Illicit trade of prescription medications through X (Twitter) in Japan: cross-sectional study

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Abstract

Background: Non-medical use of prescription drugs can cause overdose (OD) and thus represents a serious public health crisis. In this digital era, social networking services (SNS) provide viable platforms for individuals to acquire excessive amounts of medications, including prescription medications, despite their illicitness. Therefore, dynamically changing methods of illicit trading of medications should routinely be monitored to encourage the appropriate use of medications.

Objective: To specify characteristics of medications traded on X (the platform formerly known as Twitter), and characteristics of individuals who trade in or use pharmaceutical drugs obtained through X.

Methods: This is an observational, cross-sectional study, based on the publicly available open data using X (Twitter) posts, conducted between September 18, 2022 and October 1, 2022. X (Twitter) posts that included the term “Okusuri Mogu Mogu” in Japanese during the study period were investigated; “Okusuri” means medications, and “Mogu Mogu” is an onomatopoeia for eating or biting in Japanese. Characteristics of X posts that were retrieved using the search term “Okusuri Mogu Mogu”, and categorization of names of medications within posts related to trading (buying or selling), as well as all hashtags appearing in the posts were analyzed.

Results: In this cross-sectional study, 549 X posts that included the term “Okusuri Mogu Mogu” in Japanese between September 18, 2022 and October 1, 2022 were identified. Of these posts, 67 (12.2%) and 170 (31.0%) referenced buying and selling of medications, respectively. Among the sum of 237 posts, 1,041 medication names were mentioned. Nervous system drugs were dominant, representing 82.1% of the mentioned medication names, when classified according to the Anatomical Therapeutic Chemical (ATC) classification. Although this trend is consistent with our previous survey conducted in March 2021, the average daily count of medication names was substantially (5-fold) higher. Consequently, the diversity of medications expanded. When a total of 866 hashtags appearing in posts were sorted into six categories, individuals’ desire for “community formation” emerged as a dominant hashtag category.

Conclusions: Not only stringent pharmacovigilant measures by regulatory authorities to prevent illicit transactions of prescription medications but social approaches that could direct individuals to appropriate medical or psychiatric resources, would also be beneficial to support vulnerable and potentially isolated individuals, particularly those who use SNS. Clinical Trial: This research does not contain RCT.

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COI statement

The authors declare no competing interests.

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Data Availability

Data generated or analyzed during this study are included in this published article and its supplementary information files. More detailed law data are available from the corresponding author on reasonable request.

Contents

Abstract

Background: Non-medical use of prescription drugs can cause overdose and thus represents a serious public health crisis globally. In this digital era, social networking services (SNS) serves as viable platforms for illegal acquisition of excessive amounts of medications, including prescription medications. In Japan, such illegal drug transactions have been conducted through popular flea market applications, social media, and internet auction websites, with most of the trades being Over-the-counter (OTC) medications. Recently, an emerging unique black market, where individuals transact prescription medications, predominantly nervous system drugs, through a specific keyword, termed “Okusuri Mogu Mogu” has emerged on X (formerly known as Twitter).
Hence, these dynamically changing methods of illicit trading should routinely be monitored to encourage the appropriate use of medications.

Objective: To specify characteristics of medications traded on X through the search term “Okusuri Mogu Mogu”, and analyze individual behaviors associated with X posts, including types of medications traded and hashtag usage.

Methods: We conducted a cross-sectional study with publicly available posts in X, between September 18 to October 1, 2022. Posts that included the term “Okusuri Mogu Mogu” during the period were scrutinized. Posts were categorized based on contents: buying, selling, self-administration, heads-up, and others. Among posts categorized as buying, selling, and self-administration, medication names were systematically counted and categorized according to the Anatomical Therapeutic Chemical (ATC) classification. Additionally, hashtags that appeared in all the posts for analysis were also counted and classified into six categories: medication name, mental disorder, self-harm, buying and selling, community formation, and others.

Results: Out of 961 identified posts, 549 were included for analysis. Of these posts, A total of 119 (21.7%) referred to self-administration, and 237 (43.2%) referenced transactions with 67 (12.2%) for buying and 170 (31.0%) for selling medications. Among the 237 posts, 1,041 medication names were mentioned, exhibiting more than a 5-fold increase compared to the study in March 2021. When classified according to the ATC classification, nervous system drugs were dominant, representing 82.1% of the mentioned medications, consistent with the previous survey. Of note, the diversity of medications has expanded including medications that have not been approved by the Japanese government. Interestingly, OTC medications were frequently mentioned in self-administration posts with odds ratio = 23.6 [95% confidence interval 6.93-80.15]. Our Hashtag analysis, counting 866 in total, revealed efforts to foster community connections among users.

Conclusions: The present study highlighted the escalating complexity of illegal prescription medication trading facilitated by X posts. Regulatory measures to enhance public awareness should be considered to prevent illegal transactions, which may ultimately lead to misuse or abuse such as overdose. Along with such pharmacovigilance measures, social approaches that could direct individuals to appropriate medical or psychiatric resources would also be beneficial as our hashtag analysis shed light on the cohesive/closed community formation among users.

Trial Registration: This research does not contain RCT.

Keywords.

illegal trading, pharmacovigilance, social networking services (SNS), overdose, social support, antipsychotics

Introduction

Non-medical use of prescription drugs, which can lead to overdose (OD), is a serious public health crisis in worldwide [1-4]. The Centers for Disease Control and Prevention (CDC) in the United States reported that 70,630 people died from ODs in 2019. Of those, 49,860 were caused by opioids, and 9,711 by benzodiazepines [5]. In Japan, benzodiazepines such as flunitrazepam, and over-the-counter (OTC) antipyretic analgesics, antitussives, and cold medicines are reported as major causes of OD [6-9].

In this contemporary digital era, Social Networking Services (SNS) are emerging as viable platform to share health related information by individuals [10-12]. Despite its illicitness, individuals have been acquiring excessive amounts of medications [13-17]. In Japan, illegal drug transactions conducted through popular flea market applications, social media, and internet auctions websites has been reported with most of the trades being OTC medications [18-20]. On one hand, pharmacological effects of OTC drugs abuse/misuse have been characterized with i.e.) dextromethorphan, codeine (opioid), diphenhydramine, promethazine [21]. Specifically in Japan, OTC drug abuse arising problem due to the availability of drugs containing dihydrocodeine as OTC drugs [21]. Harms with abuses of such OTC drugs have been pointed to cause serious mental and physical effects, including poisoning symptom and dependence, hallucinations, euphoria, dissociative states, and even death [22-25]. Recognizing these risks, an effort has been reported to detect individuals who potentially abuse OTC drugs from consumer-generated media in Japan, where users can generate content on the social media by posting [26].

On the other hand, as a newly emerging trend, we previously discovered a unique and preliminary black market based on X (formerly known as Twitter) in Japan, where individuals engage in the trade of majorly prescription medications, instead of OTC medications, with a specific term of “Okusuri Mogu Mogu” [20]; “Okusuri” refers to medications, and “Mogu Mogu” used as an onomatopoeia for eating or biting in Japanese. The specific search term is local in Japan and unique enough to be distinguished by other transaction keywords in that most of traded medications are psychiatric prescription medications. Indeed, to seize the unique trait of illicit trading through the specific search term, the Japanese government has recently funded domestic investigative research [27].

Hence, monitoring dynamically changing methods of illicit trading should routinely be performed. The present study extends our previous effort to elucidate illicit trading thorough the specific search term, especially to characterize which kind of medications are traded by whom and with which relative keywords, which was previously unknown. Herein, we report our latest findings for the “Okusuri Mogu Mogu” trend and analysis of hashtags to investigate individual behaviors associated with X posts.

Methods

Study sample

In this cross-sectional study, we systematically investigated posts made on X (formerly known as Twitter) using the single searching term “Okusuri Mogu Mogu” in accordance with a previously described approach [20]. We selected this term because several surveillance and research studies reported that it is used by individuals to trade in medications. One surveillance activity in popular was led by grants from the Japanese regulatory authority, Ministry of Health, Labour and Welfare (MHLW) [27]. Moreover, an organization was commissioned by MHLW to monitor the term through their original X (Twitter) account to alert X users [28].

Data collection and categorization

We investigated X posts by inputting the term “Okusuri Mogu Mogu” in Japanese in the X search field without adding a hashtag. Posts made between September 18, 2022 and October 1, 2022 at Japan standard time were collected in a Microsoft® Excel spreadsheet for data analysis. Extracted post data included the date of posting, whether a hashtag was used for “Okusuri Mogu Mogu”, whether the post had accompanying images, the categorization of the post (i.e., buying, selling, self-administration, heads-up posts for illegal trading, and unknown or unclassified), and the name of pharmaceutical products mentioned in posts or images. Independent counts of medication names and hashtags were processed, which produces overlaps. All posts were extracted within one week of the post date as users can delete posts shortly after posting.

Data cleaning

Posts were distributed to two individual blinded researchers’ groups and they categorized each extracted post, followed by the comparison of the categorization between groups. Posts that were detected for only one group were excluded from the analysis, as were posts that had inconsistent categorization between groups.

Counting and categorization of posts related to buying or selling of drugs

Posts related to buying or selling pharmaceutical products were further analyzed. We followed the categorization of criteria that has previously reported [20]. The classification criteria are shown in **Supplementary Table S1**. We counted the number of drugs mentioned in these posts using text-mining tool that was available online [29]. If the named drugs were not mentioned using the official generic name but instead referenced using an abbreviation or a brand name, each term was allocated to a specific generic name by author consensus before counting. We also categorized the detected pharmaceutical drugs based on Anatomical Therapeutic Chemical (ATC) classification. ATC codes and therapeutic categories were investigated using the Kyoto Encyclopedia of Genes and Genomes (KEGG) BRITE Database [30].

Counting drug names in each category of posts

Mention of product names in posts that implied self-administration were also counted as described above. We then counted the number of drugs in each category of posts: buying, selling, and self-administration before sorting the counts from most to fewest number of mentions. Statistical analyses were carried out using Microsoft® Excel.

Hashtag classification

The number of hashtags in all the collected posts was counted except for the hashtag “Okusuri Mogu Mogu”. The extracted hashtags were further manually classified into six categories: medication name, mental disorder, self-harm, buying and selling, community formation, and other.

Ethical considerations

This cross-sectional observational study was performed only with publicly available data and did not involve any interventions or individual patient records. Thus, institutional review board approval and patients' informed consent were not necessary.

Results

Extracting posts for analysis

During the two-week investigation period between September 18, 2022 and October 1, 2022, 961 posts were identified in a search using the term “Okusuri Mogu Mogu”. These posts were grouped into categories: buying, selling, self-administration, heads-up posts for illegal trading, and unknown or unclassified. To verify the categorization, researchers divided into two independent groups and categorized posts, followed by the category-matching of individual posts. Since posts of interest were not collected simultaneously, some posts (n=192) were identified only in a single group. All of these posts were excluded from the analysis. Posts that had unmatched categorizations between groups (n=220) were also excluded. The remaining 549 posts were included in the analysis (**Fig. 1**).

Categorization of posts for analysis.

The characteristics and categorization of the 549 posts are shown in **Table 1**. Among these posts, 491 (89.4%) included the hashtag “Okusuri Mogu Mogu”. A total of 287 posts (52.3 %) included the name of at least one medication and 205 posts (37.3 %) included visual images such as tablets, bottles, blister packs, and inventory lists of medications as part of sales promotions. Of note, over 40% of all posts were categorized as transactions of medications: 67 posts (12.2%) mentioned buying or intent to purchase medications, and 170 posts (31.0%) referenced selling, promoting, and attempts to give away medications.

Users also referenced “Okusuri Mogu Mogu” to manifest their virtual presence. Instances of self-administration represented 21.7% (n=119) of posts, wherein users signified their administration of medications either before or after taking pills, or usage on a regular basis. Only 14 posts (2.6 %) served as a heads-up to users as illegal transactions of medications. Around one-third of the total posts (n=179; 32.6 %), could not be classified or had no discernible meanings.

ATC classification of posts indicating medication transactions.

To understand which kinds of medications are prevalent on the SNS-based black market, we systematically counted and categorized the names of medications that were identified in 237 posts included in the buying (n=67) and selling (n=170) categories (see **Fig. 1**). The categorization was assigned according to the ATC classification. Of these 237 posts, 185 (78.1 %) contained at least one specific medication name and in total there were 1,041 distinct medication names mentioned (**Supplementary Table S2**). The number of medications mentioned in posts for each ATC category is presented in **Table 2**, where we persisted the same screening and categorization processes with the previously reported survey conducted in March 2021 so that we could compare the change of circumstances surrounding the illicit trading with the keyword “Okusuri Mogu Mogu” [20].Notably, when classified using the ATC, drugs that affect the nervous system dominated, constituting 82.1 % of all mentioned medication names. This trend is consistent with the previous study [20]. However, relative to our earlier study the average daily count of mentioned medication names was substantially higher, exhibiting a 5-fold increase overall and an 8-fold increase for medications that act on the nervous system. Along with this substantial upsurge in mentions of medication names, the names of multiple medications that had not previously been mentioned were represented across diverse ATC categories in the present study. These categories include Alimentary trace and metabolism drugs, Blood and blood forming organs drugs, Dermatological drugs, Musculo-skeletal system drugs, and Kampo medications. In addition, a drug that has not been approved by the Japanese government was mentioned seven times.

Trends for mentioned medication names according to categories of posts.

We next investigated whether there are discrepancies in a series of medications mentioned across different categories of posts. As expected, drugs that affect the nervous system, such as

flunitrazepam, zolpidem, and etizolam, were commonly observed across categories in a comparison of the top ten lists of medication names present in each post category (**Table 3**). We also counted the mentions of medication names in the self-administration category (**Table 3, Supplementary Table S3**). Interestingly, over the counter (OTC) drugs like SS Bron® and Medicon® appeared more frequently in the self-administration category (odds ratio [OR] = 23.6 [95% confidence interval 6.93-80.15] compared with the other transactional posts). This finding suggests that discrepancies may exist between transactional posts and self-administration posts in terms of mentions of medication names.

Hashtag analysis.

Last, we analyzed all the hashtags present in the 549 posts that were considered. A total of 491 posts in the sample included hashtags. In addition to the hashtag “Okusuri Mogu Mogu”, 866 hashtags were detected. We classified these hashtags into six categories: medication name, mental disorder, self-harm, buying and selling, community formation, and other (**Table 4**). As anticipated, numerous psychiatric drugs were explicitly mentioned, and correspondingly, a substantial number of the identified hashtags were linked to symptoms related to mental disorders and self-inflicted harm. Within the transaction-related categories, the abbreviation “Letapa”, which refers to “Letrerpack”, a postal service envelope made by Japan Post Co., Ltd., ranked prominently, implying its use as a transaction method for the referenced medications. In addition to psychiatric keywords, hashtags indicative of “community formation” that encompassed endeavors to establish connections on SNS were prevalent.

Discussion

In this cross-sectional study, we used the specific search term “Okusuri Mogu Mogu” to identify posts made by individual users of X (the platform formerly known as Twitter) in Japan. These posts were made during a two-week study period in late September 2022, and concerned different types of transactions involving majorly prescription medications (95.6% - 99.0%). We found an increasing diversity of mentioned medications that encompassed Kampo medications, OTC drugs, and medications that have not received approval for use in Japan. Further systematic analysis of the mentioned medication names in each post category revealed a dominance of nervous system drugs among both trading users and individuals who expressed autonomous medication usage, and also highlighted the extensive self-administration use of OTC drugs by individuals. Our hashtag analysis that sought to understand user behaviors supported the possibility that these individuals could have relevant mental disorders or mental concerns and indicated attempts to foster distinctive communities among these users.

Transactions

The high frequency of observed medication names we observed in posts related to selling could be related to reposts and inventory lists posted by sellers (**Table 3**). Meanwhile, the lower frequency of posts related to buying might be due to the exchange of communication interfaces used to acquire drugs. Some posts indicated that discussions concerning details about trading may have switched from public posts to alternate apps or direct messaging.

The number of posts related to medication transactions increased dramatically over the 18 months since our prior study. Concurrently, the number of mentions of medications that were not referenced in the previous study increased. One reason for this increase might be due to the growing complexity of selling strategies. In fact, posts featuring lists of medications and images of inventory lists were identified in this survey, and such lists may enable traders to deal in medications systematically. Such image-based inventory lists can be a new strategy to protect traders from account suspension. Other traits we noted were prompt responses of sellers to market changes. For instance, we newly detected Lemborexant, a hypnotic that received approval in 2020 for which there has been increased marketing activity, and Medicon®, an OTC cough suppressant that contains dextromethorphan and has been marketed since 2021. Neither Lemborexant nor Medicon were identified in our previous study from March 2021. Taken together, these results support the increased complexity and strategic sales techniques used by dealers.

Concerns about overdose of OTC medications

We found that OTC medications were mentioned with higher frequency in posts in the self-administration category relative to those in the trading categories, suggesting that such OTC medications are not traded on the “Okusuri Mogu Mogu” based black market, but instead are obtained by individuals themselves. This finding may indicate that individuals who consume OTC medications are clearly distinct from those who trade in prescription medications, even though both types of users included the term “Okusuri Mogu Mogu”. We note two important implications regarding self-administration of OTC medications.

First, the risk of overdose (OD) from OTCs is apparent, especially ODs due to use of antitussive OTCs that include codeine, dihydrocodeine, and methyl-ephedrine [6,8,31]. Indeed, our results showed that SS Bron®, which includes dihydrocodeine, is the most frequently administered OTC medication by individuals (**Table 3**). To reduce the risk of OD caused by OTCs, beginning on April 1, 2023 the MHLW expanded their specified range of “pharmaceuticals that are prone to abuse or misuse” from to include six specific compounds present in OTC medications: ephedrine, codeine, dihydrocodeine, bromovalerylurea, pseudoephedrine, and methyl-ephedrine [32]. This policy modification expanded the scope of designated products and emphasizes the efforts of the MHLW to decrease the rate of OD caused by OTC medications. Additional studies are needed to evaluate

whether such pharmacovigilance policy changes do in fact affect OD rates.

Second, regulatory endeavors by agencies may be insufficient to change OD incidence. Such regulatory stances can potentially result in a protracted game of cat and mouse. In this study, the second most prevalent OTC medication mentioned by self-administration users was Medicon® (**Table 3**), which has been marketed since 2021. Despite the risk of OD caused by its active component, dextromethorphan, Medicon® was not included in the MHLW list of "pharmaceuticals that are prone to abuse or misuse"[32], perhaps because of a lack of information due to its relatively recent appearance on the market. Our findings provide two perspectives. One, the digital age of SNS can easily allow individuals to evade regulations; and two, OD caused by OTC drugs differs from dependency on narcotics and stimulants. Purchasing OTC drugs is legal, and thus complete prohibition by regulatory measures would be difficult. For individuals for whom the risk of OD could increase through the use of SNS, contact with self-help groups and simple acknowledgment that such users exist in the actual world, rather than a regulatory crackdown, could be an effective strategy to reduce the risk of OD.

Community-forming behaviors

Our study sample indicates that users are beginning to interact with each other and form distinct communities, which is consistent with previous research [33]. The most dominant hashtag in the community-formation category was "*Yami-aka-san to Tsunagaritai*", which reflects a direct intention to interact among users: *Yami-aka-san* is associated with the sharing of personal struggles related to mental health and *Tsunagaritai* literally expresses the desire of an individual to connect with someone. Such communication-intended posts were not obvious in our previous investigation.

Additionally, user interactions went beyond hashtags. An intriguing fashionable accessory, termed "Okusuri Charm", is crafted from blister packs used to package prescription drugs, and recently emerged in posts including relevant hashtags [34]. Inof teractions through such accessories is now a movement, indicating another endeavor to form a community.

Such community formation within SNS may represent traits of users, who have fragile connections to the real world and are potentially isolated, particularly since more than a few hashtags related to mental disorders or mental concerns accompanied use of "Okusuri Mogu Mogu". Unfortunately, in a highly anonymous community, sellers of medications can take advantage of the potential weakness of these users to commit fraud, which was identified in our hashtag analysis.

Limitations

Our study has several limitations. First, posts collected in this study were made within a two-week period and the number of posts analyzed was relatively small. Moreover, we considered only a single search term “Okusuri Mogu Mogu”. Some posts could not be included since users can delete their posts as well as their account, and posts from private accounts could not be collected. Thus, our results may underestimate the actual situation associated with illegal trade of medication. Second, results of our study should carefully be interpreted since they were based on manual investigation of posts. For instance, many posts were excluded because they could not be categorized, and the categorization itself was based on researchers’ individual inspections. Indeed, 22.9% (220/961) of posts were excluded for analysis due to the classification discrepancy between raters, indicating their might still remaining the posts with ambiguous classification (**Figure 1**). Further studies with regular web scraping or machine learning-based categorization are needed to further elucidate individual behaviors related to medication trading [35].

Conclusion

In this study, we shed light on the current situation surrounding illegal prescription drug transactions facilitated by SNS by scrutinizing X (the platform formerly known as Twitter) posts that contained the term “Okusuri Mogu Mogu”. Our cross-sectional study highlights the escalating quantity and diverse array of mentioned names of medications, and that strategies to allow transactions to occur have increasing complexity. We also unveiled distinctive characteristics among users around such black markets for illegal medication trading. A hashtag analysis indicated that users may use SNS to foster communication and form a sense of communal affiliation among users. From one perspective of pharmacovigilance, it is judicious for the authorities to enhance public awareness by instituting stringent measures to prevent illegal transactions of prescription medications. On the other hand, a regulatory stance alone may inadvertently reinforce cohesiveness within the confines of a closed community. Social approaches, such as self-help groups, that could direct individuals to appropriate medical or psychiatric resources would represent viable pathways to support socially vulnerable SNS users.

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Figures and Tables

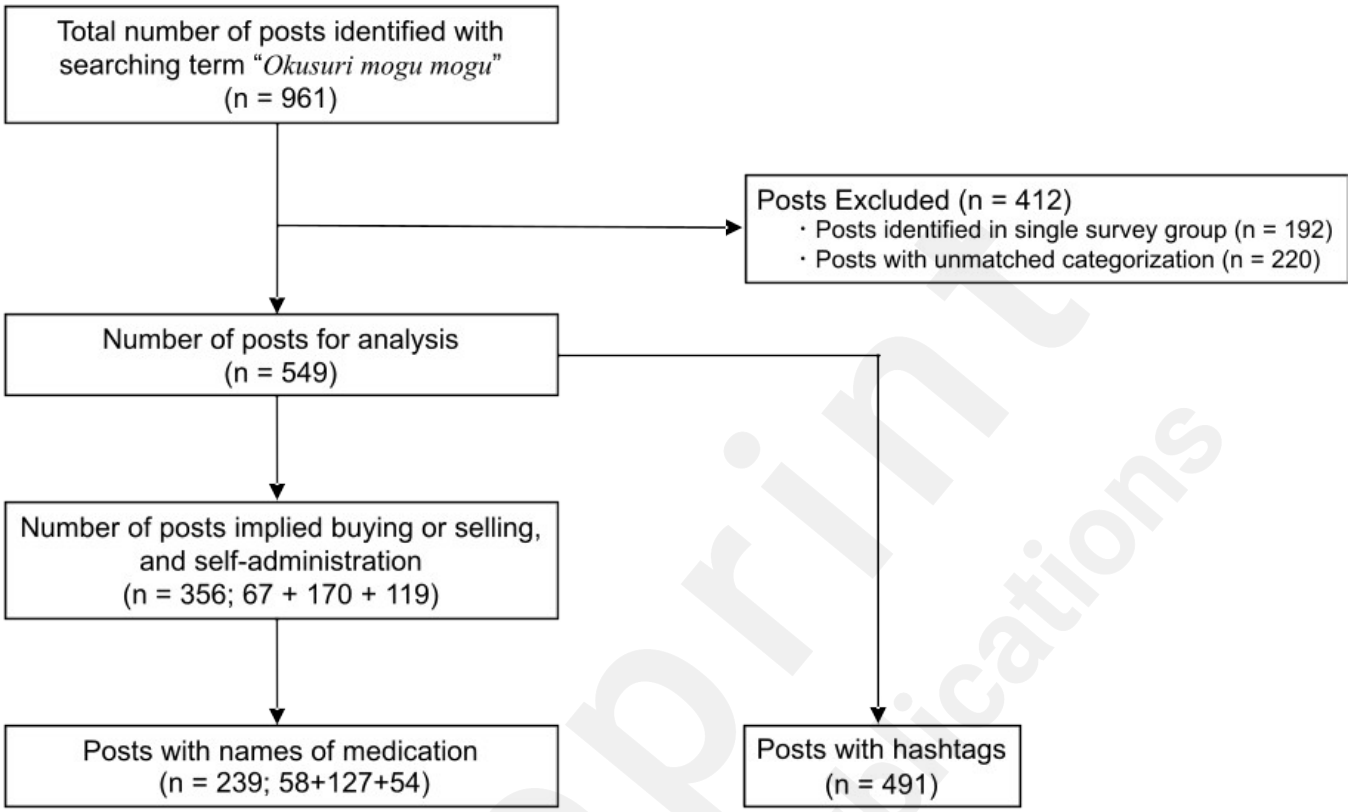

Figure 1. Flowchart of posts to be included in the analysis.

During the two-week investigation period between September 18, 2022 and October 1, 2022, 961 posts were identified. Posts identified only in a single survey group (n=192) and posts that shares unmatched categorizations between groups (n=220) were excluded from the analysis. The remained 549 posts identified for analysis, 237 referenced buying (n=67) or selling (n=170) of medications. All the names of the mentioned medications were subjected to ATC-based categorization. Of the 356 posts that implied buying, selling, or self-administration of medication, 239 mentioned names of individual medications that were all included in the count. Similarly, among the 549 posts in the analysis, 491 included at least one hashtag, and all hashtags were counted.

Table 1. Characteristics and categorization of posts for analysis (n = 549) [a,b]

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Characteristics		No. of posts (%)
Total number of posts for analysis		549 (100.0)
	Posts with hashtag "Okusuri Mogu Mogu"	491 (89.4)
	Posts that mentioned at least one medication name	287 (52.3)
	Posts with images	205 (37.3)
Categorization	**Description**	
Buying	Posts related to hoping, trying and wanting to buy or get	67 (12.2)
Selling	Posts related to selling, promotion of selling, and attempts to give away medications	170 (31.0)
Self-administration	Posts indicating users' drug administration, either before or after taking pills, and regularly	119 (21.7)
heads-up	Posts from official or unofficial accounts that alert illegal medication trading	14 (2.6)
others	Unknown, unclassifiable, and other posts	179 (32.6)

[a] Characteristics and categorization of 549 posts in X (formerly known as Twitter) for analysis that were collected between September 18, 2022, and October 1, 2022.

[b] Elaborated categorization criteria are described in the **Supplementary Table S1.** We categorized posts in accordance with the previously published method [20].

Table 2. Medications mentioned in posts that implied buying or selling categorized based on the ATC classification.

Table 2. Medications mentioned in posts that implied buying or selling categorized based on ATC classification

Investigation period (yyyy.mm.dd.)	2022.09.18-10.01.[a] n (% of total)	2021.03.01.-03.08.[b] n (% of total)
[A] Alimentary tract and metabolism	36 (3.5)	1 (0.8)
[B] Blood and blood forming organs	11 (1.1)	0 (0.0)
[C] Cardiovascular system	1 (0.1)	0 (0.0)
[D] Dermatological	19 (1.8)	1 (0.8)
[G] Genito urinary system and sex hormones	8 (0.8)	3 (2.5)
[H] Systemic hormonal preparations, excl. sex hormones and insulins	0 (0.0)	0 (0.0)
[J] Antiinfectives for systemic use	11 (1.1)	0 (0.0)
[L] Antineoplastic and immunomodulating agents	0 (0.0)	0 (0.0)
[M] Musculo-skeletal system	12 (1.2)	0 (0.0)
[N] Nervous system	855 (82.1)	107 (90.7)
N02 Analgesics	13 (1.3)	0 (0.0)
N03 Antiepileptics	119 (11.4)	4 (3.4)
N05 Psycholeptics	625 (60.0)	99 (83.9)
N05A Antipsychotics	124 (11.9)	1 (0.8)
N05B Anxiolytics	219 (21.0)	15 (12.7)
N05C Hypnotics and sedatives	282 (27.1)	83 (70.3)
N06 Psychoanaleptics	87 (8.4)	4 (3.4)
N07 Other nervous system drugs	11 (1.1)	0 (0.0)
[P] Antiparasitic products, insecticides and repellents	0 (0.0)	0 (0.0)
[R] Respiratory system	0 (0.0)	0 (0.0)
[S] Sensory organs	0 (0.0)	0 (0.0)
Kampo medicines	35 (3.4)	0 (0.0)
More than 2 classifications	22 (2.1)	2 (1.7)
No ATC classifications	14 (1.3)	3 (2.5)
Over-the-counter medications	10 (1.0)	1 (0.8)
Unapproved drugs in Japan	7 (0.7)	0 (0.0)
Total number of medications in posts	1041	118
Daily average number of mentioned-medications in posts	74.4	14.8

[a] Among 237 posts that implied transactions (67 for buying and 170 for selling), 185 (78.1%) contained at least one specific medication name, totaling 1,041 distinct medication names mentioned. These medications were categorized according to the Anatomical Therapeutic Chemical (ATC) classification.

[b] As a comparison, medication names which was collected from March 1st to 8th , 2021 under the same screening and categorization processes, has been listed [20].

Table 3. Top ten medication names for each post category [a]

Table 3. Top ten medication names for each post category [a]

Post Category	Selling		Buying		Self-Administration	
	Generic name	No.	Generic name	No.	Generic name	No.
1	**Flunitrazepam**	**72**	**Flunitrazepam**	**26**	**Flunitrazepam**	**13**
2	Lorazepam	61	**Zolpidem**	**21**	SS Bron® (OTC)	9
3	Risperidone	56	**Etizolam**	**19**	**Zolpidem**	**7**
4	**Zolpidem**	**53**	Methylphenidate	7	**Etizolam**	**6**
5	**Etizolam**	**44**	Eszopiclone	5	Medicon® (OTC)	6
6	Clonazepam	44	Triazolam	4	Pentobarbital	5
7	Sodium valproate	38	Pentobarbital	3	Lemborexant	5
8	Bromazepam	33	Lorazepam	3	Olanzapine	4
9	Clotiazepam	29	Zopiclone	2	Clonazepam	4
10	Brotizolam	28	Brotizolam	2	Pregabalin	4
Total no. of medication in posts		935		106		129

OTC = Over the counter.

[a] Among 549 posts for analysis, 356 indicated either buying (n=67), selling (n=170) or self-administration (n=119). 86.6% (58/67) of posts were categorized as buying, 74.7% (127/170) for selling, and 45.4% (54/119) for self-administration, including at least one medication name. These medication names were counted in number and the top ten of the lists are shown.

Table 4. Top five hashtags appearing in analyzed posts for each hashtag category.

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Medication name		Mental disorder		Self-harm	
hashtags (generic name)	No.	hashtags	No.	hashtags	No.
Depas (Etizolam)	30	Insomnia	15	Overdose	17
Silece (Flunitrazepam)	24	Sleep disorders	8	Wrist cut	8
Myslee (Zolpidem)	16	Attachment disorder	5	*Amuka*	7
Halcion (Triazolam)	12	Eating disorder	4	Self-harm	5
Medicon (Dextromethorphan)	10	Bulimia nervosa	4	Self-harming account	2
		Mental disorders	4		
Buying and selling		**Community formation**			
hashtags	No.	hashtags	No.		
Letapa	13	*Yami-aka-san to Tsunagaritai*	24		
Okusuri Yuzurimasu	10	*Yami-aka*	22		
Eradicate fraudsters	7	*Menhera*	14		
Fraud	3	*Menhera-joshi*	10		
Private import	3	*Arasa-joshi*	9		
		Ura-aka-joshi	9		
		Okusuri charm	9		

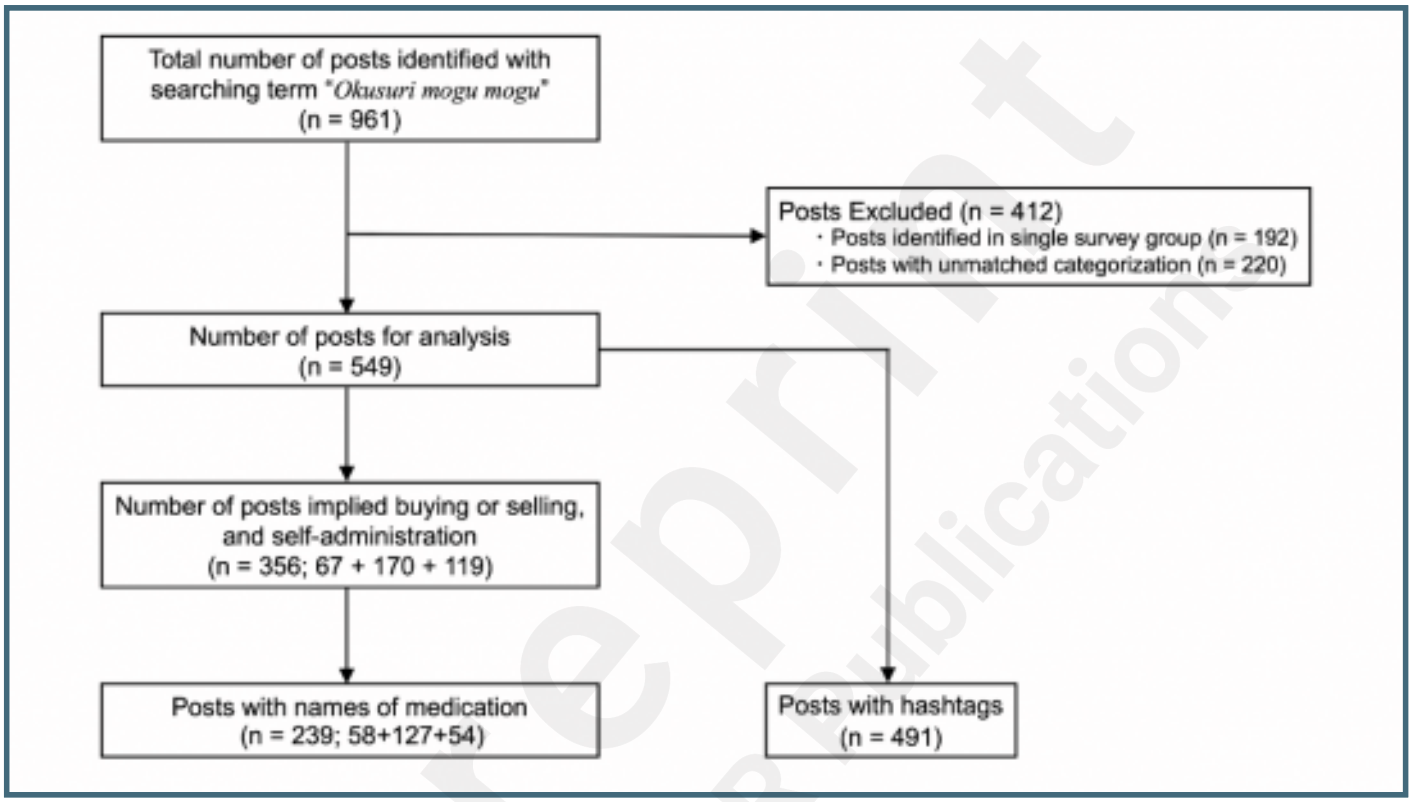
* Original posts are in Japanese, and translated into English. Total number of hashtags was 866 among 491 analyzed posts.
† *Okusuri Mogu Mogu* was excluded because all analyzed posts included this term. Hashtags in *italics* are the original Japanese and had the following definitions. *Amuka*: arm + cut that indicates self-harm by cutting the arm; *Letapa*: abbreviation of Letterpack®, mail service from the Japan Post Co., Ltd; *Okusuri Yuzurimasu*: offering medication; *Yami-aka-san to Tsunagaritai*: A desire to connect with others who share similar struggles with *Yami* indicating something on the dark side; *Yami-aka*: Sharing of personal struggles related to mental health through SNS accounts; *Menhera*: based on a term for mental health, referencing individuals who openly discuss their mental health struggles online, or people who are perceived as being clingy; *Menhera-joshi*: women who have *menhera*. *Joshi*: a term for females, including both women and girls; *Arasa-joshi*: women in their 30s; *Arasa*: Individuals who are around 30 years-old; *Ura-aka-Joshi*: Women who have secret or private accounts; *Okusuri charm*: accessories traded on SNS that are crafted from blister packs used for prescription medications.

* Original posts were all in Japanese and were translated to English. Total number of hashtags was 866 among 491 analyzed posts.
†*Okusuri Mogu Mogu* was excluded because all analyzed posts included this term. Hashtags in *italics* are the original Japanese and had the following definitions. *Amuka*: arm + cut that indicates self-harm by cutting the arm; *Letapa*: abbreviation of Letterpack®, mail service from the Japan Post Co., Ltd; *Okusuri Yuzurimasu*: offering medication*; Yami-aka-san to Tsunagaritai*: A desire to connect with others who share similar struggles with *Yami* indicating something on the dark side; *Yami-aka*: Sharing of personal struggles related to mental health through SNS accounts; *Menhera*: based on a term for mental health, referencing individuals who openly discuss their mental health struggles online, or people who are perceived as being clingy; *Menhera-joshi*: women who have *menhera*. *Joshi:* a term for females, including both women and girls; *Arasa-joshi*: women in their 30s; *Arasa:* Individuals who are around 30 years-old; *Ura-aka-Joshi*: Women who have secret or private accounts; *Okusuri charm*: accessories traded on SNS that are crafted from blister packs used for prescription medications.

Supplementary Files

Figures

Flowchart of posts to be included in the analysis. During the two-week investigation period between September 18, 2022 and October 1, 2022, 961 posts were identified. Posts identified only in a single survey group (n=192) and posts that shares unmatched categorizations between groups (n=220) were excluded from the analysis. The remained 549 posts identified for analysis, 237 referenced buying (n=67) or selling (n=170) of medications. All the names of the mentioned medications were subjected to ATC-based categorization. Of the 356 posts that implied buying, selling, or self-administration of medication, 239 mentioned names of individual medications that were all included in the count. Similarly, among the 549 posts in the analysis, 491 included at least one hashtag, and all hashtags were counted.



Multimedia Appendixes

Table S1. Classification criteria of posts and their categorization (n=549).
URL: http://asset.jmir.pub/assets/ef8ec418895d7d7236f694189f553b61.pdf

Table S2. A whole list of the number of medication names among tweets implied buying or selling. OTC = Over the counter. Kampo medication is represented in light blue and OTC medication in green.
URL: http://asset.jmir.pub/assets/eb91894092bafcf03d547b8d7918293a.pdf

Table S3. A whole list of medication names and no. of cases mentioned in the posts that implied trading. Kampo medication is represented in light blue, OTC medication in green, nationally unapproved drugs in purple, and a discontinued drug in red, respectively.
URL: http://asset.jmir.pub/assets/c498e628844e2ecdae2ff59172fcdebe.pdf