Therapeutic benefit with caveats?: Analyzing social media data to understand the complexities of kratom use

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Abstract

Background: *Mitragyna speciosa*, referred to as "kratom", is increasingly used in the United States for self-treating pain, psychiatric, and substance use disorder symptoms. It is used by some to attenuate opioid withdrawal and as a longer-term drug substitute. Most self-report data have come from online surveys, small in-person surveys, and case reports. These may not be representative of the broader kratom-using population.

Purpose: Analyze user-generated social media posts to determine if independent, descriptive accounts are generally consistent with prior U.S. kratom survey findings and gain a more nuanced understanding of kratom use patterns.

Methods: Reddit posts mentioning kratom from 42 subreddits between June 2019-July 2020 were coded by two independent raters.

Findings: Relevant posts (number of comments, upvotes, and downvotes) from 1,274 posts comprised the final sample (n=280). Of the 1,521 codes applied, 1,273 (83.69%) were concordant. Desirable kratom effects were described among a majority, but so too were adverse effects. Reports of kratom as acute self-treatment for opioid withdrawal were more prominent compared to longer-term opioid substitution. Quantitative analysis found higher kratom doses associated (p<.001) with greater odds of reported kratom addiction (OR=3.56) or withdrawal (OR=5.88), with slightly lower odds of desirable effects (OR=0.53, p=.014). Despite perceived therapeutic

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benefits, kratom was characterized by some in terms of addiction that, in some cases, appeared dose-dependent. Polydrug use was also prominently discussed.

Conclusions: Results validated many prior survey findings while illustrating complexities of kratom use that are not being fully captured and require continued investigation.

Keywords

kratom; opioids; harm-reduction; polydrug use; kratom withdrawal

1.0   Introduction

Mitragyna speciosa (referred to as kratom) is a plant indigenous to Southeast Asia (SEA). Its leaves produce approximately 40 pharmacologically active alkaloids, several of which are responsible for kratom's analgesic, stimulatory, and anxiolytic effects (Kruegel & Grundmann, 2018; Kruegel et al., 2019; Todd et al., 2020). Its two most studied constituents, mitragynine (MG) and 7-hydroxymitragynine (7-HMG), act as partial agonists at mu opioid receptors (Obeng et al., 2020; Todd, et al., 2020). These actions are atypical, seemingly "biased", in that they show selectivity for the G-protein signaling pathway, rather than the β-arrestin pathway, indicating that kratom, may produce therapeutic analgesia, but with potentially fewer adverse effects than traditional opioids (Basiliere & Kerrigan, 2020; Behnood-Rod et al., 2020; Henningfield, Fant, & Wang, 2018; Henningfield et al., 2019; Singh, et al., 2018; Singh, et al., 2019; Todd, et al., 2020; Vicknasingam et al., 2020). Kratom's pharmacology also indicates additional non-opioid mechanisms of action (Hiranita et al., 2019).

Kratom has been used in SEA for over a century (Brown et al., 2017; Jansen & Prast, 1988; Singh, et al., 2016; Suwanlert, 1975). Self-reported reasons for use in SEA include medicinal, recreational, and mood and energy improving properties (Singh et al., 2019; Singh et al., 2017; Veltri & Grundmann, 2019). Kratom has also been used in SEA to self-treat opium, heroin, amphetamine, and alcohol misuse (Singh et al., 2020; Singh et al., 2021; Vicknasingam, et al., 2010). In the U.S., kratom has been reported as being used to self-treat chronic pain, psychiatric (e.g., mood, anxiety, attention deficit, post-traumatic stress disorder), fatigue, and substance use disorder (SUDs) symptoms and to mitigate opioid withdrawal (Bath et al., 2020; Boyer et al., 2008; Coe, et al., 2019; Garcia-Romeu, et al., 2020; Grundmann, 2017; Smith & Lawson, 2017). A substantial subpopulation of U.S. adults report using kratom to attenuate opioid withdrawal, as a substitute for prescription or illicit opioids, and possibly (though not verified) to address alcohol or stimulant misuse (Assanangkornchai, et al., 2007; Coe, et al., 2019; Garcia-Romeu, et al., 2020; Saref, et al., 2019; Singh, et al., 2015; Singh et al., 2021; Smid, et al., 2018; Smith & Lawson, 2017; Swogger, et al., 2015; Swogger & Walsh, 2018; Tanguay, 2011; Vicknasingam, et al., 2010). Kratom is typically consumed either as a tea or beverage or as plant matter ground into powder that is prepared as capsules or consumed in tablespoons (Eastlack, et al., 2020; Garcia-Romeu, et al., 2020; Leong Bin Abdullah et al., 2020; Saingam et al., 2013; Singh et al., 2013, 2018, 2019).

Prevalence of U.S. kratom use is estimated at 5-15 million, although there is no scientific consensus. The 2019 National Survey on Drug Use and Health (NSDUH) estimated that 0.3% (825,000) of people aged 12 or older had used kratom within the past month, however, this may be an underestimate due to the fact that homeless and incarcerated persons were not sampled (both populations have high rates of chronic pain and SUDs, making them potentially more likely to have used kratom) and NSDUH kratom survey item wording, which excluded some kratom product types (Substance Abuse and Mental Health Services Administration, 2020). Data collected between 2018-2019 as part of the cross-sectional Survey of Non-Medical Use of Prescription Drugs estimated lifetime kratom use prevalence among a self-selected sample (59,714) of U.S. adults at 1.3% (2,031,803) and past-year use at 0.8%, extrapolating from 490 respondents who endorsed lifetime use (Schimmel et al., 2021). These two-year old data may not reflect present rates of use. Indeed, these estimates are partially offset by indirect indicators of more widespread use, including kratom industry growth, increased kratom advocacy, and upticks in kratom-related calls to poison control centers or polydrug exposures associated with kratom (Cinosi et al., 2015; Olsen et al., 2019; Post et al., 2019). Among smaller samples of substance-using adults, lifetime kratom use rates ranged from approximately 13-20% (Smith & Lawson, 2017; Smith et al., forthcoming).

Because some using kratom have a history of opioid-use disorder (OUD) and are using for withdrawal-mitigation or opioid substitution, (among other reasons), it is important to better understand such "self-treatment" (Assanangkornchai et al., 2007; Coe et al., 2019; Garcia-Romeu et al., 2020; Saref et al., 2019; Singh et al., 2015; Smid et al., 2018; Swogger et al., 2015; Swogger & Walsh, 2018; Tanguay, 2011; Vicknasingam et al., 2010). No U.S.-based controlled clinical studies investigating kratom's safety, tolerability, or effects in humans exist. Preclinical research continues to demonstrate kratom's effects and potential to substitute for full opioid agonists (Hassan et al., 2013; Hemby et al., 2019; Ismail et al., 2017; Kamble et al., 2021; Maxwell et al., 2020; Obeng, et al., 2020; Yue, Kopajtic, & Katz, 2018). This complements self-report among users. However, direct comparisons between preclinical work and self-report are complicated, as people use kratom orally in several forms (Garcia-Romeu, et al., 2020; Grundmann, 2017; Singh et al., 2016, 2018a, 2019).

Another complication is that most U.S. self-report data have been obtained from large surveys which typically include regular/current users self-selecting into kratom-specific studies. These samples represent a large portion of the kratom-using population, but are not fully representative, or may be biased towards people with highly favorable attitudes about kratom. People who may have only used kratom once, or used but subsequently quit, may not be captured. Likewise, people potentially *mis*using kratom may not be participating. Thus, in the U.S. context, we have an increasingly clear, but still limited, picture of kratom use, making it important to examine all available data sources. Despite ubiquity of social media, only one study (Swogger et al., 2015), has examined kratom experiences using social media (Erowid) text. Since then, kratom use and online discussion of kratom have proliferated, making publicly available text a relevant, timely source for feasible collection of descriptive data.

1.1. Aims

The aim of this study was to evaluate posts made on the popular social media platform, Reddit. This was done to determine if these independent descriptive accounts were consistent with common kratom survey questions and prior findings, which are presently the best, but still limited, source of self-reported kratom use data in the U.S, and to add more nuanced self-report data to the kratom literature than exists among current and (possibly) former, users. By identifying and coding text across widely-viewed, user-generated Reddit posts, a more comprehensive understanding of kratom use can be advanced to help inform future work. This text analysis was not intended as an in-depth qualitative study. Rather, it aimed to tap a highly relevant but underutilized data source to provide additional insight into kratom use among adults on social media and add more detailed self-report information that may help develop or refine new survey or qualitative interview questions. We and our collaborators are actively working to advance our understanding of kratom by using these and other methods. Formative findings reported here constitute one of our multiple starting points.

2.0. Methods

2.1. Data collection

We collected post data from Reddit, a self-organizing social aggregation website where registered members create and engage with topic-based communities and subcommunities (i.e., subreddits). Text and other content is posted such that members can promote content they find helpful or interesting. Reddit data have been examined in other studies pertaining to a wide range of topics (Brett et al., 2019; Bunting et al., 2019; Chanderasekharan et al., 2018; Sowles et al., 2018; Vosburg et al., 2021). We used the *R* package {RedditExtractoR}, which utilizes Reddit's application programming interface (API) to extract post text, comment text, and metadata utilizing search terms within subreddit communities, or for all subreddits. We selected Reddit data for analyses not only because it provides rich, unfiltered data, but also partially because other platforms with long-form posts (e.g., Facebook) impose data collection barriers (e.g., restricted API access; privacy restrictions). Reddit data are accessible, contextualized, and can provide insights into substance use experiences. Reddit does not require researchers to register an account, purchase access to API tokens, nor obtain consent from individuals, as Reddit data are primarily anonymous and publicly available. Indeed, Reddit provides not only a source of available text data to examine, but a unique level of protection to persons posting, in that Reddit usernames are seldom connected with personally identifiable information (PII) and typically only when the person posting shares it, making reverse-identification difficult or impossible in most circumstances, unlike other social media data (e.g. Twitter, Facebook) (Ayers et al., 2018; Kilgo et al., 2018).

Because Reddit has not recently released platform source code, we were unable to leverage traditional scientific database search strategies when collecting post data. Reddit's search function is designed to display relevant content and may rely on built correlations between related words, displaying posts and subreddit communities based on correlation strength, post recency, proportion of upvotes, number of upvotes, number of comments, and other metadata. Utilizing common misspellings of "kratom" yielded fewer but identical post

content than using only "kratom". Page limits appeared to throttle number of obtainable posts when searching the entire Reddit front page. Accordingly, we conducted a preliminary search to determine which subreddits contained a high frequency of posts mentioning kratom. After identifying the top 30 kratom-relevant subreddits, we conducted individual searches and collected all posts explicitly mentioning "kratom" made between June 2019-July 2020. We selected this time frame as it coincided with data collection for a separate survey study. From this search we found 5 kratom-specific subreddits and 13 subreddits dedicated to substance use broadly. Next, we conducted a general Reddit-wide search for posts containing "kratom" to include posts that may have been omitted when searching individual subreddits. This resulted in a sample of 1,274 unique posts across 42 subreddits. Next, we truncated posts to 280 by sampling the most relevant 20 unique posts from each month within our specified timeframe. Relevance was determined by examining the Reddit community interaction with the post based on three specific criteria: number of comments, upvotes, and downvotes. Per NIH IRB policy for public data without associated PII, this study was exempt from the IRB review.

2.2. Generation of codebook and text analysis

Ten codes were generated *a priori* from what we expected to encounter based on prior findings. We did this, in part, by reverse engineering questions from other surveys we (O.G., K.S.) and others have developed into a guide for analyzing Reddit text. Two additional *a priori* codes were generated based on prior direct clinical contact with kratom-using adults and analysis of social media data pertaining to kratom use during Covid-19 (Grundmann et al., submitted) and of Reddit text pertaining to tianeptine, which was often co-used with kratom (Smith et al., 2021). Accordingly, we were confident that our 12 *a priori* codes could be applied to Reddit data and serve as a foundation for initial coding.

Upon first inspection of the sample of 280 posts, group consensus resulted in finalization of the codebook with 12 primary *a priori* codes with 9 additional subcodes (presented in Table 1). This initial pass reaffirmed the presence of what we anticipated finding based on prior work and helped us develop subcodes. This codebook was subsequently used for coding by two independent raters (J.R. and D.S.). Only the unique initial posts that we identified were coded (not post comments). Had our initial pass through the post sample found posts pertaining to novel or *un*expected kratom-related topics that were reoccurring within the text, those would have been incorporated into the codebook as additional codes/subcodes, supplementing our initial *12 a priori* codes and 9 subcodes. Raters could apply codes to any text segment in order to calculate proportion of rater agreement. Thus, no text that raters believed corresponded to a code was left uncoded; only posts deemed unassociated with any code were left uncoded. Multiple, different codes could be contained in the same post (requiring application of more than one code within a post). Thus posts, and text within a single post, could have more than one code. Although the codebook was developed in advance and refined via conference, the coding process was still open to *et vade* coding and documentation of unexpected or inconsistent findings that did not fall into a code/subcode. Raters were instructed to highlight any *novel or unexpected* text identified during coding to discuss further. Raters independently coded posts using MAXQDA 2020 (VERBI Software, Berlin).

As total percent agreement was substantial (see Results) and no discordance for any code applied was less than a majority, we did not conference and subsequently *re-code* text to achieve a higher agreement rate. This is partially for transparency's sake and because we were not seeking to preform iterative coding and sampling for theory-building. Additionally, the percent agreement, whether low or high, shows the complexity of how people wrote posts and described kratom-related experiences. In other words, if two independent raters did not have 100% agreement, or potentially low agreement in one area, that could itself be an important finding[1].

2.3. Quantitative analyses

A subset of posts (n=62) identified as containing reported daily doses were examined in relation to other codes treated as outcome variables. These codes included "professed kratom addiction" and "desirable kratom effects" which we suspected would be dose-dependent. For instance, perceived kratom addiction may potentially be associated with higher daily doses, whereas perceived desirable effects from kratom, similar to other substances, may be best achieved by low or moderate doses. The dose-effect relationships were assessed using binomial logistic regression with dose coded as gm/day and log-transformed to refine distributional properties and interpretation. These analyses were conducted using *R*.

3.0. Results

Table 1 displays codes, interrater agreement rate(s) (IRR), versus disagreements, and agreement percent. A total of 1,521 unique codes were applied. Of these, 1,273 were concordant and 248 were discordant, with an IRR of 83.69% (range=57.15%--95.24%). Corrected kappa for IRR was 0.83, indicating substantial agreement, uring coding, interesting points of discussion related to kratom which emerged, but which were not reflected in the codebook, were documented for group consideration. However, these occurred at such low rates so as not to constitute a reoccurring kratom-related topic that would warrant adding it as an additional code, though we have quantified them here for potential future exploration (e.g., strategies for avoiding kratom bitterness when consuming crushed leaf or powder, n=9/280; meta commentary on the style Reddit posters tend to discuss kratom, n=14/280, negative experiences discussing kratom use with healthcare provider, n=5/280; discussion of thoughts or events unrelated to kratom, n=12/280; thus, 0 codes were applied to 40 posts). Codes applied to a given post out of the total of 280 ranged from 0-12. Unique Reddit usernames were associated with 273 of the 280 posts.

Ultimately, posts made during this one-year period contribute to a complex narrative of kratom. Partially reflecting this complexity is that the two most prominent codes applied corresponded to professed kratom addiction (n=183/280) and desirable kratom effects (n=169/280). Findings largely fell across *desirable*, therapeutic kratom effects and *unwanted* effects that, for some, involved discontinuation of use. Details of dosing and contemporaneous use were also prominent across posts.

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[1]All raw text data are available upon request.

3.1. Perceived desirable and therapeutic kratom effects

Kratom was discussed as being used to self-treat pain symptoms (n=58/280) or psychiatric conditions (n=58/280). Specific mentions for the latter included self-treatment for depressive (n=32/280) and anxiety (n=35/280) symptoms. A prominent reported benefit from kratom pertained to self-treating SUD or drug dependence (n=133/280); captured in greater depth in in Table 2, column 1 (presented as direct quotes). This included frequent mentions of kratom use to mitigate opioid (n=103/280) or other drug withdrawal (n=17/280; e.g., alcohol). Kratom's continued use as longer-term opioid substitute was mentioned less often (n=38/280) than shorter-term attenuation of withdrawal, though was described in striking detail (Table 2, column 2). Overall, desirable effects were wide-ranging, and included mood enhancement, increased energy, cognitive alertness, analgesia, and relaxation. These appear in Table 3. Number of codes pertaining to kratom's regulatory status (n=30/280) were fewer than expected given that many Reddit users reside in the U.S., where kratom's regulatory and legal status is provisional and varied.

3.2. Unwanted effects, polydrug use, and kratom use discontinuation

Despite perceived benefits of kratom use for many, people also described unwanted or adverse effects (n=79/280), such as GI upset, fatigue, memory lapses, irritability, and restlessness (see Table 3). As noted above, a prominent finding included reported kratom addiction (n=183/280). This phenomenon was evidenced both directly and indirectly as shown by quotes in Table 2, column 3. In particular, specific descriptions of kratom withdrawal (n=86/280) and kratom tolerance (n=41/280) were found. Descriptions portrayed tolerance typically developing slowly, with some exceptions. Withdrawal descriptions were wide-ranging, although effects were typically described as mild-moderate. For a minority, kratom withdrawal was described as severe (see Table 2, column 3).

Other drug use, including polydrug use, was commonly reported (n=155/280). These included concomitant use of kratom with another substance or use which was contemporaneous based on described context. Drugs from distinct classes frequently co-used with or mentioned in relation to kratom appear in Table 4. These included stimulants (n=103/280), opioids (n=91/280), benzodiazepines (55/280), cannabinoids (42/280), hallucinogens/psychedelics (61/280), and "nootropics" (n=28/280). Specific drug names appear in Table S1, and in raw text form, in Table S2 (see supplementary materials). Unwanted kratom effects were partially reflected by posts describing a desire to quit using kratom (n=43/280) or active and/or successful quit attempts (n=53/280).

3.3. Kratom dosing

Dosing ranges were frequently mentioned (n=137/280). However, specific doses that occurred within a 24-hour period could only be established for 62/280 posts. These ranged from 1.0 to 100.0 grams (mean=17.9, SD=21.6; transformed mean=2.26, SD=1.13). Higher doses were associated with greater odds of professed kratom addiction OR=3.56 [1.84,6.87], $p<.001$), greater odds of kratom withdrawal OR=5.88 [2.42,14.29], $p<.001$) and slightly lower odds of desirable kratom effects OR=0.53 [0.32,0.88], p=.014). See supplementary material for full model fit measures and coefficients. Doses were also discussed in-text as escalating (n=42/280) or being titrated over time (n=22/280).

4.0   Discussion

This study examined Reddit posts made between June 2019-July 2020 in order to determine if independent descriptive accounts were generally consistent with prior survey findings. As discussed more below, these Reddit data both converge *and* diverge from previously reported survey findings. Overall, the most relevant kratom posts from the subreddits sampled were consonant with prior survey findings and items, partially supporting the use of such items. This is evidenced by the fact that no *a priori* code was unapplied. It is also evidenced via the direct quotes provided in Table 2 which provide rich personal perspectives related to many prior survey work (e.g., kratom used to mitigate opioid withdrawal). Data examined here suggest experiences with kratom vary widely. For instance, people during different stages of use conceptualized and discussed kratom in more or less positive regard with respect to effects. This is indicated by conflicting accounts of optimal doses and attitudes towards kratom on top subreddits. Many prospective kratom users expressed positive and hopeful sentiments about kratom, while current and former users expressed conflicting opinions about kratom's short- or long-term therapeutic potential when balanced against adverse effects and addictive properties.

4.1.   Similarities between Reddit posts and U.S. survey data

Our findings overlap with some findings from large online surveys and smaller focused surveys of kratom-using adults in the U.S. with respect to motivations for use and desirable effects (Garcia Romeu et al., 2020; Grundmann; Coe et al., 2019). These include self-treatment for pain, psychiatric, or SUD symptoms. It is noteworthy that these are found across large U.S. surveys and convenience samples in SEA (Bath et al., 2020; Boyer et al., 2008; Coe, et al., 2019; Garcia-Romeu, et al., 2020; Grundmann, 2017; Singh et al., 2019; Singh et al., 2017; Smith & Lawson, 2017; Veltri & Grundmann, 2019), but also here, meaning that Reddit posts made independently and without the possibility of certain (but not all possible) biases help validate prior work. Thus, preliminary evidence about kratom use motivations is converging to indicate that use initiation and continued use occurs for primarily pragmatic forms of self-treatment or drug substitution, rather than primarily hedonic or recreational reasons (Grundmann, 2017; Prevete et al., 2021; Smith & Lawson, 2017). Here and elsewhere, using kratom for "euphoria" or expressing preference for kratom compared to other drugs to achieve a recreational "high" is not *absent*, but does not appear to be a *primary* driving factor or widespread when looking at the preponderance of findings (Coe et al., 2019; Prevete et al., 2021; Smith & Lawson, 2017; Singh et al., 2021; Swogger et al., 2015).

4.2.   Attenuating opioid withdrawal symptoms or self-treating SUD as primary motive for use

Among the most relevant kratom subreddits, none described motivations for high-risk misuse (e.g., intravenous use). Although it is likely that some people had primary motivations for use other than self-treatment, these could not be easily discerned. Still, one of the greatest distinctions between these findings and those from U.S. surveys is the degree of self-reported polydrug use that included kratom and at least one other licit or illicit substance, which warrants further study.

Perhaps the greatest point of divergence of these findings from those of U.S surveys is that a majority of people posting on kratom subreddits attributed primary reasons for use as a self-treatment of opioid withdrawal or illicit drug substitution more frequently than other motivations. Although many kratom-using adults express multiple motivations for use, survey findings largely indicate greater self-treatment for physical health conditions, pain, psychiatric symptoms, mood improvement, or *licit* opioid supplementation or substitution (Bath et al. 2020; Grundmann et al., 2017). In this sample, these were represented, but at lower rates, appearing similar to findings from Smith & Lawson (2017) which surveyed treatment-enrolled adults with illicit polydrug use history. Here, many people reported using kratom for both licit *and* illicit opioid withdrawal and self-treatment, rather than primarily medically prescribed opioids. These specific findings, somewhat contrasting those of large online surveys, could be due to our examining unsolicited self-report data about kratom from a population that included prospective, active, and remitted users which may be more difficult to reach, and which have been less explored than active, regular users who may be using for ongoing health conditions and more likely to self-select into kratom survey studies.

Kratom was consistently conceptualized as an opioid and sometimes associated with adverse effects similar to those derived from traditional opioids (e.g., GI upset, fatigue, memory impairment), albeit with less perceived or actual acute risk (e.g., likelihood of overdose). Kratom was also characterized as having the capacity to substitute for prescription opioids and heroin, which converges with preclinical work and self-report (Ahmad & Aziz, 2012; Hassan et al.,2013; Hemby et al., 2019; Ismail et al., 2017; Kamble et al., 2021; Maxwell et al., 2020; Obeng, et al., 2020; Singh et al., 2015, 2018a, 2018c; Vicknasingam et al., 2020; Wilson et al., 2021; Yue, Kopajtic, & Katz, 2018). For some, there were clearly enduring therapeutic benefits from "self-treating" with kratom that people believed achieved their desired result, including abstinence.

4.3. Adverse effects, tolerance, withdrawal, and perceived addiction

From the limited dosing data analyzed, positive effects appeared to be mediated by dose, with more beneficial effects at low to moderate doses. Still, in the context of dosing, many reported developing kratom tolerance and increasing their dose, or dosing frequency, to achieve desired effects previously felt at lower doses. Although adverse effects and withdrawal symptoms characteristic of those derived from traditional opioids have not been reported with the same incidence with respect to kratom in U.S. survey findings (Garcia-Romeu et al., 2020; Grundmann, 2017)-- but have been found among some SEA samples of regular, long-term users-- our findings are differentiated in that we identified specific, kratom-related adverse effects. Many were similar to those expected from traditional opioids (e.g., nausea, vomiting, fatigue), though these primarily ranged from mild to moderate. Specific adverse effects included tolerance, moderate withdrawal, and professed addiction. These are in keeping with limited findings from SEA and U.S. case reports but diverge from U.S. survey findings (Singh et al., 2014; Stanciu et al., 2019; Weiss & Douglas, 2021). DSM-5 use disorder for kratom could not be assessed using Reddit data, but that a majority of posts described aspects of SUD or descriptions of *feeling* "addicted" to kratom is a departure from one prior U.S. finding which indicated that most regular kratom-using adults sampled did not experience symptoms characteristic of addiction, when using a

modified DSM-5 SUD checklist (Garcia-Romeau et al., 2020). It is important to note that while tolerance and withdrawal are two DSM-5 diagnostic criteria for SUD, they are not necessarily indicative of SUD---meaning that tolerance and withdrawal descriptions cannot be presumed an indicator of misuse. Still, some believed they were addicted and articulated impairments in psychosocial functioning related to use. It is important to not diminish or delegitimize such perceptions, even if conceptualizations of "addiction" among people on Reddit may not correspond to clinical nosology. That some felt that they had a problematic relationship with kratom characteristic of addiction are sentiments that have not been widely documented. Our findings from top kratom subreddits, though limited, suggest that current U.S. kratom literature may be underestimating some adverse effects, specifically potential for developing kratom use disorder. That kratom dependence and withdrawal have been documented in case reports (Stanciu et al., 2019; Weiss & Douglas, 2021), but not on large-scale surveys, means further exploration is warranted, particularly among younger people and people with histories of polydrug use or SUDs.

4.4. Limitations

This study has several limitations. First, data were collected solely from Reddit. By examining Reddit posts, we were able to capture nuanced accounts of kratom from a more diverse group of current, former, and prospective kratom-using adults than previous work permitted. Still, Reddit is a platform that people self-select to engage with, presenting one bias. Indeed, these posts may not be representative of most people's experiences with kratom, or of the broader kratom-using U.S. population, (which may be considered a strength as well as a limitation) and might differ from accounts of kratom from another online source (e.g., chronic pain forum). Posts also did not contain demographic information or location; although it appears that most posts were written by Americans. It is also likely that most people posting were likely younger or male (Bunting et al., 2021; Pew Research Center, 2019; Vosburg et al., 2021). Additionally, posts were examined for only a one-year period. Because kratom products and use continue to evolve, social media data should be examined regularly. In future work, exploring Reddit posts with less community interaction, which failed to meet our criteria for relevance, may be another point for exploration. That people used kratom contemporaneous to or concomitantly with other substances makes scrutinizing reported effects (good or bad) challenging, if not impossible. Information on reported daily dosage could be only gleaned from a limited number of posts, meaning that dose-effect relationships should be interpreted with caution pending further study of dose-response effects. Quantitative analyses only examined a small number of posts, lowering the overall confidence with which those estimates could be made. Those exploratory findings should be considered a preliminary starting point for larger, more precise investigations.

4.5. Conclusion: It's complicated....

The detailed accounts of people posting on Reddit about kratom analyzed here, while different in some respects from U.S. survey findings, echo a similar takeaway: kratom is a complex and diverse plant and its use among U.S. adults is equally complex and diverse. As kratom pharmacology continues to be explored via preclinical investigations (Hassan et al., 2013; Hemby et al., 2019; Ismail et al., 2017; Kamble et al., 2021; Maxwell et al., 2020; Obeng, et al., 2020; Wilson et al., 2021; Yue, Kopajtic, & Katz, 2018), human studies reliant

on self-report must continue and must become increasingly methodologically refined (e.g., including purposeful sampling and designs beyond cross-sectional). Our findings partially validate large online surveys insofar as survey questions could be used to code kratom Reddit data with high agreement. Our *a priori* codes based largely on prior surveys were found along with related subcodes (e.g., self-treatment for anxiety). The heterogeneity of the broader kratom-using population was refined here.

Ultimately, kratom subreddit posts contained complicated narratives that do not make for simple characterizations. For some, kratom was lifesaving and for others it was ruinous, or yet another substance to which they had become beholden. Like other findings, the (provisional) takeaway is that it is premature to laud kratom as a cure-all and equally premature to demonize it as a dangerous substance with risk that outweighs benefit. At base, this stems from insufficient information, but also from the fact that "kratom" in the U.S. constitutes many different products with variability in alkaloid content, composition, and purity (Fowble & Musah, 2019; Griffin et al., 2016). Findings reinforce the current scientific consensus, which is that kratom is a highly varied psychoactive substance being used in different doses and for different reasons among a diverse group of people that we are only beginning to understand. Areas for focused work include those related to dose, opioid substitution efficacy, dependence, withdrawal, and addiction. In-depth qualitative work, ecological momentary assessment, and longitudinal studies can also help inform the controlled human laboratory studies critically needed to move this area of research forward.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Kratom was often used to self-treat opioid withdrawal or as an opioid substitute.

- Polydrug use that included kratom and at least one other substance was common.

- Kratom was perceived as lifesaving, but also potentially addictive.

- Kratom dependence and withdrawal symptoms were described in detail.

- Most used kratom for pragmatic health reasons, rather than to achieve euphoria.

Code	Concordant	Discordant	Total Codes Applied	% Agreement
Desirable kratom effects	137	32	169	81.07
Kratom dosing	120	17	137	87.59
Escalating dose over time	40	2	42	95.24
Titrating dose over time	14	8	22	63.64
SUD or dependence on non-kratom substance	104	29	133	78.20
Self-treatment for opioid drug withdrawal	85	18	103	82.52
Self-treatment for other drug withdrawal	11	6	17	64.71
Kratom as long-term opioid substitute	34	4	38	89.47
Self-treatment for chronic pain symptoms	53	5	58	91.38
Reports psychiatric symptoms or history	40	18	58	68.97
Self-treatment for depression	24	8	32	75.00
Self-treatment for anxiety	29	6	35	82.86
Self-treatment for other psychiatric symptoms	4	3	7	57.14
Polydrug use with kratom	130	25	155	83.87
Professed kratom addiction	160	23	183	87.43
Kratom Withdrawal	69	17	86	80.23
Kratom Tolerance	39	2	41	95.12
Adverse kratom effects	75	4	79	94.94
Desire to quit kratom	36	7	43	83.72
Quitting kratom	41	12	53	77.36
Kratom regulation discussion	28	2	30	93.33
Total	**1,273**	**248**	**1,521**	**83.69**

Table 2.

A sample of quotes from top kratom subreddit posts made between June 2019 to July 2020 detailing kratom self-treatment, kratom opioid substitution, and kratom addiction, tolerance, and withdrawal.[±]

Kratom self-treatment for SUD, drug dependence, or drug withdrawal	Long-term use as opioid substitute	Kratom addiction, tolerance, and withdrawal
"I had a comparable experience switching to kratom. I went *cold turkey* off 100 mg of METHADONE, and it worked 100%. There were no withdrawals, and even a little relaxation and euphoria." "I'll admit, kratom absolutely helped me decrease my daily amount from around 600mg to around 300mg, but I still have a long way to go." "After realizing that 100mg of hydro at once wasn't even doing the trick anymore, I "quit" using it with the help of kratom, the "fantastic and not at all harmful" plant. Two years of excessive kratom use later; I was forced to quit by way of a six-month backpacking trip to South America." "I've been taking it since the first day of withdrawal, and it makes me feel ALMOST entirely normal. I still feel slightly out of it, but have been experiencing no chills, shits, global apathy, or body pain. Though I'm still taking quite a bit at once." "in the last three to four months I've begun IV use and it could just be me, but the withdrawal seems so much worse now. Kratom is barely helping at this point" "I took kratom for several weeks and that really sustained me, likely couldn't have quit [hydrocodone] without it." **Self-treating alcohol abuse with kratom** I went into a drinking spiral that went on for 2 years, but I gave it up about 9 months ago. My friend told me to try kratom for withdrawals, and it really really helped. A lot. I haven't had the urge to drink since then. Still, I nearly killed myself on several occasions when I was still drinking. Kratom has helped me stay sober, and I'm never going back to that life. "I was arrested again after blacking out, so I finally made the decision to not drink alone anymore - like most of my drinking for the last twelve years. I considered getting totally sober, but I have a medical weed card so there's constant access and when alone, I know I can't be sober for very long. Kratom has mostly relieved my withdrawals, so that's good."	"So now I've totally stopped using traditional opiates and opioids (I still take kratom, and plan to use kratom so long as availability persists). It easily changed my life." "Essentially, compared with my relationship to alcohol and compared with others' drug habits, kratom is a miracle. My life has become infinitely better - my job, marriage, really all of my relationships, fitness, general happiness. I use kratom once a day and sometimes take days off to get better effects. It saved my life." "I let my doctor know that I've been using kratom for around two years for medicinal purposes and it does wonders to help me avoid using other opioids." "I dosed 1.5g twice on my first day, and I thought, "no way". I didn't have restless legs. and my anxiety was lessened. It felt subtle, but oh my god, it was working!! I'm on my fourth day of kratom, and it is working. It's been a miracle to me. I even passed up a connection for pills. I could never do this without kratom." "I am so grateful for Kratom and thankful that I don't have the temptation to search for pills whenever I visit someone's home. I'm so thankful I no longer get late night panic attacks thinking of the opioid feelings. I'm so thankful I don't have to contend with the constant urge to get back into what I left behind." "Without kratom I would certainly be a drunken wreck today. I really wish more people were aware of kratom and how much it helps." "I felt so fucking hopeless about ever living a normal life again. Heroin held its grip on me, and I was stuck. Some time passed and after some help from friends and family, I found kratom. Kratom relieved nearly all of the withdrawals and I got clean without feeling too sick. I was home free after the first 3-4 days I was home free."	"In retrospect, I was addicted within six months, but I wouldn't even consider the possibility until about 2 years ago, and it's only been during the most recent weeks that I have admitted that this is an addiction." "I now average around 3g - 4g per day and have for around two years so I can't speak for people that use more, but physical withdrawals are typically minor (like a cold) and last three to four days. I'm sure if you're using 50g per day, they'll be much worse." "Coming down off kratom feels similar to that of a mild anti-depressant and mild opiate... also reminiscent of Tramadol." "The dependency is so fucking real both mentally and physically" "I've been off kratom for a year, but remembering the days when I was actively addicted scares me. I had little to no control over my impulses, emotional control, stuttering, poor comprehension, memory problems, and a short attention span." "I take up to 20 grams/day now, but I re-up every couple hours and withdrawal hits really quick. I start to feel extremely uncomfortable and anxious after going more than two hours without kratom, and every morning I wake up in agonizing withdrawal. I had a full blown panic attack the last time I attempted quitting, causing my mental health to spiral out of control." "This week I have cut down to 2.5g doses, and when the withdrawals are at their worst, I use about 16g per day (which is good for me). The withdrawals kick in at night are the most troublesome, and I'm having to dose at 2am then 6am. The restless legs and the agitation are the most severe - right along with the hot sweats and cravings to use more and make all the pain go away." "Emotionally, it feels good to have told them, but physically, this is absolute complete hell. The worst part is the painful tingly feeling on my skin - on my arms but all over, lack of appetite, and the blacking out that happens from being dizzy when I stand up. I used to get that feeling as a runner, before I started using kratom but forgot how extreme it is. I can't even focus on the show I planned on watching." "It's difficult to explain to people that haven't experienced withdrawals of any kind. People understand having lethargy, aches, a runny nose, or nausea. Much harder to portray is the anxiety, restless legs, and sense of uneasiness, which is far and away the worst - especially when trying to sleep at night. It's brutal when the seconds feel like hours. I struggle to explain how it actually feels even worse than what it sounds." "I attempted a taper, but it didn't work, and now I'm having severe withdrawals, anxiety, diarrhea, hot/cold sweats and the infamous legendary restless legs syndrome." "My problem began when I no longer got the same feelings and effects that I had originally. I started using more and was shocked to see that before long, I was taking approximately 12g, four times a day."

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[+]Upon recommendation the quotes that appear in this table do not appear verbatim. Some were taken from longer post excerpts. All have been slightly modified to help safeguard the privacy of the people who posted on Reddit and whose data were examined as part of this investigation (e.g., making reverse searching the posts more challenging). We have done this while attempting to retain substance and richness as close to the original post as possible, which is of scientific and clinical interest.

Table 3.

Desirable effects, adverse effects, and withdrawal symptoms associated with kratom use that appeared at least once among the sample of kratom subreddit posts (N=280) made between June 2019 to July 2020.

Desirable effects	N	%	Adverse effects	N	%	Withdrawal symptoms	N	%
Increased energy	7	16%	Nausea	4	12%	Muscle aches	7	29%
Mood enhancement	8	18%	Vomiting	6	18%	Muscle spasms	2	8%
Relaxation and sedation (anxiolytic)	9	20%	Poor taste	9	27%	Insomnia	5	21%
Decreased feelings of depression	4	9%	Increased apathy	8	24%	Anxiety	10	42%
Decreased feelings of anxiety	5	11%	Irritability	5	15%	Depression	7	29%
Improved cognitive function (e.g., focus)	4	9%	Feelings of anxiety	4	12%	Runny nose	4	17%
Boosted productivity	3	7%	Feelings of depression	3	9%	Perspiration	3	13%
Pain relief/analgesia	5	11%	Fatigue	2	6%	Hot flashes	4	17%
Sleep aid	3	7%	Lethargy	4	12%	Chills	4	17%
Euphoria	8	18%	Itchy skin	2	6%	Irritability	6	25%
Improved Sexual performance	2	5%	Lapses in memory	2	6%	Hostility	3	13%
			Insomnia	2	6%	Aggression	2	8%
			Restlessness	3	9%	Fatigue	3	13%
			Increased heart rate	3	9%	Lethargy	4	17%
			Decreased libido	6	18%	Pins and needles (paresthesia)	2	8%
			Increased urine retention	1	3%	Loss of appetite	5	21%
			Increased urination	1	3%	Sense of uneasiness	9	38%
			Constipation	1	3%	Dizziness	1	4%
			Decreased motivation	5	15%	Nausea or vomiting	5	17%
			Decreased impulse control	2	6%	Vomiting	1	4%
			Liver injury	2	6%	Diarrhea	2	8%
			Headache	2	6%	Restlessness	3	13%
						Restless leg syndrome	5	21%
						Craving	3	13%
						Suicidal Ideation	2	8%

Table 4.

Frequencies for drug classes appearing in a sample of kratom subreddit posts (N=280) made between June 2019 to July 2020 related to kratom use and/or kratom polydrug use.

Drug Class	N (out of 280 total posts sampled)
Stimulant	103
Opioid	91
Benzodiazepine	55
Cannabinoids	42
Hallucinogen	31
Psychedelic	30
Nootropic/Supplement	28
CNS Depressant	16
Designer Drug / Benzodiazepine	11
Designer Drug / Stimulant	12
Antidepressant	9
Antitussive	7
General Anesthetic	7
Inhalant	6
Sedative	6
Antidepressant / Opioid	5
GABA analog	5
Sedative / Antihypertensive	4
Antipsychotic	3
Muscle Relaxant	2
Nonbenzodiazepine	2
Anti-diahrreal	1
Beta Blocker	1
Nasal Decongestant	1