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journal homepage: www.elsevier.com/locate/etdahExploring the use of Kratom (*Mitragyna speciosa*) via the YouTube data tool: A novel netnographic analysis

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ABSTRACT

Kratom (*Mitragyna speciosa*) is a tree native to Southeast Asia with long history of traditional medicinal use. The aim of this study was to investigate the nature of self-reported experiences as shared on YouTube™ videos. A total of 500 videos with 19,478,180 views and 134,863 comments emerged as result from the data scrape extracted via the YouTube Data Tool. 12 out of the 16 most viewed videos were manually processed and selected for inductive thematic analysis. Kratom was used to self-medicate a number of health conditions, including opioid dependence/addiction (83.4%), pain (75%), anxiety (67%), depression (42%), substance use (42%) as well as to boost energy (50%), elevate mood (25%) and its nootropic effects (25%). Although most of the described experiences were positive (58%), side-effects, such as dependence and withdrawal (50%), nausea (42%), loss of appetite (25%), sedation (25%), loss of motivation (16.7%), were also reported. These were associated in the 25% of the cases with chronic ingestions. Overall, it was found that Kratom was mainly used for self-medication, rather than recreational purposes, justifying the need for further clinical studies to better assess the safety and the efficacy of its use in a therapeutic context.

1. Introduction

Mitragyna speciosa, most commonly known as Kratom, but also *Biak* or *Ketum*, *Kakuam*, *Ithang* or *Thom*, grows native in Southeast Asia, particularly in Malaysia, Thailand and Indonesia. With a long history of traditional medicinal use (Eastlack et al., 2020; Kruegel and Grundmann, 2018; Singh et al., 2016, 2020), the leaves of this evergreen tree are consumed in the local context for its dose-dependant stimulant and 'opioid-like' effects for intensifying work efficiency, as a pain reliever, and to substitute opioids (Prozialeck et al., 2012; Vicknasingam et al., 2010).

Kratom contains more than 40 different alkaloids (Shellard, 1974; Takayama, 2004), though the majority of its pharmacological properties are related to its two active psychoactive compounds: *mitragynine* and its metabolite *7-hydroxymitragynine* (Eastlack et al., 2020; Hassan et al., 2013; Kruegel et al., 2019). *Mitragynine* displays a complex action on

the Central Nervous System (CNS) as a full agonist of the μ -opioid receptors and as a partial agonist of δ -, and antagonist of κ -opioid receptors (Carpenter et al., 2016; Kruegel et al., 2016). It also acts on neuronal Ca²⁺ channels and descending noradrenergic/serotonergic system (Matsumoto et al., 1996, 2006). Furthermore, *mitragynine* is found to produce an effect on other receptors such as the serotonin (5-HT) 2A, 5-HT_{2C} and 5-HT₇, adenosine-2a, dopamine-2, and postsynaptic alpha-2 adrenergic receptor (Boyer et al., 2008; Kruegel and Grundmann, 2018; Matsumoto et al., 1997). This broad pharmacological profile largely explains its wide, and sometimes contradictory behavioural actions at different titrations, some of which have been observed in animal models including anxiolytic-like (Hazim et al., 2014), antidepressant (Idayu et al., 2011), and antipsychotic effects (Vijeeppallam et al., 2016). The pharmacodynamics, metabolism (Kamble et al., 2019), and the pharmacokinetic properties of Kratom have been mainly studied in preclinical models (Ya et al., 2019). In addition, it has been shown that in humans

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doses up 76.3–114.8 mg of *mitragynine* taken on a daily basis did not appear to cause any major health problems (Singh et al., 2018). Over the last decade, a wide range of Kratom products, though a substantial number was found to be adulterated, are now made available widely in Western countries as well as in Japan (Maruyama et al., 2009). Most frequently, they are sold on the internet and in smart (head) shops as a plant-based Novel Psychoactive Substance (NPS; Corazza and Roman-Urrestarazu, 2018). These include raw leaves, capsules, tablets, powders, and concentrated extracts, with little standardization of contents or potency.

Evidence suggests that Kratom products are also used (including recreationally) in combination with other substances, such as antidepressants or anti-psychotic agents and/or opiates/opioids, benzodiazepines, alcohol and some NPS (e.g., designer opioids and synthetic cathinones) (Corkery et al., 2019). This has led to previously unreported adverse effects and fatalities, mainly in North-Western Europe and the United States, which have not been reported in native countries (Alsarraf et al., 2019; Corkery et al., 2019; Singh et al., 2017). Although in 2016 the Drug Enforcement Administration (DEA) proposed placing Kratom into Schedule I of the Controlled Substances Act (CSA) because of its opioid-like abuse potential and poorly defined safety risk, the attempt was later halted by the outcome of a public outcry, which supported the continued legal access to Kratom because of its purported therapeutic benefits (Griffin and Webb, 2018; Henningfield et al., 2018). Consequently, Kratom currently remains legal and available in the United States, where individuals use Kratom to self-manage various health conditions such as pain, also in Covid-19 disease (Metastasio et al., 2020), mental health problems (e.g. ADHD, mood and anxiety disorders), and opioid/alcohol addiction and/or withdrawal (Bath et al., 2020; Garcia-Romeu et al., 2020; Swogger and Walsh, 2018).

Despite the widespread use, the scientific evidence underlying such medical applications is still lacking. Most of the currently available information on the benefits of Kratom to mitigate such conditions are often anecdotal and shared by users on social media and internet discussion fora, which, in absence of clinical trials, became of paramount importance for a better understanding of the plant and its properties. For example, a previous study performed by Swogger et al. (2015) provided a qualitative analysis on Kratom users' experiences as published on Erowid, a well-known website used for sharing information on psychoactive substances. Similar investigations on social media platforms have been carried out to study psychedelic microdosing (Andersson and Kjellgren, 2019; Hupli et al., 2019; Johnstad, 2018), *Salvia divinorum* use (Casselmann and Heinrich, 2011) and use of NPS (Corazza et al., 2013; Soussan et al., 2018) as well as to contribute to drug education and prevention activities (Andreotta et al., 2019; Chiauzzi et al., 2013; Manning, 2013; Soussan and Kjellgren, 2014). Among social media, the YouTube™ platform has shown in previous studies to provide a valuable aid in the field of qualitative drug and health care research (Andersson and Kjellgren, 2019; Casselman and Heinrich, 2011; Hasamnis and Patil, 2019; Hupli et al., 2019; Kataja et al., 2019; Lange et al., 2010; Madathil et al., 2015). In recent years, video hosting services quickly became the Internet's primary hub for expression of opinions on various matters. The mere quantity of videos makes this medium very rich in content, and as the slogan of YouTube™ states "Broadcast Yourself", a large amount of the content is user-generated which comprise the ecology of YouTube alongside with traditional media sources (e.g. Burgess and Green 2009). Ethnographic research on YouTube™ is still rare (Burgess and Green, 2009; Wesch, 2009), especially around drug use, but as Murthy (2008: 849) has stated the "combination of participant observation with digital research methods [...] may provide a fuller, more comprehensive account."

This study aims to better understand the use of Kratom and its underlying motivations, perceptions and potential side-effects as shared on YouTube™ platform.

2. Materials and methods

The YouTube Data Tool (YDTS 2018; Digital Methods Initiative 2018; Hupli et al., 2019; The Politics of Systems 2018) was used to extract data via the YouTube API (Application Programming Interface). The "video list module" was selected to create a selection of videos according to a specific search query. The search word "Kratom" was entered in the search query to extract the maximum number of iterations available (max 10 and 1 iteration gives 50 items). An initial data extraction was done in July 2019, followed by a subsequent search in February 2020. Cut-off for inclusion in the analysis was 250,000 views. Automated English transcripts of the most viewed videos were created by YouTube's machine learning algorithms, and imported as .doc files, including words, spaces, and correspondent times, for the subsequent qualitative analysis (see Table 1). The latter was carried out in the form of inductive thematic content analysis, following the method of collaborative online interpretation ("Crowded Theory", see Bröer et al., 2016; Andersson and Kjellgren, 2019). Entries were manually revised in conjunction with a screening of the videos as the quality of the automated transcripts can vary and classified according to (a) the motivations of use/therapeutic benefits and/or other applications and (b) the reported side effects and other safety issues. No initial hypothesis was used, and video comments were not taken into account. The study was approved by the Human Sciences Ethics Committee at the University of Hertfordshire (APHAEC/1042(04)).

3. Results

500 YouTube™ videos emerged from the original data scrape in July 2019, with a total of 18,700,721 views and 135,982 comments. The number of videos was confirmed by a second data scrape six months after (February 2020), where the view count increased to 19,478,180, though there was a decrease in the number of comments (134,863), probably due to the dynamic nature of online information (Burgess and Green, 2009). Twelve (12) out of the sixteen (16) most viewed videos at the time of the first data extraction were selected for further thematic analysis. Four videos were excluded from our study (one was in German, two were no longer viewable at the time of the second scrape and the transcript for one of them was not generated by the program). Included videos had a total length of 2 h 23 m 11 s (average 25 min 21 s), 7928,274 views, 111,321 likes, 13,284 dislikes and 42,584 comments. As shown in Table 1, selected YouTube™ videos reported data derived from the experiences/comments of 23 individuals articulated in the form of self-reported experiences, sometimes discussed during an interview (9) as well as a talk show involving non-using experts, where different opinions were expressed about Kratom (1), a report by a science communicator (2), a documentary about Kratom (3).

3.1. Motivation of use

Kratom was described across all the analysed videos as "a safe natural substance", that "did not seem to be a drug, but an herbal medicine". Claims such as "it has been used for hundreds of years as a natural traditional medicine", with users attesting "its powerful therapeutic benefits" were very common. In 75% of the videos (n. 1, 2, 3, 4, 7, 8, 9, 10 and 11) both the physical and psychological benefits of Kratom consumption were described. These included references to an energy boost (in 50% of twelve videos) "similar to a caffeine boost", which helped users to increase their productivity at work, combat fatigue and "feel revitalised or energised". Nootropic effects (25%), such as an increased "ability to concentrate" and "to focus", since Kratom was described as a "fantastic boost for ...creativity" and recommended as potential "replacement for Adderall in people who are currently using it to focus"; mood elevation and euphoria (25%) ("dose of 4 to 5 gs puts me in a much more euphoric", "...it improves your mood and makes you euphoric", "two to three grams is enough to boost mood and put into a

Table 1
List and characteristics of the most viewed qualitative analysed Kratom videos on the YouTube™.

Video i.n.	Title	Channel	Published on	Duration	Views Count	Likes/Dislikes Count	Comments Count	Description	N. of people	Characters	Main Content	Message
1	Joe Rogan - Why Kratom is Illegal	JRE Clips	26-Jun-18	13 m 29 s	2,487,970	25,488/1389	9512	Discussion	2	User, interviewer	M, BT, S	P
2	Kratom - Overview + SafetyGuide	Psyched Substance	15-Aug-16	16 m 31 s	1,410,570	21,550/751	4729	Sharing personal knowledge, education and harm reduction	1	User	M, BT, S	P
3	Why I Stopped Taking Kratom	Psyched Substance	11-Jan-18	19 m 24 s	1,068,250	21,339/2376	9683	Sharing personal knowledge	1	User	M, BT, S	N
4	Joe Rogan Discusses Kratom	PowerfulJRE	07-Sep-16	7 m 37 s	529,558	6949/172	2572	Discussion	2	User, interviewer	M, BT	P
5	What You Should Know Before Taking Kratom	The Doctors	05-Dec-16	6 m 35 s	415,275	1234/3987	3534	Discussion	6	Talk show participants, including doctors	M, BT	U
6	7 Days on Kratom Ruined me	VEE3RDEYE	10-Dec-18	12 m 55 s	338,680	2745/1988	2684	Sharing personal experience	1	User	M, S	N
7	WTF Is Kratom and Is It A Dangerous Drug?	Seeker	15-Sep-16	5 m 17 s	310,457	3660/1742	1795	Sharing knowledge	1	Science communicator	M, S	P
8	Chris Bell: Kratom Is the Cure for the Opioid Epidemic	ReasonTV	03-May-17	25 m 21 s	294,536	4795/241	2131	Discussion	2	Author of a documentary about Kratom users, interviewer	M, S	P
9	Bastiaan use Kratom and goes up and down (Mitragnyna)	Drugslab	20-Jan-17	10 m 05 s	292,357	6199/79	1747	Drug educational experience	1	User	M, S	N
10	Liberal Redneck - Talkin Bout Drugs	Trae Crowder	07-Sep-16	3 m 42 s	280,107	11,169/97	963	Sharing personal knowledge	1	User	M, BT, S	P
11	Kratom; Testimonial of a Long Time User	Carpo Orr	02-Jun-16	14 m 42 s	250,292	3323/285	1940	Sharing personal experience	1	User	M, BT, S	U
12	Kratom Is Helping This Heroin-User Break His 6-year Addiction World of Hurt (HBO)	VICE News	27-Oct-17	7 m 33 s	250,222	2870/177	1294	Sharing personal experience	1	User	M, BT, S	P

i. n.: Identification number; m: minutes; s: seconds; M: motivations; BT: benefits and therapeutic applications; S: side effects; P: positive; N: negative; U: undetermined.

Table 2
Motivations of use and other applications as described by Kratom users.

Motivation		Revised Original Transcripts created by YouTube™	N. of videos
THERAPEUTIC APPLICATIONS	Pain	“It is a less addictive treatment for pain” “It’s pain cover” “It’s been used to relieve pain for centuries”	9
	Opioid dependence/addiction	“All I’m hearing is it helps people with heroin addiction” “We’re talking about replacing opium, heroin” “Kratom could be the very first cure for the opioid epidemic” “People have been using it to keep off with their addiction” “People were using it as an alternative to heroin and opiates” “Kratom is not addictive alternative to methadone or buprenorphine” “Kratom made me feel better from the heroin withdrawal”	10
	Substances use	“I would take Kratom for prescribed amphetamines” “It can help with marijuana...alcohol withdrawals” “Kratom helps people with methamphetamine problem” “Kratom is a safe alternative for any substance”	5
	Depression self-treatment Anxiolysis and relaxation	“If it’s not for Kratom he suffers such bad depression” “It also has kind of benefit of antidepressant” “It was found to have an acute ability to reduce anxiety” “People used it as alternative to anti-anxiety medication” “It also has kind of benefit as Anxiolytic” “You feel just really relaxed ... like everything is okay in life”	8
POSITIVE PHYSICAL AND PSYCHOACTIVE BENEFITS	Nootropic effects	“I ... recommend Kratom to anyone who needs a boost in focus” “I’m suggesting try Kratom to those who are using ... Adderall to focus”	3
	Energy Boost	“It is a stimulant” “I’m feeling the energy from the Sun ... my thoughts (are) pretty clear” “It makes you energetic and euphoric” “You’re very restless”	6
	Mood elevation	“Euphoric enough that you feel like going out and doing things” “I feel very content, like I’m covered with a warm blanket” “I really feel happy. I really feel genuinely happy”	3
	Socialization and Entactogenic effects	“I also feel a lot more friendly” “I could just walk up to people and start a conversation”	4

productive state”); anxiolysis and relaxation (67%) (“it can be quite sedating”, “I think it’s much more healthy and safe than Benzodiazepine”, “it can make someone feel very relaxed and chill”) were also commonly described. Kratom was also used to complement social interactions in “religious ceremonies” (8.4%) and its entactogenic effects were also reported (33.3%). These included “feeling of empathy”, with some users recommending “Kratom as an alternative to drinking” as “socialization becomes more unsuppressed and effortless”.

Therapeutic applications were found in all videos, described as Kratom benefits in the 67% of them (n. 1, 2, 3, 4, 5, 10, 11 and 12) by seven users and talk show participants. They were referred to cases of acute/chronic and “extreme pain” management (75% of twelve videos) (“people use it really to fight pain”, “Kratom is a powerful analgesic” and “a painkiller” better than “every single form of opiate”). As highlighted in Table 2, Kratom was also used for “improving health and well-being”, detoxifying from substances of abuse (42%) (e.g. amphetamine), as well as for managing “addiction” and “marijuana and alcohol withdrawals”. In 83.4% of the videos, some users claimed that “Kratom reduces the intake of more addictive and dangerous opioids”, “it is the only substance that managed to get them off heroin”, and “helps people to overcome opiate/opioid addiction”, and found to be useful in treating a variety of other conditions, such as “diarrhoea” (8.4%), sexual desire (8.4%) (“Kratom may act as an aphrodisiac in women... and decrease erection problems in men”), psychological disorders (42%, “depression”, “PTSD and anxiety”) and sleep problems (8.4%) (“I slept well...feel pretty good” and “rested”).

3.2. Side effects

We also documented the side-effects of Kratom use. Eighty-three percent of the videos (n. 1, 2, 3, 6, 7, 8, 9, 10, 11 and 12) showed that Kratom can cause adverse effects. Some (42%) claimed that users

“can become nauseous to the point where they vomit sometimes for hours”, and experience headache (16.7%) (“I do not feel so good as I experienced long-lasting episodes of headache throughout the day”). In addition, some of the commonly reported side-effects associated with Kratom use include sedation (25%), loss of appetite (25%), loss of motivation (they felt “very unmotivated” and “apathetic”) (16.7%), drowsiness and decrease in attention (16.7%), dry mouth and frequent urination (16.7%), anger (16.7%), weakness and sweating (8.4%), decrease in sexual desire (8.4%), and dizziness (8.4%). However, from the discussions that emerged from the videos, all these negative effects usually occurred when someone consumes Kratom multiple times a day, and “there are not many choices of drugs to be safely used every day”. “Kratom affects your muscles, and eye muscles” and “some users can begin to feel sedation from as little as three grams”, and at 4 gs the sedating effects becomes more intense. Moreover, the other profound side-effects linked to the chronic use of Kratom (25%) were weight loss, insomnia, dark skin, constipation, dysphoria, and mild depression. Half (50%) reported that Kratom can cause addiction (especially for “addictive personality”, “I find it can be very easy to get addicted”), dependence with tolerance (“frequent use will give you a tolerance”), and opiate-like withdrawal syndrome (“unfortunately for some, Kratom is also habit forming; with withdrawal manifesting both physically and mentally”, “the withdrawal...causes tremors, anxiety, joint and muscle, aches and limb jerks, mood swings, hostility, aggression, depression, insomnia, sweating, nausea, and headaches”), and fatalities (33.3%) (“in the United States a total of 36 people have died from overdosing”, related mostly to combination with other substances, “14 related overdoses, none... Kratom was not alone”, “9 deaths were in Sweden and Kratom was laced with fentanyl”). Except for severe toxicities caused by extreme cases of addiction (with “jaundice and some liver toxicity”, “runny nose, irritability”) or very high intake of Kratom use (“from 12 to 15 gs of Kratom per day”), in normal doses the substance was mainly

Table 3
Side effects reported by users.

Described effects	Revised Original Transcripts created by YouTube™	N. of videos
Nausea	“I may initially get nauseous” “I was really nauseous”	5
Loss of motivation	“I just felt really no urge to exercise anymore”	2
Anger	“It always made me feel angrier...to lose my temper”	2
Decrease of sexual desire	“It actually decreases the amount of testosterone”	1
Weakness, Sweating	“Feel weaker” “I’m sweating all mornings”	1
Headache	“My head is like throbbing” “By day three and four headaches”	2
Loss of appetite	“Kratom dehydrates you and it takes away your appetite” “Kratom suppresses the appetite, ...you’re less hungry”	3
Dry mouth and frequent urination	“I do have a very dry mouth” “And a more frequent urge to pee”	2
Alteration in breath and blood pressure	“May lead to trouble with breathing or to a heightened blood pressure”	1
Sedation	“Can make you extremely tired safety-wise” “I feel very tired suddenly, very listless”	3
Dizziness and decrease of attention	“I’m about to faint” “That may cause your sight to become fuzzy and unfocused” “You can’t focus anymore”	1
Drowsy and sluggish state	“When you take more Kratom, you may get drowsy and sluggish” “I just feel very tired and sluggish”	2
Effects at high doses	“I had the runny nose” “Dizziness, especially in high doses constipation” “In high doses you run the risk of dysphoria, intense nausea” “Dangerous and even deadly”	3
Addiction, dependence, and withdrawal syndrome	“Addiction with the potential for withdrawal” “I personally can see the substance being very addicting” “There is actually an addictive property to Kratom” “Six hours later I would start getting withdrawal effects” “I started getting withdrawal effects which was really a runny nose” “I had no energy, I felt sick” “I started getting shakes my body” and “joint pain” “People become addicted” “Kratom is an addictive herb that give withdrawal and tolerance”	6
Fatalities	“Not a single person has died directly as a result of Kratom” “In three deaths Kratom was ...in combination” “No one ... died directly as a result of Kratom” “To combine it with MAO inhibitors can be lethal” “Overdosing can cause seizures, coma, and death”	4

reported to be a safe drug. Supplementary information can be found in [Table 3](#).

4. Discussion and conclusion

Building on previous online surveys (Coe et al., 2019; Grundmann, 2017) and analysis of Kratom’s experiences on fora (Swogger et al., 2015), our study is the first one to have considered the first-person video accounts shared on YouTube™ to better understand uses, motivations, perceptions and potential risks related to its unsupervised applicability. Our findings show that Kratom is widely used for its medicinal value (see also [Section 3.1](#) and [Table 2](#)) as a natural remedy for self-treating a wide range of adverse health conditions, rather than for its psychoactive properties. The large majority of the most popular videos (58%) conveyed a positive message about its consumption and claimed that the substance can alleviate suffering from chronic pain, opioid, amphetamine-type-stimulant (ATS) and alcohol related problems, as well as improve mental and physical functioning. A state of opioid-like relaxation as well as other benefits that were more linked to the plant’s psychostimulant (e.g., euphoria, increased sexual energy)

and “entactogenic” properties, such as enhanced communication, were often reported. Such claims are supported by literature where Kratom use is associated with mood elevation, anxiolysis, enhanced socialisation and nootropic effects (Bath et al., 2020; Swogger and Walsh, 2018), including in traditional settings, like Malaysia and Thailand, where the plant is commonly consumed for earning extra income and enhancing productivity (Saingam et al., 2013). We also found the use of Kratom to ‘taper off’ opioids, manage withdrawal symptoms, or as a substitute subsistence dose to minimise the risk of relapse in those who were dependant on illicit substances, since Kratom is not addictive like opioids and manage to help them overcome their opioid, or Substance Use Disorder (SUD). Such anecdotal reports would provide some support to Kratom’s potential as an opioid substitute. Evidence of this has been previously collected in a few large survey-based studies, which found that Kratom can help illicit and prescription opioid users refrain from, reduce and stop opioid use (Coe et al., 2019; Garcia-Romeu et al., 2020; Grundmann, 2017) as well as a study where *mitragynine*, the primary alkaloid, showed to have limited abuse potential and the advantage to reduce morphine intake in rats (Hemby et al., 2019). Taken together, these findings would show that Kratom is widely

used and known as a medicinal aid rather than a recreational NPS. However, this was not without risks, with 25% of the videos having a negative message, and the content reported in 50% of the examined videos referred to the risk of adverse/side effects (Table 3). These were mainly associated with chronic ingestions and the intake of higher doses of Kratom, leading to weakness, sweating, insomnia, runny nose, dizziness, loss of motivation, and constipation, dysphoria, and decrease of sexual desire. Cases of addiction, dependence, and withdrawal syndrome (e.g., tremors, anxiety, hostility, depression) were also reported. Some of these symptoms have already retrospectively been described in the scientific literature (Saref et al., 2019; Singh et al., 2014), where it has also been suggested that the limited and misleading information on suggested doses in available sold Kratom products might have made the insurgence of unwanted effects even more likely (Williams and Nikitin, 2020). In addition, products bought from the internet or convenience stores might provide different effects than brewed Kratom juice, as they could be adulterated with other unknown substances which can lead users to experience deleterious health effects (Cinosi et al., 2015; Corkery et al., 2019; Nacca et al., 2020). However, some studies showed that long-term Kratom use do not seem to cause toxic effects on the haematology and biochemical parameters of Kratom users (Singh et al., 2018). Its discontinuation does not seem to cause withdrawal for about twenty hours (Vicknasingam et al., 2020) and Grundmann (2017) found those who use Kratom regularly did not experience any negative effects if they hold back their dose for more than 48 h. In fact, a substantial percentage have also not sought medical or mental treatment from healthcare providers despite using Kratom for prolong periods. Moreover, results from a few large-scale studies reported Kratom's adverse reactions were usually mild and self-manageable and did not carry any significant risks (Coe et al., 2019; Garcia-Romeu et al., 2020). This suggests that a monitored Kratom consumption is not associated with significant health problems and it is possible to think that its regular use in smaller amounts may be safe for its intended therapeutic properties. However, users may not have adequate information on Kratom's side-effects, as the literature on the topic is still poorly elucidated, with our study giving a little contribution on it. Finally, the content presented in the remaining 17% of the videos expressed a neutral more balanced view on the use of Kratom.

Methodologically, the novel netnographic approach used for this study, that combined digital data (YouTube™ videos) and “offline” automatic transcripts on Kratom use, provided a valuable source of information on Kratom's perceptions and use patterns. YouTube™ has been previously deployed with success to investigate the use of *Salvia divinorum* and psychedelic microdosing over which there is only minimal data from controlled studies available (Lange et al., 2010; Casselman and Heinrich 2011; Hupli et al., 2019). These studies made use of different data extraction techniques to produce generalizable samples, noting however that as the ecology of YouTube™ changes by the minute, it would be difficult to replicate these samples (Manning 2013). However, YouTube™ has been used increasingly in the field of digital drug research for other emerging psychoactive substances, showing that this netnographic exploration provides interesting insights into the effects and risks of substances use, and, in our case, helped to inform Kratom education needs, as well as provided insight on its safety and therapeutic benefits. It is important to consider that this method has some limits *per se*, since it does not allow an intensive data collection procedure. This aspect must be taken into account also to understand our study's limitations. Firstly, our data are limited to a self-selected and non-randomised small number of videos that could contribute to bias, and the authenticity of the claimed therapeutic benefits of Kratom use cannot be clinically confirmed since it is solely based on users' personal experiences and views, thus our findings from the YouTube™ videos cannot be generalised. As many videos included a mix of self-reported experiences with broader knowledge/views on Kratom, the percentages should be considered as indicative only of awareness of, not personal experience

of any effect or side effect - the inclusion of a statement in the video is not meant to infer frequency of occurrence – i.e. people spoke about risk of serious side effect, without having experienced this themselves. Second, we only analysed English language videos, hence this reduces our ability to analyse other non-English videos and provide a more comprehensive narration on the benefits of Kratom use. The collected evidence is not intended to compare with the self-reported data collected from surveys with a greater number of users (e.g. Grundmann, 2017). Instead, it provides an undirected, unsolicited view into the knowledge exchange provided on the YouTube™ platform. In absence of controlled clinical trials, it shares novel insights on the material available on the Internet that can be freely accessible by (potential) users, and forms the basis upon which people base their decision-making. It is hoped that our findings lend support for future investigations in the field and visibility to novel methods of data collection, capable of adapting to face-paced developments in how we share information.

In conclusion, the results of our study helped to shed light on the less explored medicinal benefits of Kratom, rather than reinforcing its previous association with harmful effects typical of classical opioids. However, such findings require further contextualization outside the digital milieu of YouTube™, and further controlled clinical studies are needed to better understand the safety, therapeutic efficacy and long-term perils of Kratom use – if it is used to treat a wide range of health conditions. Finally, our work generates new critical questions on whether Kratom could be used as a natural remedy to mitigate the present opioid misuse epidemic.

Ethics statement

Authors declare that ethics approval for this study is included in method section.

Authors' note

Authors confirm that this work is original and has not been published previously elsewhere. It is currently not under consideration for publication elsewhere, or in press at other journals and its publication is approved by all authors.

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CRediT authorship contribution statement

Elisabeth Prevele: Formal analysis, Data curation, Writing - original draft, Visualization, Writing - review & editing. **Alexi Hupli:** Conceptualization, Investigation, Methodology, Formal analysis, Data curation, Writing - review & editing. **Shanna Marrinan:** Conceptualization, Formal analysis, Data curation, Writing - review & editing. **Darshan Singh:** Writing - review & editing. **Bruno D' Udine:** Writing - review & editing. **Giuseppe Bersani:** Writing - review & editing. **Kim P.C. Kuypers:** Writing - review & editing. **Johannes G. Ramaekers:** Writing - review & editing. **Ornella Corazza:** Conceptualization, Writing - review & editing, Supervision, Project administration.

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