European Monitoring Centre
for Drugs and Drug Addiction

ISSN 2315-1463

EMCDDA PAPERS

m-Health applications for responding to drug use and associated harms

Content: Introduction (p. 2) | Methods (p. 5) | Results (p. 7) | Discussion (p. 13) | Conclusions (p. 16) | References (p. 17) | Aknowledgements (p. 20)

Abstract: The fast developmental pace and widespread use of mobile technology and the internet mean that smartphone-based m-health (mobile health) applications (apps) have huge potential to further expand the reach of and access to drug-related health services towards a common goal of ensuring a healthier Europe. However, m-health for drug users and for health professionals in the field of drugs is still in its infancy and poorly documented at European Union (EU) level.

The aim of this scoping study was therefore to carry out a first exploration of available smartphone applications in the drugs field within a European and global context. It explored the range of m-health applications available to users and professionals seeking information, support and advice in a wide range of EU languages.

The systematic search of drug-related smartphone applications identified a total of 67 applications across the three main app stores. The identified m-health applications apply various technologies ranging from simple text-based content display to more advanced interactive functions such as video transmission, geo-tagging functions and automated personalised feedback. Based on the main objectives, content and target end-users of the 67 identified apps, three main groups of drug-related m-health applications emerged: apps that aim to disseminate drug-related information and advice, apps that provide interventions and support for drug users and apps for capacity building among health professionals. Most m-health apps address risk behaviour associated with drugs in general or drug use in specific settings (e.g. nightlife settings). Some drug-specific apps are available for more commonly used drugs such as cannabis and cocaine.

A number of challenges for users, app developers and policymakers were identified in this scoping study. The lack of scientific evaluations of drug-related m-health interventions is concerning considering the increasing interest in and availability of such apps. Additionally, the lack of quality control of the content of these apps available to EU citizens, with no age limits, remains to be addressed. Global differences in therapeutic approaches used in the identified apps were apparent, especially between the United States and Europe, and this raises questions about the cross-cultural relevance of m-health applications. At the same time, the impact of the new EU General Data Protection Regulation may be of particular relevance in a context of fast global development of drug-related m-health apps available to EU citizens.

Keywords m-health interventions apps health information

Recommended citation: European Monitoring Centre for Drugs and Drug Addiction (2018), *m-Health applications for responding to drug use and associated harms*, EMCDDA Papers, Publications Office of the European Union, Luxembourg.

Introduction

What are e-health and m-health?

Digital healthcare, also known as e-health, refers in general to tools and services that use information and communication technologies (ICTs) to improve prevention, diagnosis, treatment, monitoring and management of health. Optimised digital healthcare has the potential both to improve access to and quality of care and to increase the efficiency of the health sector and national healthcare systems. The European Commission recognises the potential of e-health and its applications to improve health outcomes. Its e-health Action Plan 2012-2020 provides a roadmap to 'empower patients and healthcare workers, to link up devices and technologies, and to invest in research focused on personalised medicine in the future. This means providing smarter, safer and more patient-centred health services through the use of digital technologies' (European Commission, 2012).

The term 'e-health' is used to describe the interaction between patients and healthcare providers, the transmission of patient data between healthcare providers and peer-to-peer communication among patients and health professionals. Potential e-health services include making electronic health records available to professionals and patients across the European Union (EU), e-prescribing, virtual healthcare teams and telemedicine (medical consultations via the internet or using mobile health applications on smartphones; see Table 1). Given the fast-growing uptake of tablets and smartphones, the EU's e-health Action Plan also includes a special focus on mobile health and encourages Member States to make further use of digital solutions within and across national healthcare systems.

Mobile health, or m-health, is a component of e-health. The Global Observatory for eHealth defines m-health as 'medical and public health practice supported by mobile devices, such as mobile phones, tablets, portable patient monitoring devices, personal digital assistants and other wireless devices' (WHO, 2011). m-Health is thus a general term that describes the use of wireless technology in the delivery of medical care (Patrick et al., 2008; Fjeldsoe et al., 2009).

For the most part, m-health technology makes use of the core utility of voice and short messaging service (SMS) of mobile devices, be they smartphones or tablets. It also uses more complex functionalities and information-sharing utilities through applications (apps), which draw on a variety of data sources such as remote web servers, the Global Positioning System, internal sensors (acceleration, gyroscope, barometer) and additional peripheral wearable devices connected via Bluetooth technology, such as smartwatches and electronic wristbands.

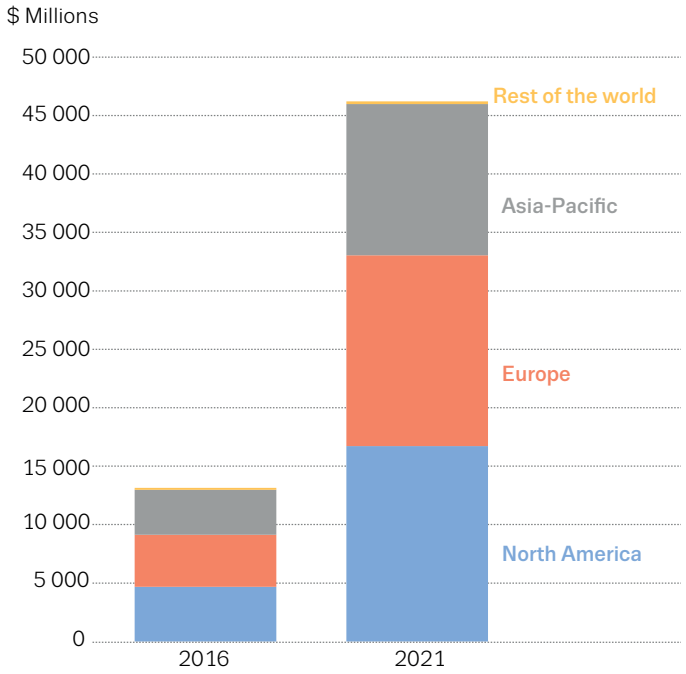
The wide public adoption of mobile phones and smartphones connecting to the internet is key to the proliferation of m-health. The internet plays a fundamental role as it is both a major communication channel and a source of data for m-health technologies. In the EU, more than 80 % of those aged 16-74 used the internet in 2016, with mobile phones and

TABLE 1
e-Health technologies and functionality (adapted from Pagliari et al., 2005)

e-Health technology	Functionality
Electronic health records	Communication of patient data between healthcare professionals
Computerised professional requests	Requesting diagnostic tests and treatments electronically, receiving results electronically
e-Prescribing	Access to prescribing options, electronic transmission of prescriptions from doctors to pharmacists, etc.
Clinical decision support system	Providing information electronically about protocols and standards for healthcare professionals to facilitate diagnosis and treatment
Telemedicine	Diagnosis and treatments at a distance, including telemonitoring of patients' functions
Consumer health informatics	Use of electronic resources on healthcare topics by patients and other individuals, for example decision aids for patients facing difficult choices, public information and educational tools for specific clinical groups, clinician-patient communication tools, rating information on the quality of professional services, and 'virtual' health communities
Health knowledge management	Fast access to concise treatment relevant information, for example an overview of the results of a recent meta-analysis on opioid substitution treatment, best practice guidelines or epidemiological tracking
Virtual healthcare teams	Connecting electronically inter-professional healthcare workers who collaborate and share information on patients
m-Health	Includes the use of mobile devices in collecting aggregate and patient-level health data, providing healthcare information to practitioners, researchers and patients, real-time monitoring of patients' vital signs and direct provision of care (via mobile telemedicine)
Technologies to analyse and use big data	Powerful computing and data management technologies to handle large amounts of heterogeneous data
Health informatics/healthcare information systems	Software solutions for appointment scheduling, patient data management, work schedule management and other administrative tasks

FIGURE 1

Predicted global revenues for m-health in 2021 (adapted from BCC research, 2017)



Definitions

Electronic health (e-health)
The use of emerging information and communication technology to improve or enable health and healthcare (Norman et al., 2007). e-Health technologies have three main overlapping functions: (1) to enable the storage, retrieval and transmission of data; (2) to support clinical decision-making; and (3) to facilitate remote care.

Mobile health (m-health)
Medical and public health practices, health information dissemination and patient data collection supported by mobile devices such as smartphones, patient monitoring devices, personal digital assistants and other wireless devices (WHO, 2011). m-Health is a subsegment of e-health.

Mobile application (mobile app)
A type of software programme designed to run on mobile devices such as smartphones and tablets; commonly referred to as an 'app'.

smartphones as the devices most frequently used to surf the internet (Eurostat, 2017). These findings highlight the strategic significance of new mobile technologies in the provision of healthcare interventions to individuals at risk and professionals alike. In fact, market research foresees that global revenues for m-health will reach nearly USD 46 billion (EUR 39 billion) in 2021 (see Figure 1), with Europe amongst the largest m-health markets worldwide (BCC Research, 2017).

What are drug-related e-health and m-health interventions, and do they work?

Digital methods of delivering drug-related interventions or disseminating drug-related information initially relied on desktop and laptop-based devices, with content accessible on computers via web browsers connected to the internet. A variety of different websites support people using licit and illicit substances. They range from the purely informational to the fully automatised online treatment programmes. Desktop-based drug-related treatment interventions are structured drug treatment interventions, offered on and communicated over the internet, possibly involving therapist interaction. They may be specifically designed for a desktop platform or adapted to desktop use from existing interventions elsewhere. Treatment interventions tend to have a defined schedule and time frame, with more advanced interventions including psychosocial intervention approaches such as cognitive behavioural therapy (CBT), motivational interviewing and relapse prevention theory. If websites incorporate responsive design features, then their content automatically adapts to the layout of smartphone screens. This functionality allows users to access desktop-based drug-related interventions through their smartphones. Systematic reviews of traditional desktop-based interventions delivered via the internet conclude that these are effective in achieving positive behavioural changes in people with alcohol, tobacco and other substance-related problems (Gainsbury and Blaszczynski, 2011; Hoch et al., 2016; Quaglio and Esposito, 2017). However, the systematic reviews also highlight that, owing to the variety of programmes, features and target groups, a stronger research base is needed to establish a conclusive evidence base. In this context, the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) has published two reports on the availability and effectiveness of desktop-based interventions, such as internet-based drug treatment for problem cannabis use (see EMCDDA 2009, 2014).

The transition to mobile technologies in the delivery of drug-related interventions took off with the introduction of SMS. SMS-based interventions involve daily or weekly motivational text messages to support behavioural change, computer-generated personalised assessment and automated feedback on drug consumption and well-being. These interventions may be delivered in conjunction with traditional face-to-face therapies or desktop-based internet treatment interventions. SMS-based treatment has shown effectiveness primarily in aiding smoking cessation and in reducing alcohol consumption (Keoleian et al., 2015; Berman et al., 2016; Fowler et al., 2016; Kazemi et al., 2017). The research base for illicit substances appears to be limited. The type of technology is only one factor influencing the impact of internet-based interventions. According to Litvin et al. (2013), other moderating factors

include the nature of the content (static or dynamic) and level of tailoring; contact with clinicians and peers; the theoretical framework; attrition, duration and exposure to the interventions; and the setting and location where the intervention is received by the user.

A significant advance in portable and mobile phone technology occurred with the development and widespread public adoption of smartphones. Smartphones are mobile phones with an integrated computer and include features not originally associated with mobile phones, such as an operating system, touchscreens, web browsing and the ability to run software applications. These technological mobile features enabled the application and delivery of a range of advanced digital health drug-related interventions, such as treatment, patient monitoring and supervision, drug prevention, harm reduction services, digital outreach and drug-related e-learning. Furthermore, digital interventions can be applied on a wide range of 'smart' mobile devices beyond phones, for example tablets and wearable devices such as smartwatches and electronic wristbands.

Smartphone-based m-health applications, in particular, provide new possibilities for health practices in the drugs field, such as the provision of location-based services via geo-tagging. Geo-tagging is the process of adding geographical identification metadata to media sources, including not only photographs and videos but also websites and apps. This feature allows app users to locate geo-tagged service points, in this case nearby peers or healthcare professionals and institutions in case of emergency. One novel feature of m-health is the just-in-time adaptive intervention (Nahum-Shani et al., 2016). These mobile interventions seek to adapt to a user's emotional, social and physical state to prevent negative health outcomes arising, for example, from high-risk drug use, and to promote healthy behaviours via users' smartphones or smartwatches. Researchers in Europe, for instance, are currently contemplating the development of low-cost electronic wristbands for drug users at high risk of overdose (e.g. heroin users). The wristbands can monitor heart rate and transmit an emergency signal to nearby health providers or relatives, alerting them to a potential drug overdose. Geo-tagging and just-in-time adaptive interventions are just two examples revealing the potential of m-health technologies as a tool to support drug users and professionals in the field.

To date, the number of studies assessing the effectiveness of smartphone m-health interventions for substance users remains limited. Three recent systematic reviews (Berman et al., 2016; Fowler et al., 2016; Kazemi et al., 2017) of m-health interventions in substance use have found 26 studies, of which only four involved smartphone applications (Gajecki et al., 2014; Gustafson et al., 2014; Witkiewitz et al., 2014; Gonzalez and Dulin, 2015). The four studies involving smartphone m-health interventions, as detailed below, were randomised control trials assessing the impact of particular applications on high-risk alcohol use. The most recent one, by Gonzalez and Dulin (2015), compared the effects of a smartphone application intervention and a web-based intervention, for six weeks, among 54 adults with diagnosed alcohol use disorders. The results showed a large increase in daily hours of abstinence among the app group, while both interventions resulted in significant reductions in the number of drinks consumed per week. Gustafson et al. (2014) evaluated the use of a smartphone application for a period of eight months among 349 adults with alcohol use disorders. The experimental group used the application-based intervention in combination with treatment as usual, while the control group received only treatment as usual. The results showed that the average number of days on which high-risk drinking occurred was lower, and likelihood of consistent abstinence higher, in the experimental group than in the control group. Only one study reported an overall negative result. Gajecki et al. (2014), who tested an existing application on hazardous drinking behaviour among university students, reported that the number of drinking occasions increased among male student app users.

Overall, although the range of existing smartphone-based interventions for substance users available for downloading appears to be vast, the number that have been empirically tested remains worryingly low. A qualitative review of smartphone apps for drinking behaviour found over 700 apps on the iTunes platform alone (Cohn et al., 2011). However, it was found that the majority focused on facilitating alcohol consumption through drinking games, and only one was intervention oriented. Among the latter, three of the four principles of effective alcohol-related treatments were represented, but about half relied on self-monitoring techniques, which constitute only a small part of an effective treatment. The review also found that roughly 10 % of the intervention apps could not be categorised as empirically based or potentially effective. Although several were found to be based on empirical principles, no review data were provided to inform the user as to whether or not the apps had been empirically tested.

A similar qualitative review of smoking cessation smartphone apps found 98 apps on download platforms for the most common smartphone operating systems, iOS and Android (Abroms et al., 2013). Although some apps were found to have useful attributes, such as interactive features or being specific to behaviours such as smoking, the vast majority of them lacked basic evidence-based practices. Potentially useful features that were largely omitted included referral to a quit smoking line (no apps) and recommendation of approved medications (4.1 % of apps). Only a few apps were found to include text alerts, and no apps included text messaging,

the most tested and proven application of mobile phones for smoking cessation (Whittaker et al., 2016).

An Australian study investigated the content of smartphone apps for addiction recovery and the reviews reported by users on their download platforms (Savic et al., 2013). Out of 87 apps, only six focused on illicit drugs, with the vast majority (77 %) focusing on addiction in general or alcohol disorders in particular. The study found that apps typically provided information on recovery, as well as content to enhance motivation and promote social support, and tools to monitor progress. Reviews by users commented on how the apps informed them, kept them focused, inspired them and connected them with other people and groups. Nevertheless, no information on their outcomes or effectiveness in reducing addictive behaviours was available. It should be noted that existing published content analyses of smartphone-related m-health interventions relate to apps developed either in the United States or in the English language, which may have implications for the cross-cultural validity of interventions and their geographical relevance. Another important issue that remains to be addressed in a systematic and coordinated manner by m-health professionals and developers, and European policymakers, is the lack of clear guidelines addressing the ethical challenges associated with m-health interventions in the drugs field relating to the transmission of personal data, data protection and user privacy.

The fast developmental pace and widespread usage of mobile technology and the internet, mean that m-health smartphone apps have great potential to further expand the reach of and access to drug-related healthcare services towards a common goal of ensuring a healthier Europe. However, drug-related m-health practices and interventions for either users or professionals remain in their infancy and are as yet poorly documented at EU level.

Objectives

This research sought to carry out a first exploration of available drug-related m-health apps in Europe. It explores the different apps available to users and health professionals in 16 European languages. Owing to its exploratory nature, and the possible wide range of apps in multiple languages, the study was intended not as a rigorous scientific content analysis but rather as an exploration of the range of drug-related m-health apps available in the EU as well as their primary objectives and target end-users. An exploratory exercise of this nature provides the opportunity to identify in the first instance relevant apps that may be analysed for content in future follow-up studies. It also enables an informed discussion on the current limitations and challenges in the field. Finally, it highlights implications for app developers, researchers and European decision-makers in relation to research gaps, quality standards, ethical concerns and investment priorities.

Methods

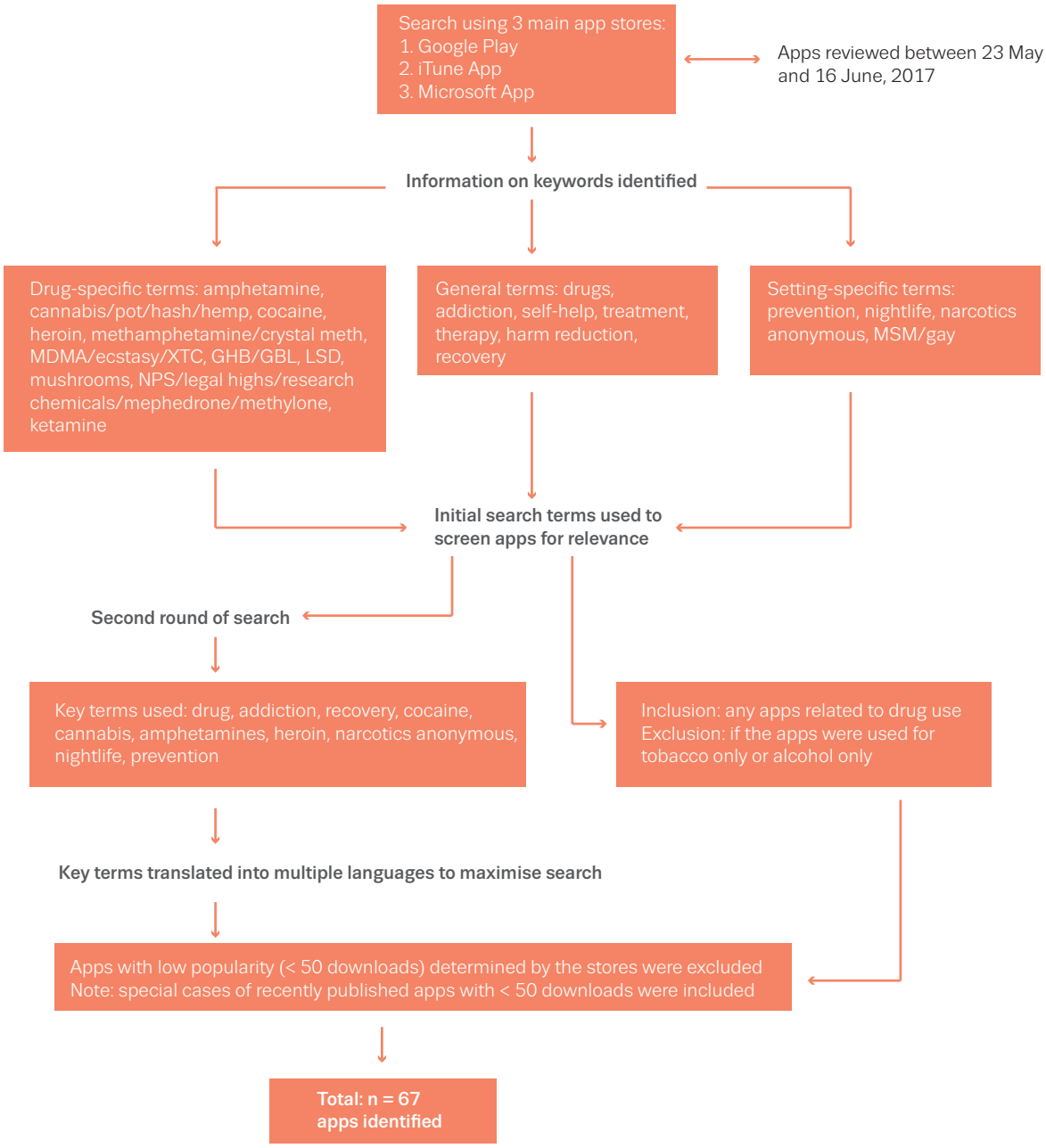
The approach used in this scoping study involved a systematic search across the main mobile application stores — Google Play (Android), App store (iOS) and Microsoft store (Android) — between 23 May and 16 June 2017. Keywords related to drugs, health interventions and intervention settings were used as initial search terms (see Figure 2), and the apps found were screened for relevance. All apps with content related to illicit drug use were included. Apps tailored exclusively to the use of licit substances, such as alcohol and tobacco, were excluded.

Based on the frequency of success to generate a high yield of available apps, key terms were selected for the second round of searches. These included drug, addiction, recovery, cocaine, cannabis, amphetamines, heroin, Narcotics Anonymous, prevention and nightlife. These key terms were translated into the following European languages: Croatian, Danish, Dutch, French, Finnish, German, Greek, Hungarian, Italian, Lithuanian, Norwegian, Portuguese, Serbian, Spanish and Swedish. The study excluded 10 official languages of the EU owing to the lack of access. Unpopular apps — downloaded by users fewer than 50 times — were excluded from the study; an exception was made for two apps that, although downloaded fewer than 50 times, had been recently launched (less than four months before the initial search).

A total of 98 apps met the inclusion criteria, resulting in a working sample of 67 apps after removal of duplicates. App content was then analysed by two researchers and coded and grouped according to type of intervention, primary objectives of the application and application features such as target group, language, country of origin, developer affiliation, content and intervention background. The researchers drew on the apps' descriptive information available at the app stores. In the event of uncertainty, the app was downloaded, installed on a smartphone and analysed by the researchers.

The chosen methodology encompasses limitations that need to be considered when interpreting the data. Search engines work with algorithms that are devised for particular platforms with particular goals in mind. The algorithm of search engines within app stores is very different from that of a systematic search in a scientific search engine such as PubMed. For example, app stores' search engines do not allow for the use of the 'AND' command, which may render some apps more difficult to find. Furthermore, inconsistent search results were observed during the search period, possibly as a result of

FIGURE 2
Methods flow chart



changes to the terms' characteristics controlled by the app stores or their search engines. To ensure the consistency of results, searches were carried out multiple times.

Another limitation concerns the number of app downloads: only the Android app store provided the number of downloads for each app. In addition, the number of downloads is merely indicative as it is possible that apps are downloaded but not used, or that the download figures are not accurately reported by the app store.

Geo-blocking was another concern. It is possible that some searches were geo-blocked, most likely those in languages not corresponding to the country where the search took place. For the present study, the search took place primarily in Switzerland, but also in Portugal, Finland and Lithuania. Therefore, it cannot be assumed that a similar systematic search will yield the same results if carried out in different EU countries. Furthermore, because of the large number of languages used in the search, inter-coder reliability analysis was not feasible; hence the homogeneity of content coding between independent coders cannot be guaranteed.

Finally, because this exercise is intended as an exploratory investigation of available m-health apps, no quality assessment was performed on the content of the apps. Future studies

should include a minimum quality assessment examining the usability, evidence and relevance of app content to enhance the potential use of findings.

Results

The systematic search for drug-related smartphone apps resulted in a set of 67 apps: 59 from the Google app store, 37 from the iTunes App Store (30 duplicates available in both stores were removed) and two from the Microsoft App Store (one duplicate was removed).

Background information on drug-related m-health apps

Country of origin

The vast majority of apps were devised in the United States (n = 33) and Europe (n = 26), with only eight originating from other parts of the world (see Figure 3). In Europe, the United Kingdom (n = 7) and Germany (n = 6) take the lead, together accounting for half of the drug-related m-health apps (Figure 4).

Language

For the most part, the app language reflects its country of origin, with the large majority of drug-related m-health apps providing content in English (n = 47). Of these, only one offered additional languages to English (Spanish, Portuguese and other, non-European, languages). Other m-health apps provided content in German, French, Spanish, Dutch and Italian (Figure 5).

Target group

The target end-user of drug-related m-health apps is difficult to ascertain as it depends on the content and purpose of each app. For example, apps that provide extensive drug-related information on the effects and harms of drug use may be of interest not only to drug users but also to parents and relatives, health professionals and other interested members of the public.

As illustrated in Figure 6, most apps provided content related to drugs, drug addiction and drug-related addictive behaviour in general. Only a small number focused on one specific drug (e.g. cannabis or cocaine), possibly targeting users seeking

FIGURE 3
Origin of drug-related m-health apps (N = 67)

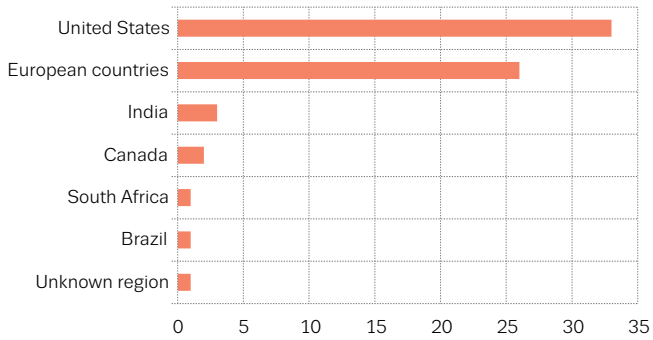


FIGURE 4
Country of origin of the European drug-related apps (N = 26)

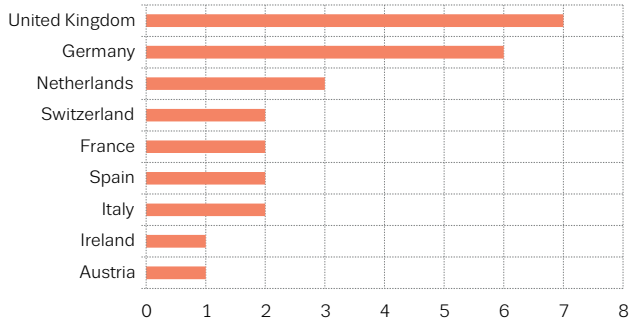
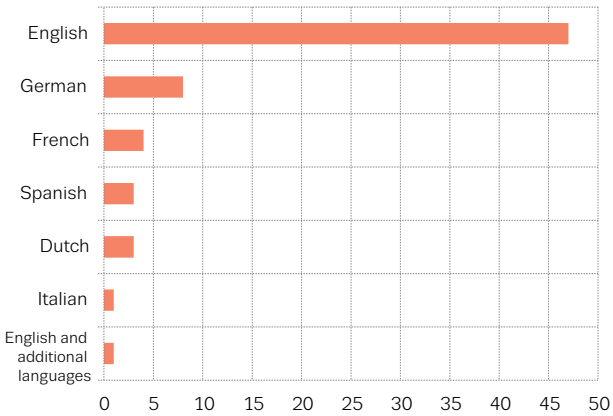


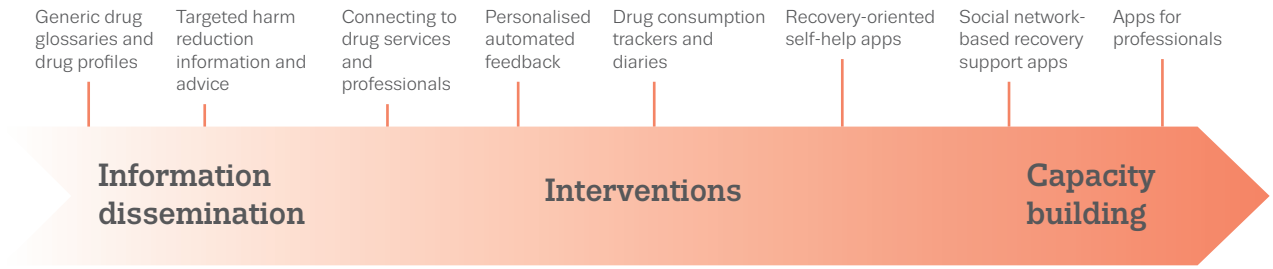
FIGURE 5
Language of drug-related m-health apps (N = 67)



support in reducing harms associated with the use of specific substances. However, some apps were clearly catering for particular groups such as partygoers, men who have sex with men (MSM) using drugs and abstinent or recovering drug users. A small number were directed at health professionals working in the drugs field.

FIGURE 6

Three main groups of m-health apps based on primary objectives



Cost to users

The majority of apps (n = 59) can be downloaded free of charge with no subsequent costs to users. Only eight apps involve costs. In four cases direct costs are payable at the time of download (ranging from EUR 1 to 4). The other four charge for advanced functions only, that is optional add-ons to the basic functions of the app. Advanced functions include individualised feedback message (costs ranging from EUR 1 to 12) and assistance from an addiction professional (costs approximately EUR 52). These charges are applied only when services are activated. Three apps with associated costs originate from Europe (Germany, Italy and the United Kingdom), four from the United States and one from India.

It is a common strategy for app distributors to make their apps and all contents freely available, and to introduce charges only when the app becomes popular and reaches a high number of downloads. Sometimes app distributors introduce in-app costs in an updated version of the app. However, the drug-related apps under examination here do not appear to have yet been affected by these commercial strategies.

Main groups of drug-related m-health apps

Based on the main objectives, content and target end-users of the 67 identified apps, three main groups of drug-related m-health applications emerge. The first group comprises apps that focus primarily on the dissemination of drug-related information and contain drug glossaries and health-related information with harm reduction advice targeted at drug users in nightlife settings (see 'Dissemination of drug-related information through m-health apps'). The second group of apps are interventions aimed at raising awareness of users' own drug consumption, reducing drug use or supporting abstinence and recovery from drugs using, for example, drug consumption trackers, automated feedback on personal drug consumption, direct contact with counsellors, abstinence-oriented self-help (see 'm-Health interventions through m-health apps') or social networking-based support. The third group comprises apps that are primarily tools dedicated to capacity building among health professionals in the drugs field (see 'm-Health tools for capacity building among health professionals in the drugs field').

Thus, drug-related m-health apps appear to be positioned along a continuum between dissemination of drug-related information and advice, interventions and support for drug

TABLE 2

m-Health apps providing primarily drug-related information

App name	Main language	Country of origin	Developer category	Android installations (1)	With costs
Drogas	Spanish	Spain	Private individual	h	No
Drogen — Lexikon PRO	German	Germany	Private individual	c	Yes
DrogoQuiz	Spanish	Spain	NGO	c	No
Drug Effects Guide & Quiz Game	English	United States	Private company	f	No
GRC Drogues	French	Canada	Governmental organisation	e	No
Informação sobre Droga	Portuguese	Unknown	Private individual	b	No
Overcoming Addiction+	English	United States	Private individual	N/A	Yes
Meth Ice	English	India	Private individual	N/A	No

(1) a = 50-100, b = 100-500, c = 500-1 000, d = 1 000-5 000, e = 5 000-10 000, f = 10 000-50 000, g = 50 000-100 000, h = 100 000-500 000.
N/A, not applicable; NGO, non-governmental organisation.

TABLE 3

m-Health apps providing drug-related information and harm reduction advice for users in nightlife settings

App name	Main language	Country of origin	Developer category	Android installations (1)	With costs
KnowDrugs	English	United States	NGO (nightlife)	d	No
Psychoactif	French	France	NGO (nightlife)	c	No
Techno+	French	France	NGO (nightlife)	d	No
Redalert	Dutch	Netherlands	Research institute	e	No
Dance Safe Mobile	English	United States	NGO (nightlife)	e	No
Tripsit	English	Not available	Not available	f	No

(1) a = 50-100, b = 100-500, c = 500-1 000, d = 1 000-5 000, e = 5 000-10 000, f = 10 000-50 000, g = 50 000-100 000, h = 100 000-500 000.
NGO, non-governmental organisation.

users and tools for professionals (see Figure 6). Similarly, the various apps along this continuum target different end-users, ranging from groups among the lay public, such as relatives of drug users or teachers, to current active drug users, individuals in recovery and health professionals in the drugs field.

Dissemination of drug-related information through m-health apps

The first group of m-health apps identified in this study includes applications that aim primarily at disseminating information on the pharmacology, effects and health risks associated with various psychoactive substances. Most of these apps contain general information on drugs and use a similar content style to available online resources such as the EMCDDA's drug profiles or drug-specific Wikipedia pages. Some of these apps offer knowledge tests about substances and their effects, through which users can expand their knowledge on the risks and harms associated with drugs (Table 2). An example is the Spanish app 'Drogas', which provides drug profiles compiled from online encyclopaedias and professional websites and has been downloaded more than 100 000 times. A number of these apps were developed by individuals about whose professional background and expertise little or no information is provided, leading to concerns about the reliability of the information offered to users and the likelihood of the app being kept up to date. This is of real concern considering the number of rapidly appearing new psychoactive substances (NPS) on the market and the associated harms.

A subgroup of these applications is targeted primarily at partygoers and recreational drug users. These apps adopt a harm reduction approach, with a focus on informing users in these setting of the health risks associated with drug use (Table 3). These apps are mostly developed by nightlife prevention organisations. For example, the French app

TABLE 4

m-Health apps connecting users to healthcare providers

App name	Main language	Country of origin	Developer category	Android installations (1)	With costs
About Addiction and Health	English	United States	NGO (prevention)	a	No
Beratungs-stellen OO	German	Austria	Private organisation	a	No
Bridge to Sobriety!	English	United States	NGO (treatment)	b	No
Crystal-App	German	Germany	NGO (prevention)	c	No
Drug & Alcohol Helpline	English	Canada	NGO	N/A	No
Drug Addiction	English	United States	Private individual	f	No
Mindzone	German	Germany	NGO (nightlife)	d	No
Quit Porn/Drug/Food Addiction	German	United States	Private company	h	Yes
Rehabs Finder	English	United States	Private individual	N/A	No
Right Path Addiction Centers	English	United States	NGO (treatment)	a	No
Say No to Drugs	English	United States	Private individual/ academia	c	No

(1) a = 50-100, b = 100-500, c = 500-1 000, d = 1 000-5 000, e = 5 000-10 000, f = 10 000-50 000, g = 50 000-100 000, h = 100 000-500 000.
N/A, not applicable; NGO, non-governmental organisation.

'Techno+', developed by the nightlife organisation of the same name, and downloaded between 5 000 and 10 000 times through Google Play, not only provides information on safer use of party drugs, but also allows users to check the potential risks of multiple drug use by clicking on corresponding drug use combinations. Another example is the Dutch app 'Redalert', which provides information and alerts on drug checking (also known as pill testing) and communicates safer drug-using behaviours through the app. It provides information on tablets and powders with high concentrations of psychoactive substances, or those containing harmful adulterants identified through its drug-checking services. This app has been developed by the Dutch research institute Trimbos and has also been downloaded between 5 000 and 10 000 times.

m-Health interventions through m-health apps

The largest group of m-health applications identified in this scoping exercise is applications that provide drug-related interventions aimed at raising drug users' awareness of their own drug consumption with the goal of reducing drug consumption or drug-related risk behaviours, and also some apps that provide supportive in-built tools to promote reduction of or recovery from drug use. For example, some apps aim at connecting users with health professionals via built-in encrypted messaging systems and facilitating access to drug services through geographical information on nearby health professionals and treatment services (Table 4). Most of these originate in the United States or Canada and were developed by non-governmental organisations (NGOs) with a focus on drug-related prevention, treatment and helplines (Table 4). The 'Mindzone' app, developed by a German prevention organisation, targets primarily partygoers and offers counselling services with prevention and harm reduction professionals over a secure connection as well as contact information for health services in close geographical proximity based on the users' smartphone location.

A few m-health apps were developed to provide personalised automated feedback on users' own drug use levels as a health intervention to prevent or reduce drug use. Personalised feedback is generated through screening tools such as the Drug Use Disorder Identification Test, or other large drug-related information databases. These apps provide individualised feedback on the risk levels associated with patterns of use of specific drugs. They also attempt to adjust perceptions of drug use by running a comparison regarding how much a particular drug — such as cannabis, cocaine, mephedrone or MDMA — is used by peers of the same demographic group. The comparative approach appears to be inspired by the 'social norms' approach, which has gained increasing attention as a prevention intervention. Social norms interventions have been successful in reducing alcohol and tobacco use in college and high school populations (Berkowitz, 2005). According to the social norms theory, individuals incorrectly perceive the attitudes and/or behaviours of peers and other community members in certain situations to be different from their own. This misperception of norms (e.g. my peers smoke a lot of cannabis) leads to increased consumption to become closer to the misperceived norm. Social norms theory-based interventions aim to correct misperceptions by revealing the actual, healthier norm. This has a beneficial effect on most individuals, who will either reduce their participation in potentially problematic behaviour or feel encouraged to engage in protective, healthier behaviours. Perception of norms is a key element of comprehensive evidence-based prevention interventions, yet there is no evidence base for its effectiveness as a stand-alone practice. Five apps that use this approach were identified (Table 5). For example, 'Drugsmeter Mephedrone' anonymously assesses the user's mephedrone use patterns and standardises the results based on medical and family histories. It compares individuals' outcomes with those of other Global Drug Survey participants who reported mephedrone use in the user's residential area. It also includes an optional personal drug-problem quiz to assess levels of mephedrone dependence, and makes recommendations about how to best reduce its use. It provides information regarding

TABLE 5

m-Health apps providing personalised automated feedback

App name	Main language	Country of origin	Developer category	Android installations (1)	With costs
Drugsmeter Cannabis	English	United Kingdom	Private company	f	No
Drugsmeter Cocaine	English	United Kingdom	Private company	e	No
Drugsmeter MDMA/ GHB/GBL	English	United Kingdom	Private company	e	No
Drugsmeter Mephedrone	English	United Kingdom	Private company	e	No
Substance Use & Addiction	English	United States	Private individual	b	No

(1) a = 50-100, b = 100-500, c = 500-1 000, d = 1 000-5 000, e = 5 000-10 000, f = 10 000-50 000, g = 50 000-100 000, h = 100 000-500 000.

TABLE 6
m-Health apps providing consumption-tracking tools

App name	Main language	Country of origin	Developer category	Android installations (1)	With costs
Addiction Tracker (Colsner)	English	India	Private company	d	Yes
Addiction Tracker (Etilox)	English	India	Private company	b	No
Addiction zero	English	United States	Private company	N/A	No
Arud Konsum-tagebuch	German	Switzerland	NGO (treatment)	b	No
C:KYL (Chems: Know Your Limit)	German	Germany	Private individual	a	No
IMQuit - Quit addiction	English	United States	Private company	h	No
Checkpoint C	German	Germany	NGO (treatment)	b	No
No Drugs Calendar	English	United States	Private company	N/A	No
Quit Cannabis	English	United Kingdom	Private company	f	Yes
Ralli Recovery	English	United States	Private company	N/A	No
Schluss mit Sucht	German	Germany	Private company	f	Yes
Stop cannabis	French	Switzerland	Research institute	f	No
7 day challenge	Dutch	The Netherlands	NGO	N/A	No

(1) a = 50-100, b = 100-500, c = 500-1 000, d = 1 000-5 000, e = 5 000-10 000, f = 10 000-50 000, g = 50 000-100 000, h = 100 000-500 000.
N/A, not applicable; NGO, non-governmental organisation.

safer mephedrone use, mephedrone and driving or gender-specific safer sex advice in the context of chemsex.

More sophisticated drug-related interventions delivered via apps contain drug consumption trackers or diaries to monitor use and set goals towards reduction in drug use or abstinence (Table 6). For example, the 'Stop cannabis' app, developed by the University of Geneva in Switzerland, uses a method similar to the empirically evaluated online desktop-based cannabis intervention 'Quit the Shit' (Tossmann et al., 2011). The Swiss app allows users to set their own cannabis consumption goals, enter information about their daily drug consumption patterns, take note of particular drug-related events in the diary (e.g. cravings), receive personalised and automated motivational messages or advice and receive automatically produced achievement reports. Another example is the 'IMQuit' app, which allows users to log data on their drug consumption and drug use behaviour (for several drugs), enabling them to monitor their own patterns. It includes machine learning algorithms that analyse users' behavioural patterns and provide feedback to support relapse prevention or reduce occurrence of new consumption patterns. The app is designed for patients in drug treatment and allows the attending healthcare professionals or supervisors to have access to the patient's consumption record through a website dashboard. This app has been downloaded between 500 000 and 1 000 000 times — it is by far the most downloaded app in this category.

The 'Ralli Recovery' app combines drug use tracking with social media functions that invite friends and relatives to participate and support users in their effort to reduce drug use. Two apps in this category, 'Addiction Tracker (Colsner)' and 'Schluss mit Sucht', involve in-app costs ranging between EUR 1.50 and 2.50. Although these apps are free to download, more complex functionalities can be optionally activated at a cost.

Interestingly, a number of apps have been primarily developed to support recovery from drugs through abstinence-oriented self-help tools. These have nearly all been developed in the United States by either private companies or recovery-oriented organisations such as Narcotics Anonymous (NA) (Table 7). One of the most downloaded apps developed by Narcotics Anonymous groups is the 'NA 12 Steps App' (50 000-100 000 downloads). This app aims at supporting NA members in traditional NA therapeutic processes and social support groups that facilitate peer support and the sharing of experiences to maintain abstinence. Another example of an abstinence- or recovery-focused self-help app is 'No More! Quit your Addictions', which has features that allow users to count their abstinence days, receive motivational quotes and congratulatory messages on their achievements and customise in-app shortcuts to instantly access a trusted person or community website for social support. The app 'Addiction AVERT' provides relapse prevention techniques based on negative reinforcement: it supports individuals to challenge cravings by bringing up associated negative events and situations that may occur with continued use of drugs. 'Addiction AVERT' can be customised to help motivate an individual's personal recovery programme and provides opportunities to work with a sponsor.

TABLE 7

m-Health apps oriented towards recovery

App name	Main language	Country of origin	Developer category	Android installations (1)	With costs
Drug Addiction	English	United States	NA organisation	f	No
Drug Addiction (IGT)	English	United States	Private company	d	No
Field Guide to Life Pro: Recovery Support	English	United States	Private company	d	No
MAPconnect — Addiction Recovery Support	English	United States	Private company	a	No
Marijuana Anonymous	English	United States	NA organisation	f	No
My Sober Life Pro: Young Adult Recovery Support	English	United States	Private company	b	No
NA 12 Steps App	English	United States	NA organisation	g	No
NA Ireland	English	Ireland	NA organisation	b	No
New2Recovery for Addictions	English	United States	Private company	e	No
No More! Quit your Addictions	English	Italy	Private company	h	Yes
PW recovery	English	United States	Private company	N/A	No
Recovery from Drug Addiction	English	United States	Private company	N/A	No
Self Help *Just for today* NA	English	United States	NA organisation	h	No
Sober Time — Sobriety Counter	English	United States	Private company	h	No
Sober Tool	English	United States	Private company	g	Yes
Addiction AVERT	English	United States	Private company	b	No
Hypnosis for Addiction & Sober	English	United States	Professional person	d	Yes
Overcome Addictions Hypnosis	English	United Kingdom	Professional person	c	No

(1) a = 50-100, b = 100-500, c = 500-1 000, d = 1 000-5 000, e = 5 000-10 000, f = 10 000-50 000, g = 50 000-100 000, h = 100 000-500 000.
N/A, not applicable; NGO, non-governmental organisation.

Our scoping exercise on drug-related m-health apps found two apps that foster an online social network approach for drug users who are attempting to reduce or in recovery from drug use. These apps use the same approach as popular online social networking applications by using features such as adding friends, giving 'likes' and sharing pictures and events (Table 8). For example, the app 'Mober' allows users to share pictures and videos among friends so they can witness their progress towards abstinence. Close members of an individual's online social support network can validate and co-sign positive achievements and alert other members of the social network when an individual needs support. 'Party Friends', developed by the Trimbos Institute, also aims to develop a network of friends, but with a focus on the Dutch party scene. Users can find how many virtual friends are at the same event and arrange for transport and accommodation. Additionally, users can find out about how to respond to acute drug-related harms. The app also features an emergency call button. Both apps have a relatively low volume of downloads, despite sufficient and attractive social media functions. Having to set up a new network of virtual friends alongside established

TABLE 8

m-Health apps providing support through social networking

App name	Main language	Country of origin	Developer category	Android installations (1)	With costs
Mober	English	United States	Private company	c	No
Party friends	English	The Netherlands	NFPO	a	No

(1) a = 50-100, b = 100-500, c = 500-1 000, d = 1 000-5 000, e = 5 000-10 000, f = 10 000-50 000, g = 50 000-100 000, h = 100 000-500 000.
NFPO, not-for-profit organisation.

TABLE 9
m-Health apps for healthcare professionals

App name	Main language	Country of origin	Developer category	Android installations (1)	With costs
Addiction 101	English	South Africa	Private company	c	No
NICE Guidance	English	United Kingdom	Professional organisation	h	No
miDOT	English	United States	Private company	c	No
SITDintasca	Italian	Italy	Professional organisation	a	No

(1) a = 50-100, b = 100-500, c = 500-1 000, d = 1 000-5 000, e = 5 000-10 000, f = 10 000-50 000, g = 50 000-100 000, h = 100 000-500 000.

popular social networking platforms may account for their apparent lack of success.

m-Health apps for capacity building among health professionals in the drugs field

Surprisingly, we found only a few apps that can assist professionals in the drugs field in their daily work (Table 9). One of these apps is the 'NICE guidance' app. It was developed by the National Institute for Health and Care Excellence (NICE) in the United Kingdom and features all available clinical guidelines, including those addressing interventions for drug-related problems. 'SITDintasca', an app from the Italian Society of Addiction Disorders, facilitates access to relevant documents, web news and events. It also runs a forum for professionals and experts in the field of addiction. The American company EMOCHA produced an app to be used by patients in opioid substitution treatment that acts as a tool for prescribers to monitor users' adherence to treatment. EMOCHA's 'miDOT' app uses asynchronous videos to manage directly observed therapy. In other words, it allows patients to use their smartphones' video function to record themselves taking the medication. Patients can also report side effects or symptoms and record every dose of medication using the smartphone app. Clinicians can then view and manage patient data, communicate with patients and review their progress on a web interface. This m-health app for practitioners and patients is aimed at encouraging patient engagement and medication adherence.

Discussion

This scoping exercise identified 67 smartphone apps downloadable in Europe that provide different forms of drug-related information or interventions. These apps apply different technologies ranging from simple text-based content display to advanced interactive functions such as geo-tagging, video transmission and automated personalised feedback. Most apps featured some content information on drugs, their effects and associated risks and harms. The majority of drug-related apps have more advanced functionalities that include some type of intervention. These range from approaches inspired by harm reduction and prevention interventions to more structured or sophisticated interventions for users aiming at reducing or abstaining from drug use via their smartphones or tablet devices. Generally, such apps were commonly developed by NGOs and research institutes with an established presence in the field of drugs and drug addiction.

Geographical differences in approaches

Interestingly, differences emerge in intervention approaches between apps originating in the United States and those from Europe. United States-based apps providing interventions tend to adopt a recovery-based approach inspired by the Alcoholics Anonymous approach for recovery from alcohol dependence. This is illustrated by the number of US m-health apps developed by NA groups aiming to facilitate contact between recovering drug users and sponsors or to provide motivational messages to remain abstinent.

In contrast, Europe-based apps delivering m-health interventions tend to adopt a preventive and harm reduction approach towards drug use with interventions rooted in established scientific approaches, such as brief interventions or CBT. The Swiss 'Stop Cannabis' application is a good example: it uses motivational interviewing and CBT approaches. This contrast between United States- and Europe-based apps may also be reflected in target end-users. Europe-based apps tend to cater for partygoers or recreational users while United States-based apps tend primarily to address ex-users in recovery. Similarly, Europe-based app developers more commonly include NGOs operating in nightlife settings or research institutes such as the Dutch Trimbos Institute, while the majority of US apps are developed by private companies. Differences in m-health approaches between world regions may also reflect historical differences in demand reduction traditions and policies. It may therefore be easier for Europe-based organisations to produce content with harm reduction

messages. For example, drug testing in nightlife settings may not be tolerated in other parts of the world. These differences raise questions on the relevance and attractiveness of available drug-related m-health content and interventions to users from different regions of the world. This is also relevant in the EU context, in that apps developed in one Member State may not be as relevant and attractive to users in other Member States. Language, quality and type of content, age, target user groups and data protection issues can be relevant factors in this regard.

Limited language coverage

All m-health apps identified in this publication can be downloaded by anyone geographically located in Europe. However, the limited number of apps in native European languages may constitute an important barrier to the use of digital intervention tools in the field of drugs and drug addiction. The method used in our search applied 16 European languages in the search for apps and found that drug-related m-health apps were available in fewer than 10 EU Member States languages, with searches in Scandinavian and Eastern European languages yielding no results. These findings should be interpreted carefully as it is possible that apps from particular Member States were geo-blocked to the researchers, as discussed in the Methods section. Nevertheless, the findings suggest that the number of apps available in languages other than English is limited, with apps in French, Dutch, German and Spanish primarily aimed at the dissemination of harm reduction information and advice among partygoers. Treatment-related m-health interventions supporting the reduction or abstinence from drug use are currently still limited in Europe, while those that are available have not yet documented scientific evidence of efficacy or effectiveness. Thus, while several apps were found to adopt empirically based principles in their interventions, no review data was provided to the user to support whether or not these apps have been empirically tested.

Drug- and setting-specific focus

Most m-health apps identified here address risk behaviour associated with drugs in general or drug use in specific settings (e.g. nightlife settings) or include drug-specific sections. Some drug-specific apps are available for more commonly used drugs such as cannabis or cocaine. However, we found one application that exclusively addresses NPS. As the number of NPS present in the European market continues to be significant, the development of dedicated mobile apps by authoritative institutions providing timely information on newly identified NPS and their known and potential health risks, as well as harm reduction features, could be an efficient way to reach large numbers of NPS users. National and European early warning systems may consider the utility of such apps for users and health professionals in the field. It should be noted that this information may already be available on websites accessible primarily from desktop computers, such as the EMCDDA Action on new drugs web page, which is publicly available. However, it is important that website developers be encouraged to apply a responsive design that allows web pages to change their appearance and usability to suit the viewing properties of mobile devices (e.g. smartphones, tablets).

Underrepresented target groups

Most apps that were identified address the information or intervention needs of drug users in general or, in some cases, more targeted groups, such as users in nightlife settings. However, some specific user groups were found to be currently underrepresented within the target groups of available drug-related m-health apps, such as MSM engaging in chemsex and high-risk drug users.

Chemsex is a term often associated with the use of psychoactive substances within the context of sexual practices among MSM. Chemsex is associated with particular risk behaviours, such as unprotected sex and the sharing of drug paraphernalia, both of which increase the risk of transmission of infections such as HIV and hepatitis C virus. A study by the European Centre for Disease Prevention and Control (ECDC, 2015) reported a proliferation of mobile dating platforms for MSM, which included explicit exchanges between users seeking chemsex. While digital outreach by health professionals within these apps has proven to be difficult, the development of separate m-health apps targeting MSM engaging in chemsex may be important in accessing this hard-to-reach group. In this scoping exercise we retrieved only one app specifically catering for people engaging in chemsex: the German 'C:KYL' ('Chems: Know Your Limit'). This app allows users to document and track the use of drugs (such as poppers, GHB/GBL (gamma-hydroxybutyrate/gamma-butyrolactone), cocaine and methamphetamine) used during sexual activities with partners but does not offer any further harm reduction or drug consumption reduction interventions. Further investments are required in the development of relevant, attractive and scientifically sound apps for European MSM that include sexual health promotion, chemsex-related harm reduction and drug use reduction interventions.

High-risk drug users, such as heroin injectors in and out of treatment, may also benefit from m-health apps. A recent meta-analysis of internet-based interventions for illicit substance users (Boumparis et al., 2017) demonstrated that internet interventions could be effective add-ons to substitution treatments for this population. We found only one app focused on this user group: a US application that

helps patients in opioid substitution treatment to adhere to their treatment regime through daily video and text-based interaction with their health providers. It could be argued that some of the apps described in this report may address some of the supportive needs of former high-risk drug users in recovery. However, further harm reduction apps for active high-risk drug users could be developed that include overdose emergency components, such as emergency numbers, training on the use of naloxone emergency kits and provision of wristbands that monitor vital signs and automatically connect to emergency services in the event of overdose.

More m-health tools needed for health professionals

Health professionals in the field of drugs and drug addiction could also benefit from further development of m-health tools. Mobile devices may provide access to relevant clinical material and e-learning tools to clinicians at any time. The app from NICE (see 'm-Health apps for capacity building among health professionals in the drugs field') is a good example of high-quality and accessible clinical content on smartphones and tablets. However, similar user-friendly mobile e-learning tools for European drug professionals are currently rare. Further developments in this area could focus on m-health tools that facilitate exchange of knowledge and skills between classroom settings and clinical practice and assist health professionals in reviewing and applying skills with patients. For example, Satre et al. (2017) developed and tested, with positive results, a mobile learning app for health professionals (e.g. nurses, social workers, medical trainees), based on the theory of planned behaviour, to deliver screening, brief intervention and referral to treatment (SBIRT), which is an effective approach to identify and treat individuals at risk of problem alcohol or drug use.

Quality challenges

As technology and interest in m-health apps in the drugs field is likely to grow, a number of important points need to be addressed. First, a large number of m-health apps containing drug-related information appear to be aimed at young users, especially partygoers. However, there is no consensus on the age limit that would be appropriate for such apps. For the most part, drug-related m-health apps do not undergo formal quality control and, as mentioned earlier, are not necessarily based on sound scientific evidence, which means that the drug-related information and interventions they provide may cause unintentional harm, especially among young inexperienced users. Possible ways to minimise potential harms of m-health apps include tighter parental controls, regulation ensuring minimum quality control and careful screening of content for accreditation.

Another issue to consider is whether or not the quality standards and accreditation systems that are applied when implementing new drug-related services should also be applied to the development and provision of drug-related m-health apps and to the health providers using them. There are adapted standards for internet addiction counselling (Schaub et al., 2014) that could be tailored to the context of drug-related intervention apps. The recent European Minimum Quality Standards in Drug Demand Reduction interventions (Council of the European Union, 2015), adopted at EU level, could be updated to include minimum quality standards for e-health and m-health at EU level. As mentioned before, there is a general lack of information provided by app developers on clinically relevant results and evidence of safety and effectiveness of their product. A regulatory process could address this gap by carefully evaluating m-health apps, or requiring evidence of safety, effectiveness and ethical conduct before routine public distribution and clinical use (Capon et al., 2016).

Concerns about data protection for EU citizens

Finally, the use of drug-related m-health apps that log personal information raises important ethical and legal considerations with regards to data storage, data ownership, third-party access, informed consent, privacy and personal data protection (Capon et al., 2016; Pisani et al., 2016). This is particularly relevant as the processing of personal data (e.g. health or drug-related data) provided in such apps remains obscure. For instance, there is no clear information on safeguards concerning data breaches and the sharing of personal behavioural data with third parties or government institutions. The EU General Data Protection Regulation (GDPR)([1]) , adopted in April 2016, was designed to 'harmonise data privacy laws across Europe, to protect and empower all EU citizens' data privacy, and to reshape the way organizations across the region approach data privacy' (European Commission, 2016).

An in-depth discussion of European data protection laws relevant to m-health is beyond the scope of this study. However, there are significant inclusions in the new EU Regulation that will affect personal data sharing, as in the case of exchange of personal health or drug-related data within m-health apps. Probably the most important regulatory change consists in the extraterritorial applicability of the GDPR and concerns all companies processing the personal data of subjects residing in the EU, regardless of the company's location. As a consequence, any m-health developers located

([1]) Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).

outside the EU but collecting or processing data obtained within the EU will have to abide by the EU GDPR. This means that the request for consent must be in an intelligible and easily accessible form, with a statement of the purpose for data processing attached to that consent. In addition, the GDPR states that EU residents will have the right to obtain from the data controller (e.g. m-health app developer) confirmation as to whether or not their personal data are being processed and, if so, where and for what purpose. Further, the owner of an app is required to provide a copy of personal data upon request, free of charge, in an electronic format, and the user has the right to transmit those data to another entity (data portability), for example to another health service, thereby facilitating the bridge between virtual and actual drug treatment service provision for patients and healthcare providers. This new EU-wide directive will undoubtedly create difficulties for future epidemiological data collection on drug use and treatment demands as the number and usage of m-health interventions continues to increase. Nevertheless, this directive will ensure that, by providing for increased transparency and accountability, m-health apps in the drugs field can become an essential and secure intervention tool for users and professionals across Europe.

Conclusions

There is growing interest in the use of m-health apps as add-ons to current drug use prevention, harm reduction and drug treatment provision systems. The individual, societal and economic potential of m-health in general, and in the drug use field in particular, is vast. As mobile technologies are increasingly available and ever more sophisticated, there is a need to further advance the development, quality and usability of m-health apps to increase access to drug treatment and harm reduction for those in need and reduce general treatment costs. Despite the limitations of the methodology used in this exercise, we identified a number of initial gaps in the drug use field related to m-health applications that can guide future investment priorities in this area.

First, there is a clear need to improve the evidence base behind the methods applied within drug-related m-health applications and their interventions. Currently, the very limited evidence base in this field concerns m-health applications with alcohol-related interventions. The development of drug-related m-health applications may be an attractive endeavour for governmental and private agencies, but it would be wrong to assume that they do not have the potential to cause harm to users. The negative impact of the apps currently downloadable to European users and reported here is unknown. With an increasing number of such apps developed and available, investments in funding research assessing the scientific evidence, rather than only the development, of mobile-based interventions in the drugs field, should be a priority at EU and national levels. In this respect, the development and implementation of EU-wide minimum quality standards of m-health interventions in the drugs field should also be considered. These quality standards, alongside the newly adopted EU data protection directives, will ensure safer, more transparent, development of digital drug intervention tools provided via mobile platforms.

Furthermore, cross-border content relevance of m-health interventions appears to be significant, especially between world regions. The successful evolution of m-health in the European drug use field will therefore rely on the development of apps that that are relevant and attractive to European citizens and drug use prevention and treatment professionals. Cooperation and synergy between EU governments and NGOs operating in the prevention and treatment field will therefore be crucial. Common core intervention apps with a sound scientific evidence base and adapted to national characteristics and language are a cost-effective way to increase the availability of these tools in Europe.

Another investment priority is the development of m-health apps targeting hard-to-reach user groups currently underrepresented in the m-health field, such as high-risk drug users or MSM. The development of competence-building m-health tools for European drug use professionals is another investment priority highlighted in this study. A positive development in this field will hopefully have an immediate positive impact on professional skills, treatment quality and overall public health.

Finally, the enormous popularity of smartphone apps as a communication tool and trendsetting medium highlights the need to develop an EU-wide consensus on effective and safe risk communication strategies when communicating drug alerts via m-health apps.

References

- Abroms, L. C., Lee Westmaas, J., Bontemps-Jones, J., Ramani, R. and Mellerson, J. (2013), 'A content analysis of popular smartphone apps for smoking cessation', *American Journal of Preventive Medicine* 45(6), pp. 732-736 (available at http://www.ncbi.nlm.nih.gov/pubmed/24237915).
- BCC Research (2017), *Mobile health (mHealth) technologies and global markets*, BCC Research, Wellesley, MA (available at https://www.bccresearch.com/market-research/healthcare/mobile-health-technologies-report-hlc162b.html).
- Berkowitz, A. D. (2005), 'An overview of the social norms approach', in Lederman, L. C. L. C. and Stewart, L. P. (eds.), *Changing the culture of college drinking: a socially situated health communication campaign*, Hampton Press, Cresskill, NJ, pp. 193-214..
- Berman, A. H., Gajecki, M., Sinadinovic, K. and Andersson, C. (2016), 'Mobile interventions targeting risky drinking among university students: a review', *Current Addiction Reports* 3(2), pp. 166-174 (available at http://link.springer.com/10.1007/s40429-016-0099-6).
- Boumparis, N., Karyotaki, E., Schaub, M. P., Cuijpers, P. and Riper, H. (2017), 'Internet interventions for adult illicit substance users: a meta-analysis', *Addiction* 112(9), pp. 1521-1532 (available at http://www.ncbi.nlm.nih.gov/pubmed/28295758).
- Capon, H., Hall, W., Fry, C. and Carter, A. (2016), 'Realising the technological promise of smartphones in addiction research and treatment: an ethical review', *International Journal of Drug Policy* 36, pp. 47-57 (available at http://www.sciencedirect.com/science/article/pii/S0955395916301670).
- Cohn, A. M., Hunter, Reel, D., Hagman, B. T. and Mitchell, J. (2011), 'Promoting behavior change from alcohol use through mobile technology: the future of ecological momentary assessment', *Alcoholism: clinical and experimental research* 35, pp. 2209-2215 (available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3221771/).
- Council of the European Union (2015), *Council conclusions on the implementation of the EU Action Plan on Drugs 2013-2016 regarding minimum quality standards in drug demand reduction in the European Union*, doc. DS 10371/1/15 REV 1 (http://data.consilium.europa.eu/doc/document/ST-11985-2015-INIT/en/pdf).
- European Centre for Disease Prevention and Control (ECDC) (2015), *Understanding the impact of smartphone applications on STI/HIV prevention among men who have sex with men in the EU/EEA*, ECDC, Stockholm.
- EMCDDA (European Monitoring Centre for Drugs and Drug Addiction) (2009), *Internet-based drug treatment interventions: best practice and applications in EU Member States*, 10th ed. Publications Office of the European Union, Luxembourg.
- EMCDDA (2014), *Perspective on drugs: internet-based drug treatment*, Publications Office of the European Union, Luxembourg (available at http://www.emcdda.europa.eu/system/files/publications/2742/att_228235_EN_POD2014_Internet-based%20treatment.pdf).
- European Commission (2012), *e-health Action Plan 2012-2020: innovative healthcare for the 21st century*, European Commission, Brussels (available at https://ec.europa.eu/health/sites/health/files/ehealth/docs/com_2012_736_en.pdf).
- European Commission (2016), *Questions and answers — data protection reform package*, European Commission, Brussels (available at http://europa.eu/rapid/press-release_MEMO-17-1441_en.htm).
- Eurostat (2017), *Digital economy and society statistics — households and individuals*, Eurostat, Luxembourg (available at https://ec.europa.eu/eurostat/statistics-explained/index.php/Digital_economy_and_society_statistics_-_households_and_individuals).
- Fjeldsoe, B. S., Marshall, A. L. and Miller, Y. D. (2009), 'Behavior change interventions delivered by mobile telephone short-message service', *American Journal of Preventive Medicine* 36(2), pp. 165-173 (available at http://www.ncbi.nlm.nih.gov/pubmed/19135907).
- Fowler, L. A., Holt, S. L. and Joshi, D. (2016), 'Mobile technology-based interventions for adult users of alcohol: a systematic review of the literature', *Addictive Behaviors* 62, pp. 25-34 (available at https://www.sciencedirect.com/science/article/abs/pii/S0306460316302131).

- Gainsbury, S. and Blaszczynski, A. (2011), 'A systematic review of internet-based therapy for the treatment of addictions', *Clinical Psychology Review* 31(3), pp. 490-498 (available at http://www.ncbi.nlm.nih.gov/pubmed/21146272).
- Gajecki, M., Berman, A. H., Sinadinovic, K., Rosendahl, I. and Andersson, C. (2014), 'Mobile phone brief intervention applications for risky alcohol use among university students: a randomized controlled study', *Addiction Science & Clinical Practice* 9(1), p. 11 (available at http://www.ncbi.nlm.nih.gov/pubmed/24985342).
- Gonzalez, V. M. and Dulin, P. L. (2015), 'Comparison of a smartphone app for alcohol use disorders with an internet-based intervention plus bibliotherapy: a pilot study', *Journal of Consulting and Clinical Psychology* 83(2), pp. 335-345 (available at http://www.ncbi.nlm.nih.gov/pubmed/25622202).
- Gustafson, D. H., McTavish, F. M., Chih, M.-Y., Atwood, A. K., Johnson, R. A., Boyle, M. G., Levy, M. S., et al. (2014), 'A smartphone application to support recovery from alcoholism', *JAMA Psychiatry* 71(5), p. 566 (available at http://www.ncbi.nlm.nih.gov/pubmed/24671165).
- Hoch, E., Preuss, U. W., Ferri, M. and Simon, R. (2016), 'Digital interventions for problematic cannabis users in non-clinical settings: findings from a systematic review and meta-analysis', *European Addiction Research* 22(5), pp. 233-242 (available at https://www.karger.com/Article/FullText/445716).
- Kazemi, D. M., Borsari, B., Levine, M. J., Li, S., Lamberson, K. A. and Matta, L. A. (2017), 'A systematic review of the mHealth interventions to prevent alcohol and substance abuse', *Journal of Health Communication* 22(5), pp. 413-432 (available at http://www.ncbi.nlm.nih.gov/pubmed/28394729).
- Keoleian, V., Polcin, D. and Galloway, G. P. (2015), 'Text messaging for addiction: a review', *Journal of Psychoactive Drugs* 47(2), pp. 158-176 (available at http://www.ncbi.nlm.nih.gov/pubmed/25950596).
- Litvin, E. B., Abrantes, A. M. and Brown, R. A. (2013), 'Computer and mobile technology-based interventions for substance use disorders: an organizing framework', *Addictive Behaviors* 38(3), pp. 1747-1756 (available at http://www.ncbi.nlm.nih.gov/pubmed/23254225).
- Nahum-Shani, I., Smith, S. N., Spring, B. J., Collins, L. M., Witkiewitz, K., Tewari, A. and Murphy, S. A. (2016), 'Just-in-time adaptive interventions (JITAIs) in mobile health: key components and design principles for ongoing health behavior support', *Annals of Behavioral Medicine* 52(6), pp. 446-462 (available at http://www.ncbi.nlm.nih.gov/pubmed/27663578).
- Norman, G. J., Zabinski, M. F., Adams, M. A., Rosenberg, D. E., Yaroch, A. L. and Atienza, A. A. (2007), 'A review of eHealth interventions for physical activity and dietary behavior change', *American Journal of Preventive Medicine* 33(4), pp. 336-345 (available at http://www.ncbi.nlm.nih.gov/pubmed/17888860).
- Pagliari, C., Sloan, D., Gregor, P., Sullivan, F., Detmer, D., Kahan, J. P., Oortwijn, W. and MacGillivray, S. (2005), 'What is eHealth (4): a scoping exercise to map the field', *Journal of Medical Internet Research* 7(1), e9 (available at http://www.ncbi.nlm.nih.gov/pubmed/15829481).
- Patrick, K., Griswold, W. G., Raab, F. and Intille, S. S. (2008), 'Health and the mobile phone', *American Journal of Preventive Medicine* 35(2), pp. 177-181 (available at http://www.ncbi.nlm.nih.gov/pubmed/18550322).
- Pisani, A. R., Wyman, P. A., Mohr, D. C., Perrino, T., Gallo, C., Villamar, J., Kendziora, K., et al. (2016), 'Human subjects protection and technology in prevention science: selected opportunities and challenges', *Prevention Science* 17(6), pp. 765-778 (available at http://link.springer.com/10.1007/s11121-016-0664-1).
- Quaglio, G. L. and Esposito, G. (2017), *Technological innovation strategies in substance use disorders*. Science and Technology Option Assessment, Brussels.
- Satre, D. D., Ly, K., Wamsley, M., Curtis, A., and Satterfield, J. (2017), 'A digital tool to promote alcohol and drug use screening, brief intervention, and referral to treatment skill translation: a mobile app development and randomized controlled trial protocol', *JMIR Research Protocols* 6(4), e55 (available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5413801/).

Savic, M., Best, D., Rodda, S. and Lubman, D. I. (2013), 'Exploring the focus and experiences of smartphone applications for addiction recovery', *Journal of Addictive Diseases* 32(3), pp. 310-319 (available at http://www.ncbi.nlm.nih.gov/pubmed/24074196).

Schaub, M. P., Wenger, A., Bachmann, A., Stark, L. and Haug, S. (2014), 'Qualitätsentwicklung in der internetgestützten suchthilfe am beispiel des Schweizer suchtportals Safe Zone', *Suchtmedizin in Forschung Und Praxis* 16(4), pp. 187-193.

Tossmann, H.P. , Jonas, B., Tensil, M.D. , Lang, P. and Strüber, E. (2011), 'A controlled trial of an internet-based intervention program for cannabis users', *Cyberpsychology, Behavior, and Social Networking* 14(11), pp. 673-679.

Whittaker, R., McRobbie, H., Bullen, C., Rodgers, A. and Gu, Y. (2016), 'Mobile phone-based interventions for smoking cessation', *Cochrane Database of Systematic Reviews* 4, CD006611 (available at http://www.ncbi.nlm.nih.gov/pubmed/27060875).

Witkiewitz, K., Desai, S. A., Bowen, S., Leigh, B. C., Kirouac, M. and Larimer, M. E. (2014), 'Development and evaluation of a mobile intervention for heavy drinking and smoking among college students', *Psychology of Addictive Behaviors* 28(3), pp. 639-650 (available at http://www.ncbi.nlm.nih.gov/pubmed/25000269).

World Health Organization (WHO) (2011), *m-health: new horizons for health through mobile technologies: second global survey on e-health*, WHO, Geneva (available at http://apps.who.int/iris/handle/10665/44607).

TD-AU-18-003-EN-N

Acknowledgements

Authors: Michael P. Schaub, Jenny Yi-Chen Lee and Alessandro Pirona.

The authors would like to thank the following for their collaboration Gianluca Quaglio and Eva Hoch (external reviewers), Nicola Singleton, Inês Hasselberg, Zili Sloboda, João Matias, Marica Ferri, André Noor and Jane Mounteney.

About the EMCDDA

The European Monitoring Centre for Drugs and Drug Addiction is the hub of drug-related information in Europe. Its mission is to provide the European Union and its Member Stateswith 'factual, objective, reliable and comparable information' on drugs and drug addiction and their consequences. Established in 1993, it opened its doors in Lisbon in 1995, and is one of the European Union's decentralised agencies. The Centre offers policymakers the evidence base they need for drawing up drug laws and strategies. It also helps professionals and researchers pinpoint best practice and new areas for analysis.

Related publications

Internet-based drug treatment interventions, 2009

Perspective on drugs: internet-based drug treatment, 2014

These and all other EMCDDA publications are available from www.emcdda.europa.eu/publications

Luxembourg: Publications Office of the European Union

PDF doi:10.2810/379921 | ISBN 978-92-9497-368-9

This publication is only available in electronic format.

EMCDDA, Praça Europa 1, Cais do Sodré, 1249-289 Lisbon, Portugal
Tel. (351) 211 21 02 00 | info@emcdda.europa.eu
emcdda.europa.eu | twitter.com/emcdda | facebook.com/emcdda

Publications Office