



## Routes of administration for cannabis use – basic prevalence and related health outcomes: A scoping review and synthesis



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### ABSTRACT

**Background:** Cannabis use is common, and associated with adverse health outcomes. 'Routes of administration' (ROAs) for cannabis use have increasingly diversified, in part influenced by developments towards legalization. This paper sought to review data on prevalence and health outcomes associated with different ROAs.

**Methods:** This scoping review followed a structured approach. Electronic searches for English-language peer-reviewed publications were conducted in primary databases (i.e., MEDLINE, EMBASE, PsycINFO, Google Scholar) based on pertinent keywords. Studies were included if they contained information on prevalence and/or health outcomes related to cannabis use ROAs. Relevant data were screened, extracted and narratively summarized under distinct ROA categories.

**Results:** Overall, there is a paucity of rigorous and high-quality data on health outcomes from cannabis ROAs, especially in direct and quantifiable comparison. Most data exist on smoking combusted cannabis, which is associated with various adverse respiratory system outcomes (e.g., bronchitis, lung function). Vaporizing natural cannabis and ingesting edibles appear to reduce respiratory system problems, but may come with other risks (e.g., delayed impairment, use 'normalization'). Vaporizing cannabis concentrates can result in distinct acute risks (e.g., excessive impairment, injuries). Other ROAs are uncommon and under-researched.

**Conclusions:** ROAs appear to distinctly influence health outcomes from cannabis use, yet systematic data for comparative assessments are largely lacking; these evidence gaps require filling. Especially in emerging legalization regimes, ROAs should be subject to evidence-based regulation towards improved public health outcomes. Concretely, vaporizers and edibles may offer potential for reduced health risks, especially concerning respiratory problems. Adequate cannabis product regulation (e.g., purity, labeling, THC-restrictions) is required to complement ROA-based effects.

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## 1 Introduction

Cannabis is the most commonly used psychoactive drug globally. Current use rates in the general population typically range from 2–5% in different global regions, yet are highest (~10–13%) in North America; use is generally concentrated among adolescents and young adults (Azofeifa et al., 2016; Health Canada, 2014; United Nations Office on Drugs & Crime (UNODC),

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2015). Globally, there were an estimated 13 million cannabis-dependent individuals in 2010, with the highest prevalence among those aged 20–24 (Degenhardt, Ferrari, et al., 2013). While the overall population health burden from cannabis use is smaller than that from alcohol or tobacco (Degenhardt, Whiteford, et al., 2013), several health problems are well-documented to be associated with cannabis use, including acute cognitive and psycho-motor impairments and related injuries (e.g., motor-vehicle accidents [MVAs]), brain development and functioning, disorders/dependence and psychosis, pulmonary/bronchial system problems, and other potential long-term complications (National Academies of Sciences, Engineering & Medicine, 2017; Volkow, Baler, Compton, & Weiss, 2014; World Health Organization (WHO), 2016). Recent Canadian estimates suggest that the largest extent of cannabis-attributable disease burden is associated with cannabis dependence and MVAs, including sizeable mortality in the latter category (Fischer, Imtiaz, Rudzinski, & Rehm, 2016; Imtiaz et al., 2016).

While the iconic image of cannabis use has traditionally been smoking a joint, use practices have greatly diversified recently, as influenced by several developments, including emerging cannabis legalization regimes in select North American jurisdictions. For example, the range of cannabis products – including an ever-growing number of cannabis strains with different cannabinoid compositions and potencies – has vastly grown (Mehmedic et al., 2010; Office of National Drug Control Policy (ONDCP), 2009; World Health Organization (WHO), 2016). Simultaneously, substantial diversification in cannabis use practices or ‘routes of administration’ (ROAs) has occurred. Specifically, while the majority of cannabis products traditionally have been smoked (e.g., by a cannabis cigarette (joint), or a hash pipe), an increasingly varied range of ROA methods has evolved, including both inhalational (e.g., smoking and/or vaporizing) and non-inhalational (e.g., edible, other) use routes (Geshtakovska & Stefkov, 2016; Schauer, King, Bunnell, Promoff, & McAfee, 2016; Subritzky, Pettigrew, & Lenton, 2016). Hence, cannabis use practices have evolved into an increasingly heterogeneous phenomenon, similar to diversification of administration routes that have emerged for other psychoactive substances such as, for example, tobacco and cocaine (Gossop, Griffiths, Powis, & Strang, 1994; King, Dube, & Tynan, 2012).

While specific cannabis ROAs have been associated with direct health outcomes (e.g., smoking with pulmonary/respiratory problems), others have been designed and intended to reduce such health consequences (e.g., vaporizers) (Gieringer, 2001; Grotenhermen, 2001). Various studies exist on these different ROAs for cannabis use with relevant information on health outcomes, yet no comprehensive review has been completed. This exercise, however, is worthwhile and timely given the fundamental changes in cannabis control in several jurisdictions, most notably, implemented or proposed ‘cannabis legalization’ initiatives (e.g., in Uruguay, several US states and Canada) (Pardo, 2014; Room, 2014; Task Force on Cannabis Legalization & Regulation, 2016). In contexts of legalization, key aspects of cannabis use (e.g., products and ROAs) can be regulated for the benefit of public health objectives, due to its legal status. Thus, evidence-based knowledge on the health risks from different ROAs for cannabis use is increasingly relevant, as it would aid to inform related regulations and interventions, as well as educate users and policymakers in regards to ROAs as an important variable in cannabis use-related public health outcomes. In this context, we present a comprehensive scoping review of existent ROAs for cannabis use, including basic prevalence indicators, focusing on available data on related health outcomes, with the intended aim to compare – acute and chronic – health outcomes for different ROAs where possible.

## 2 Methods

The present scoping review on prevalence and health outcomes related to different cannabis ROAs followed a structured approach, and was based on electronic searches for peer-reviewed publications in relevant scientific databases (i.e., MEDLINE, EMBASE, PsycINFO, Google Scholar). The search strategy focusing on ROAs for cannabis included MeSH headings and keywords related to different forms of cannabis and cannabis products (e.g., cannabis, marijuana, hashish, cannabinoids), routes of administration (e.g., drug delivery systems, drug administration routes, mode/method of use, etc.), and specific related names or terms and variations thereof (e.g., joint, spliff, pipe, blunt, water-pipe, bong, vaporizer, edibles, etc.). The principal search strategy, including header, operating and command terms, was developed for MEDLINE, and is appended for illustration (Appendix A); this search strategy was revised accordingly for the other databases. The databases were searched between August 24, 2016 to February 17, 2017 for studies published in English language since Jan 1, 2000; these search data parameters were set for the review to focus on relatively recent developments and data in cannabis use ROAs. The database searches resulted in a total of 908 identified records; removal of duplicates and exclusions for content (based on initial screening and/or full-text review) resulted in 72 studies for inclusion, data review and extraction, and narrative data presentation and synthesis. Further, web-based searches to identify additional relevant ‘grey literature’ (e.g., reports, non-journal publications, websites, etc.) were conducted by use of standard Internet search engines, e.g. Google, utilizing the same keywords and variations thereof, as well as the same search timeframe used for the primary searches. In addition, bibliographies of articles identified were hand-searched for relevant grey literature sources. Studies were included if they contained any information on prevalence (medical and non-medical) and/or health outcomes related to ROAs for cannabis use; studies were excluded if they did not present data reported specifically for cannabis or if cannabis health outcomes were insufficiently reported or unclear. Titles and abstracts of studies retrieved were screened by two individuals who discussed and resolved instances of discordance concerning inclusion when those arose. Full-text review and data extraction was conducted by the first author. Data of included studies were extracted, organized by themes and narratively synthesized under distinct ROA categories identified for cannabis use. Concretely, the results were divided into inhalational and non-inhalational ROAs as a principal organizational structure. The inhalational results section was then organized to encompass smoking (i.e., involving inhalation of combusted cannabis products) and vaporizer-based (i.e., electronically heated) ROAs. Correspondingly, the non-inhalational section was divided to encompass the use of edible and drinkable products, and other ROAs (e.g., tinctures or dermal applications). It should be noted here that for the purposes of this review, and where data allowed, we have made an explicit distinction between vaporizer devices that exclusively utilize ‘natural’ cannabis (i.e., plant material) versus newer vaporizer devices that utilize cannabis ‘concentrates’ (e.g., butane hash/honey oil (BHO), wax, shatter, etc.).

## 3 Results

### 3.1 Inhalational ROAs

#### 3.1.1 Smoking

Smoking combusted cannabis materials (e.g., by way of a joint, spliff, pipe, blunt, water-pipe/bong) remains the most predominant ROA among users in North America. For instance, in a recent (2014) nationally representative US survey, ROAs for combusted

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