A systematic review to determine the existence, composition and quality of publically available smartphone apps about crystal methamphetamine (‘ice’)

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Abstract

**Background:** Amid considerable community concern about prevalence and harms associated with crystal methamphetamine use, increased use of smartphones to access health information and a growing number of available smartphone applications (‘apps’) related to crystal methamphetamine (ice), no previous reviews have examined content and quality of these apps.

**Objective:** This present study aimed to systematically review existing apps in the iTunes and Google Play Stores to determine the existence, composition and quality of educational smartphone apps about methamphetamines, including ice.

**Methods:** The iTunes and Google Play Stores were systematically searched in April 2017 for iOS Apple and Android apps, respectively. English-language apps that provided educational content or information about methamphetamine were eligible for inclusion. Eligible apps were downloaded and independently evaluated for quality by two reviewers using the Mobile Application Rating Scale (MARS).

**Results:** A total of 2205 apps were initially identified, of which 18 were eligible and rated using the MARS. The mean MARS quality total score for all rated apps was 3.0 (SD = 0.6) indicating poor to acceptable quality. Overall mean scores were highest for functionality ($\bar{x} = 4.0; SD=0.5$) and lowest for engagement ($\bar{x} = 2.3, SD=0.7$).
**Conclusions:** The present study demonstrated a shortage of high-quality educational and engaging smartphone apps specifically related to methamphetamine. The findings from this review highlight a need for further development of engaging and evidence-based apps that provide educational information about crystal methamphetamine.

**Keywords:** mobile applications, review, methamphetamine, substance-related disorder, internet
Introduction

In recent years there has been significant concern about the use of crystal methamphetamine, or “ice”, and the considerable harms associated with its use for both individuals, their loved ones and communities. According to the latest National Drug Strategy Household Survey [1] approximately 1.4% of the Australian population (aged 14 or over) reported past year use of methamphetamine (including ice) in 2016. Whilst these data indicate that rates of methamphetamine use in the general population have remained fairly stable over the last decade, data from several sources suggest that there have been significant changes in patterns of use and harmful use. These include increases in the number of regular users who report using crystal methamphetamine (ice), as opposed to powder (speed) as their main form of methamphetamine [1, 2], increases in the number of regular and dependent users [3] and an increase in the number of harms associated with use [4, 5]. Data from several sources suggest that rates of crystal methamphetamine use in regional and rural areas of Australia are of particular concern [1, 6, 7] and in 2016, 40% of Australians rated ice as the drug of most concern, compared to 16% in 2013 [1]. Whilst these data focus on Australian statistics, international data also indicate increasing use and harms associated from methamphetamines. Methamphetamines now account for 11% of overdose deaths in the United States [8] and market analyses in a number of parts of the globe indicating increased use of methamphetamines (including ice) in recent years [9].
A key component of addressing community concern around illicit drugs including ice, and preventing use and related harms, is the provision of accurate and evidence-based information, resources and support. The use of the Internet, smartphone applications (‘apps’) and mobile technology is a key means of disseminating public health information to the community, and facilitating broad reach and engagement. Smartphone devices are now widely used, with 64% of the US and 74% of the Australian population owning a device in 2015-16 [10, 11], and 62% of smartphone owners reporting that they used their phone to access health-related information in the past year [10]. Like Internet-based interventions, smartphone apps offer numerous advantages in terms of addressing public health issues [12, 13], such as increased accessibility, portability of information, low-costs, anonymity, and the ability to provide tailored feedback and support.

Over the past decade there has been a dramatic increase in the number of smartphone apps designed to address health-related issues [14], with more than 165,000 health applications available for download in 2015 [15]. Systematic reviews of smartphone apps have been conducted in a range of health domains including depression [16], anxiety [17], bipolar disorder [18], smoking cessation [19, 20], nutrition [21], diabetes management [22], suicide prevention [23], health information-seeking for cancer [24] and psychology or general mental health [25-27]. The majority of these reviews focuses on quality and content of apps and conclude that existing apps vary in quality, with few grounded in scientific evidence. Nonetheless, the results from these reviews provide useful
information about the features and functionality of high quality apps and an increased understanding of community information and support needs. Thus, they serve to guide future app development, as well as future research.

When looking at the substance use field, systematic reviews and content analysis of available apps that specifically target illicit drug use are sparse. We identified several reviews of apps that target alcohol use and related behaviours e.g. [28-30], or addiction and addictive behaviours in general [31]. We found one review that specifically reviewed apps that promote illicit drug use [32], and one review that analysed illicit drug overdose apps [33]. We identified two systematic reviews of online and mobile interventions targeting problematic substance use [12, 13], both of which reviewed published intervention studies rather than available apps per se. We were unable to identify an existing systematic review of publicly available apps targeting either illicit drug use in general or crystal methamphetamine specifically. This is despite the fact that a significant number of apps related to crystal methamphetamine exist, and amid increasing community concern about ice use and related harms.

Therefore, the present study aimed to systematically review existing apps in the iTunes and Google Play Stores to determine the existence, composition and quality of educational smartphone apps about methamphetamines, including ice. It was anticipated that the results from this review will inform future development and research in this area.

**Methods**
**Search Strategy**

Adopting similar methodology to that used in previous reviews of smartphone apps [20, 23], the Australian Google Play store for Android phone apps, and Australian iOS iTunes store for Apple iPhone apps were searched in April 2017. A comprehensive list of keywords, including common street names for crystal methamphetamine, were used including; ‘crystal methamphetamine’, ‘methamphetamine’, ‘crystal meth’, ‘ice drug’, ‘meth’, ‘shabu’, ‘tina’, ‘glass’, ‘illegal drugs’ and ‘illicit drugs’. Given the changes in app availability that occurs day-to-day, all searches were undertaken on the same day.

**Eligibility Criteria and App Selection**

Free and paid apps containing educational or information-based content related to methamphetamines, including “ice”, were included if they could be downloaded via the official Android and iOS stores. Apps were excluded if they were in a language other than English, if their content did not relate to crystal methamphetamine at all, if they did not include educational content about methamphetamine (e.g. gaming apps, apps promoting drug use), or they were an audiobook (i.e. voice recordings). After removing duplicate apps, initial screening of the titles and descriptions of identified apps was conducted by one author (KC) using the above eligibility criteria to identify potentially relevant apps. Potentially eligible apps were then downloaded onto their respective devices (iPhone or Android) and independently assessed by two reviewers (LB and HD) to confirm eligibility.
App Classification and Quality Rating Tool

App quality was evaluated using the Mobile Application Rating Scale (MARS) [34]. Increasingly used in the mobile health field e.g [20, 35], the MARS is designed to collect descriptive and technical information about the app (App Classification) and assess the quality of the app (App Quality Ratings). App classification information includes name, brief description, version, developer, costs, platform, focus of the app, theoretic background, affiliations (commercial, government, non-government organisation, or university), target age group and technical aspects (e.g. ability to send reminders or share on social media). A 23-item Quality Rating scale assesses app quality across five dimensions: engagement (interactivity and interest; 5-items), functionality (ease of use and navigation; 4-items), aesthetics (layout, graphics and visual appeal; 3-items), information quality (accuracy, evidence base, credibility; 7-items) and subjective quality (likelihood to use and recommend, 4-items). Responses are made on a five-point scale (1=‘inadequate’) to (5=‘excellent’), with mean scores calculated for each dimension. An overall mean quality rating score is calculated by combining the mean scores for the first four subscales, excluding subjective quality. The mean of the subjective quality items is also calculated to produce a separate subjective quality total score.

A total of 18 eligible apps were rated independently by two assessors (LB and HD) according to the MARS. Both assessors watched an online training video provided by the scale’s developers. Prior to rating the apps,
assessors engaged with each app for at least 10 minutes. There was high inter-rater agreement between the assessors (Intraclass correlation coefficient = 0.904), indicating strong agreement between raters.

**Results**

Figure 1 displays a PRISMA flow chart of the full search strategy and app selection process. A total of 2205 apps were identified through the iTunes and Google Play Stores. Of these, 223 were duplicate apps and 1953 were ineligible [not about crystal methamphetamine (n=1919); about crystal methamphetamine, but not educational (n=23); not in English (n=11). A total of 30 potentially relevant apps were downloaded for further screening, and 18 apps were selected for final data extraction and quality ratings.
App Classification

Table 1 presents descriptive information about each of the 18 included apps. Just over half of the apps (n=10/18, 56%), were designed to be used on an iPhone or iPad with just under half designed for use on the Android platform (n=8/18, 44%). The majority of apps were freely available for download, while six apps (n=6/18, 33%) required payment before download, with costs ranging from $1.49 - $42.99 per app. The majority of apps were affiliated with a commercial organisation (n=10/18, 56%), while three (n=3/18, 17%) were affiliated with a university or government department, and one app was affiliated with a non-government organisation. The affiliations of four apps (n=4/18, 22%) were unable to be determined due to insufficient information provided by the app developers.

Whilst all rated apps included information on methamphetamines (including ice), the majority (n=15/18, 83%) also included content about other drugs, with only three apps exclusively focused on crystal
methamphetamine. The most common app feature was the provision of factual information and educational materials (n=17/18, 94%), followed by offering advice, tips, strategies or skills training (n=6/18, 33%), assessment of drug use (n=2/18, 11%), feedback on drug use (n=2/18, 11%), monitoring and tracking (n=2/18, 11%) and goal setting (n=1/18, 5%). None of the identified apps explicitly mentioned a specific theoretical background or utilised evidence-based theory. In terms of technical requirements, one app (Street Drugs Organisation) explicitly stated that it needed internet access to function, another reported using automatic sensing (e.g. GPS) which only functioned in the US (Drug Sign) and one app required a password to log in (ASSIST app). Nearly all apps (n=17/18, 94%) were targeted to the general population, however one app (Pure Rush) was specifically designed for use by young people aged 12-25 years.
Table 1. Classification and content of included Apps.

<table>
<thead>
<tr>
<th>App name</th>
<th>Platform</th>
<th>Cost</th>
<th>Focus: What the app targets</th>
<th>Theoretic Background / Strategies</th>
<th>Affiliations</th>
<th>Target age groups</th>
<th>Technical Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol + Drugs e-Learning Pro</td>
<td>Android</td>
<td>$3.15</td>
<td>Methamphetamine (including ice), Other drugs</td>
<td>Information / Education</td>
<td>Commercial</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>ASSIST App</td>
<td>iPhone</td>
<td>Free</td>
<td>Methamphetamine (including ice), Other drugs</td>
<td>Assessment; Feedback; Information / Education; Monitoring/ Tracking; Advice/ Tips/ Strategies/ Skills training</td>
<td>Government University</td>
<td>General</td>
<td>Allows password protection Requires login</td>
</tr>
<tr>
<td>Drug Addiction</td>
<td>Android</td>
<td>Free</td>
<td>Methamphetamine (including ice), Other drugs</td>
<td>Information / Education</td>
<td>Unknown</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Drug Addiction - How to Stop Your Dependence on Drugs</td>
<td>iPhone</td>
<td>$1.49</td>
<td>Methamphetamine (including ice), Other drugs</td>
<td>Information / Education</td>
<td>Commercial</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Drug Addiction: Drugs Handbook</td>
<td>iPhone</td>
<td>Free</td>
<td>Methamphetamine (including ice), Other drugs</td>
<td>Information / Education</td>
<td>Unknown</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Drug Detection App</td>
<td>iPhone</td>
<td>Free</td>
<td>Methamphetamine (including ice), Other drugs</td>
<td>Information / Education</td>
<td>Commercial</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Drug Detection App – Family and Home</td>
<td>iPhone</td>
<td>$5.99</td>
<td>Methamphetamine (including ice), Other drugs</td>
<td>Information / Education</td>
<td>Commercial</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Drug Effects Guide &amp; Quiz Game</td>
<td>Android</td>
<td>Free</td>
<td>Methamphetamine (including ice), Other drugs</td>
<td>Information / Education</td>
<td>Unknown</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Drug Sign</td>
<td>iPhone</td>
<td>$42.99</td>
<td>Methamphetamine (including ice), Other drugs</td>
<td>Assessment; Information / Education; Advice/ Tips/ Strategies/</td>
<td>Commercial</td>
<td>General</td>
<td>Uses automatic sensing (e.g. GPS)</td>
</tr>
<tr>
<td>App name</td>
<td>Platform</td>
<td>Cost</td>
<td>Focus: What the app targets</td>
<td>Theoretic Background / Strategies</td>
<td>Affiliations</td>
<td>Target age groups</td>
<td>Technical Aspects</td>
</tr>
<tr>
<td>----------------------------------------------</td>
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<td>---------------------------------------------------------------------------------------------</td>
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<td>-------------------</td>
</tr>
<tr>
<td>Emergency Responder</td>
<td>Android</td>
<td>$2.43</td>
<td>Methamphetamines (including ice)</td>
<td>Information / Education; Advice/ Tips/ Strategies/ Skills training</td>
<td>Commercial</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Ice Your Body Belongs to You</td>
<td>iPhone</td>
<td>Free</td>
<td>Methamphetamines (including ice)</td>
<td>Information / Education</td>
<td>Commercial</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Meth Ice (methamphetamine)</td>
<td>Android</td>
<td>Free</td>
<td>Methamphetamines (including ice)</td>
<td>Information / Education</td>
<td>Unknown</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Meth Streetdrugs.org</td>
<td>Android</td>
<td>$2.54</td>
<td>Methamphetamines (including ice)</td>
<td>Information/ Education</td>
<td>Commercial</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>National Drugs Campaign</td>
<td>iPhone</td>
<td>Free</td>
<td>Methamphetamines (including ice), Other drugs</td>
<td>Information / Education</td>
<td>Government</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Overdose Aware</td>
<td>iPhone</td>
<td>Free</td>
<td>Methamphetamines (including ice), Other drugs</td>
<td>Information / Education</td>
<td>NGO</td>
<td>General</td>
<td>None listed</td>
</tr>
<tr>
<td>Pure Rush</td>
<td>Android</td>
<td>Free</td>
<td>Methamphetamines (including ice), Other drugs</td>
<td>Information / Education</td>
<td>Government University</td>
<td>14yrs +</td>
<td>None listed</td>
</tr>
<tr>
<td>Street Drugs Organisation</td>
<td>Android</td>
<td>Free</td>
<td>Methamphetamines (including ice), Other drugs</td>
<td>Information / Education</td>
<td>Commercial</td>
<td>General</td>
<td>Needs web access to function</td>
</tr>
<tr>
<td>Triggr Health - Support for Reducing Drinking/ Using</td>
<td>iPhone</td>
<td>Free</td>
<td>Methamphetamines (including ice), Other drugs</td>
<td>Feedback; Monitoring/ Tracking; Goal Setting Advice/ Tips/ Strategies/ Skills training</td>
<td>Commercial</td>
<td>General</td>
<td>None listed</td>
</tr>
</tbody>
</table>

**App Quality Ratings**

Table 2 presents mean subscale scores and overall mean quality ratings on the MARS for each included app. Figure 2 presents overall mean scores on the MARS subscales for included apps. The mean MARS quality total
score for all rated apps was 3.0 (SD = 0.6) indicating poor to acceptable quality. A cut off of 3.0 has been established as a minimum acceptability score [34] and nearly half (n=8, 44%) of the rated apps failed to meet this threshold. Only two apps (Pure Rush and TriggerHealth) achieved an overall quality score greater than 4, indicating they were of good quality. Similarly, the mean subjective quality total was poor at 1.8 (SD=0.8). No apps received a rating of 4 or more on both overall quality and subjective quality, indicating there were no apps of overall good or excellent quality when both scales were considered together.

When examining the mean MARS subscale scores for included apps we observed considerable variability in mean ratings of engagement, functionality, aesthetics and information quality. Overall mean scores were highest for functionality ($\bar{x} = 4.0; SD=0.5$) with 44% of apps (n=8/18) achieving a score of 4 or more indicating good functionality. Mean scores were lowest for engagement ($\bar{x} = 2.3, SD=0.7$), with only one app scoring 3 or more and none scoring 4 or more. Mean scores for aesthetics were also poor with only two apps scoring 4 or more, indicating a rating of good. Whilst the overall mean score for information quality was low for included apps ($\bar{x} = 2.8, SD=0.8$), there was considerable variability across apps, with two apps scoring less than 2 and three scoring 4 or more.

Table 2. MARS ratings.
<table>
<thead>
<tr>
<th>App name</th>
<th>Engagement</th>
<th>Functionality</th>
<th>Aesthetics</th>
<th>Information</th>
<th>Overall Quality Total</th>
<th>Subjective Quality Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol + Drugs e-Learning Pro</td>
<td>3.5</td>
<td>4.1</td>
<td>3.5</td>
<td>3.6</td>
<td>3.7</td>
<td>2.1</td>
</tr>
<tr>
<td>ASSIST App</td>
<td>2.3</td>
<td>3.5</td>
<td>2.3</td>
<td>4.0</td>
<td>3.0</td>
<td>2.1</td>
</tr>
<tr>
<td>Drug Addiction</td>
<td>1.6</td>
<td>4.1</td>
<td>2.0</td>
<td>1.8</td>
<td>2.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Drug Addiction - How to Stop Your Dependence on Drugs</td>
<td>2.3</td>
<td>4.4</td>
<td>2.2</td>
<td>1.8</td>
<td>2.7</td>
<td>1.3</td>
</tr>
<tr>
<td>Drug Addiction: Drugs Handbook</td>
<td>1.3</td>
<td>4.3</td>
<td>1.3</td>
<td>2.0</td>
<td>2.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Drug Detection App</td>
<td>2.0</td>
<td>3.4</td>
<td>3.0</td>
<td>3.2</td>
<td>2.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Drug Detection App – Family and Home</td>
<td>2.0</td>
<td>3.9</td>
<td>3.0</td>
<td>3.2</td>
<td>3.0</td>
<td>2.1</td>
</tr>
<tr>
<td>Drug Effects Guide &amp; Quiz Game</td>
<td>2.6</td>
<td>2.9</td>
<td>2.8</td>
<td>1.4</td>
<td>2.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Drug Sign</td>
<td>2.1</td>
<td>3.5</td>
<td>3.7</td>
<td>2.7</td>
<td>3.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Emergency Responder</td>
<td>2.0</td>
<td>4.0</td>
<td>2.7</td>
<td>3.2</td>
<td>3.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Ice Your Body Belongs to You</td>
<td>2.9</td>
<td>4.0</td>
<td>3.0</td>
<td>2.8</td>
<td>3.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Meth Ice (methamphetamine)</td>
<td>1.8</td>
<td>4.3</td>
<td>2.3</td>
<td>2.2</td>
<td>2.6</td>
<td>1.3</td>
</tr>
<tr>
<td>Meth Streetdrugs.org</td>
<td>1.8</td>
<td>4.4</td>
<td>2.3</td>
<td>2.1</td>
<td>2.6</td>
<td>1.5</td>
</tr>
<tr>
<td>National Drugs Campaign</td>
<td>1.8</td>
<td>3.5</td>
<td>1.8</td>
<td>4.1</td>
<td>2.8</td>
<td>2.1</td>
</tr>
<tr>
<td>Overdose Aware</td>
<td>2.2</td>
<td>4.5</td>
<td>3.5</td>
<td>4.0</td>
<td>3.6</td>
<td>2.9</td>
</tr>
<tr>
<td>Pure Rush</td>
<td>3.6</td>
<td>4.6</td>
<td>5.0</td>
<td>3.8</td>
<td>4.2</td>
<td>3</td>
</tr>
<tr>
<td>Street Drugs Organisation</td>
<td>2.1</td>
<td>4.3</td>
<td>3.0</td>
<td>2.7</td>
<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Triggr Health - Support for Reducing Drinking/Using</td>
<td>4.0</td>
<td>4.8</td>
<td>4.5</td>
<td>2.9</td>
<td>4.0</td>
<td>3.6</td>
</tr>
</tbody>
</table>
Features of the top ranked apps

While no apps were identified as ‘high-quality’, two apps achieved a good overall quality rating, with acceptable subjective quality ratings (TriggrHealth – Support for Reducing Drinking/Using and Pure Rush). TriggrHealth is a commercial app developed by the US company TriggrHealth (see Figure 3). The app targets addiction recovery and is focused on reducing substance dependence for a range of drugs including crystal methamphetamine. The app connects the user to a real-time behavioural change ‘guide’ named Taylor who interacts with the user to set personalised goals and recovery plans. It also utilises predictive machine learning algorithms to identify smartphone use patterns and ‘check in’ with users about their goals and recent activity. To date no
efficacy or effectiveness data exists to indicate that the TriggrHealth app can prevent or reduce crystal methamphetamine use and harms.

Figure 3. Screenshots of TriggrHealth App.

Pure Rush is a serious educational game [36] for young people including information about cannabis, hallucinogens, crystal methamphetamine and MDMA/Ecstasy (see Figure 4). Within the app users select a character and navigate through a music festival, with the goal of the game to avoid ‘running into’ drugs. The app provides educational information about the negative effects of different drugs in an engaging manner. Pure Rush has been evaluated in one published peer-reviewed study [37], in which 281 young people (aged 13-16 years) were randomly allocated to receive a
lesson involving Pure Rush or to an active control lesson. This evaluation found that the app was enjoyable to use, with both conditions associated with a significant increase in drug knowledge from pre- to post-test. There was some evidence that females who received Pure Rush showed greater knowledge gains compared to those in the control. While this evaluation is promising, it focused on overall illicit drug knowledge, and its effects on drug usage and specifically, crystal methamphetamine, is not known. Further, it should be noted that the app was designed to be implemented alongside a companion booklet which provides additional information (normative education, assertiveness skills, addressing common misperceptions), rather than as a standalone educational tool [37].

Figure 4. Screenshots of Pure Rush App.
Other than for functionality, very few apps achieved ratings of good on any of the MARS subscales (information quality, engagement, aesthetics). Three apps achieved ratings of good on the information quality subscale. These were the ASSIST app, the National Drugs Campaign app and Overdose Aware app. Both the ASSIST and the National Drugs Campaign apps are affiliated with a university or government department, and Overdose Aware is affiliated with a non-government organisation. The ASSIST app was developed by the University of Adelaide and provides information, self-assessment and links to support services for a range of drugs including amphetamines. Information covers the physical and mental effects of different drugs, harm reduction information and links to relevant support services. The information provided is of high quality, but focused on a wide range of drugs and amphetamines as a broad class of drugs. The National Drugs Campaign app is a companion app to the Australian Government National Drugs Campaign website. It provides information about a range of drugs, including crystal methamphetamine, and links to external support sites. Overdose Aware was developed by the Pennington Institute and targets overdose education, including information about what an overdose is and recognising overdose symptoms. It focuses on four classes of drugs; stimulants, depressants, opioids and alcohol. None of these apps achieved a score of acceptable or above for engagement.

**Discussion**

**Principal Results**
The present study aimed to systematically review existing apps to determine the existence, composition and quality of educational smartphone apps about methamphetamines, including ice. We used the MARS to identify descriptive features and content of the apps and to systematically rate quality in terms of engagement, functionality, aesthetics, and quality of information. We examined app store descriptions for 1983 apps, downloaded and assessed 30 apps for eligibility and rated 18 for content and quality. Only three identified apps focused exclusively on crystal methamphetamine with the majority focusing on illicit drugs in general. The majority of apps reviewed focused on providing information or education, one third provided advice, tips, strategies or skills training, with few offering other features such as self-assessment of drug use, feedback, monitoring and tracking of drug use. Whilst functionality was rated as acceptable to good on the majority of apps, overall quality was low, with only two apps achieving a rating of good on overall objective quality and acceptable on subjective quality according to the MARS. Ratings of information quality varied considerably with only three apps achieving a rating of good in this domain, despite 94% of apps aiming to provide accurate information and education.

**Comparison with Prior Work**

Several findings warrant further comment. It is of note that of the apps that achieved either an overall rating of good (n=2), or a rating of good in terms of information quality (n=3), only one carried a commercial affiliation (TriggrHealth). The remainder were affiliated with either a
university or government department (Pure Rush, ASSIST app, National Drugs Campaign), or an NGO (Overdose Aware). Previous reviews have noted that the involvement of health professionals or other experts in health-related app development is often lacking or difficult to assess [29, 33]. It is likely that this has contributed to low quality particularly in terms of the evidence-base of the apps and points to the need to involve experts in development of good quality apps in this area. It also highlights the need to clearly identify affiliations and/or the evidence-base used in the development of apps so that consumers can make informed choices [33]. Reviewers of apps in the substance use field have suggested clearer guidelines for the public [25], more stringent regulations [32], or more visible means of identifying quality apps [33] to improve consumer choice.

In the process of conducting the present review over 1900 irrelevant apps were identified in the searches. This has significant implications for people who are genuinely seeking help or information about crystal methamphetamine or other drugs and underscores the need for both better quality apps on the market and better ways of guiding consumer choice about these apps.

Even within the context of crystal methamphetamine apps that do provide high quality and evidence-based information, the lack of interactive and engaging features represents a significant lost opportunity for reach and impact [31]. Only three apps offered interactive features such as monitoring, tracking or goal-setting. A previous review of smartphone apps to manage alcohol use, found that features such as tracking and
tailoring were significantly associated with app popularity (in terms of downloads) and user-rated quality [30], providing support for the inclusion of these features in future app development. One of the challenges in development is that whilst government or university developed apps may be more likely to be based on evidence, and involve health professional and other expert input, they are often competing with higher budget apps in the commercial space [30]. In the current review, TriggrHealth was the only app to achieve a score of good in terms of engagement, and this was also the only commercial app to achieve an overall quality rating above acceptable. It did however, achieve its lowest rating in the area of information quality, further highlighting the need to balance credibility and accuracy of information with highly specialised technical features and interactivity.

A final point worthy of discussion is the large number of entertainment-based apps about crystal methamphetamine that were identified in the initial searches of the app Stores. For example, there were several apps capitalizing on the popularity of the television show, Breaking Bad, in which the central character manufactures and deals crystal methamphetamine. Although some of the available apps were seemingly harmless, e.g. trivia about the episodes, downloadable artworks and ringtones, others included game functionality where users could virtually cook methamphetamine or search for methamphetamine crystals. These latter apps highlight the influence of the media and popular culture on commercial app development as a potential public health concern,
especially for young people or vulnerable groups. Gaming technology does hold great potential for app development, especially for apps related to addiction and other health issues [31, 37], however it is critical that app developers achieve the right balance between gamification, evidence and quality of information.

**Limitations**

There are several limitations to the current review that warrant discussion. Firstly, the app market is a highly dynamic one. Availability of apps changes regularly and this review can only offer a snapshot at one particular point in time. Whilst this is a methodological challenge inherent in any study of this kind, it does limit the scope of the review. Within this context, it should be noted that app stores do allow publishers to restrict distributions to particular countries. Whilst a previous systematic review of suicide apps available in Australia found 100% concordance between available apps across iOS app stores in a number of countries [23], the present review focused on apps available for download in Australia. Secondly, whilst this review focused on systematically rating the content and quality of apps, it does not provide information about the effectiveness of the apps in promoting accurate messages about crystal methamphetamine, or preventing or reducing use and harms. Whilst one of the apps reviewed had been subject to a randomised controlled trial [37], rigorous evaluations of app effectiveness in the illicit substance use field are rare [12, 13]. Whilst scientific evaluation of the effectiveness of apps is important, the speed with which the app market and the
technology on which it is based changes rapidly, and the length of time needed to conduct and publish randomised controlled trials presents a considerable challenge to researchers [12]. Some reviewers have suggested it might be useful for the mHealth field more broadly to focus on more pragmatic and less traditional modes of evaluation to assess the effectiveness of apps and other mHealth interventions to enable the field to build the evidence-base more quickly [20, 25].

Conclusions

Crystal methamphetamine is a high impact drug that is associated with considerable harms and high levels of community concern. Importantly, the majority of people using crystal methamphetamine do not want to engage with traditional treatment or support services for fear of stigma and concerns about relevance [38]. This makes the increasing availability of app-based information and support for crystal methamphetamine (and other substances) critically important. This study was the first to systematically review the quality of available apps focusing on methamphetamine, including ‘ice’. Despite the fact that many available apps purport to be about crystal methamphetamine – most do not offer educational content. Of those that do, most have not been subject to rigorous evaluations, they vary in quality and despite having good functionality, few are likely to engage the public. Given the enormous potential of smartphone apps to promote positive and accurate public health messages and to prevent use and harms, this represents a significant opportunity for future development.
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Conflict of interest

CC, LS, NN and MT are four of developers of the Pure Rush app. They derive no financial interest from this program.

Abbreviations

MARS: Mobile Application Rating Scale
References


30. Hoeppner BB, Schick MR, Kelly LM, Hoeppner SS, Bergman B, Kellya JF. There is an app for that – Or is there? A content analysis


