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# Identification and Characterization of Illegal Sales of Cannabis and Nicotine Delivery Products on Telegram Messaging Platform

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## Abstract

**Introduction:** Unregulated and potentially illegal sales of tobacco, nicotine, and cannabis products have been detected on various social media platforms, e-commerce sites, online retailers, and the dark web. New end-to-end encrypted messaging services are popular among online users and present opportunities for marketing, trading, and selling of these products. The purpose of this study was to identify and characterize tobacco, nicotine, and cannabis selling activity on the messaging platform Telegram.

**Methods:** The study was conducted in three phases: (1) identifying keywords related to tobacco, nicotine, and cannabis products for purposes of detecting Telegram groups and channel messages; (2) automated data collection from public Telegram groups; and (3) manual annotation and classification of messages engaged in marketing and selling products to consumers.

**Results:** Four keywords were identified (“Nicotine,” “Vape,” “Cannabis,” and “Smoke”) that yielded 20 Telegram groups with 262 506 active subscribers. Total volume of channel messages was 43 963 unique messages that included 3094 (7.04%) marketing/selling messages. The most commonly sold products in these groups were cannabis-derived products (83.25%,  $n = 2576$ ), followed by tobacco/nicotine-derived products (6.46%,  $n = 200$ ), and other illicit drugs (0.77%,  $n = 24$ ). A variety of marketing tactics and a mix of seller accounts were observed, though most appeared to be individual suppliers.

**Conclusions:** Telegram is an online messaging application that allows for custom group creation and global connectivity, but also includes unregulated activities associated with the sale of cannabis and nicotine delivery products. Greater attention is needed to conduct monitoring and enforcement on these emerging platforms for unregulated and potentially illegal cannabis and nicotine product sales direct-to-consumer.

**Implications:** Based on study results, Telegram represents an emerging platform that enables a robust cannabis and nicotine-selling marketplace. As local, state, and national tobacco control regulations continue to advance sales restrictions and bans at the retail level, easily accessible and unregulated Internet-based channels must be further assessed to ensure that they do not act as conduits for exposure and access to unregulated or illegal cannabis and nicotine products.

## Introduction

Recent research and investigative journalism has discovered that the use of Internet technologies—including websites, e-commerce platforms, social media channels, and the darkweb—have enabled access to unregulated and potentially dangerous tobacco, nicotine, and cannabis delivery devices and products.<sup>1,2</sup> Though illegal or unauthorized smoking and vaping products pose a clear public health risk, the ubiquity of the Internet and social media platforms has created an environment where direct-to-consumer marketing and sales can bypass regulatory and state license control systems because of ease of accessibility, lack of proactive monitoring and

enforcement by platforms and regulators, and greater anonymity for sellers.<sup>3–5</sup>

This includes potentially targeting at-risk populations, such as adolescents and young adults, who are active users on social media platforms where tobacco and vaping marketing exposure has already been widely reported.<sup>6–8</sup> Specifically, unsanctioned marketing and sale of vaping products using social media sites including Twitter, Instagram, and TikTok can be difficult to regulate. This is because of the varying types of content created on these platforms, the highly unstructured nature of user-generated data, and the general lack of adequate enforcement by technology platforms to remove

tobacco and nicotine product promotion content, particularly when generated by individual sellers.

Launched in 2013, Telegram, is a free and open-source user-focused social media application that is cross-platform, encrypted, cloud-enabled, and is commonly used as an instant messaging, chat, and video calling platform.<sup>9</sup> According to existing market research, in 2022, Telegram had over 700 million active users and was one of the top 5 downloaded applications globally.<sup>10</sup> It has also been reported that 31% of Telegram users are between the ages of 25 and 34 and that the top 3 countries with the most downloads of the application in 2023 were from India, Russia, and the United States.<sup>11</sup> Similar to other social media and messaging application platforms, users search for channels (ie, one-way communication channels, where only the administrator can post) and groups (ie, two-way communication channels, where all administrators or users who join the group can post), using a built-in search engine function directly on the Telegram application. Depending on the settings of the Telegram channel or group, users can then request to join (ie, a private channel or group) or simply directly participate in a group (ie, public channel or group) and also message other users in the group (ie, channel messages). Users can also interact with other users privately through encrypted direct messages. Hyperlinks to specific Telegram channels and groups can also be shared by users to invite greater participation.

Telegram also allows for developers to engage in building and publishing their own in-platform applications as well as deploying bots on the platform.<sup>12</sup> Moreover, the platform is also known for its instant messaging application that offers strong end-to-end encryption software to ensure privacy of user messages, voices, video calls, and communications in channels or groups that are created to host content.<sup>9</sup> These Telegram channels and groups are self-created by users and as aforementioned, can be organized as freely accessible public or closed private channels or groups that broadcast information to both small and large audiences of users.<sup>13</sup> The anonymity and security offered by Telegram are strong appealing factors to encourage user engagement, but can also be used for unregulated and illegal online commerce and interactions.<sup>14</sup>

While many Telegram channels and groups have legitimate uses, they can also harbor suspicious, dangerous, and criminal activity. For example, it has been reported that in 2016, Islamic States of Iraq and the Levant militants and sympathizers moved from Twitter to Telegram to propagate radical terrorist ideology and coordinate operations through hundreds of groups that often pushed over 30 000 Telegram channel messages per week.<sup>15</sup> Additionally, the trade of illicit products and services on Telegram has widely been reported, with cybersecurity company investigations revealing that cybercriminals have exploited platform features, including its encryption and use of groups, to sell various illegal goods (eg, fake documents, COVID-19 vaccines, narcotics, and so on).<sup>16–18</sup>

While previous studies have examined the use or exploitation of different social media platforms, online influencers, and website results from Internet search engines implicated in the unregulated and illegal sale of different tobacco, nicotine, and cannabis products; the literature is extremely limited in studies specific to messaging applications that have public channel or group functions such as Telegram.<sup>3–5,19–23</sup> Specifically, no existing published research to our knowledge has analyzed Telegram data to characterize possible illegal

direct-to-consumer sales of tobacco, nicotine, and cannabis products despite identified risks of cybercrime and other illegal activities occurring on the platform. In response, this study conducted a multiphase structured data collection, content analysis, and simulated purchase study to identify and characterize sales of tobacco, nicotine, and cannabis products on Telegram.

## Methods

The study was conducted in three phases: (1) automated data collection from public Telegram channels and groups to identify and characterize selling activity using general search keywords related to tobacco, nicotine, and cannabis terms; (2) manual annotation and content analysis of channel messages to detect offers for marketing and selling of tobacco, nicotine, and/or cannabis products direct-to-consumer; (3) and conducting a separate content analysis and simulated purchase assessment of hyperlinks in user messages to assess if linked websites were engaged in the sale of tobacco, nicotine, and/or cannabis products. Further, we conducted statistical testing to determine if there was an association between certain Telegram groups and product types sold via linked websites.

## Data Collection

We first conducted structured Telegram search queries using the built-in search function on the Telegram application as downloaded and installed on a dedicated computer device. For detection of the broadest possible sample of data for the study topic of interest, we used four general keywords, “Nicotine,” “Vape,” “Cannabis,” and “Smoke,” which were used in structured keyword searches and returned results for related Telegram groups. For each Telegram group identified from the Telegram search algorithm results, the group-specific hyperlink was manually copied from the biography page of the group, and the group was inspected and validated to ensure that the link had not expired. Only groups considered “public,” meaning that permission to join the group was not required and any public user could freely participate in the group by simply clicking on a link to the group, were analyzed.

For these public groups, the exporting feature was set to enabled, which allowed for exporting the group user messages, which when exported were labeled as “channel messages.” Exported data for channel messages also included channel message ID, channel message content, channel message data, channel message from user (if available), and channel message from user id (if available). It also included additional media or attached files, which could include “Photos,” “Videos,” “Voice messages,” “Video messages,” “Stickers,” “GIFs,” and “Files” for any publicly available data. The exported file size was set to the maximum of 4GB and the file format was set to “JSON.” Any public channel message chat files from each group were then exported separately.

Following data collection from groups returned by structured searches, scripts written in the Python programming language were used to clean the data and translated all foreign language messages to English using the Google Translate integration feature built into data files populated on Google sheets. The data collection period of the study began on August 7 and continued until August 20, 2022, which included the

collection of any retrospective data available prior to these dates as posted to these groups.

## Data Analysis

### Manual Annotation and Analysis

All unique Telegram channel messages from groups ( $n = 43\,963$ ) were manually annotated to confirm if they included content engaged in the promotion and sale of tobacco, nicotine, or cannabis delivery products. The study relied on human annotation with coders experienced in detection and characterization of illegal and unregulated online sale of health products as there are few published studies specifically examining Telegram on this topic and there are no publicly available data sets that could be used to classify this content using other strategies (eg, supervised machine learning, additional data filtering/mining, and so on).<sup>24</sup>

To better streamline the coding process, an inductive coding schema was applied to only unique channel messages collected from the Telegram groups. First, a binary coding classification was used to identify any channel messages that were clearly associated with promotion and selling of products by using an inclusion criteria used in prior studies assessing if content included: (1) explicit selling queues (eg, text related to buying, selling, placing an order, pricing, and so on); (2) identified a specific tobacco, nicotine, cannabis, or other drug-related product; and (3) if content included ways to transact with the seller (eg, direct message, personal contact information, hyperlink to external site to purchase, and so on) and/or information about ordering or shipping information.<sup>3,25–28</sup> After this binary coding approach was completed, all channel messages that met the inclusion criteria ( $n = 3094$ ) were then inductively coded for subcodes associated with product type identified and other characteristics of interest described in the message. First and fourth authors coded all Telegram content independently and achieved a high intercoder reliability ( $\kappa = 0.97$ ).<sup>29</sup> In case of inconsistent results, authors reviewed and conferred on the correct classification with the last author to achieve consensus on classification.

Subcodes for channel messages classified as relevant to product selling included assessing the: (a) product type offered for sale, including subcategories of specific tobacco, nicotine, or cannabis products or inventory mentioned; and (b) channel messages or chats that were identified as selling items through website links (ie, hyperlinks, URLs) that underwent further web content and simulated purchasing analysis (described below). Fisher's exact test was used to identify any possible association between product type being sold and types of Telegram groups where channel messages were posted to determine if there were any significant proportional differences in the product types sold by different groups. These characteristics were chosen on the basis of assessing whether a particular product type was more likely to be sold by a specific group type or product topic. Statistical analysis was conducted using RStudio version 4.1.2.

### Website Content Analysis for Age Verification and Simulated Purchase

All hyperlinks originating from Telegram groups, channel messages, and associated chat messages obtained during the data collection and coding classification were further analyzed using website content analysis and a simulated online purchase process as used in prior studies examining illegal

nicotine and cannabis product sales online.<sup>4,30</sup> Hyperlinks were reviewed through a separate web browser and coders reviewed websites to determine if they were engaged in selling (eg, presence of a product list and shopping cart) and if they specifically offered tobacco, nicotine, or cannabis products. Additionally, websites were reviewed for any form of age verification utilized (additional details below) and the location of their Internet Protocol (IP) address as queried using publicly available data from the WHOIS database that provides information on domain registrations of websites managed by ICANN.

After identifying websites linked to Telegram channel messages engaged in product sales, the first and third authors conducted simulated online purchases for those websites. Simulated purchases consisted of browsing for and selecting a relevant tobacco, nicotine, or cannabis product that was advertised on the Telegram channel message from the website, placing it in the website's e-commerce shopping cart, proceeding through the purchase process, and terminating the purchase process once the online ordering process was denied or approved for confirmation of payment. For purposes of simulating the purchasing transaction process without actually buying the product, authors used a credit card number generator that is typically used for e-commerce testing purposes. The majority of transactions using the number generator ended with the payment being denied at point-of-sale but nevertheless evidenced the site's ability to proceed through the order process. For transactions that received a confirmation of payment message despite the number generator card information not being valid, no separate order confirmation was received, and no product was ever shipped to authors.

## Results

A total of 20 Telegram groups were identified using the four keywords selected for this study. Combined, a total of 262 506 users were actively subscribed to these 20 groups at the time of data collection. From these groups, a total of 70 884 channel messages were obtained, of which 43 963 (62.02%) were unique channel messages (ie, not duplicate messages or chats). After manual annotation using our inductive coding approach based on our inclusion criteria, 3094 (7%) channel messages were identified as engaged in the direct-to-consumer marketing and sale of a tobacco, nicotine, cannabis, or other illicit drug product (see Figure 1 for examples of channel messages).

The highest volume of channel message selling posts (64.60% of all selling messages,  $n = 1999$ ) were detected in searches for the term "vape," which included groups selling both cannabis and nicotine vaping products. In contrast, using the general search term "cannabis," only one group was identified from returned search results that included channel messages with online selling activity, yet it had the highest proportion (92.81%,  $n = 142$ ) of unique messages with marketing and selling activity compared to content generated by other keywords. Searches for the general term "smoke," included the most diversity of products, though cannabis products still made up the majority (83.25%,  $n = 2576$ ) of selling messages (see Table 1 for summary of results by search keywords and product types). The proportion of channel messages selling CDPs in the cannabis keyword groups was significantly higher than that in vape and smoke keyword groups ( $p < .001$ ). Additionally, the proportion of messages

 <p>WHITE GUAVA GELATO 1200/P 1150/10+</p>	<p>Cannabis flowers sold in bulk.</p>
 <p>100 [redacted] \$1000</p>	<p>THC vapes sold in bulk.</p>
 <p>Even if you don't see it on the menu just ask.....</p>	<p>Nicotine vapes (described as “off menu”).</p>
<ul style="list-style-type: none"> <li>🍏 Apple mango pear</li> <li>🍌 Blueberry yogurt</li> <li>🍿 Caramel popcorn</li> <li>🍇 Grape blackcurrant</li> <li>🍇 Mango grape</li> <li>🍌 Mango pineapple peach</li> <li>❄️ Melon ice</li> <li>🍷 Orange soda</li> <li>🍷 Raspberry lemonade slushie</li> <li>🍏 Red apple guava</li> <li>🍓 Strawberry coconut pineapple</li> <li>🍉 Strawberry watermelon bubblegum</li> </ul> <p>Для заказа:</p> <p>👉 [redacted]</p>	<p>Menu of flavored vaping products.</p>

**Figure 1.** De-identified examples of direct-to-consumer selling channel messages.

selling tobacco/nicotine products in vape groups was significantly higher than that in smoke groups ( $p < .001$ ).

A host of different types of products were detected as being sold on Telegram including various vapes, cartridges, and different CDPs including flowers, edibles, pre-rolls, and

concentrates. The four parent categories of specific products identified included: (1) CDPs; (2) tobacco/nicotine-derived products; (3) illicit drugs (eg, cocaine, MDMA, LSD); and (4) other products, which were not drugs, tobacco, or cannabis products (eg, coils, batteries, accessories). The

majority (83.25%,  $n = 2576$ ) of selling channel messages were associated with the sale of various CDPs, followed by tobacco/nicotine-derived products (6.46%,  $n = 200$ ). Channel messages marketing and selling illicit drugs, such as cocaine, LSD, or MDMA, were less than 1% ( $n = 24$ ), an unsurprising result as the keywords utilized in this study for structured searches were not associated with illicit drugs and these products were not the focus of this study.

Among CDPs advertised for sale, cannabis flower was the most popular subproduct type, accounting for 61.5% ( $n = 1583$ ) of all CDP selling messages, followed by cannabis vapes (17.6%,  $n = 453$ ), and cannabis cartridges (14.6%,  $n = 377$ ) (see Table 2). Cannabis drinks, edibles, and combustible products accounted for less than 10% of all other CDP sales messages detected. Among the tobacco and nicotine-derived products sold, tobacco/nicotine vapes were the most popular subproduct type, accounting for 75.5% ( $n = 151$ ), followed by e-liquids (12.5%,  $n = 25$ ), and tobacco/nicotine cartridges (10.5%,  $n = 21$ ) (see Table 2). All of these tobacco/nicotine subproduct types included flavored products that may be banned in certain jurisdictions. Other miscellaneous tobacco/nicotine products such as cigars and hookahs constituted only 1.5% ( $n = 3$ ) of the products detected as advertised and sold.

Two specific categories of marketing and selling channel messages operationalized purchases including: (1) channel messages that included information in the text on how to make contact directly with a seller and enter into a transaction (eg, “DM me to purchase,” contact via phone/email, information to contact via other platforms/messaging apps); and (2) channel messages including information about products sold with a hyperlink to an external website

where buyers could enter into a transaction. The first category involves the initiation of contact with an individual seller, whether it be through direct messaging or chatting within the Telegram group or through contacting a seller via an alternative platform (eg, WhatsApp, Snapchat, Wickr, and so on) and comprised 99.54% ( $n = 3080$ ) of all selling messages. The second category, which only had 14 (0.045%) detected selling messages, adopts a traditional marketing approach by advertising a product in a channel message and then redirecting users to external websites where they can enter into a purchase via traditional e-commerce tools, such as viewing a product catalog, adding a product to a shopping cart, and transacting through entering payment and shipping information.

### Simulated Purchases and Age Verification

In total, 14 unique hyperlinks to external websites were identified from the “Vape” keyword groups. The hyperlinks redirected users to nicotine vape websites that purportedly sold electronic nicotine delivery devices (ENDS) direct-to-consumers via e-commerce platforms typically indexed by search engines (see Figure 2). Simulated purchases were conducted in September 2022 to identify if websites used age verification processes through their online ordering processes and to assess if purchase transactions could be simulated. All 14 websites identified had a form of age verification when entering the website. Over half (57.14%,  $n = 8$ ) mentioned accepting only  $\geq 18$  ages; five websites (35.71%) had a binary selection for ages  $\geq 21$ ; and one website had binary question for “legal age.” However, on further validation of additional age verification processes through simulated orders, over half

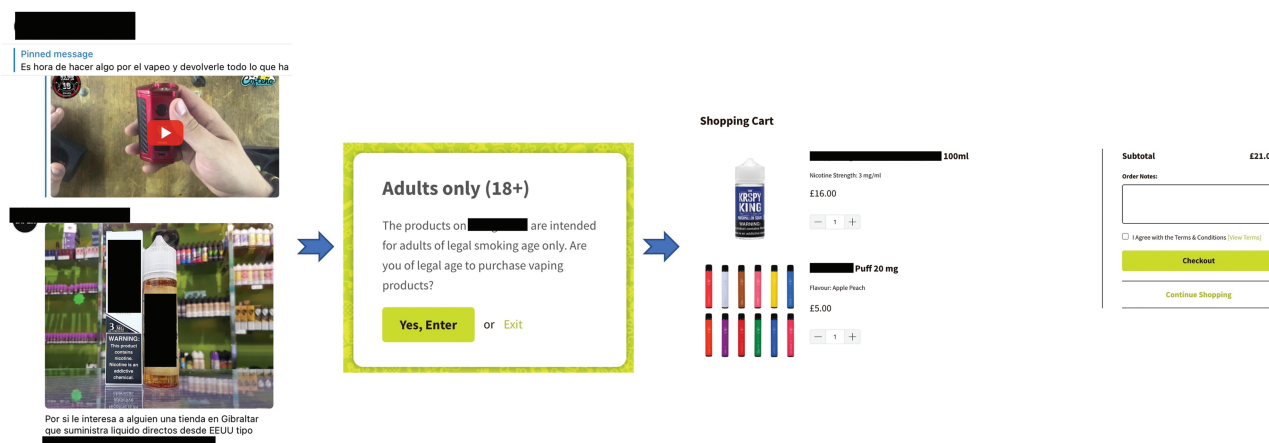
**Table 1.** Proportion of unique channel messages with selling content by search keyword and product type

Keyword groups	Groups identified*	Unique channel messages	Selling messages	Product type			
				Cannabis-derived products	Tobacco/nicotine-derived products	Illicit drugs	Other
Nicotine	6	16 017 (36.43%)	1	0	1	0	0
Vape	8	23 797 (54.13%)	1999	1634 (81.7%)	156 (7.8%)	1 (<0.01%)	208 (10.4%)
Cannabis	1	153 (0.35%)	142	140 (98.6%)	0	0	2 (1.4%)
Smoke	5	3996 (9.09%)	952	802 (84.2%)	43 (4.5%)	23 (2.4%)	84 (8.8%)
<b>Total</b>	<b>20</b>	<b>43 963</b>	<b>3094</b>	<b>2576 (83.25%)</b>	<b>200 (6.46%)</b>	<b>24 (0.77%)</b>	<b>294 (9.5%)</b>

\*Specific Telegram group names are not mentioned in order to ensure that these groups are not further promoted or used by the public to engage in the purchase of potentially illegal products.

**Table 2.** Types of cannabis-derived products and tobacco/nicotine-derived products sold on Telegram

Cannabis-derived products		Tobacco/nicotine-derived products	
Item type	N (%)	Item type	N (%)
Vape	453 (17.6%)	Vape	151 (75.5%)
Cartridge	377 (14.6%)	E-liquid	25 (12.5%)
Flower	1583 (61.5%)	Cartridge	21 (10.5%)
Consumption (drinks, edibles)	103 (4.0%)	Miscellaneous (cigars, hookah, external links)	3 (1.5%)
Combustible products (prerolls)	30 (1.2%)		
Miscellaneous (mixture, concentrate)	30 (1.2%)		
<b>Total</b>	<b>2576</b>	<b>Total</b>	<b>200</b>



**Figure 2.** Simulated order process from e-commerce website.

of the websites (64.29%,  $n = 9$ ) did not require any form of ID verification at point-of-sale (ie, providing proof of age or identity to finalize order). Of the websites that did not require any form of ID verification, 33.33% ( $n = 3$ ) were located in the United States with the remaining 66.67% ( $n = 6$ ) with IP servers located internationally in Spain ( $n = 4$ ), Canada ( $n = 1$ ), and Germany ( $n = 1$ ).

## Discussion

To the author's knowledge, this is the first study to identify, characterize, and report marketing and sales of cannabis, tobacco, and nicotine products on the social media and instant messaging service platform Telegram. Most published literature examining Telegram has focused on its use for healthcare communication and education, to disseminate hate speech, disinformation, and conspiracy theories, analysis of user reporting of health behaviors (eg, adverse events for vaccine, discussions related to COVID-19), use to mobilize social movements and protests, and a study examining online psychoactive substance trade on the platform.<sup>31–46</sup> This study specifically identified direct-to-consumer sales of predominantly various CDPs and also a smaller volume of nicotine and tobacco products.

Distinctly different from legal and regulated sales of cannabis (that can generally only occur in the United States in jurisdictions where recreational or medical cannabis is legal and licensed and from reputable dispensaries or online sources) and tobacco and nicotine products (that generally require valid tobacco retail licenses), Telegram sellers exhibited high-risk activities known in illegal and black markets.<sup>47</sup> These high-risk characteristics included offering direct-to-consumer sale through direct seller contact, offering products in bulk purchases and not individual items, describing products as “off-menu” or directing users to contact sellers for additional items, and lack of age verification at point-of-sale for linked websites or individual selling posts. These results are consistent with prior studies that have also identified poor oversight and lack of enforcement of tobacco, nicotine, cannabis, and other drug sales online.<sup>3–5,27,30,48–51</sup>

In the context of specific tobacco and nicotine products detected, the general category of vaping products made up approximately three-quarters of all sales offers identified. When taken as an entire group of vaping products, e-liquids, and

nicotine cartridges, these products made up 98.5% ( $n = 197$ ) of all tobacco and nicotine product types detected, with only three sales messages consisting of other tobacco products (eg, cigars, hookah, and so on). Based on this exploratory analysis, we observed few offers for combustible and traditional tobacco products, though more research is needed to further assess the potential use of Telegram in the context of tobacco smuggling activities. Interestingly, the eight Telegram groups associated with the keyword “Vape” had selling messages predominantly associated with CDPs (81.7%,  $n = 1634$ ) compared to nicotine vaping products (7.8%,  $n = 156$ ). This may indicate that Telegram groups associate vaporizing as a modality for administration of substances primarily focused on cannabis and THC. This was similar for the groups derived from the keyword “Smoke,” where a similar split favoring CDPs versus nicotine products was observed.

Additional characteristics of concern included our finding that Telegram groups that were returned in our “Vape” and “Smoke” keyword searches also included content associated with the sale of illicit drugs. This may indicate that users searching for cannabis and nicotine-related content on Telegram may also be exposed to other illicit substances that have a high potential for abuse and addiction, a concern as other studies and news reports have already identified active selling networks of illicit drugs and psychoactive substances on Telegram.<sup>38,52</sup> Furthermore, for the 14 websites identified from Telegram selling messages, more than half lacked appropriate controls to ensure underage users could not finalize a transaction to buy these products. Additionally, over half had IP addresses outside of the United States, raising the possibility of unregulated importation of nicotine products from other jurisdictions.

## Limitations

This study has certain limitations. Certain groups detected in keywords searches during the data collection process experienced a prolonged processing time or programming error and were omitted from further data processing. During each exporting process, if a Telegram group froze during data collection for over 10 minutes for three consecutive times, the group was considered to contain programming errors and these groups were omitted from data collection and analysis. It is also possible that some groups may have prevented data collection from processing through internal settings set by

the public moderator of the group. Hence, this data set of Telegram groups and channel messages is likely not representative of all discussions, marketing, and selling activity associated with tobacco, nicotine, and cannabis-related products on the platform. Additionally, the initial set of exploratory keywords used for searching for Telegram groups was generated based on initial manual searches that were believed to be related to selling and trading activity. Future studies should employ a more specific set of keywords with better association with cannabis or tobacco and nicotine products to get a more representative sample of data. A further limitation is the incompleteness of the simulated shopping methodology, as the methodology did not involve the actual purchases of products online to confirm if the package could be physically shipped to a requested location or country. Additionally, we did not conduct simulated purchasing on Telegram channel messages that included information on how to directly contact the seller to enter into a transaction for various legal and ethical reasons. These limitations limit the interpretation of study results that focus on confirming the actual availability of products being advertised and purportedly sold and whether underage access to products would lead to a finalized transaction. Finally, channel messages collected from Telegram groups did not have any specific geolocation or geotagged data unless a user self-reported their location in the text of the message. As these data were highly unstructured and likely unreliable, we did not analyze messages for possible location of sellers. Given Telegram's popularity in markets outside the United States, and the presence of messages in other languages, future studies are needed to better assess location attributes of Telegram groups and messages and the implications for enforcement and regulation.

## Conclusions

This study found that the majority of Telegram groups and channel messages reviewed were engaged in the direct-to-consumer sale of various cannabis-derived products compared to a lower volume of sale messages associated with tobacco and nicotine products. Results generated from this study provide preliminary evidence of the presence of a robust alternative marketplace to market and sell unregulated, illegal, and potentially dangerous tainted or adulterated products outside the legitimate retail and licensed supply chain. Future research is needed to build tools to proactively identify these and other unregulated sources of tobacco, nicotine, and cannabis products in order to enhance consumer safety and online enforcement efforts. Apart from circumventing existing product restrictions, sales bans, and licensure requirements, lack of compliance among these unregulated online sellers can further "digitize" harmful consumer exposure to illegal marketing, trading, and access to addictive and dangerous products, which can occur across communities and global borders.

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## Declaration of Interests

MN, ZL, MZL, and TKM are employees of the startup company S-3 Research LLC. S-3 Research is a startup funded and

currently supported by the National Institutes of Health—National Institute of Drug Abuse through a Small Business Innovation and Research contract for opioid-related social media research and technology commercialization. Authors report no other conflicts of interest associated with this manuscript.

## Author Contributions

Matthew Nali (Conceptualization [lead], Formal analysis [equal], Investigation [equal], Methodology [equal], Writing—original draft [lead]), Vidya Purushothaman (Formal analysis [equal], Software [equal], Writing—original draft [equal], Writing—review & editing [equal]), Zhuoran Li (Data curation [equal], Formal analysis [equal], Methodology [equal], Software [equal]), Meng Larsen (Data curation [equal], Formal analysis [equal], Investigation [equal], Writing—review & editing [equal]), Raphael Cuomo (Funding acquisition [equal], Supervision [supporting], Writing—review & editing [equal]), Joshua Yang (Funding acquisition [equal], Supervision [supporting]), and Tim K. Mackey (Funding acquisition [lead], Resources [equal], Supervision [lead], Writing—review & editing [equal])

## Ethical Compliance

Not applicable/not required for this study. All information collected from this study was from the public domain and the study did not involve any interaction with users. Any user-identifiable information was aggregated and removed from the study results.

## Disclaimer

The opinions expressed are those of the authors alone.  
Patient Consent for Publication  
Not applicable.

## Data Availability

De-identified data with channel message or group ID is available by request.

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