This methodological approach is particularly appropriate to assess a complete set of scientific studies and reports about an issue based on both quantitative and qualitative scientific research methods and to assess the quality of the studies. The review was conducted according to the procedure presented below as described in the Prisma guidelines for reviews.

3.1/ Literature Search

First, we followed the criteria for systematic reviews when collecting quantitative and qualitative studies of drug checking in nightlife (Bydam et al., 2013; Buus et al., 2008). The criteria for inclusion in the literature search were that the studies should be quantitative or qualitative, focusing on drug checking in nightlife (including festivals). Scientific studies, literature reviews, and reports in English and Scandinavian languages were included. The literature search was not limited by age or nationality of the studies. A systematic literature search consists of *both* an unsystematic *and* a systematic search.

The search strategy of the literature search first included an unsystematic chain search that started with lists of references from previous reports. The unsystematic strategy was prolonged by searching on the relevant references of the reports in Google Scholar and use 'cited' and 'related' articles to identify additional studies. During this phase of the unsystematic literature review, we relied specifically on the knowledge among the research team of existing reports and studies. Hence, we searched the list of references in the tender/project description of this report, the EMCDDA report (Brunt, 2017), and the report "Global review of drug checking services operating in 2017" (Barratt et al., 2018a) for relevant studies that met the criteria of inclusion. Through identification of the relevant studies and the authors/researchers who came up repeatedly across lists of references and studies, it became evident that two renowned researchers in particular have conducted research with specific relevance for this review, the Australian drug and alcohol researcher Monica Barratt and the Dutch health researcher Tibor Brunt. During the next step, we searched Google Scholar for related studies of the relevant studies and specifically, for Barratt's and Brunt's publications. On the basis of the references in all ongoing international drug checking projects in 2017 described in the report "Global review of drug checking services operating in 2017" (Barratt et al., 2018a), we searched Google for all reports describing ongoing projects even if it was not possible to identify reports from all the projects. The aim of the systematic literature search was to identify all relevant references in the databases PubMed, Scopus, and Web of Science. These databases were chosen because they index references in social and health sciences that cover the scientific interface where studies of drug checking in nightlife can be placed. The systematic search was designed as a block search in which the topic "drug checking in nightlife" was 'translated' to the controlled keywords of the databases used to index the studies in the database. Based on the studies retrieved in the unsystematic search, the systematic search was developed by identifying how the studies were indexed using the controlled keywords of the databases. First, we constructed the structured database search by developing three search blocks. In a close collaboration between Jeppe Oute (JO) and research librarian Gina Bay (GB), all synonyms of controlled keywords covering (a) context, (b) topic, and (c) drug type were identified and combined by the Boolean

operator ≪OR≫. Finally, the three search blocks were combined by the Boolean operator ≪AND≫. This was done in each of the three databases. The development of the search blocks led to the construction of new 'search strings' that were copied into the database. The iterative process of constructing search strings meant that JO and GB updated the search blocks several times, either when new controlled keywords were identified as part of the search in the different databases, or when a search term turned out not to be precise or comprehensive. The search strings for each of the three databases were as follows:

3.1.1/ Scopus (*searched in Advanced Search)

(TITLE-ABS-KEY (cannabis OR cannabinoids OR nps OR "new psychoactive substances" OR lsd OR mdma OR fentanyl OR crack OR amphetamine* OR speed OR co-caine OR ecstasy OR "street drugs")) AND ((TITLE-ABS-KEY ("drug test*" OR "drug surveillance" OR "drug detection" OR "trans-european drug information" OR checkit OR "drug in-formation and monitoring system" OR "pill test*" OR "adulterant screening" OR "multi agency safety test*" OR "street drug analysis")) OR (TITLE-ABS-KEY ("drug checking" OR "drug safety test*" OR "harm reduction")))

3.1.2/ Web of Science (searched in Advanced Search)

TS=("drug test*" OR "drug surveillance" OR "drug detection" OR "trans european drug information" OR checkit OR "drug information and monitoring system" OR "pill test*" OR "adulterant screening" OR "multi agency safety test*" OR "street drug analysis" OR "drug checking" OR "drug safety test*" OR "harm reduction") AND TS=(cannabis OR cannabinoids OR nps OR "new psychoactive substances" OR LSD OR mdma OR fentanyl OR crack OR amphetamine* OR speed OR cocaine OR ecstasy OR "street drugs")

3.1.3/ PubMed

(("drug testing") OR ((((("drug surveillance" OR "drug detection")) OR "trans european drug information") OR checkit) OR ("drug information and monitoring system")) OR ("pill testing" OR "adulterant screening" OR "multi agency safety testing" OR "street drug analysis" OR "drug checking" OR "drug safety testing" OR "harm reduction")))) AND (cannabis OR cannabinoids OR nps OR "new psychoactive substances" OR LSD OR mdma OR fentanyl OR crack OR amphetamine OR amphetamines OR speed OR cocaine OR ecstasy OR "street drugs" OR "N-Methyl-3,4-methylenedioxyamphetamine"[Mesh])

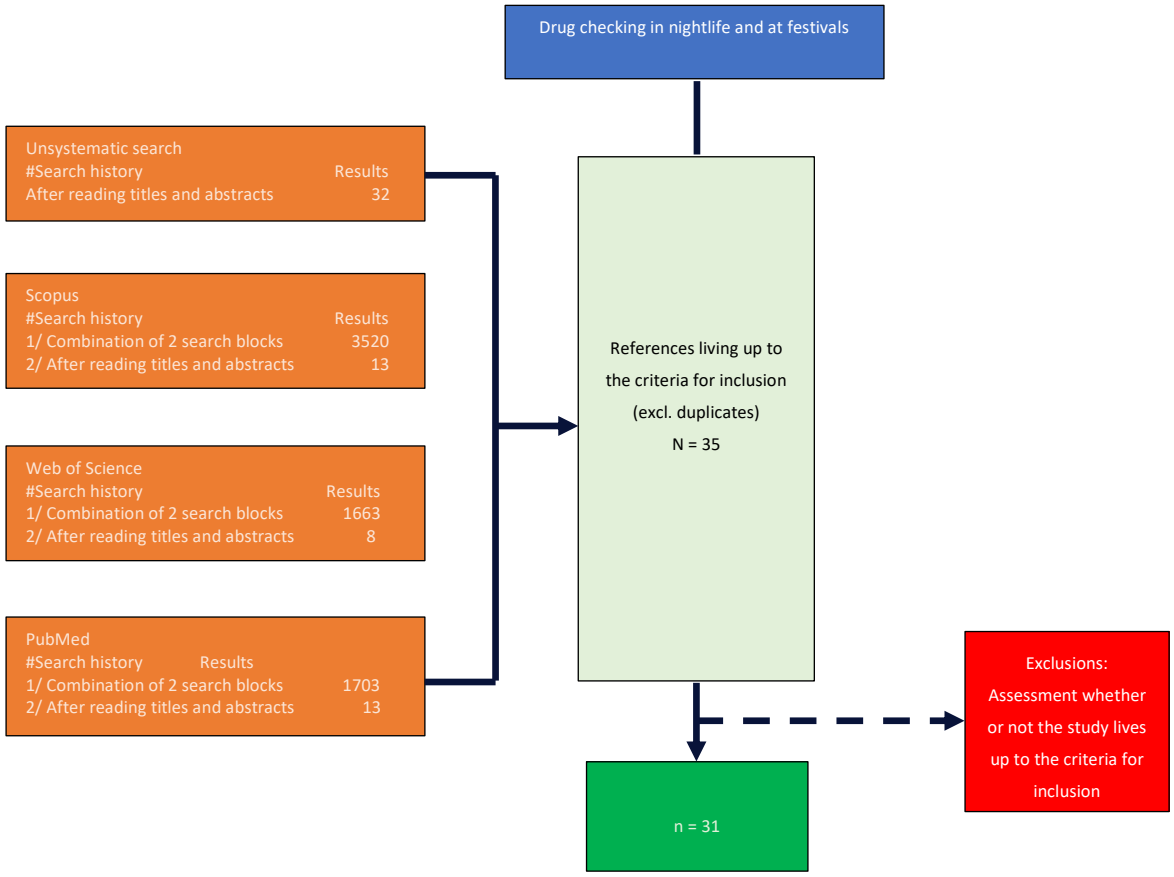

Fig. 1. Flowchart: The Literature Search Process

3.2/ Summary of the Literature Search

As described in the flowchart in fig. 1 and the references to the identified reports and studies below, we found 31 texts living up to the criteria of inclusion. They consist of 12 international reports (two of those consist of a main report and a profiling of ongoing drug checking services) and 19 articles. The reports were published by different political bodies in the drug and alcohol field between 2006 and 2018, e.g. Royal Society of Public Health and EMCDDA, and research institutions with expertise in alcohol and drug research, e.g. University of New South Wales. Of those reports, 9 were published between 2016 and 2018 (Barratt et al., 2018a). The articles were published in renowned, international journals such as *International Journal of Drug Policy* or *Addiction* between 2011 and 2018.

Overall, the reports and articles reflect an increased international interest in and debate about what might be considered good policy development and research in relation to drug checking in nightlife.

The findings of the literature search illustrate that the researchers Barratt and Brunt must be considered authorities in this field as they individually and together are listed as primary author, co-author of or as a reference in the majority of the included publications; 7 out of 12 reports and 6 out of 19 articles, respectively ((TEDI), 2012, Barratt and Ezard, 2016b, Barratt et al., 2018a, Barratt et al., 2018b, Barratt and Ritter, 2017, Brunt, 2017, Brunt et al., 2017b, Brunt and Niesink, 2011, Butterfield et al., 2016a, Camilleri and Caldicott, 2005, Day et al., 2018b, EMCDDA, 2017, Gine et al., 2017, Groves, 2018, Health, 2017,

Hungerbuehler et al., 2011a, Kerr and Tupper, 2017, Kriener H, Laing et al., 2018a, Lefkovits, 2016, Makkai, 2018, Miller et al., 2016, Nicholas, 2006, Palamar et al., 2017, Saleemi et al., 2017a, Sande and Šabić, 2018, Schneider et al., 2016a, Schroers, 2002, Ventura et al., 2013, Winstock et al., 2001, Harper et al., 2017).

3.3/ Methodological Considerations for the Database Search

During the search process that was carried out from late October to early November 2018, a number of reservations emerged. They are presented here.

- Including a search block about the scientific methods used in the studies created too much "noise" (i.e. many irrelevant articles in the searches due to inaccurate search).
- It was necessary to specify the type of drugs rather than using a generic search term for drugs.
- The combination of the three search blocks was potentially to narrow and hence, did not capture all relevant studies indexed in the databases.

In response to the first two reservations, we substituted the search block about methods with a search block that included all types of drugs that are being checked. In response to the third reservation, and despite producing more "noise" without the context block (e.g. 'nightlife'), we decided to conduct a wider search. It meant that we excluded the "context" search block and conducted the database search using the search blocks 'topic' and 'drug type' to capture all relevant articles and reports in the databases.

In addition, during the search process it turned out that drug checking has been studied in a number of contexts that do not or just indirectly relate to drug checking in nightlife (e.g. Brunt, 2017). Examples include studies of drug checking related to 1) doping and elite sports, 2) police enforcement of traffic laws and DUI, 3) crypto-markets, 4) "chemsex" and harm reduction among LGBT persons, 5) drug use in the workplace, and 6) border control. Even if drug checking is the topic of these studies, we decided to exclude them in the database search as they are considered adjacent research areas.

Despite these reservations, it seems that the methodological balancing act of expanding and narrowing the search was accurate. Across the unsystematic searches and the searches in the three databases, we identified at least 14 duplicates. As indicated in fig. 1, the relationship between duplicates and the total number of relevant studies and reports reflects the fact that the search was relative comprehensive.

4.0 Quality assessment of articles and reports

To carry out homogenous assessments of the quality of the literature, we wanted to use standardized and validated checklists because we expected to find and compare quantitative and qualitative studies of drug checking in nightlife. However, the results of the literature search showed that the checklists that were chosen in advance were not particularly suitable to assess the literature. This was due to the fact that the methods, sampling, type/genre, and qualities of the literature were a lot more diverse than expected, cf. table 1 and appendix 1. Furthermore, it was a challenge that the overall character of and variation in the literature were not compatible with natural and health scientific criteria for the concept of 'evidence' (Devisch & Murray, 2009). That meant that the previously chosen standardized checklists could not be used to assess the strengths and weaknesses of the literature by measuring and ranking the evidence of the articles and reports to indicate the credibility of individual conclusions. Hence, we developed a generic checklist (table 1) that was used as a guide to formulate general reservations for the review of the results. The properties of the individual articles and reports and critical remarks on their weaknesses are presented in appendix 1.

Year and country Title, authors, country	Aim	Method	Sample	Results	Content and organization of the drug checking programs	Positive and negative effects of drug checking programs	Test equipment and analysis processes	Remarks

Table 1. Generic checklist for the critical review of articles and reports on drug checking in nightlife

This checklist was inspired by the construction and criteria of the previously chosen and standardized Prisma and Qoreq checklists (Moher et al., 2009; Tong et al., 2007). Furthermore, we added three items focusing on the documentation of the analyses, discussions, and conclusions of the reports and articles pertaining to the research questions:

i) Test equipment and analysis processes in relation to drug checking (e.g. validity, price, and mobility)
ii) Content and organization of the drug checking programs (e.g. drug testing, counseling, monitoring, target group, and competences), and
iii) Positive and negative effects of the drug checking programs.

Due to the variation in methods, sampling, type/genre and qualities of the literature, the quality assessments of the literature in this report cannot be interpreted as a systematic critique of the research evidence. It should be seen as quality assessments of the general nature, strengths and weaknesses, and results of the, sometimes, mixed literature. Below, the overview of the types/genres of the literature and critical comments to the literature are presented.
The comments also refer to the attached diagram (appendix 1) that provides an overview of the quality assessment of each report and article. The quality assessments of the methods, sampling, and results of the

literature indicate that the types of the 31 articles and reports that were identified may be categorized as follows (also see attached assessments of articles and reports in appendix 1):

- ***Reports.*** These include, e.g. 'evidence review', best practice guidelines, policy recommendations, etc. ((TEDI), 2012, Barratt et al., 2018a, Barratt et al., 2018b, Brunt, 2017, EMCDDA, 2017, Health, 2017, Kerr and Tupper, 2017, Kriener H, Lefkovits, 2016, Makkai, 2018, Nicholas, 2006, Ventura et al., 2013).

- ***Not original research articles*** include so-called commentaries, letters to the editor, response papers (Barratt and Ritter, 2017, Groves, 2018, Winstock et al., 2001, Gine et al., 2017, Miller et al., 2016, Barratt and Ezard, 2016a).

- ***Literature reviews*** include evaluations, background articles, historical overviews, literature reviews (Butterfield et al., 2016b; Laing et al., 2018a; Schroers, 2002).

- ***Studies of drug checking methods*** that include both development and implementation (Camilleri and Caldicott, 2005, Sande and Šabić, 2018, Schneider et al., 2016a).

- ***Monitoring studies*** that consist of surveys and monitoring studies (Brunt et al., 2017b, Brunt and Niesink, 2011, Day et al., 2018b, Harper et al., 2017, Hungerbuehler et al., 2011a, Palamar et al., 2017, Saleemi et al., 2017a).

4.1/ Critical comments to this literature review

Similar to the last chapter, a critical reflection on the comprehensiveness of this review must be made as well as how it relates to the literature in the field in general. This literature review may be criticized for potentially having excluded a number of important experiences with drug checking in nightlife because we did not include and assess smaller non-scientific reports and descriptions of ongoing drug checking services.

That means that there may be non-scientific descriptions of ongoing drug checking services that may have been omitted. However, it should be noted that they are most likely indirectly included in this review as several descriptions appear in the Australian as well as the global review of ongoing drug checking services (Barratt et al., 2018b; Barratt et al., 2018a). Nonetheless, it should be noted as a strength that the aim, methods, and results of this review are remarkably similar to the review report by Kerr & Tupper (2017). This review includes the review experiences from the report by Barratt et al., 2018 and hence, we update the study by Kerr & Tupper from 2017. Altogether, that supports that the search and the results of the review not only correspond with the results of previous reports and articles but also provide an update.

4.1.1/ Quality Assessment of the Drug Checking Literature: Critical Remarks

In general, the quality assessment of the literature showed that the identified literature – dependent on the premises of the genre/type of the literature – should be regarded as a credible pool of scientific work. However, all the articles and the origins, type, methods, and quality of the reports can be regarded as

diverse individually and in total. This makes it extremely difficult to draw definite conclusions about the effects of drug checking services. As presented in the categorization above as well as in the attached appendix 1, the literature also includes a number of methodological-empirical and contextual weaknesses and shortcomings presented below.

However, despite these critical shortcomings and weaknesses the literature sends a message of a high level of professional as well as political legitimacy because it includes scientific articles and scientific reports that are often requested or financed by political bodies. This is supported by the fact that more studies have been prepared in a collaboration between different political bodies, e.g. EMCDDA, and renowned researchers, and that they are often published in reputable journals. Two general comments should be made regarding the 1) methodological-empirical foundation and 2) contextual weaknesses of the literature to show that the results and conclusions of the literature are not just uncritically accepted. They should be understood[4] as general reservations in the review of the results. These two general comments each include a number of smaller but more specific considerations that are described in the following:

First, the literature – as shown above – includes a number of articles and reports that are based on a very diverse methodological-empirical foundation. It finds its expression in different scientific and non-scientific contributions that adhere to different genres, e.g. monitoring studies, literature reviews, reports, etc. Furthermore, a relatively large number of cross-references can be identified in several literature reviews and reports written by the same authors, e.g. Monica Barratt, Tibor Brunt or other well-established researchers in the field. This might indicate a risk of the relative narrow circle of established researchers reproducing the same findings over and over again, as long as no new empirical evidence is produced.

This is supported by the fact that most of the most recent reviews (and hence, this report) refer to the relatively methodologically-empirically weak studies and reports (Kerr & Tupper, 2017) that are often based on the same datasets, e.g. the TEDI project or previous projects (Brunt et al., 2017b). Even if it can hardly be called a surprising result per se, this general basic issue in the literature is reflected in the fact that the literature seems to consist of a preponderance of reports, literature reviews, and commentaries that individually and in combination rest on a small number of original empirical (monitoring) studies, often conducted by the same authors.

As seen in appendix 1, it is often a weakness in the identified studies that they really cannot document an effect of drug checking, including harm reduction measured by a change in the user's drug behavior (Day et al., 2018a; Sande and Sabic, 2018; Brunt and Niesink, 2011; Groves, 2018). Thus, several reports and articles mention that it is difficult to draw final scientific conclusions about the harm reduction effects and/or monitoring from drug checking. This general point even seems to be remarkably stable in the drug checking field, as it was already presented in an early report from 2001 by Kriener et al.:

> "there is so far no real "state of the art" as regards pill-testing evaluation and it is not possible on the basis of the current situation to provide "hard" outcome data to policy-makers in order for them to

[4] The way this report presents generalized critiques of the general reservations for reading the results in the literature can also be found across the identified articles and reports (cf. Brunt, 2017; Kerr & Tupper, 2017).

decide scientifically upon the value of setting up on-site pill testing interventions" (Kriener et al., 2001:8).

Even if this earlier critique is most likely still valid it should be noted that this review indicates that the literature seems to be more credible in relation to documenting the effects of drug checking as a monitoring tool than of drug checking as a harm reduction effort (Brunt et al., 2017a). This, because there currently does not exist a robust methodological-empirical foundation to conclude that drug checking in nightlife lead to less or more safe use of drugs among youth, whereas the TEDI and DIMS projects have already contributed to developing a substantial monitoring work in Europe and other parts of the world (Brunt and Niesink, 2011; Brunt et al., 2017a). In other words, these circumstances indicate that the literature seems to present clearer evidence for monitoring as a support for cross-sectional and structural prevention, but only to a lesser degree delivers scientific evidence for implementing drug checking programs with harm reduction and secondary prevention aims.[5]

The critical reservations that we have described are also found in previous assessments of drug checking in nightlife. For example, critics have argued that drug checking may give drug users in nightlife a false sense of security. This is due to the fact that there is still some uncertainty about measurements related to the different methods of analysis while at the same time, drug checking can contribute to legitimizing or 'normalizing' drug use (Butterfield et al., 2016c, EMCDDA, 2017, Brunt, 2017). However, the challenge here is that there does not seem to be a robust foundation for that conclusion. To obtain in-depth knowledge of whether or not and/or how drug checking programs may contribute to changing drug users' behavior or lower their use, the existing literature indicates a need for developing more and better clinical trials, monitoring studies, and ethnographic studies of the effects of different types of drug checking programs (Kerr & Tupper 2017: 21). A better knowledge foundation requires different types of scientific studies that can provide real insight into long-term changes in drug use in nightlife, real changes in drug users' behavior, and drug users' understanding of and way of relating to drugs in nightlife (EMCDDA 2017; Kerr & Tupper 2017: 21). The need for a more multi-facetted knowledge foundation is backed by more recent studies of the users' attitudes to drug checking that suggest that drug checking may be a promising intervention to reduce the number of drug-related hospitalizations at festivals. Furthermore, some studies suggest that drug checking may have a more deterrent than encouraging effect in relation to drug use among festival participants. A number of remarks must be made about these studies. On one hand, these types of smaller and non-generalizable studies suggest that drug checking may contribute to a reduction in drug use among those who submit their drugs for testing because some recreational users may be inclined to not using the drugs. On the other hand, they also illustrate that because of limited access to drugs, other recreational users take the chance and use drugs despite knowledge of potentially dangerous compounds (Gine et al., 2017, Pirona et al., 2017, Kerr and Tupper, 2017).

Second, the results of the studies that were included are difficult to compare 1:1 because the articles and reports have a number of contextual weaknesses. The challenge of comparing the present studies and project reports is related to the current literature rarely – if at all – taking variations in the local and national drug scenes, general use patterns, and international and regional differences in party and drinking cultures

[5] The meaning of cross-sectional and structural prevention is used here in accordance with the Danish Health Authority's 'Terminology: Prevention, Health Promotion, and Public Health' (2005)

into account. This well-known problem is also related to insecurity about whether present data actually represent users with a recreational use of drugs in nightlife or if they only include people who e.g., use drugs on a weekly basis. At the same time, it is also unclear whether it is possible to compare the available information from the different studies and projects because the users (the respondents) have had varying access to drug checking. Furthermore, the drug testing that was used varied across the nations where the studies were conducted (Brunt et al., 2017). As indicated below and in the attached appendix, it is also a known fact that the different testing methods used in the studies and reports make it difficult to compare the results (Brunt et al., 2017). The challenge of comparing the results of the studies and reports could also be related to the results and conclusions being produced and subsequently presented in very different social, organizational, political, and cultural contexts. Several reports and literature reviews also mention that the local, national policies in relation to regulation and enforcement of drug possession and use and the concurrent introduction of drug checking often are seen as barriers for the implementation of drug checking services (Makkai, 2018; Brunt, 2017).

Several articles and reports also point to a problematic relationship between competing political demands for drug checking and regulation of drugs in nightlife in the individual countries. It makes it difficult – perhaps even impossible – to study and/or implement drug checking methods and services as well as to assess the effects in practice. Furthermore, the present conclusions about drug checking are based on practices that occur in very different legal frameworks. Even if only a very narrow empirical foundation exists, more recent projects indicate that competing demands can be limited through collaborative efforts among police, drug checking personnel, researchers, users, and organizers to find flexible interpretations of those demands (Makkai, 2018; Barratt et al., 2018a). This approach seems to be related to previous discussions about the considerations for the police's, the users', and the health personnel's approach to injection rooms. With these two general, critical reservations for the quality of the literature, the results of the review are presented in chapter 5.

5.0 Results

This chapter presents the literature review's answers to the previously mentioned research questions. The answers should be read with the reservations for the critical remarks about the qualities of the studies and reports in mind.[6] In this chapter, the answers from the literature to the research questions are presented one by one.

5.1/ Test Equipment and Analysis Processes

The literature review identified 1) an 'evidence review' report (Kerr and Tupper, 2017) that answers many of the same questions that this report attempts to clarify, 2) a review of the analysis methods used for drug checking in nightlife (Harper et al., 2017) and 3) a report on the possibilities for and the challenges in relation to offering drug tests as a harm reduction intervention for recreational users (Brunt, 2017). This literature review indicates that these three texts, in particular, clarify the different kinds of test equipment and analysis processes that have been used in nightlife contexts so far. Hence, this chapter is based on that work and compares and discusses the presentation of the reliability and price of the methods in those reports.

5.1.1/ Drug Testing Methods

A review report from the Canadian researchers Kerr & Tupper (2017) point out that technology and methods for drug testing may vary depending on how suitable the specific method is for drug checking in nightlife. The review presents a very good overview of nine of the most wide spread testing methods used, including the authors' assessment of ten relevant parameters (Table 2). In addition, the authors provide a more thorough description of the specific testing methods than several of the other reports as well as an assessment of pros and cons in relation to on-site drug checking.[7]

[6] For transparency, it is recommended that the reader continuously checks the quality of the specific article or report in the appendix.

[7] A rigorous review/translation of the specific testing methods, currently used for drug testing in nightlife contexts, described in the literature is beyond the scope of this report. Hence, the reader is referred to Kerr's & Tupper's excellent review of the specific methods (Kerr & Tupper, 2017:12-25).

Technology	Detect a wide variety of compounds	Ability to detect fentanyl and other opioids	Ability to detect multiple compounds at once	Specificity	Sensitivity	Quantitative analysis	Can identify unknown compounds	Speed per sample	Cost	Suitable drug checking settings
Colorimetric Reagent Testing[6,17,20-23]	Moderate	Low	Low	Low	Low	No	No	<6 min	$	Stationary, Mobile
Fourier-transform Infrared Spectroscopy (FTIR)[24-27]	High	Moderate	High	High	High	Low	No	<2 min	$$	Stationary, Mobile
Thin Layer Chromatography (TLC) with UV detection[6,20,23-25]	Moderate	Weak	Moderate	Moderate	Moderate	Low	No	30 min, multiple at once	$$	Stationary
Capillary Electrophoresis (CE) with UV detection[23,24,26-28]	High	Moderate	Moderate	Moderate	Moderate	Moderate	No	<2min*	$$	Stationary
High Performance Liquid Chromatography (HPLC) with UV detection[6,17,23,24,29-31]	High	High	High	High	High	High	No	15 min	$$	Stationary, Mobile
High Performance Liquid Chromatography (HPLC) with MS detection[6,17,24,32-34]	Highest	Very high	Very high	Very high	Highest	Highest	Yes	7.5 min*	$$$$	Stationary**
Gas Chromatography (GC) with MS detection[6,17,24,33,35,36]	Very high	Very high	Very high	Very high	Very high	Very high	Yes	14.5 min*	$$$$	Stationary
Ion Mobility Spectrometry[37-42]	Moderate	Moderate	Moderate	Low	High	Moderate	No	<1 min*	$$	Stationary, Mobile
Ion Mobility with MS detection37-41	High	High	Very high	High	Very high	High	Yes	20-30min*	$$$$	Stationary

*These durations are estimates based on machine-specific run times alone, and do not include collection, preparation, report generation, or consultation.
** While this technology has also been used in mobile lab-in-a-van settings, but the equipment is not considered portable.

Table 2. Comparative overview of testing methods and their properties

First, Kerr's & Tupper's review of existing drug testing methods provides a diverse image of the analytic-technical strengths and weaknesses of the methods, their price and mobility, and how fast they can generate an analysis result, cf. table 2. In general, the review points out that there is a relationship between price, speed, and applicability of the testing methods in nightlife contexts and the quality of the generated analysis result. Thus, cheaper analysis methods (colorimetric test, thin layer chromatography, capillary electrophoresis) produce a lower quality analysis response than the more expensive and more advanced chromatographic techniques. However, the cheaper methods have strengths due to their applicability for on-site drug testing because they are mobile and often easier to operate.

Second, another review by Harper, Powell, and Pijl (2017) assesses several different analysis methods for drug testing, used primarily in European drug checking programs. In the article, a comprehensive diagram is presented (Harper et al., 2017:3-4), that provides an overview of drug testing technologies and methods closely related to Kerr's & Tupper's literature review (2017). In addition to the assessment of the strengths and weaknesses of the methods, the review includes indications of the necessary level of experience by the users of the different testing methods. The article provides a description of the principle of analysis and ability of detection of the selected testing methods, comparable to the review by Kerr & Tupper (2017).

In relation to changes on the Danish drug market, it should be mentioned that both of these Canadian reviews build on the current national opioid problems. Hence, the ability of the testing methods to identify fentanyl is assessed as a separate parameter.

Third, in collaboration with EMCDDA Brunt published a report with the aim to review the possibilities and challenges of offering drug checking as a harm reduction intervention for recreational users (Brunt, 2017). In line with the two previous review reports, mentioned in this chapter, Brunt reviews the strengths and weaknesses of the different testing methods, what methods have been used by European studies, the

variation in the benefits of the drug testing methods (see below), the different ways of how drug checking services may differ from each other, if drug checking services can save lives, legal challenges related to drug checking services, and the future of these services in Europe (Brunt, 2017).

Despite discrepancies about the interpretations of the drug testing methods and their strengths and weaknesses in the three reviews, the conclusions by Harper et al. (2017), Kerr & Tupper (2017), and Brunt (2017) seem both reliable and transparent. Together and separately, the two above mentioned reviews and the report provide a good overview of the most commonly used methods for drug testing as well as their strengths and limitations. However, it would be beneficial to reflect a little on their interpretations.

First, they all point out that the ability of several of the methods to identify new and known substances and to distinguish between them is partially overlapping. At the same time, this ability also varies substantially among them. To a larger extent than the other two reviews, Brunt's (Brunt, 2017:10) interpretation (table 3) of the most common methods seems to emphasize that the properties of the methods vary gradually:

Ways in which drug checking services can vary

Technique	Colormetric reagents	High-performance liquid chromatography	Gas chromatography	Mass spectrometry
Timing				
Testing for	Presence or absence of a component	Information on whole range of substances present		Quantitative information about all compounds
Setting	At home	On-site/mobile		Remote site
Who	Individuals		Professionals	
Results	Drug content	Public health alerts	Harm reduction information	Brief interventions
Use of results	Individual harm reduction		Public health action	Market monitoring

Table 3. European overview of common drug testing methods

In contrast to Kerr's & Tupper's (2017) comparative and transparent table (Table 2), a strength of Brunt's table is that it to a larger extent illustrates a gradual variation in the ways of how drug tests can be used. Even if Brunt (2017) largely refers to the same test types as both Kerr & Tupper (2017) and Harper et al. (2017), Brunt indicates that there may be a smooth transition between the accuracy of the methods, time needed for the tests, what the tests can and cannot show, and where the tests can be used. Another strength of table 3 is that it, as opposed to both Harper et al.'s (2017) and Kerr's & Tupper's (2017) work, emphasizes when non-specialists or professionals respectively can and perhaps should use the test, what the test results are good for, and in what contexts the test results are particularly suitable.

Second, table 3 does not show the variation in the price of testing equipment as is the case for the reviews by Kerr & Tupper (2017) and Harper et al. (2017), albeit in Canadian and US dollars, respectively. According to Kerr & Tupper (2017) the range of the prices for the equipment for the different testing methods is from a few hundred Danish kroner to several thousand Danish kroner (Kerr and Tupper, 2017). The relationship between price and the ability of the methods to identify new substances, to perform accurate analyses of all types of compounds of substances, and to distinguish between the profiles of the substances and related chemical compositions does not increase exponentially. Hence, Kerr & Tupper, like Brunt (2017), point out

that the methods must be assessed based on the aim of the test, i.e. what it is expected to contribute in the actual setting (Kerr and Tupper, 2017).

Third, often implicitly a cost-benefit variable exists in the literature that in combination with the other variables/parameters, price, mobility, sensitivity, etc. often show up as a tendency of stationary laboratories being able to deliver more and better drug tests by drop-off or submission of drug samples. On the other hand, faster and cheaper drug tests that are easier to operate by partly unskilled personnel and deliver the results to the user (for harm reduction) seem to work better for on-site drug checking services. However, as previously pointed out (Brunt, 2017) on-site laboratories often use the possibility of quickly submitting drug samples to a close-by stationary laboratory with more advanced testing equipment. These considerations about the presentations of the methods not being neutral may not be surprising because this critique sounds like an echo of the more recent aforementioned study of similar methods for analyses of illegal substances (Harper et al., 2017). In the article, Harper et al. initially present the argument that ”any substance can be identified using MS in combination with a separation (chromatographic) technique” (Harper et al., 2017:2). However, the study does point out that there are many variables to include that are related to the ones mentioned in this report. Without otherwise looking at the contextual factors in which drug checking in nightlife takes place, the study in the end argues that recommendations for the use of certain testing methods in nightlife ”include a strong bias to cost-benefit and beg the important question of whether some of the less discriminatory interventions are better than no intervention at all” (Harper et al., 2017:11). On the basis of their indication that recommendations for certain kinds of drug checking in nightlife may be influenced by external values and from time to time could be counterproductive, they conclude the following:

> ”The techniques that are the strongest candidates based on all considerations are IMS, IR, Raman spectroscopy, and spot/colorimetric tests, although these too have some associated drawbacks.[…] In our review, the best methods for point-of-care drug testing are handheld IR or Raman spectroscopy. From a cost-to-benefit analysis, these methods (specifically the portable/handheld units) are superior in almost every way to every other method.” (Harper et al., 2017:11)

On one hand, the quotation highlights the result of this review that was just accentuated. On the other hand, it also emphasizes that the debate about the best methods for drug testing is far from clear-cut and over as the reliability of the methods as well as their price and practical usability must be considered.

Finally, it is also a point of attention that some testing methods are still being developed and that only a few of the methods have been scientifically tested in nightlife contexts. The latter is highlighted by Harper et al.’s above mentioned conclusion from 2017: That Raman spectroscopy that was considered promising but was not included in Kerr’s & Tupper’s review from the same year (Kerr and Tupper, 2017) together with a number of older and practically usable methods should be considered most cost effective, and hence, better than most other methods. Thus, the presentation above of the relative speed, selectivity, sensitivity, ability to analyze more or complex drug samples, practical pros and cons, etc. of the testing methods must be understood in light of the professional standpoint of the messenger (e.g. forensic researcher or policy analyst) and drug policy interests, exactly as in Harper et al.’s study (2017).

Summary

In summary, on the basis of the available information it can be concluded that the assessment in the literature of the reliability of the testing methods is valid, while the conclusions about prices, applicability of

the equipment, and its mobility must be considered indicative. This is due to the assessments, as a minimum, not being conclusive as they both rest on a less robust, scientific foundation and are colored by human and political standpoints and adjoining interests cf. chapter 4. Hence, the literature on drug checking methods in nightlife calls for a conscious assessment of the best methods for the context in which they are used.

Based on the review of the three overview articles of drug checking methods, the overall conclusion is that despite minor differences in their assessment in general the authors agree about the applicability and the strengths and weaknesses of the drug checking methods for both nightlife contexts and in more stationary drug testing laboratories. Furthermore, because the techniques vary considerably on the parameters that were studied (price, quality, mobility, level of experience for the user, etc.) a significant point is that it is important to know the exact aim before choosing a testing method. For example, more advanced chromatographic analysis techniques are not well-suited for on-site drug testing at festivals and techno-parties even if these methods are considered the gold standard for drug testing. On the other hand, the colorimetric tests are very applicable for on-site testing and are both inexpensive and easy to use for non-professional personnel.

However, the ability of these tests to distinguish between substances and detect new drug types is inferior. Despite these limitations, colorimetric tests may be the best choice of testing method in certain contexts. The conclusion is that all the testing method that were described have strengths and weaknesses dependent on the context they are being used for. High quality testing methods are often cost heavy and require trained personnel with specific competences (see below). Conversely, inexpensive testing methods are of less quality.

Finally, it should be mentioned that Harper et. al. emphasize the more recent and, in drug checking contexts, less applied testing methods, Raman spectroscopy and FTIR, as being interesting in relation to future drug testing. Both testing methods are in the middle range pricewise and can be operated by persons without comprehensive knowledge about chemical analyses. At the same time the quality of the analysis results is better than with the other on-site testing methods. Even if handheld Raman spectroscopy is known in other analytic-technical contexts, the overview articles point out that there is a lack of scientific findings from drug checking projects using this technique. In Denmark, Raman spectroscopy is used in customs control. FTIR has been used in the project 'The Loop' and the local drug checking project at 'Mændenes Hjem' (Men's Home) in Copenhagen.

5.2/ Content and Organization of Drug Checking Programs

In this chapter we present an overview that combines Barratt's and Brunt's presentations of drug checking services globally and in Europe, published in 2018 and 2017 respectively. In the chapter we describe the drug checking programs with a particular focus on their status, mobility, delivery of harm reduction counseling, and monitoring of the drug market and the competences necessary to provide these services. With the exception of the drug checking service at 'Mændenes Hjem' in Copenhagen and similar projects that have not yet been described in the literature, the chapter provides a relatively comprehensive overview of the organization of all known and current drug checking services in the world up until 2017.

5.2.1/ Global Overview of Drug Checking Services

The table below is based on the two most recent reports we have identified in the literature review. Based on review data and survey data, they describe European and global drug checking services that have been

active up until 2017 (Barratt et al., 2018b, Barratt et al., 2018a, Brunt, 2017). The table aims at giving an overview of drug checking services as of 2017, the country where they take place, the starting year, the mobility, the testing methods used, the organization of services, and the price.

Drug Checking Services Name	Country	Start-year	Mobility	Analyses*	Services**	Price
Drug Information and Monitoring System	Holland	1992	Stationary	GC-MS, LC-MS, IT- MS, FTIR, Reagents	Providing information, results within 1 week, one-on-one sessions, informational materials	1M Euro /year
Asociación Hegoak Elkartea	Spain	1994	Mobile & stationary	TLC, Reagents	Results after 30-59 min.	Not known
Technoplus	France	1995	Mobile	TLC	Providing information	<100 Euro/year
Modus Fiesta	Belgium	1996	Mobile	GC-MS, TLC, Reagents	Results after 2-4 weeks	10,000 Euro/year
checkit! – Suchthilfe Wien	Austria	1997	Mobile	HPLC-MS/MS, UHPLC, MALDI-IT-MS/MS, HRMS	Providing information, one-on-one conversation intervention, results after 15-30 min.	Not known
Dancesafe	USA	1998	Mobile	Reagents	Not known	<140,000 USD/year
Raveitsafe.ch; Safer Dance Basel, Nuit Blanche; Saferparty.ch	Schweiz	1998	Mobile	HPLC, GC-MS, LC- MS, UV	Brief intervention with personnel, results within 15-29 min.	Per invoice
DrogArt	Slovenia	1999	Mobile & stationary	HPLC, GC-MS, Reagents	Sharing of information, one-on-one intervention, results within 2-4 weeks	Not known

Energy Control	Spain	1999	Mobile, stationary & mail	HPLC, GC-MS, UV, TLC, Reagents	Providing information, one-on-one conversation, results within 1-2 hours	200,000 Euro/year
SINTES	France	1999	Mobile, stationary & mail	HPLC, UHPLC, GC-MS, LC-MS, UV, FTIR	Providing information, results by e-mail after 1 week, one-on-one conversation,	10,000 Euro/year
DrugsData/EcstasyData	USA	2001	Mail/stationary	GC-MS, Reagents	Providing information, results after 1-2 weeks	93,000 USD /year
Jugendberatung Streetwork/saferparty.ch	Switzerland	2001	Mobile & stationary	HPLC, GC-MS, LC-MS	Providing information, results after 15-29 min. on-site/1-2 days w. stationary lab	Not known
ANKORS Festival Harm Reduction	Canada	2002	Mobile & stationary	Raman, TLC, Reagents	Providing information, results after 5 min., informational materials	Mobile, 15,000 CDN /festival
Lonja Laket Project; Punto Fijo; Testing Project	Spain	2002	Mobile & stationary	GC-MS, TLC, Reagents	Providing information, results between 5/15-30 min./30 days, one-on-one conversation, informational materials	Not known
Kosmicare Association – Integrated Drug Checking Service at The Boom Festival	Portugal	2006	Mobile	TLC	Providing information, results between 30-59 min, one-on-one conversation	10,000/year (2016)

XBT Program	France	2009	Mobile & stationary	TLC	Providing information, results after 30-59 min., one-on-one conversation	Not known
ACT Investigation of Novel Substances Project	Australia	2013	Stationary (hospital)	HPLC, UHPLC, GC-MS, LC-MS, FTIR, NMR	Providing information, results after 1-3 days	Not known
DAT2 Psy Help	Hungary	2013	Mobile	Reagents	Iproviding information, assist users to test their own drugs, informational materials	Not known, donations of equipment
The Loop	Great Britain	2013	Mobile	UV, FTIR, Reagents	Providing information, one-on-one conversations, results after 30-59 min., informational materials, medical assistance, social support	Not known
Servicio de Analisis de Sustancias (Substance Analysis Service)	Colombia	2013	Mobile & stationary	GC-MS, UV, TLC, Reagents	Providing information, results after 5-15 min, one-on-one conversation	USD 4,000/month
dib+, raveitsafe.ch by Contact – Siftung für Suchthilfe	Switzerland	2014	Stationary	HPLC, GC-MS, LC- MS	Providing information, results after 1-3 days, one-on-one conversation, informational materials	116,000 CHF/year
Drogenarbeit Z6 Drug Checking	Austria	2014	Stationary	GC-MS, LC-MS	Providing information, results after 4 days, one-	70 Euro/drug test

					on-one conversation questionnaire	
Programa de Analisis de Sustancias	Mexico	2014	Mobile & stationary	TLC, Reagents	Providing information, results after 15-30 min., one-on-one conversation, informational materials	USD 9,000/mobile
Association Bus 31/32	France	2015	Mobile & stationary	TLC	Providing information, results after 1-2 weeks, one-on-one conversation, informational materials	18,000 Euro/year
Be Aware on Night Pleasure Safety	Italy	2015	Mobile	Raman	Providing information, results after 5 minutes, one-on-one/group conversation, informational materials, questionnaire	Not known
KnowYourStuffNZ	New Zealand	2015	Mobile	FTIR, Reagents	Providing information, results after 5-10 min., informational materials	35 NZD/ drug test
DUCK	Luxenbourg	2016	Mobile	GC-MS, LC-MS	Providing information, results after 1-2 days	150,000 Euro/year
Imaginario 9	Uruguay	2016	Mobile	TLC, Reagentes	Providing information, results after 30-59 min., one-on-one conversation, informational materials	Not known

SIN Lab	Poland	2016	Mobile	Reagents	Providing information, results after a few seconds, support for interpretation of results	Not known
* FTIR: Fourier-Transform Infrared Spectrometer; GC-MS: Gas Chromatography/Mass Spectrometry; HPLC: High-performance liquid chromatography; HPLC-MS/MS: High-performance liquid chromatography-tandem mass spectrometry; HRMS: High resolution mass spectrometry; ITMS: Ion trap-mass spectrometry; MALDI-IT-MS/MS: Matrix assisted laser desorption ionization-ion trap-tandem mass spectrometry; NMR: Nuclear magnetic resonance; LC-MS: Liquid chromatography-mass spectrometry; Raman: Raman spectroscopy; TLC: Thin layer chromatography; UHPLC: Ultrahigh pressure liquid chromatography; UV: Ultra-violet. **Services include providing information (anonymous sharing of test results with collaborators, e.g. the police, festival organizers and hospitals, etc. by e-mail, informational materials, home page, databases or verbal contact), results to users (e-mail, verbally, home page) and one-on-one conversations (counseling, psycho-social intervention, informational materials)						

Table 4. Global overview of drug checking services and their drug testing methods

The reviews of the two reports presented in table 4 clarify similarities and differences among all the 31 different drug checking services in the world in 2017 (that are organized by 29 different organizations), including services considered benchmarks methodologically like DIMS (Holland), checkit! (Austria) and The Loop (Great Britain) (Barratt et al., 2018b, Barratt et al., 2018a, Brunt, 2017). Below, the information of the table is used to answer the research question.

5.2.2/ Status, Mobility, Monitoring, Harm Reduction Counseling and Required Competences

The identified services have been in existence for 2 to 25 years. The overview shows that in line with what the authors and publishing institutions of the identified literature indicate, there is a significant majority of European drug checking services with few services in countries like USA, Canada, New Zealand, and Mexico.

With respect to the mobility of the laboratories, table 4 shows that there is a relatively equal distribution of mobile and stationary laboratories with a majority of mobile units. At the same time, it is apparent that a significant number of the existing services have both mobile and stationary units that often collaborate. As is also apparent from the presentation below of the results of the studies in terms of effects, this might mean that the mobile laboratories often offer cheaper, yet more questionable tests, whereas the stationary services are more precise but not always suitable for harm reduction interventions because of the extended response time for the test result. In addition, the table shows that the laboratories' use of testing methods vary significantly with reagent tests as the most widely used and Raman tests as the least used methods.

In general, the on-going projects all offer services both focusing on monitoring (back house) and harm reduction (front house), as they provide information for authorities and collaborators, and test results, conversations, and information to the users. As Harper et al. (2017) also mention in their review, the present overview shows that the service from time to time also gives the user the opportunity to get rid of the remaining illegal drugs in a safe way.

The final price of the specific services is hard to determine as the different services are funded by different sources, e.g. from public funds and European project funds to donations and sales of testing equipment. Furthermore, the estimated service costs, including the different choices of testing methods that are presented in very different currencies and even for different time periods, vary from a few hundred Danish kroner to 7M DKK per year.

As shown in table 4, there are very few descriptions of the competences required to provide harm reduction interventions in relation to drug checking. For example, several of the existing services' profiles show that the content consists of brief, psycho-social interventions, e.g. 'counseling' and handing out informational materials. However, there are no descriptions of the prerequisites in the form of specific competences that the professionals or voluntary workers should have. Even if Kerr's & Tupper's (2017) review report to a larger extent than Barratt et al. (2018) and Brunt (2017) highlights the professional competences required to provide drug checking services, these recommendations are only presented as descriptions related to operation of the testing equipment. As such, Barratt et al.'s presentation of the specific drug checking services (2018) and Brunt's (2017) and Kerr's & Tupper's descriptions of the professional competences required for advanced drug testing can only be regarded as generic in relation to who is actually capable of conducting particular and complicated drug tests using expensive technological equipment. However, this must be regarded as a relatively grainy image of the competences and training that are required to conduct drug testing, including one-on-one conversations, counseling, and instructions and operation of – sometimes – advanced equipment (Kerr and Tupper, 2017, Brunt, 2017, Brunt et al., 2017a). This lack of specification in the literature means that it is unclear what training the personnel has received, what is

required/desired as a minimum, and how the training is carried out. Nevertheless, it is noted that the services alone or in combination rely on professionals and volunteers in collaboration with public institutions, e.g. the police, health authorities and local festival organizers, door men, bar owners, etc. This could indicate that there might be services that do not, or to a lesser extent, ensure their personnel's competences and training. On the other hand, there are without a doubt services that rely on highly specialized, professional personnel, i.e. sociologists, social workers, nurses, medical doctors, lab technicians, and/or pharmacists (ibid.).

5.3/ Effects of the Drug Checking Programs

In this chapter, we analyze the positive and negative effects[8] of the drug checking programs. In general, the review shows that the positive and negative effects of drug checking services focus on a number of remarkably similar arguments that are often presented by a small group of researchers. At the same time, the review also sends another message: That the assessment of positive and negative effects neither directly nor unequivocally shows what works well, and what has negative consequences. As was pointed out previously, the literature reflects a polarized debate about the effects of drug checking because positive and negative effects of using drug checking are interpreted, or at least emphasized, differently. As shown below, the polarization is partly seen in the interpretation of positive and negative effects in the articles and reports, partly in the prolonged correspondence on the effects of drug checking that recently took place in scientific journals involving some of the most well-established international researchers in the field (Gine et al., 2017, Miller et al., 2016, Pirona et al., 2017, Barratt and Ezard, 2016a).

In relation to the use of drug checking, Brunt circumvents several of these discussions in a relatively recent report, commissioned by EMCDDA, by arguing that the specific drug tests, both the more doubtful and the more advanced and accurate, may have different value, depending on the context of the test. This argument is illustrated in fig. 2 (Brunt, 2017:9):

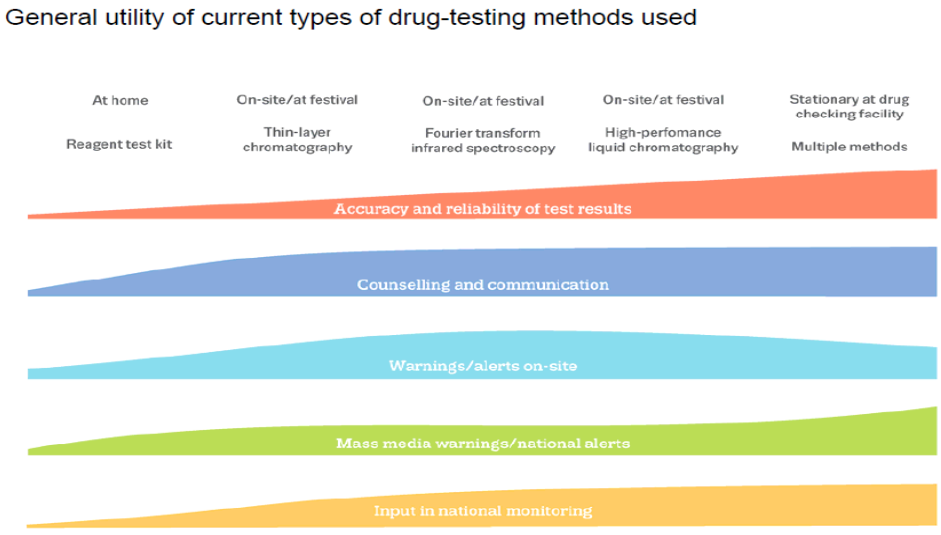

Fig. 2. General value of drug checking methods

[8] The word 'effect' is a broad category covering many different types of effects and consequences. In this report, the word is interpreted in the widest possible way as both 'outcome' of interventions, logical effects, spill-over effects, and expected effects in line with the argument of the article or report. As pointed out previously in this report, it must also be taken into account that the argumentation of the effects does not unequivocally reflect quantitatively measured effects in the sense of 'outcome'.

In relation to the argumentation that the appropriateness of the testing methods etc. must be understood as context specific assessments, this model also indicates that the discussion about the effects of drug tests and drug checking programs must be understood in light of their use and utility.

Given that the established arguments about positive and negative effects of the drug checking programs may appear polarized, there are often references to the same discussions, while at the same time relying on some closely related arguments. Below, we will review the effects of drug checking in nightlife that are presented as positive or negative in the literature.

5.3.1/ Positive Effects: Harm Reduction and Monitoring

The review of the literature revealed a number of arguments about positive effects of drug checking in nightlife. The issues appeared across at least two of the reports and/or articles that were included (Gine et al., 2017, Barratt and Ezard, 2016a, Brunt et al., 2017a, Brunt and Niesink, 2011, Brunt, 2017, Makkai, 2018, Sande and Sabic, 2018, Ventura et al., 2013, Lefkovits, 2016, Kerr and Tupper, 2017, Barratt et al., 2018a, Schroers, 2002, Butterfield et al., 2016b, Laing et al., 2018b, Hungerbuehler et al., 2011b, Saleemi et al., 2017b, Palamar et al., 2016). The positive effects can be categorized by the issues of harm reduction and monitoring, even if it is difficult to separate the issues completely. The first issue contains descriptions of drug checking programs presenting a potential for harm reduction, as well as an increased use of drug testing services and communication with recreational users as a positive effect. The other issue deals with the positive effects of monitoring. Monitoring the drug market, including access to new groups of drug users, sharing of information, and cross-sectional prevention are seen as positive effects. It should be noted that neither specific studies nor any direct documentation of the possibility of preventing any drug-related deaths were identified, as this seems to be an implicit argument related to the harm reducing effects of drug checking.

5.3.1.1 Harm Reduction

The review of the articles and reports shows that one of the effects of the drug checking programs is presented as users being less likely to use drugs as a consequence of the drug checking service. This is indicated by the fact that a substantial number of the users discarded their drugs at the drug checking service after obtaining information on-site.

Whereas it is often mentioned that the users are given the possibility of testing what drug they actually want to take, it is also pointed out that drug dealers are inclined to use the results of the drug checking program with the intention of ensuring that they do not sell impure or contaminated substances.

Several times, it is pointed out that both evaluations of and the collection of the users' experience with drug checking neither normalize drug use nor provide a false sense of security because reservations, on a scientific basis, about the safety of the testing methods are clearly communicated. It is also pointed out that arguments about drug checking encouraging youth to take drugs or to take more drugs than usually must be considered unjustified as drug use did not increase after drug checking services were introduced in a country.

The argument is related to two other arguments about benefits of on-site drug checking services. One is that the drug checking service provides results and information immediately, and the other that drug checking services often are seen as more trustworthy than the police that, among other things, also provide drug checking in nightlife. It also links up to the circumstance that the numerous on-going projects are a

testament to drug checking programs working in practice as they are used by users in spite of the services often being inconsistent with national laws and policies, e.g. the police's zero-tolerance policy.

In addition, it is argued in several reports and articles that drug checking services are particularly effective in providing access to a group of recreational drug users that is often hidden. This is related to another frequently presented argument, that drug checking services may have a special harm reducing effect because they facilitate faster and more accurate access to information about drugs, counseling, and drug treatment as well as acute somatic or psychiatric help if necessary. Similarly, it is also pointed out that more and more users receive information and counseling from the available services. Even if this indicates an increased demand among users, it is not clear if this is the case for on-site and/or stationary services.

5.3.1.2 Monitoring

The review of the literature also revealed an issue about the positive effects of drug checking pertaining to monitoring. A frequently recurring argument in favor of drug checking is that it is an effective monitoring tool that is characterized by being ideal for monitoring the emergence of new – often psychoactive – drugs on the European and global drug market.

In addition, it is emphasized several times that drug checking, information from drug users, and knowledge from forensic analyses can be used to validate each other and that the combination of this information in particular, has the potential of creating awareness of new and old drugs. Similar to Brunt's (2017) conclusions about the value of drug checking in nightlife, the argument is made that this particularly valid combination of information can contribute to the following:

In part, the literature indicates that monitoring the movements and trends in new and old drug markets may enable tracking groups of new groups of 'hidden' users with increased risk more quickly. In this regard, the literature indicates that monitoring may have positive effects for public health or for the health of smaller groups, as monitoring the drug market and vulnerable groups enables the authorities to intervene at an earlier stage and more effectively based on a nuanced picture of the drug markets and the users.

Second, it is pointed out that monitoring can contribute to secure information about drugs for both users, professionals, door men, and festival organizers, etc. While the information from drug checking is considered a possibility per se for drug users to seek help and treatment (that also has the potential of leading to behavior change among users), the information may also contribute to professionals and others more quickly and effectively being able to facilitate contacts to key persons in the drug environments to support harm reduction interventions. This way the literature indicates that monitoring may facilitate cross-sectional prevention as more and nuanced information has the potential to prepare support systems, e.g. the police and hospitals so they can respond adequately at (mass)poisonings, etc.

5.3.2/ Negative Effects: Harm Reduction and Methodological Problems

The review of the literature revealed that the negative effects are expressed in two related issues, methodological problems and harm reduction. To a large extent, the issues illustrate a number of critiques of the arguments for the positive effects. As with the descriptions of the positive effects, the two issues appeared across at least two of the reports and/or articles that were included (Day et al., 2018a, Nicholas, 2006, Laing et al., 2018b, Miller et al., 2016, Kerr and Tupper, 2017, Barratt et al., 2018a, Lefkovits, 2016, Ventura et al., 2013, Brunt, 2017, Schneider et al., 2016b, Winstock et al., 2001).

Pertaining to the first issue, it is argued that the lack of methodological certainty of the drug checking service is an improper foundation for conclusions about positive consequences. The other issue partly

contains descriptions of a number of shortcomings that may mitigate the positive effects, and partly arguments for the opposite standpoint pertaining to the interpretation of some of the positive effects.

5.3.2.1 Methodological Uncertainties

This issue contains descriptions of how methodologically specific problems of drug checking in nightlife may be critical for drug checking services not being able to, or at least facing difficulties in creating positive effects.
Similar to the chapter on drug testing methods, the issue appears in those articles and reports that indicate that drug testing methods are often uncertain. This is done, e.g. by pointing out that some drug testing methods have limitations related to detecting synthetic opioids, while others are not accurate enough to assess if the drug is pure.

Another position mentioned frequently is that pill-identification requires that all pills are identical or that all pills from the same shipment have the exact same content. Given, that there is not necessarily an equal distribution of the drug in the individual pill or in all pills from the same shipment, the most frequently used method, reagent test, is considered unreliable and uncertain. This is because the test is based on a scrape from the surface of the pill. Hence, the reagent test in particular, is often considered potentially misleading and as a method that may lead to a false sense of security due to false-negative results. From this starting point, many articles and reports refer to chromatography as a more suitable testing method. This, despite emphasizing that chromatography is both expensive and time consuming and that using it is problematic because drug dependent users are more likely not to be able to wait long enough for the test results from services with a long response time.

Thus, it is emphasized that a long response time, as is often the case with more advanced and accurate tests, may reduce the harm reducing value of these drug tests, despite higher accuracy and reliability. With the stipulation of a difference between more drug dependent users or recreational users, it is also emphasized that specifically on-site drug checking services do not have the same harm reducing effect as stationary services. This is explained by recreational users more often purchasing their drugs from crypto markets and having the option of drug testing well in advance. This indicates that the drug checking services may have varying effects if drug checking services are not tailor made for specific target groups. Despite a clear lack of arguments for negative effects of monitoring, this is linked to general warnings about drugs and the drug market not being generalizable to groups of people who use drugs on a daily basis.

5.3.2.2 Harm Reduction

Several articles and reports also point out that the harm reducing effect decreases or disappears entirely because of inaccurate and often unreliable test results. This is supported by the fact that toxicological tests neither guarantee clean drugs nor safe use and that drug tests as a harm reduction intervention still do not take into account that bio-variability also can lead to unexpected effects of the drug.

Furthermore, it is specified that drug tests may contribute to drug dealers wanting to test their drugs or have others do it. This argument builds on the perhaps most frequently used argument about the negative consequences of drug testing: That both drug testing and information about drugs may give the users, the drug dealers, and the professionals a false sense of security about the quality and purity of drugs.

At the same time, the competing argument is emphasized that the positive harm reducing effect decreases because counseling and information is disturbed by noise or intoxication, particularly with on-site services that are most common. Furthermore, it is argued that the harm reducing effect decreases because users still often take the chance and use the drug despite the available information about impure or dangerous drugs.

Hence, it is also mentioned as a critique that only 9 out of 31 services assist in discarding drugs responsibly to avoid further use and circulation.

It is also argued that harm reducing drug checking programs potentially can do more harm than good because the programs are not based on a safe scientific and controlled knowledge foundation but in practice consist of projects based on expert knowledge. Finally, several of the articles and reports discuss how drug testing as harm reduction may be ineffective if they are not included as a component in a larger harm reduction intervention, which is difficult to implement in practice due to competing legal frameworks and different trends in national drug markets.

6.0 Conclusion

The aim of this report was to conduct a systematic review of national and international research literature on the effects of drug checking in nightlife. The review focused on 1) the testing methods used for drug checking in nightlife, 2) the organization of drug checking services, and 3) the positive and negative effects of the drug checking programs. The systematic literature search was conducted in the databases Scopus, Web of Science and PubMed and identified 12 international reports and 19 articles. The critical review of these 31 texts indicates that the literature only to a limited extent provides scientifically based directions for the implementation of drug checking programs for harm reduction and secondary prevention. However, the literature seems to indicate stronger evidence for drug checking programs being used for monitoring that can support cross-sectional and structural prevention.

In regard to testing methods, the review shows that three more recent articles and reports provide a good overview of testing equipment and analysis processes that have been used in nightlife contexts to date (Brunt, 2017, Harper et al., 2017, Kerr and Tupper, 2017). The review emphasizes that the assessments of the reliability of the testing methods in the literature are valid, while the presentation of prices, the appropriateness of the equipment and its mobility must be considered indicative.

In regard to the organization of drug checking services, the report provides an updated overview of 31 drug checking programs in Europe and globally. Furthermore, a specific overview of the status, mobility, price, delivery of harm reducing counseling, and monitoring of the drug market as well as the competences required to deliver services is provided. It is pointed out that globally there is a relatively even distribution of mobile and stationary laboratories with a slight majority of mobile units.

In regard to the question about positive and negative effects of drug checking programs, the review shows that the positive and negative effects are concentrated on a number of remarkably similar arguments. In an almost polemic way, these arguments are put forward by a small group of researchers. In this way, the report illustrates that determining the positive and negative effects is not a simple task. Because of the sometimes polemic presentation of the effects in the literature, the conclusion is that the review neither directly nor unambiguously is able to show what works, or what the negative effects of drug checking in nightlife are. On one hand, the positive effects are that drug checking programs represent a potential opportunity for harm reduction and that increased use of drug checking services and communication with recreational users may have a positive effect. Monitoring is also described as an opportunity that may lead to insights into trends on the national and international drug markets, access to new groups of drug users as well as information sharing and cross-sectional prevention. On the other hand, our review also shows that more conservative descriptions of the negative effects in which the researchers behind the studies and reports concluded that there is a lack of robust foundation for drawing clear conclusions about the positive effects. It is argued that drug checking programs may produce a false sense of security because the lack of methodological certainty (of the individual drug checking service) does not directly provide a foundation for the positive effects that are described.

In general, the review has a number of prospective implications for policy and future research to provide a more unambiguous foundation for assessing the reliability and the price of the testing methods. On one hand, the literature can be considered a credible pool of scientific work based on its own scientific premise. This assessment rests on the premise that the qualities of the literature must be understood in light of its type/genre, origins and methods. On the other hand, we assess that the articles and reports vary so much that it is difficult to make unambiguous conclusions about the effects of drug checking services. Hence,

based on the existing empirical foundation (the literature) it was not possible to measure and rank the evidence of effects of drug checking programs in the articles and reports, according to the strict health scientific concept of evidence (Devisch & Murray, 2009). Because of these competing issues, the overall finding is that the conclusions about the effects of drug checking programs in the literature rest on a weak scientific foundation, and they are influenced by human and political standpoints and related interests. Thus, the literature on drug checking methods in nightlife requires critical reflection when assessing what methods are the best for what target group and in what context. To gain more insight into whether and how drug checking programs contribute to changing the behavior of drug users or reducing their use, the review indicates a need for more and better clinical trials and monitoring studies. Also, there is a need for ethnographic studies of the work of frontline personnel in the drug checking programs and the effects of different kinds of drug checking interventions. It is necessary to produce different types of scientific studies that can provide actual insight into long-term trends of drug use in nightlife, actual change in the drug behavior of the users, and drug users' understanding of and dealings with drugs in nightlife.

7.0 References

T. E. D. I. (TEDI) 2012. Guidelines for Drug Checking Methodology. San Sebastián, Spain: Nightlife Empowerment & Well-being Implementation Project (NEWIP).

BARRATT, M. J. & EZARD, N. 2016a. Drug checking interventions can track the nature and size of the discrepancy between self-report and actual drugs consumed. *Addiction,* 111**,** 558-9.

BARRATT, M. J. & EZARD, N. 2016b. Drug checking interventions can track the nature and size of the discrepancy between self-report and actual drugs consumed. *Addiction,* 111**,** 558-559.

BARRATT, M. J., KOWALSKI, M., MAIER, L. J. & RITTER, A. 2018a. Global review of drug checking services operating in 2017. Sydney, Australia: Drug Policy Modelling Program Bulletin.

BARRATT, M. J., KOWALSKI, M., MAIER, L. J. & RITTER, A. 2018b. Profiles of drug checking services in 2017. *Drug Policy Modelling Program Bulletin.* Sydney: National Drug and Alcohol Research Centre.

BARRATT, M. J. & RITTER, A. 2017. Commentary on Vrolijk et al. (2017): The paradox of the quality control problem. *Addiction,* 112**,** 101-102.

BRUNT, T. M. 2017. Drug checking as a harm reduction tool for recreational drug users: opportunities and challenges Background paper commissioned by the EMCDDA for Health and social responses to drug problems: a European guide. *In:* EMCDDA (ed.). European Monitoring Centre for Drugs and Drug Addiction.

BRUNT, T. M., NAGY, C., BÜCHELI, A., MARTINS, D., UGARTE, M., BEDUWE, C. & VENTURA VILAMALA, M. 2017a. Drug testing in Europe: monitoring results of the Trans European Drug Information (TEDI) project. *Drug Testing and Analysis,* 9.

BRUNT, T. M., NAGY, C., BÜCHELI, A., MARTINS, D., UGARTE, M., BEDUWE, C. & VENTURA VILAMALA, M. 2017b. Drug testing in Europe: monitoring results of the Trans European Drug Information (TEDI) project. *Drug Testing and Analysis,* 9**,** 188-198.

BRUNT, T. M. & NIESINK, R. J. 2011. The Drug Information and Monitoring System (DIMS) in the Netherlands: implementation, results, and international comparison. *Drug Testing and Analysis,* 3**,** 621-34.

BUTTERFIELD, R. J., BARRATT, M. J., EZARD, N. & DAY, R. O. 2016a. Drug checking to improve monitoring of new psychoactive substances in Australia. *The Medical journal of Australia,* 204**,** 144-145.

BUTTERFIELD, R. J., BARRATT, M. J., EZARD, N. & DAY, R. O. 2016b. Drug checking to improve monitoring of new psychoactive substances in Australia. *Med J Aust,* 204.

BUTTERFIELD, R. J., BARRATT, M. J., EZARD, N. & DAY, R. O. 2016c. Drug checking to improve monitoring of new psychoactive substances in Australia. *Med J Aust,* 204**,** 144-5.

BUUS, N., TINGLEFF, E. B., BLACH ROSSEN, C. & MUNCH KRISTIANSEN, H. 2008. Litteratursøgning i praksis : begreber, strategier og modeller. (Literature Search in Practice: Concepts, Strategies, and Models), *Sygeplejersken,* 108**,** 2-8.

BYDAM, J., COLLISON, G. & HAMER, S. 2013. *Evidensbaseret praksis : grundbog for sundhedspersonale. (Evidence-Based Practice: Textbook for Health Professionals)*, Kbh.: Nota.

CAMILLERI, A. M. & CALDICOTT, D. 2005. Underground pill testing, down under. *Forensic Sci Int,* 151**,** 53-8.

CHATWIN, C., BLACKMAN, S. & O'BRIEN, K. L. 2018. Intersections in (New) drug research. *Drugs: Education, Prevention and Policy,* 25**,** 297-300.

DAY, N., CRISS, J., GRIFFITHS, B., GUJRAL, S., JOHN-LEADER, F., JOHNSTON, J. & PIT, S. 2018a. Music festival attendees' illicit drug use, knowledge and practices regarding drug content and purity: a cross-sectional survey. *Harm Red J,* 15.

DAY, N., CRISS, J., GRIFFITHS, B., GUJRAL, S. K., JOHN-LEADER, F., JOHNSTON, J. & PIT, S. 2018b. Music festival attendees' illicit drug use, knowledge and practices regarding drug content and purity: a cross-sectional survey. *Harm reduction journal,* 15**,** 1.

DEVISCH, I. & MURRAY, S. J. 2009. 'We hold these truths to be self-evident': deconstructing 'evidence-based' medical practice. *J Eval Clin Pract,* 15**,** 950-4.

EMCDDA 2017. Health and social responses to drug problems. A EUROPEAN GUIDE. EMCDDA.

FERNANDEZ-CALDERON, F., CLELAND, C. M. & PALAMAR, J. J. 2018. Polysubstance use profiles among electronic dance music party attendees in New York City and their relation to use of new psychoactive substances. *Addict Behav,* 78**,** 85-93.

GINE, C. V., VILAMALA, M. V., MEASHAM, F., BRUNT, T. M., BUCHELI, A., PAULOS, C., VALENTE, H., MARTINS, D., LIBOIS, B., TOGEL-LINS, K., JONES, G., KARDEN, A. & BARRATT, M. J. 2017. The utility of drug checking services as monitoring tools and more: A response to Pirona et al. *Int J Drug Policy,* 45**,** 46-47.

GROVES, A. 2018. 'Worth the test?' Pragmatism, pill testing and drug policy in Australia. *Harm Reduct J,* 15**,** 12.

HARPER, L., POWELL, J. & PIJL, E. M. 2017. An overview of forensic drug testing methods and their suitability for harm reduction point-of-care services. *Harm Reduction Journal,* 14**,** 52.

HEALTH, R. S. F. P. 2017. Drug safety testing at festivals and night clubs. United Kingdom: Royal Society for Public Health.

HUNGERBUEHLER, I., BUECHELI, A. & SCHAUB, M. 2011a. Drug Checking: A prevention measure for a heterogeneous group with high consumption frequency and polydrug use - evaluation of zurich's drug checking services. *Harm Reduction Journal,* 8.

HUNGERBUEHLER, I., BUECHELI, A. & SCHAUB, M. 2011b. Drug Checking: A prevention measure for a heterogeneous group with high consumption frequency and polydrug use - evaluation of zurich's drug checking services. *Harm Reduct J,* 8**,** 16.

KERR, T. & TUPPER, K. 2017. Drug checking as a harm reduction intervention: Evidence Review Report. Vancouver, Canada: British Columbia Centre on Substance Use.

KRIENER, H., BILLETH, R., GOLLNER, C., LACHOUT, S., NEUBAUER, P. & SCHMID, R. 2001. ON-SITE PILL-TESTING INTERVENTIONS IN THE EUROPEAN UNION. Executive summary. EMCDDA.

KRIENER H, S. R. Check your pills. Check your life. ChEck iT! High quality on-site testing of illicit substances: information, counselling and safer use measures at raves in Austria. . DrugText. [Internet] 2005. https://www.pdf.investintech.com/preview/72856708-1d0a-11e8-b174-0cc47a792c0a/index.html. Accessed 14 Jan 2017.

LAING, M. K., TUPPER, K. W. & FAIRBAIRN, N. 2018a. Drug checking as a potential strategic overdose response in the fentanyl era. *International Journal of Drug Policy,* 62**,** 59-66.

LAING, M. K., TUPPER, K. W. & FAIRBAIRN, N. 2018b. Drug checking as a potential strategic overdose response in the fentanyl era. *Int J Drug Policy,* 62**,** 59-66.

LEFKOVITS, Z. G. 2016. A Pill too Hard to Swallow? A Public Health and Legislative Consideration of Methods to Reduce Drug-Related Harm in the Victorian Party Scene: On-site Pill Testing, Market Monitoring and Publication of Publication of Police Drug Seizure Data. Parliament of Victoria, Melbourne, Australia.

MAKKAI, T., MACLEOD, M., VUMBACA, G., HILL, P., CALDICOTT, D., NOFFS, M., TZANETIS, S., HANSEN, F. 2018. Report on the ACT GTM Pill Testing Pilot: a Harm Reduction Service. Canberra, Australia: Canberra GTM Harm Reduction Service, Harm Reduction Australia.

MILLER, P. G., DROSTE, N., CURTIS, A. J., PENNAY, A. & JENKINSON, R. 2016. Drug testing, accuracy and harm reduction: a response to Barratt & Ezard. *Addiction,* 111**,** 559-60.

MOHER, D., LIBERATI, A., TETZLAFF, J. & ALTMAN, D. G. 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med,* 6**,** e1000097.

NICHOLAS, R. 2006. On-site ecstasy pill testing - a consideration of the issues from a policing perspective. Marden, Australia: Australasian Centre for Policing Research.

PALAMAR, J. J., ACOSTA, P., SHERMAN, S., OMPAD, D. C. & CLELAND, C. M. 2016. Self-reported use of novel psychoactive substances among attendees of electronic dance music venues. *Am J Drug Alcohol Abuse,* 42**,** 624-632.

PALAMAR, J. J., SALOMONE, A., GERACE, E., DI CORCIA, D., VINCENTI, M. & CLELAND, C. M. 2017. Hair testing to assess both known and unknown use of drugs amongst ecstasy users in the electronic dance music scene. *Int J Drug Policy,* 48**,** 91-98.

PEDERSEN, P. U. 2018. Fra forskning til praksis. Kbh.: Nota.

PIRONA, A., BO, A., HEDRICH, D., FERRI, M., VAN GELDER, N., GIRAUDON, I., MONTANARI, L., SIMON, R. & MOUNTENEY, J. 2017. New psychoactive substances: Current health-related practices and challenges in responding to use and harms in Europe. *International Journal of Drug Policy,* 40**,** 84-92.

SALEEMI, S., PENNYBAKER, S. J., WOOLDRIDGE, M. & JOHNSON, M. W. 2017a. Who is 'Molly'? MDMA adulterants by product name and the impact of harm-reduction services at raves. *Journal of Psychopharmacology,* 31**,** 1056-1060.

SALEEMI, S., PENNYBAKER, S. J., WOOLDRIDGE, M. & JOHNSON, M. W. 2017b. Who is 'Molly'? MDMA adulterants by product name and the impact of harm-reduction services at raves. *J Psychopharmacol,* 31**,** 1056-1060.

SANDE, M. & SABIC, S. 2018. The importance of drug checking outside the context of nightlife in Slovenia. *Harm Reduct J,* 15**,** 2.

SANDE, M. & ŠABIĆ, S. 2018. The importance of drug checking outside the context of nightlife in Slovenia. *Harm Reduction Journal,* 15.

SCHNEIDER, J., GALETTIS, P., WILLIAMS, M., LUCAS, C. & MARTIN, J. H. 2016a. Pill testing at music festivals: can we do more harm? *Internal Medicine Journal,* 46**,** 1249-1251.

SCHNEIDER, J., GALETTIS, P., WILLIAMS, M., LUCAS, C. & MARTIN, J. H. 2016b. Pill testing at music festivals: can we do more harm? *Intern Med J,* 46**,** 1249-1251.

SCHROERS, A. 2002. Drug checking: Monitoring the contents of new synthetic drugs. *Journal of Drug Issues,* 32**,** 635-646.

SUNDHEDSSTYRELSEN 2018. Sundhedsstyrelsens vurdering af stoftest i nattelivet. (Danish Health Authority's Assessment of Drug Checking in Nightlife), Sundhedsstyrelsen.

TONG, A., SAINSBURY, P. & CRAIG, J. 2007. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care,* 19**,** 349-357.

TOUMBOUROU, J. W., STOCKWELL, T., NEIGHBORS, C., MARLATT, G. A., STURGE, J. & REHM, J. 2007. Interventions to reduce harm associated with adolescent substance use. *Lancet,* 369**,** 1391-1401.

VENTURA, M., NOIJEN, J., BÜCHELI, A., ISVY, A., VAN HUYCK, C., MARTINS, D., NAGY, C., SCHIPPER, V., UGARTE, M. & H., V. 2013. Drug checking service: good practice standards. Nightlife Empowerment & Well-being Implementation Project:.

WINSTOCK, A. R., WOLFF, K. & RAMSEY, J. 2001. Ecstasy pill testing: harm minimization gone too far? *Addiction,* 96**,** 1139-48.

8.0 Appendix 1: Schematic Overview of the Assessment of the Literature

Year, country, title, authors	Aim	Methods	Sample	Results	Content and Organization of Drug Checking Programs	Positive and negative effects of Drug Checking Programs	Test Equipment and analysis processes	Notes
Reports								
2001, Austria Kriener et al., (2001) EMCDDA scientific report. On-site pill-testing interventions in the European Union	The aim was to give an overview of aims, methods, results, and evaluations of drug checking projects in Europe both ongoing and those that are in the planning process and will be launched shortly.	Questionnaires were sent to all known organizations. Telephone interviews and e-mails were used to highlight individual problems or shortcomings at drug checking interviews. In November 2000 there was a meeting in Vienna with represen-tatives from drug checking projects to discuss the legal	People from professional areas are involved in drug checking projects. They most important funding sources are public. In 1999 all projects in the study listed at least 40 on-site conversa-tions with potential users event with max. 250 conversa-tions. In relation to target groups,	Pill identification, Marquis-test (colorimetric test), immunology test, chromato-graphy.	As the budget for drug checking interventions is limited the most appropriate procedure for on-site drug checking projects seems to be to find collaboratorswi th the required chromato-graphic knowledge and the analytic units (a version of chromato-graphy, potentially High Pressure	Because of shortcomings and problems with the evaluation, there is no scientific evidence for the preventive effect of on-site drug checking interventions but on the other hand, there is no scientific evidence that such interventions promote drug use or may be used by dealers	Methods for drug identification are based on pills submitted by users being compared to lists of previously analyzed pills. Marquis-tests (colorimetric tests) are simple and inexpensive and can identify ecstasy-like drugs but not differentiate between them or show amount.	So far, there is no actual technical level in relation to the evaluation of drug testing. On the basis of the current situation, it is not possible to produce ”hard” evidence for policy makers to make decisions based on scientific evidence about the value of initiating on-site test interventions. This critique also pertains to this report. Even if it is a strength that it primarily refers to tests of ecstasy and MDMA in the rave scene, it is a weakness that methods, sampling, and analyses do not get enough attention. That makes it difficult to assess the foundation for the conclusions of the report.

		situation, project aims, analytic procedures and genuine information sharing.	drug checking projects attempt to reach users and potential users of psychoactived rugs. The minimum criteria for belonging to a target groups is *not using but interested in party drugs.*		Liquid Chromato-graphy, perhaps in combination with drug identification).	for market aims. However, the collection of existing knowledge is the first step towards deciding on new intervention models.	Immunology tests are based on a reaction to a specific antibody to a drug and visualization of this reaction. Chromato-graphy is breaking down a mix of compounds into their compounds.	
2006, Australia Nicholas, R. et al (2006) On-site ecstacy pill testing – a consideration of the issues from a policing perspective	A policy analysis of opportunities and limitations in an Australian context, based on European experiences with pill testing.	Recommen-dations based on a literature review.	Not relevant – analysis based on a literature review.	European experiences are difficult to transfer to an Australian context because of legal limitations, and drug checking should not primarily be a prevention tool. Focus on a broader contexts, including where ecstasy is used, that impact mortality.	Drug checking as a prevention strategy.	A number of limitations are identified pertaining to initiating drug checking in line with European experiences in an Australian context, including legal limitations, differences in price of ecstasy in Australia compared to Europe .	Different pill testing methods are reviewed.	The report is from 2006 and is focused on implications of drug checking for police work – in an Australian context. Thus, the primary relevance of the article is the consideration of the legal flexibility pertaining to the initiation of drug checking programs.
2012, Holland	Report focusing on	Review of technical	Not relevant.	Notrelevant.	Notrelevant.	Not relevant.	TLC – Thin Layer	The report is a purely technical review of different methods and create requirements

Trans European Drug Information (TEDI) (2012) Guidelines for Drug Checking Methodology	technical information, limitations and benefits, targeting personnel in drug checking programs or drug checking programs themselves - development of standards for drug tests. Aim: 1: Assist services with an interest in drug checking programs, 2: Offer complemen-tary information for services that carry out drug testing, 3: Standardize methods development in Europe.	requirements for drug checking programs.					Chromatography -Gas Chromatography/Mass spectrometry (GC/MS) -High Performance Liquid Chromatography (HPLC) & HPLC-Mass Spectrometry (LG-MS).	for, e.g. drug testing methods. It is targeting practitioners who want to offer drug checking programs and lists contact persons for the different methods.
2013, Europe Ventura, M. et al. (2013) Drug checking service good practice standards.	To develop best practice guidelines for drug checking in nightlife, based on experiences from existing	Literature review of academic literature, assessment of available guidelines, expert group	Existing drug checking programs in Europe, selected based on their experiences with drug	Standards for drug testing: 1. Needs assessment: in relation to policy and target group,	Not relevant.	Pros: Contribute to reducing the number of drug-related accidents - Increases effectiveness	Not indicated.	The experiences summarized in the report are practice-based and draw from experiences with existing drug checking programs in Europe.

	drug checking programs.	meetings, workshops, survey of existing interventions in Europa.	checking in nightlife.	2. Resource assessment: in relation to population of target group and collaboration, 3. Program formulation: definition of the population of the target group, 4. Intervention design: analyses and interview data, 5. Management and mobilisation of resources: financial requirements, definition of team, steering committee, program materials, 6. Delivery and monitoring: test program and adjustment, 7. Final evaluations, 8. Dissemination and improve-		of government response in relation to new and lethal drugs - Enables early intervention for drug users in an early stage as well as for those who are not normally reached by prevention efforts. Cons: Efforts cannot be evaluated in controlled settings, interventions are not evidence-based but developed in practice and based on expert input.		

				ments: experiences and unintended effects.				
2016, Australia Lefkovits, Z. G. (2016) A pill too hard to swallow?	Government report consisting of assessments of drug policies with a special emphasis on MDMA and drug checking.	Based on a review of experiences from other studies.	Not relevant – literature review.	Based on a literature review of limitations and benefits of drug checking programs, the report recommendso n-site laboratory drug tests at music events and festivals based on chromato-graphy and mass spectrometry.	Drug testing at music festivals.	Cons: - Reagent-based testing cannot test for purity, i.e. may provide misleading results. - On-site test with Chromato-graphy is better suited. Pros: - Monitoring and data collection. - Contact with group that would otherwise would not receive support and counseling. - Indications that drug testing decreases the use of dangerous drugs.	Reagent-testing kits Chromato-graphic techniques.	The foundation for the recommendation of drug testing is unclear.
2017, Canada Kerr & Tupper (2017).	To conduct a review of literature that	The evidence base consisting of two search	The reference list of selected articles was	The review found many of the same	Is reviewed compre-hensively in	Is reviewed compre-hensively in	Is reviewed compre-hensively in	It is unclear how they selected the identified articles but it appears that Kerr & Tupper included more studies of drug checking in

Drug Checking as a Harm reduction intervention: Evidence review report	covers techniques, models of implemen-tation, and benefits and risks of drug checking as a harm reduction intervention, with a specific focus on existing drug checking services.	processes of service models and technologies for drug testing. Initial literature search in PubMed and Google Scholar with search terms ”drug checking”, ”drug testing”, ”pill testing” and ”pill checking”.	reviewed. During the process of reviewing studies from initial search results, names used in drug testing were documented and used as search terms, followed by a review of lists of references from selected articles.	references as we did.	the second part of the review.	the first part of the review.	the second part of the review.	nightlife contexts than we did. However, this is extremely difficult to assess as the method is only briefly described. Similarly, it remains unclear how the researchers assessed the quality of the research.
2017, Luxembourg EMCDDA (2017). Health and social responses to drug problems: a European guide	By offering an overview of the existing knowledge in the field and providing access to detailed information and practical tools, the report and the related internet resources provide support for policy makers and practitioners who work to decrease social	Not described.	Not described.	The evidence for drug checking is described in the context of responses to new psychoactive drugs and in nightlife, festival, and other recreational contexts. Drug checking services enable drug users to have synthetic drugs analyzed, giving information and advice,	Monitoring through laboratory tests, harm reduction, prevention, and good practice depend on the legal approach to drug regulations in the country, organization of tests, and collaboration with other authorities.	Drug checking services are controversial but a valuable addition to early warning systems in the EU. The evidence of the effect on drug use or risky behavior is limited. Arguments for the use of these tests are that there are examples of information from the drug checking services has	Recycling from Brunt, 2017 (drawing on a publication by Brunt et al., 2017).	The lack of methodological and analytical perspectives is remarkably conspicuous, particularly in light of the report being produced by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) in collaboration with a number of international experts in the drug field. This makes it hard, if not impossible, to understand the basis for the assessment of the evidence and the recommendations for good practice.

	and health consequen-ces of drug use. The topics clarify what are often considered the important questions in Europe.			and even brief interventions. The effectiveness in terms of changing behavior is not clear but it can potentially engage drug users and for monitoring aims.		had a positive influence on public health, and they could potentially reduce harm by engaging young, recreational drug users, something that is not experienced with other efforts.		
2017 Great Britain Royal society of public health (RSPH) (2017) Drug safety testing at festivals and night clubs	The use of disco drug like ecstasy is typically more careless, pleasure based and non-dependent, and there is wide socio-demographic variation among the users. Education may be more effective in reducing harm from disco drugs than from drugs related to dependent use.	"Front house"-crime technical testing as a service directly to individual users of the service is a new initiative in Great Britain. It is also known as Multi Agency Safety Testing (MAST) and was tested for the first time at two festivals (Secret Garden Party and Kendal Calling) in the summer of 2016.		Initial results: 18% chose to have their drugs destroyed, which decreases circulation of potentially more harmful drugs. All users leave the MAST intervention with more knowledge about how serious health risks decrease, e.g. by just taking half of the drug and wait two hours before taking more.	The test process uses four analysis methods, Fourier Transform Infrared (FTIR) spetroscopy, UV spectroscopy, a number of reagent tests, and chemistry. The drug sample is destroyed during testing, and potential leftovers are handed to the police. The users are offered secure disposal of the	Drug checking services including counseling may provide drug users the opportunity to make informed decisions. Survey with 1300 festival guests and 1300 disco guests: 95% festival guests and 90% disco guests support drug checking services and would consider using it.		The premise for positive effects (harm reduction by securing drugs) is based on weak evidence. This is relevant because the method is spreading.

					drugs they might.			
2017, Holland Brunt (2017): Drug checking as a harm reduction tool for drug users: opportunities and challenges	The article was requested by EMCDDA as background information to inform about and contribute to setting up "Health and social responses to drug problems: a European guide."	No clear, see Brunt et al., 2011.	Not clear, see Brunt et al., 2011	Background: A story about drug checking in Europe. Types of available drug checking services, and pros and cons. Can drug checking services save lives? Drug policies and legal challenges in Europe. Future of drug checking in Europe. Conclusions.	Overview of the different types of drug checking services and implications for testing reliability and accuracy as well as preventive functions and potentials for harm reduction can be seen in fig. 2.	<u>Pros</u> - A way to reach recreational users. - Campaigns are seen as unreliable scare tactics as opposed to well-informed personnel. - Drug checking can be an intervention tool. - False sense of security using drugs can be minimized by drug checking and communica-tion about it. <u>Cons</u> - Testing does not guarantee that drugs are safe. - Distracting music or intoxication at on-site test laboratories may affect the effect. - Stationary	In spite of most drug checking services having been used for harm reduction aims, chemical drug analyses may vary. Techniques used: Colorimetric reagents, advanced Gas Chromatograp hy (GC) coupled to Mass Spectrometry (GC/MS), GC coupled to Mass Spectrometry (GC/MS/MS), GC coupled to Quantitative Time-of-Flight Mass Spectrometry (GC/QToF/MS). However, laboratory techniques also depend on the contexts.	As noted in the report, the conclusions are not based on empirical evidence. The report is based on findings from the DIMS study, which is pointed out several times. This indicates that the report and the findings are biased as the author is behind the most important articles (2011, 2017), focusing on this study.

						test laboratories can provide the users with an opportunity for testing ahead of time when purchasing in advance (e,g, the crypto market). - Quick oni-site tests are often inaccurate, unreliable, and less harm reducing. - Some users take their drugs despite the drug test. - Promote drug use among youth (cf. Bücheli et al. (2010), drug use does not increase after drug checking was introduced in a country).		
2018, Australia. Makkai et al., (2018). Report on the ACT GTM Pill Testing Pilot: a Harm	The overall aim of these services is to save lives by: Offering the opportunity for users to make informed	The drug is weighed and photogra-phed, and a small sample of the drug is separated and tranferred to	The drugs were submitted in several different forms (41 capsules, 25 pills, 10 powders, and 6 crystals (and a	The aim of the pilot test was to test aspects of drug checking services at a popular Australian	Data collection process and aspects for future.	One dangerous drug was identified in the samples that were tested on-site, leading to hospitalization	Drug tests were conducted using the Fourier-transform infrared spectroscopy	This is pilot study pf drug checking at a festival. The study is based on the same measurement methods as Harper et al. and The Loop use, which increases comparability and the validity of the findings of the study

Reduction Service	decisions about whether or not to take the drug. Minimizing the number of people that may need an ambulance, hospital, police, and the judicial system. Drug checking gives the opportunity for public health warnings about new drugs and gives law enforcement knowledge of illegal drug developers and imports in Australia. The aim of the pilot test was to effectively test the concept in an Australian context.	the FTIR machine for spectrum measure-ment. A background spectrum is required immediately before each test spectrum to ensure that the collected data relate to the sample that was submitted. The spectrum test is matched to library spectra, and a ranked list of noted matches is produced to identify the main compound.	non-classified)), with a weight of 45-1107 mg. Two were deemed unusable due to low weight, which left 83 usable drug samples for testing.	festival. It was possible to provide an on-site ”front of house” chemical checking services at the festival. Even if the festival guests did not get any information about the checking service, 129 people found the service and estimated it as usable for drug testing. They received counseling about the service and were willing to sign a certificate. FTIR testing was conducted, and the analysis identified a number of drugs from lactose to pure MDMA, cocaine, and ketamine, and the test		in New Zealand and deaths in USA. 61% of the users were surprised by the test result. Drugs in tablet form to a much larger extent had lower purity than in other forms. High purity MDMA most often came in capsules. Despite having guards at the drug checking service, the police performed their routine work but kept their distance. They inspected the service to make sure that the guidelines were in place. If there was not a spectrum documented, FTIR would automatically identify the best possible match. Hence, low scores may	(FTIR) by using an ALPHA II machine. This technology was used by *We Are The Loop* in UK and drug-taking facilities in British Columbia. Harper Powell and Pijl concluded that the best method for point-of-care drug testing is handheld infrared Spectroscopy, Raman Spectroscopy and Ion Mobility Spectrometry. Mass Spectrometry is the current golden standard in chemical drug analysis.	However, the study, which is an experimental study, that took place ”live” does not show any actual measured effect in the form of quantitative clarification of harm reduction, as it had only individual measurements. However, the study shows that the service can be used despite contrary policies by the police, etc.

				confirmed the assumption about a significant variation in the purity of illegal drugs.		be meaningless. All the time, new synthetic drugs are produced, and it is important that quick testing can identify and add these to the library spectra.		
2018 Australien Barratt, M.J., et al (2018). Global review of drug checking services operating in 2017.	This bulletin id the first example of a global perspective. This work attempted to identify and document the available drug checking services around the world in 2017.	A survey was developed for drug checking services about techniques, contexts, process, extent, length, and funding for the procedure, as well as challenges. Known services were invited to participate in the survey, and they were asked fo other contacts for drug checking services. Hence, the list was expanded in each country and region,	9 out of 31 services reported that they analyze samples from people who live outside their own country. 2 out of 3 with mail service reported that they accepted samples from all over the world.	Represen-tatives from services from 20 countries responded to the survey representing 31 different checking services. 23 services were in Europa, 6 in USA, 2 in Australia. The median for years of procedure was11. 13 organizations conducting services had only done so since 2013. There were three ways of	Sharing of the results of the drug tests depends on judicial framework and the capacity of the site. If drug checking is allowed at an event, it may decrease the chance of public funding because it indicates that the organizer is aware that drug use is happening (Levy, 2004). Almost all services (30) offered brief-	Information is shared with users, home pages, and (health) professionals in different systems as well as the organizers of the night club or festival. Critique: Reagent tests have been criticized because of limitations and the potential for a false sense of security. Almost all services	Older techniques (TLC, reagent test) are still used (easy to administer and cheaper). Drug checking services provided a list of their drug analysis methods (see Fig. 4).	Studiet er i sin rapportform overbevisende og giver som det eneste et udtømmende og skematisk overblik over tilbuddene. References to the individual drug checking programs. We already know that new services have started in countries that did not participate in the bulletin. Please note, that Barratt et al. ”Profiles of drug checking services in 2017” is a profile overview of current drug checking services and not a study in itself. Hence, in reality it works as a background paper for this report.

		meaning that the researchers had confidence in having identified the existing services.		submitting samples for checking services: 23 had on-site service. 18 had fixed-site service and 2 of those were in a hospital or emergency room context. 3 services had mail service.	intervention, 25 services offered a harm reduction folder, 11 had other interventions, and one service did not offer anything apart from the drug test. 9 services had facilities for safe disposal of drugs.	offered brief intervention and information about harm reduction. Only 9 offered disposal of drugs. The drug checking services often communica-ted the test results to stakeholders (in addition to the users).		
Not original research articles								
2001, Great Britain Winstock et al. (2001) Ecstasy pill testing: harm minimization gone to far?	To study factors that contribute to the wide variation in pill content and the challenges often related to drug checking. Discussion of potential consequen-ces of ecstasy.	Commentary.	Not relevant.	Critical examination of the rationale behind drug checking.	Not relevant.	Not relevant.	Not relevant.	PRISMA: 0, not systematic review. Winstock et al. Present a critical commentary in relation to testing illegal drugs. A key argument by the authors is that testing will not provide the necessary accuracy to state whether the drug is contaminated, if the purity is higher than it should be, no matter what testing method is used to test the drug. In addition, they point out that biovariability means that unexpected effects of the drug may appear and that harm reduction efforts should take this into account.
2016, Australia Barratt, M. et al. (2016) Drug checking interventions	Response to study by Miller et al. "Drug use in Australian nightlife	Review of more recent literature about technical	Not relevant – short commentary.	Sophisticated techniques for drug testing exist: In Switzerland	Laboratory test.	<u>Pros:</u> contributes to knowledge gathering about the drug	High-Pressure Liquid Chromato-graphy Capacity. Thin	One-page commentary to study by Miller et. Al.

can track the nature and size of the discrepancy between self-report and actual drugs consumed	settings: estimation of prevalence and validity of self-report".	aspects of on-site testing.		High-Pressure Liquid Chromatography Capacity is used, in Spain and Portugal on-site drug testing with Thin Layer Chromatography (TLC) or gas Chromato-graphy-Mass Spectrometry (GC-MS). In Holland drug testing is incorporated into the drug monotoring system. Drug testing may provide information about trends in the drug market.		market, relevant for prevention efforts as well as monitoring.	Layer Chromatography (TLC) or gas Chromato-graphy-Mass Spectrometry (GC-MS).	
2016 Australia Miller P. G. et al (2016) Drug testing, accuracy and harm reduction: A response to Barratt & Ezard	Response to commentary by Barratt & Ezard (note that the final published version is by Butterfield et al. 2016, that are also included in this report).		Not relevant – short commentary.	Methods will be difficult to implement in nightlife, as they require further testing and are too time consuming for clients.	Laboratory tests.	Methods are too inaccurate, must be improved to work as preventive efforts. Must be made more effective to minimize waiting time for the client		One-page response to commentary by Barratt & Ezard. It is not demonstrated why drug checking in nightlife is not possible according to the authors.

						when having the drugs tested.		
2017 Australia a.o. Giné, C. V. (2017) The Utility of drug checking services as monitoring tools and more: A response to Pirona et al	Commentary to Pirona et al.	Short commentary (2 pages) based on a literature review.	Notrelevant / literature review.	Not relevant – Not an original study.	Not relevant.	<u>Pros</u>: - Identify the discrepancy between what people think they take, and what they actually take. - Access to a user group that is rarely seen. - Effective monitoring tool. - Some of the users discard the drugs after testing.	Not relevant.	The article is a short commentary to another study by Pirona et al. with references to other studies.
2017, Holland Barratt M. et al (2017) Commentary on Vrolijk et al: The paradox of the quality control problem	To refine the understan-ding of drug testing as a monitoring and prevention tool, and to identify limitations for drug testing as a contributor to monitoring.	Commentary to study by Vrolijk et al.	Not relevant – not original study.	Holland's Drug Information Monitoring Service (DIMS) only shares information with the user, not the wider public, unless warnings are distributed due to health-related issues. No evidence for more access to information about drugs	Monitoring.	Effective monitoring tool but could be improved if the information is made available to more users.	Monitoring (DIMS).	The article is a one-page commentary to Vrolijk et al. Based on experiences from Holland (DIMS), the authors recommend implementation of a similar program in Australia.

				encouraging more people to use. DIMS is an effective monitoring system in relation to new drugs.				
2018, Australia Groves (2018) Worth the test? Pragmatism, pill testing and drug policy in Australia	To study Australia's national drug policy and drug testing through a pragmatic lens to determine whether there is room for testing methods under current policy.	Commentary.	Not relevant.	Critical examination of the rationale behind drug checking.	Not relevant.	Not relevant.	Not relevant.	PRISMA: 0, not a systematic review. Groves discusses the Australian situation and the role drug checking could play in relation to official goals of drug policies. Narrative review of the literature about the effects of laboratories. Primarily evaluated from the perspective of imagined scenarios, in which drug users must decide what they would do if they received a specific test result about their drugs. It is argued that drug checking has led to changes in the supply of drugs with less contamination and higher consistency, and hence, fewer poisonings. This rationale may be correct (the risk that drugs will be revealed as of bad quality increases focus on a consistent product, and a consistent product will decrease the risk of unexpected effects) but the evidence is not as strong as Groves suggests. Overall, the article does not provide clear evidence for or against implementing drug checking in any context, including in Denmark.
Literature reviews								
2002, Germany. Schroers, A. (2002). Drug checking: Monitoring the contents of	To give an introduction to drug checking and information about current possibilities	Background article: Review of available knowledge in 2002 about	Not relevant.	Describes drug checking programs in 2002.	Drug checking programs are broken down by on-site testing, and clinical/	Positive effects: -Monitoring of the drug market. -An otherwise hard-to-reach	Not relevant.	Background article from 2002.

new synthetic drugs	and limitations of the procedure in the frame work of early-drug-reconnais-sance system.	drug checking programs.			centralized testing.	target group is reached. -It works both in terms of prevention and harm reduction.		
2016, Australia Butterfield, R. J. et al Drug checking to improve monitoring of new psychoactive substances in Australia	To describe a method for harm reduction that has been used in Europe.	Background article: Short description of pros and cons of drug checking programs with the aim of implemen-tation in Australia.	Not relevant.	Mentions selected drug checking programs in Europe.		The article mentions both pros and cons of drug checking programs.		
2018, Canada Laing, M. K. et al (2018) Drug checking as a potential strategic overdose response in the fentanyl era	To study whether experiences from drug checking in nightlife / festivals can be used for marginalized drug users and for overdoses with opioids .	Literature review.	Analysis based on a literature review.	Studies the potential of drug checking for marginalized drug users.	Adaptation of drug checking to marginalized / dependent drug users.	Users at drug checking in nightlife / festivals reported changes in their drug use, and some of them discarded their drugs after testing. Drug checking as quality control – dealers are (without a doubt) less likely to sell impure drugs if	Not relevant.	The study is not very relevant to drug checking in nightlife. It builds on experiences with drug checking in nightlife to study if these experiences can be applied to marginalized/heavy drug users to reduce overdoses from opioids.

						users can have it checked. There might be limitations in relation to marginalized opioid users.		
Studies of drug checking methods								
2005 Australia Camilleri A. M. et al (2005) Underground pill testing down under	To compare the relationship between pill design and compounds in drugs from a rave party and drugs submitted to a forensic laboratory over a 6 month period, including the month of the rave party.	Original article: Comparison of results from a qualitative colorimetric test of ecstasy pills collected at the drug checking program Enlighten, with subsequent GC/MS analysis.	Participants at an Australian techno event who voluntarily chose to have their pills tested for MDMA and other substances.	84 pills were examined using the two analysis methods. Overall, the methods showed the same results in relation to drug category (MDMA vs. ampheta-mines). Certain substances and mixtures could not be identified using the qualitative test.	Test of submitted substance for main compound. Voluntary opportunity at a techno event, by the organization Enlighten.	The drug checking program is not discussed. Focus is on the comparison of results from the two analysis methods.	On-site, qualitative analysis using drip test, colorimetric test, GC/MS.	The study is from 2005, prior to the introduction of NPS.
2016, Australia Schneider, P. et al. (2016) Pill testing at music festivals: can we do more harm?	Review of technical limitations with drug checking.	Reference to results from other surveys and articles.	Not relevant – literature review.	The article identifies technical limitations reducing the efficiency of drug checking as a prevention tool.	Drug checking programs (laboratory tests).	Information about compounds may be understood as confirming the quality and purity of the pill. False sense of security because of	Pill identification. Reagent testing kits Chromatograp hic techniques.	The article refers only to other articles and not research by the authors themselves. Is only concerned about purely technical aspects and mainly about limitations in relation to drug checking.

						false negative. Pill identification assumes that all pills in a shipment have the same dose and content. Reagent test kits are limited by the substance not being distributed equally in the individual. Chromato-graphy: better picture but more expensive and time consuming. The methods only look for known compounds.		
2018, Slovenia. Sande et al. (2018). The importance of drug checking outside	To evaluate the imple-mentation of drug checking services in Slovenia and study the opinions of the users, reasons for drug checking, and their opinion	Original article: Survey conducted in 2 samples. Short interviews with staff from the 9 drug checking sites. On this basis, a short survey was developed (5	2 samples: 1) High-risk drug users (N = 104) who participate in a harm reduction day program, in which off-site drug checking is offered.	76 % of high-risk users and 45 % of nightlife users knew of drug checking. >80 % see drug checking as harm reducing and find information about drugs	Drug checking is not a part of the study (data are survey data of drug users' opinion and knowledge about drug checking in Slovenia). Drug checking in Slovenia is	Cross-sectional data (hence, cannot assess *effect* of drug checking). The users think that drug checking is harm reducing and that it does not encourage to	Not relevant.	The study contributes with useful knowledge about how high-risk users and nightlife users relate to drug checking. Pros of drug checking, e.g. a majority consider it harm reducing. The participants are not randomly selected, and some participants online do not answer / do not answer completely. Sampling of high risk and nightlife users is relevant as they are obvious users of drug checking.

	about contami-nation of the drugs they use.	min). Most questions were the same across the two surveys.	2) Drug users in nightlife, online sample (N=554). Recruited from the internet (marijuana is the most widely used drug, followed by MDMA).	important (>95 %). >85 % think that drug checking does not encourage people to use, and <50 % is OK with counseling at drug checking. For drug checking: Distrust in quality of drugs, harm reduction and a demand for information. Against drug checking: Wait time and worries about anonymity.	not on-site but consists of NGO-driven information sites: the drug is shipped for analysis. Afterwards the user and an early warning system are notified.	increased use, but the study cannot reject or confirm if this is actually true.		The authors write that they complete responses from 102 (high-risk) and 554 (nightlife) but N varies in the result section. It is unclear if online responses are anonymous and if a person may have responded more than once.
Monitoring studies								
2011, Holland Brunt et al (2011). The Drug Information and Monitoring System (DIMS) in the Netherlands: Implementation, results, and international comparison	To describe the DIMS-method and review the results from three large psycho-stimulating drug markets that were monitored, e.g. ecstasy, ampheta-mine, and cocaine. In addition, results from	Review of DIMS.	Articles and reports based on DIMS.	Presentation of DIMS.	National program aiming at making drug checking available.	Is not clearly presented.	Thin Layer Chromato-graphy followed by Gas Chromato-graphy-Nitrogen-Phosphorous identification.	PRISMA: 0, not systematic review. Narrative review of research from DIMS. Practical circumstances for data collection and analysis of drug samples, and overview of the potential of the monitoring system. Comprehensive review of the illegal drugs occuring during what periods, purity, variations of the drugs, and additives. Rich context for the system in Holland and factors influencing purity and the use of additives. According to Brunt et al. the DIMS-system is important in relation to providing warnings and knowledge to potential drug users, but we cannot specifically identify how the

	monitoring hallucinogens are described for the first time.							results of the analyses were disseminated to young potential users, or how the researchers concluded that the knowledge from DIMS was available to youth and adults. The article is not able to clarify the potential value of mobile / stationary laboratories for analysis of illegal drugs in Denmark from a harm reduction perspective.
2011, Switzerland Hungerbuehler, I. et al (2011). Drug Checking: A prevention measure for a heterogeneous group with high consumption frequency and polydrug use - evaluation of Zurich's drug checking services.	Via Drug checking services an anonymous questionnaire was collected, used to collect knowledge about a large, and to a large extent, unknown group of drug users and their use pattern.	The questionnaire included items about the socio-demographic characteristics of the group, use patterns, experience with drug checking, and social support.	7,622 consultations and 2055 drug samples. The participation of the users in this study was not voluntary as the questionnairew as a requirement for having access to the services.	The majority of the users were men (20-35 years of age) with long-term drug use. They present a heterogenous group with respect to socio-demo-graphics and use. The users of on-site drug checking were younger, less experienced about drug checking services and more often were poly-drug users.	A youth counseling in Zurich has provided on-site and stationary drug checking since. In addition, they provide counseling aiming at harm reduction, monitoring, and preventive efforts.	The service has provided access to testing of many drug samples, to many people, and many counseling conversations longer than 15 min since 2001. Due to positive experiences with on-site drug checking services, the drug information center (DIZ) was established in 2006.	High-Pressure Liquid Chromato-graphy (HPLC) analyses were used.	Despite the study being published in 2011, data were collected in 2003, 2005 and 2010, respectively. As the questionnaire was a requirement for having access to the services, it could provide a biased picture of the actual group and its use patterns because some users may have stayed away from the services for fear of repercussions.
2017, USA Saleemi, S., Pennybaker, S. J., Wooldridge, M., & Johnson, M. W. (2017). Who is	To examine the content of drugs with MDMA, the relative purity of substances known by	Original article: Analysis of data from the voluntary drug checking program, DanceSafe,	Participants at American music festivals who voluntarily had their drugs checked for MDMA.	60% of 529 samples tested positive for MDMA. With a negative/positi ve test result	Drug testing for main compound. Voluntary service at music festivals delivered by	It is concluded that the drug checking program contributes to changing the behavior of the	On-site, qualitative analysis using drip test, colorimetric test.	The group of respondents was not randomly selected. Many participants declined to answer the questionnaire.

'Molly'_ MDMA adulterants by product name and the impact of harm-reduction services at raves	other names, and the effect of drug checking on user behavior.	collected over a 5-year period (2010 – 2015).		for MDMA, 26%/46%, respectively, said that they still intended to take the drug. The difference between the two groups was significant.	the organization DanceSafe.	users. With a negative test result for MDMA, a small group of users chose to take the drugs afterwards.		
2017, USA Palamar et al., (2017) Hair testing to assess both known and unknown use of drugs amongst ecstacy users in the electronic dance scene	Biological data may validate drug use and capture unknown use such as NPS. The researchers attempted to identify the extent of the use of different drugs in a high-risk context.	Original article: Collection and analysis of hair samples from people with self-reported use of MDMA and other drugs. Samples collected at techno events.	Participants at techno events in New York in 2016 who chose to give a hair sample and answer a questionnairea bout drug use in the past 12 months.	51% of 90 hair samples that were analyzed showed presence of drugs that the person had not reported having used during the past 12 months.	Collection and analyses of drugs in hair samples. No drug counseling.	The study contributes to monitoring the drug market. Retrospective study of epidemio-logic nature.	UPLC-MS/MS quantitative analysis at low level.	Participation in the study was voluntary.
2017, Canada Harper L. et al (2017) An overview of forensic drug testing methods and their suitability for harm reduction point-of-care services	To describe the most common methods for testing illegal drugs and, based on this review make recommendations for the most appropriate methods for on-site testing.	Overview of methods for drug testing.	Not relevant.	Not relevant.	Not relevant.	Not relevant.	Several are presented.	PRISMA: 0, not systematic review. The practical circumstances of drug testing in laboratories are covered as well as the accuracy of different types of tests, drugs they can identify, prices, and duration of test. This can be a useful source for implementation of a project but is not relevant in terms of *if* a project would have harm reducing effects.

2017 Brunt, T. M. et al (2017). Drug testing in Europe: monitoring results of the Trans European Drug Information (TEDI) project	Based on the European collaboration, the TEDI project, this article reports results on illegal drugs (essential on the European drug market) and the emergence of the market for NPS.	Survey of information of data from previous drug checking projects from Portugal, Spain, Switzerland, Holland, Belgium, and Austria.	The drug samples for the study were collected through projects with face-to-face contact with the users. About 70% of the users were white, well-educated, European men.	There are considerable similarities across the European drug market. The differences are that the purity of cocaine and ampheta-mine often is lower in Austria while it is high Spain and Holland. At the same time, Holland and Switzerland have a large market for ecstasy, while there is often more MDMA in Portugal and Spain. Project data point to a general increase of NPS on the European market between 2008 and2013.	Drug samples that underwent colometric testing were handled in stationary and mobile drug testing laboratories, most often by means of Marquis-reagents, that facilitate differentiation among the most common drugs on the market. Pill characteristics and possibly batch were also documented. In the case of new pills, fluids, and powder a number of different other instrumental techniques were used.	It is pointed out that drug checking can be used to identify, document, and communicate about dangerous additives. Furthermore, it is stressed that drug checking is appropriate for monitoring of new, often psychoactive, drugs on the European and global drug markets by combining drug testing, information from drug users, and knowledge from forensic analyses and thus, explain new and old drugs, which may lead to a reduction in and prevention of deaths and health risks.	-The DIMS-laboratory (Holland): Liquid Chromatography with LC-DAD and GC-MS. -Energy Control (Barcelona), mobile checking service in Ailaket (Spain) and Checkin (Portugal): Thin Layer Chromato-graphy (TLC). -Checkit (Austria) and Saferparty (Switzerland): Mobile High Performance Liquid Chromato-graphy (HPLC) with DAD/UV-Vis Spectrometer and autosamplers.	The sampling refers to previous studies building on smaller studies like Hungerbuehler et al. 2011 (that is also part of this review), and hence should be seen as an echo of previous research. The study points to significant differences among the types of drug samples that were submitted to various checking services. While Holland and Belgium got the most ecstasy pills, Portugal and Spain got none. The Austrian and Spanish services identified higher prevalence of MDMA crystal powder compared to the corresponding services in Holland, Belgium, and Switzerland.

2018, Australia Day, N. et al (2018). Music festival attendees' illicit drug use, knowledge and practices regarding drug	Study the prevalence of drug use among youth, their opinion about on-site drug checking at festivals and possibly effect on the use.	Original article: Survey conducted at music festival.	Festival guests in Australia in 2016. Recruitment from a stand (N= 642; 61% women, 18-30 years old). Anonymous response; no identification information. Recruitment during the day to minimize the risk of intoxication. Eksclusion criteria: visibly intoxicated. Inclusion criteria: 18-30 years old.	73% had used illegal drugs the past year. 87% think drug checking may help users and reduce harm and should be combined with counseling (85%). 69% think that dealers possibly would use it for quality control. <50% would use a free drug checking service and avoid taking the drug, if the test found content of other substances.	Not relevant. Drug checking is not a part of the study.	Data cannot be used directly to study the effect of drug checking. The participants' opinions point to positive and negative effects, but the study cannot directly examine the effects of drug checking.	Not relevant. Drug checking is not a part of the study.	The study contributes useful knowledge on what festival guests think of drug checking. The study points to benefits of drug checking, e.g. that the majority perceive it as harm reducing. However, many think that dealers possibly will use it for quality control. Participants are not randomly selected. Sampling of festival guests is relevant as they are obvious users of drug checking. It cannot be ruled out that a person may have responded more than once. Cross-sectional data - (hence, cannot assess the *effect* of drug checking).