Title

Is This Safe? Examining Safety Assessments of Illicit Drug Purchasing on Social Media Using Conjoint Analysis

Journal

Substance Use & Misuse, 59(7)

ISSN

1082-6084

Authors

Haupt, Michael Robert
Cuomo, Raphael
Cui, Manying
et al.

Publication Date

2024-06-06

DOI

10.1080/10826084.2024.2310507

Is This Safe? Examining Safety Assessments of Illicit Drug Purchasing on Social Media using Conjoint Analysis

Illicit substance sales facilitated by social media platforms are a growing public health issue given recent increases in overdose deaths, including an alarming rise in cases of fentanyl poisoning. However, little is known about how online users evaluate what features of social media posts convey safety, which can influence their intent to source illicit substances. This study adapts conjoint analysis which assessed how attributes of social media posts (i.e., features) influence safety evaluations of mock posts selling illicit substances. 440 participants were recruited online for self-reporting use or purchase of controlled substances or prescription medicines recreationally. The following attributes were tested: drug packaging, drug offerings, profile photo of seller, payment info provided, and use of emojis. Results from the conjoint exercise found that packaging was ranked the most important attribute (Average Importance =43.68, Offering=14.94, Profile=13.86, Payment=14.11, Emoji=13.41), with posts that displayed drugs in pill bottles assessed as the most safe. Attribute levels for advertising multiple drugs, having a blank profile photo, including payment information, and including emojis also ranked higher in perceived safety. Rankings were consistent across tested demographic factors (i.e., gender, age, and income). Survey results show that online pharmacies were most likely to be perceived as safe for purchasing drugs and medications. Additionally, those who were younger in age, had higher income, and identified as female were more likely to purchase from a greater number of platforms. These findings can assist in developing more precise content moderation for platforms seeking to address this ongoing threat to public safety.

Keywords: Online drug purchasing; Controlled substances; Drug dealing; Social media; Online content moderation; Conjoint analysis

Introduction

The US has been experiencing a rapidly escalating public health crisis over the past decade concerning drug-related overdoses and deaths. Between 2010 and 2017, the opioid-involved overdose death rate rose from 21,088 to 47,600, and by 2019 increased again to 49,860 (National Institute on Drug Abuse, 2023). Between 2013 to 2019, the death rate for synthetic opioids, such as fentanyl, increased by a staggering 1,040% (3,105 to 36,359 deaths), reflecting a new chapter in the crisis characterized by the dangers associated with counterfeit products and other illicit drugs laced with fentanyl (Mattson et al., 2021). While not as prevalent as natural and synthetic opioids, deaths due to the involvement of other drugs such as psychostimulants (e.g., methamphetamine) and the non-medical use of prescription psychoactive drugs has been rising as well (Bonnie et al., 2017; Mackey et al., 2013). The COVID-19 pandemic also had a major impact on public drug use: since the beginning of the pandemic the US experienced a dramatic increase of over 20,000 additional drug-related deaths from the previous year, resulting in the largest single-year percentage increase on record since 1999 (Baumgartner & Radley, 2021).

While multiple factors have contributed to the opioid crisis (see Humphreys et al., 2022 for review of causes), the increased use of social networking sites (SNS) further exacerbates this issue by providing convenient and accessible spaces for conducting drug sale transactions. In fact, drug transactions on SNS have been documented extensively by research and investigative reporting detecting illegal opioid sales and prescription drug dealing across several platforms such as Twitter, Facebook, Discord, Instagram, and TikTok (Fuller et al., 2023). See the following papers for a review of transactions across platforms and drugs types, and factors influencing online purchasing (Constine, 2018; Demant et al., 2020; Dwoskin, 2018; Hu et al., 2021; Lapowsky, 2018; Lytvynenko, 2018; Mackey et al., 2017; Mackey & Kalyanam, 2017;

Mackey et al., 2018; Oksanen et al., 2020a; 2020b; Peterson et al., 2021; Rutherford et al., 2022; Tiku, 2018; van der Sanden et al., 2022; Whelan et al., 2023; Yang & Luo, 2017). Additional evidence for online drug purchasing is shown in a recent study of US survey respondents conducted during COVID-19 which found that 18% have bought medications online, including from several social media and communication platforms such as Tumblr, Wickr, and Pinterest and specifically for prescription-controlled sedatives (e.g., Xanax, Valium), stimulants (e.g., Adderall, Ritalin), and other narcotic medicines (e.g., Vicodin, Percocet, Oxycontin) (Moureaud et al., 2021). This despite the fact that, in the United States, it is explicitly illegal to purchase controlled substances through online platforms, including online pharmacies and social media (Liang & Mackey, 2009; Mackey et al., 2013). Further, online drug purchasing behavior may become more normalized due to the emergence of digital health platforms that provide drug coupons for discounts on medications such as GoodRx, and the increased involvement of established corporations such as CVS, Walgreens, and Amazon in telepharmacy. Importantly, these legal transactions can still introduce potential harm as recent studies raise concerns about telemedicine being associated with overprescribing from physicians (Hoffman, 2020; Ray et al., 2019).

Consistent health burden related to drug overdose despite increased restrictions on public gatherings during the peak of COVID-19 social-distancing measures suggests that networking sites continue to be popular environments for drug sale transactions, which have concomitantly experienced increased use during the pandemic (De' et al., 2020; Huang et al., 2021; Mouratidis & Papagiannakis, 2021; Nguyen et al., 2020). Older work examining drug dealer transactions previously argued that awareness and initiation of drug use is facilitated by long-term interpersonal relationships in order to reduce uncertainties associated with the illegality and lack of reliable information of the product offered (Atkyns & Hanneman, 1974; Moeller, 2018). However, this model based solely on in-person interactions is lacking as the use of the internet and social media sites deemphasize the need for pre-existing long-term relationships for facilitating drug transactions. A more appropriate framework developed during the internet era that can account for online communication dynamics between drug sellers and potential buyers is called the information forager model (Pirolli, 2001; Pirolli & Card, 1999). According to the information forager framework, which is based on ecological models of food scavenging behaviors, online users are considered "foragers" who balance the value gained from finding new information with the time cost needed to obtain it. In order to make this assessment, users rely on "information scents" which are proximal cues on webpages (e.g., the title of a link, images) that indicate the value and relevance of new information based on the user's goals (Pirolli & Card, 1999). Within the context of illicit online drug purchasing, potential buyers may search for scents from social media posts that signal the legitimacy of the supplies and the credibility of the seller in order to assure themselves that the transaction is safe or is not fraudulent (e.g., non-delivery scam, identity theft, etc.). Hence, understanding what features of social media posts that signal safety to users despite lacking a prior relationship to the dealer is crucial for designing interventions that address illegal drug sales within virtual environments.

In order to investigate how online environments can promote illicit drug sales between individuals with weak or non-existent social ties, this study uses survey measures adapted from recent work (Moureaud et al., 2021) to assess safety perceptions and drug purchasing behavior across multiple platforms. To assure that the sample is relevant to online drug purchasing behaviors, participants were recruited if they self-reported ever using or purchasing controlled substances or prescription medicines recreationally. This study also uses conjoint analysis to examine what specific scents (e.g., signals) of drug-selling social media posts are perceived as safe to online users. More specifically, 48 hypothetical social media posts advertising the sale of controlled substances and prescription medicines were created to test the following attributes: packaging of drugs, drug offerings, profile of seller, payment info provided, and use of emojis. These attributes have been associated with engagement and credibility evaluation in previous social media research, and therefore were selected in the present study as they could also signal safety for potential drug transactions.

Overview of conjoint analysis

This study uses a technique called conjoint analysis to assess which features of social media posts that advertise drugs convey safety when making a purchase. Conjoint analysis was developed in the field of mathematical psychology and was initially employed by market researchers to quantify preferences for different products or services among consumers (see the following for a more comprehensive review: Green et al., 2004; Green & Srinivasan, 1990). Conjoint analysis uses experimental design to mimic complex decision-making processes that require people to "consider jointly" multiple attributes and lets respondents choose, rate, or rank hypothetical product alternatives that differ by attributes and levels. For stated preference studies, conjoint is considered a decompositional method. Decompositional methods allow respondents to evaluate each product or situation, and through experimental design, estimate the utilities, decomposed, from the answers of the respondents. In conjoint analysis, a product is thought of as being made up of various attributes (e.g., Color) and each attribute has several possible levels (e.g., Blue, Red). By varying the levels of the attributes presented in the conjoint exercise, respondent preferences are revealed as part-worth utility scores.

The use and popularity of conjoint analysis in health-related research has grown in recent years (Al-Omari et al., 2022). Pharmacology researchers and medical scientists have used conjoint analysis for evaluating patient preferences for PreP HIV prevention medication (Shrestha et al., 2018), vaccine treatments (Sun et al., 2020), disease modifying therapies (Wilson et al., 2014), physician prescribing intentions (Chinburapa & Larson, 1988), and the impact of health policies when enrolling in medical coverage (Knudsen & Havens, 2021). Another advantage of conjoint analysis is that it has been shown to reduce social desirability bias in survey responses and identify covert attitudes that are not aligned with overt values (Caruso et al., 2009; Horiuchi et al., 2022; Korn et al., 2020). Avoiding social desirability bias is especially important for research questions that require respondents to disclose sensitive information such as drug purchasing preferences, and therefore was chosen for the current study to mitigate this concern.

While previous research has used conjoint analysis to examine drug preferences for treatments in legal settings, there is currently no work assessing illicit contexts such as when drugs are advertised on social media sites. As shown in **Table 1**, the attributes tested in the current study are *packaging*, *offerings*, *profile*, *payment*, and *emoji*, and are based on actual drug-selling posts on Instagram identified in previous research (Haupt et al., 2022; Li et al., 2019; Mackey et al., 2020; Shah et al., 2022, Yang & Luo, 2017). Instagram was tested in the current study due to its specialization in visual marketing (such as targeted ads), popularity among younger users, and previous work evidencing illicit substance sales on the platform (Haupt et al., 2022; Shah et al., 2022). The three levels for *packaging* (official packaging, pill in hand, no image) were selected to assess how visual display of drug supply or product influences trust in the seller. The levels for *offering,* which test whether only one drug is advertised (Adderall) as opposed to multiple drugs, were selected to assesses if having a higher quantity of offerings signaled a more established dealer hence being associated with higher credibility and safety. Adderall was selected for the ‘only one’ drug level due to it having less stigma associated with use, its high use among youth and adolescents, and it generally not being equated to an illicit drug despite being commonly abused and subject to counterfeiting. For multiple offerings, other drugs such as weed, cocaine, LSD, and psilocybin (i.e., shrooms) were included in addition to Adderall. Similar to *offering*, inclusion of *payment* information was tested to see if providing information for facilitating a potential transaction also signals a more established dealer.

The remaining attributes assess the extent to which meta-features of posts not directly related to drug supplies are also considered when evaluating the safety of initiating illicit online drug deals. Previous research shows that profile photos and image content can influence engagement (e.g., “liking”), perception of the post’s author (Kramer et al., 2017; Li & Xie, 2019), and cultural stereotypes of drug use (Bakken & Harder, 2022). We tested animated faces as we believed that other factors associated with real life images, such as gender, race, and age, would be confounding factors for safety perceptions and would require further ethical considerations. The inclusion of emojis in posts can increase understandability and believability of posts (Daniel & Camp, 2020) and are widely used by social media influencers as persuasion strategies (Ge & Gretzel, 2017). This study tested whether these features that encourage engagement also signal safety when interacting with a drug dealer online.

Table 1. Tested attributes and levels of social media posts advertising illicit substance sales.

Attribute	***Levels***
Packaging	Drug is displayed as pills with hand
	Drug is displayed in official packaging
	No picture of supplies (Blank White/Gray)
Offerings	Advertises only one type of drug (Adderall)
	Advertises multiple types of drugs
Profile	Human face (animated)
	Blank profile
Payment	No payment info
	Mentions payment methods (Venmo, paypal, BtC)
Emojis	Includes emojis
	Does not include emojis

Methods

The survey used in the current study is divided into 2 parts. In part 1 respondents answered questions assessing safety perceptions and drug purchasing across multiple online platforms and demographic factors (e.g., age, gender, income). In part 2 respondents completed the conjoint exercise. See the following Open Science Framework (OSF) link for study materials and anonymized dataset[1].

Data collection

A total of 440 respondents were recruited from Amazon Mechanical Turk (MTurk) after filtering for data quality (i.e., outlier speed and failed attention checks) between October 13th-14th, 2022. As described by Amazon, MTurk is "a marketplace for completion of virtual tasks that requires

[1] https://bit.ly/3RxSBHS

human intelligence" and is traditionally used for recruiting humans to improve training datasets for artificial intelligence software (Bohannon, 2016). MTurk has become widely used as a sampling source in social science research (Bohannon, 2011; 2016) and recently used for surveying online drug purchasing preferences (Moureaud et al., 2021). Respondents were selected based on whether they reported having ever purchased or used a prescription drug recreationally (defined to participants as pharmaceutical drugs that legally requires a medical prescription by a licensed healthcare professional to be dispensed), or having ever purchased or used a controlled substance (defined as drugs or other substance tightly controlled by controlled substance act regulations due to their potential for abuse or addiction to the substance, including: opioids, stimulants, depressants, hallucinogens, and anabolic steroids).

Ethics approval for this study was granted by the University of California, San Diego (IRB protocol number: 804899). MTurk workers had access to the survey on the worker website, completed it anonymously, and were compensated based on standard survey-taking rates on the platform.

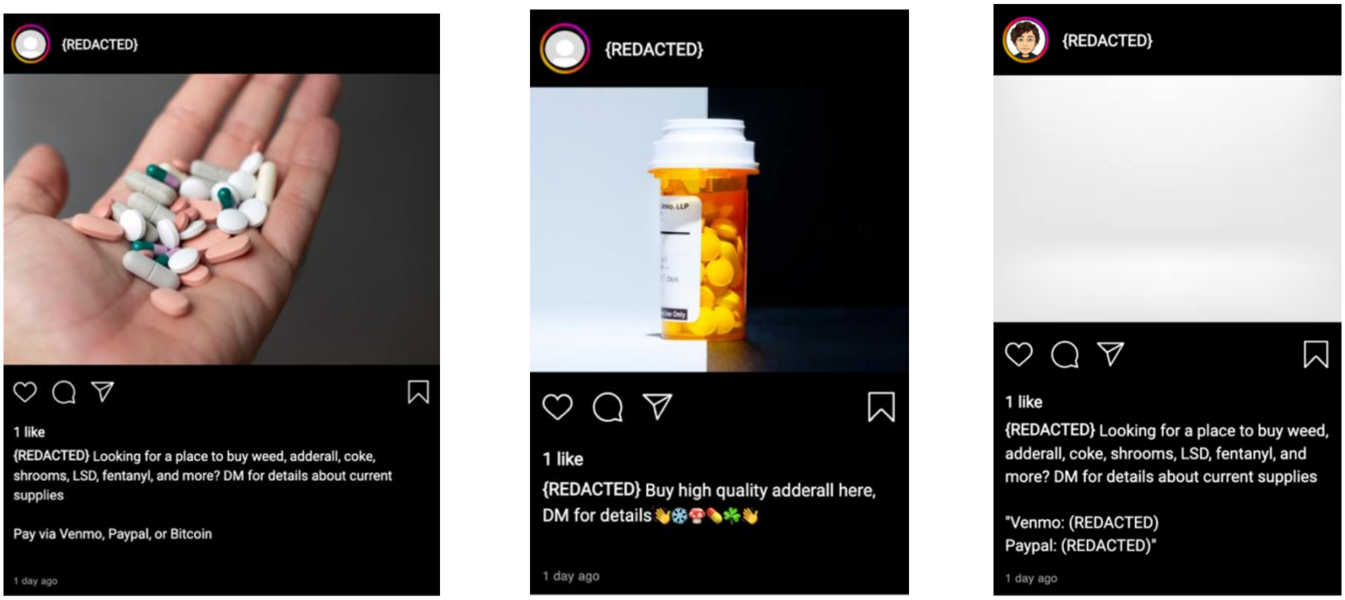
Online drug purchasing perceptions and behaviors

The following survey questions were adapted from related work (Moureaud et al., 2021) to measure safety perceptions and drug purchasing across online platforms. For safety perceptions, participants were asked to rate from 1 to 6 (1 = Very unsafe and 6 = Very safe) how safe it is to buy drugs/medications for 24 platforms (e.g., online pharmacy, Amazon, eBay) based on their own self-reported assessment. The responses "Safe" and "Very safe" were aggregated to compare safety perceptions across platforms and demographic subgroups. For online drug purchasing, participants were asked to select platforms that they have ever used to purchase a drug or medication of any kind. 48 platforms were asked in total, ranging from online pharmacies, e-commerce site, messaging platforms, to social media sites. Age, gender, and income were chosen as demographics for analysis as they are relevant to drug-use and online behaviors (Boardman et al., 2001; Fittler et al., 2018; Spigner et al., 1993; van der Sanden et al., 2021).

Conjoint exercise

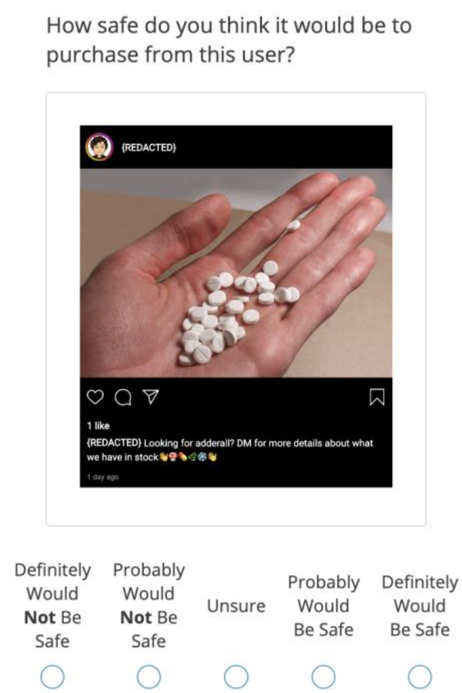
48 hypothetical drug advertising posts were created based on every possible combination of the tested attributes (*Packaging* (3 levels) x *Offering* (2 levels) x *Profile* (2 levels) x *Payment* (2 levels) x *Emojis* (2 levels) = 48). Each respondent evaluated 21 posts selectively chosen to assure sufficient exposure for each attribute. The variant of conjoint analysis used in the current study is called Conjoint Value Analysis (CVA), which uses ratings-based evaluations of tested concepts. Within the conjoint exercise, respondents were shown 1 post at a time and asked to rate how safe it would be to purchase from the user of the post. The scale used to measure safety ranged from 1 = Definitely would not be safe to 5 = Definitely would be safe. Posts were produced using an online mock social media post generator. In order to assure variety of the posts, 3 different versions for each attribute level were created (e.g., 3 different images were used to represent the level “pill in hand” for packaging). See **Figure 1** and **Figure 2** for examples of mock posts and conjoint exercise task.

Figure 1. Example social media posts for conjoint exercise.



Attribute combinations displayed in figure: (*Left*) Packaging = Pill in hand, Offerings = Multiple, Profile = None, Payment Info = Included, Emojis = None; (*Center*) Packaging = Official, Offerings = Adderall only, Profile = None, Payment Info = None, Emojis = Included ; (*Right*) Packaging = Blank, Offerings = Multiple, Profile = Animated human face, Payment Info = Included, Emojis = None

Figure 2. Example of task from conjoint exercise.



Each tested level is used as an independent variable for multiple regression modeling while the dependent variable is the safety rating. The program Lighthouse Studios developed by Sawtooth Software produced part-worth utility scores (i.e., beta coefficients) using hierarchical bayes estimations that account for choices from individual respondents and the sample average. Utilities per attribute are averaged and scaled to be normalized "zero-centered diffs," which cause the utilities to sum to 0 within each attribute. When interpreting results from conjoint analysis, the levels with the highest average utility scores indicate higher preference. Further, only utility scores of levels within the same attribute can be compared, but not across attributes. For example, the levels "Drug is displayed as pills with hand" and "Drug is displayed in official packaging" within the *packaging* attribute can be directly compared with each other but not with "Advertises only one type of drug (Adderall)" from the *offerings* attribute. While levels cannot be directly compared across attributes, it is possible to assess which attributes overall are weighted most heavily in respondent decision-making processes (e.g., comparing the influence of the *packaging* attribute vs *offering*) by using importance scores, which are computed for each attribute by taking the difference of the range in utility values and then dividing it by the sum of the differences in ranges across all attributes.

Results

Average age of MTurk respondents was 35.44 (SD = 10.58) and 60% identified as male. The racial and ethnic background of the sample consists of 85.9% White, 4.1% Black, 3.2% Asian, and 19.5% of respondents identified as Hispanic or Latino. 44.5% of respondents reported earning a household income of $60,000 USD or more. For previous drug purchasing behaviors of respondents, 48.4% reported having both purchased and used prescription medicines recreationally, 15.9% have used recreationally but never purchased, 27.7% have purchased but never used recreationally, and 8.0% have never purchased or used prescriptions recreationally. For previous experience with controlled substances, 44.3% have purchased and used, 25.9% have used but never purchased, 23.6% have purchased but never used, and 6.1% have never used or purchased.

For analysis, age and income were converted into binary variables to distinguish between older and younger respondents, and respondents with low vs high income. The cutoff for older respondents was 35 or older based on the mean age of the sample (35.44). Respondents were classified as high income if they earned at least $60,000 or higher based on the median of the sample. This threshold is also consistent with the median household income among the general US population.

Online platforms - perceptions & behaviors

When evaluating safety perceptions of platforms, online pharmacies (59%) and Amazon (59%) were most likely to be perceived as safe for purchasing drugs while Kik (45%) and QQ (45%) (e.g., Kik and QQ and are private messaging applications that could be used to transact in drug sales) were the least likely as shown in **Figure 3**. **Figure 4** shows that Amazon Pharmacy was used most often (58%) for ever purchasing a drug or medicine of any kind (including non-controlled drugs) followed by Instagram (42%) and Facebook (40%). The least used platforms were Element (9%), Line (9%), Twitch (7%), and Simple Meds (6%).

Figure 3. Safety Perceptions of Purchasing Drugs and/or Medications from Online Platforms (% Rated Safe or Very Safe)

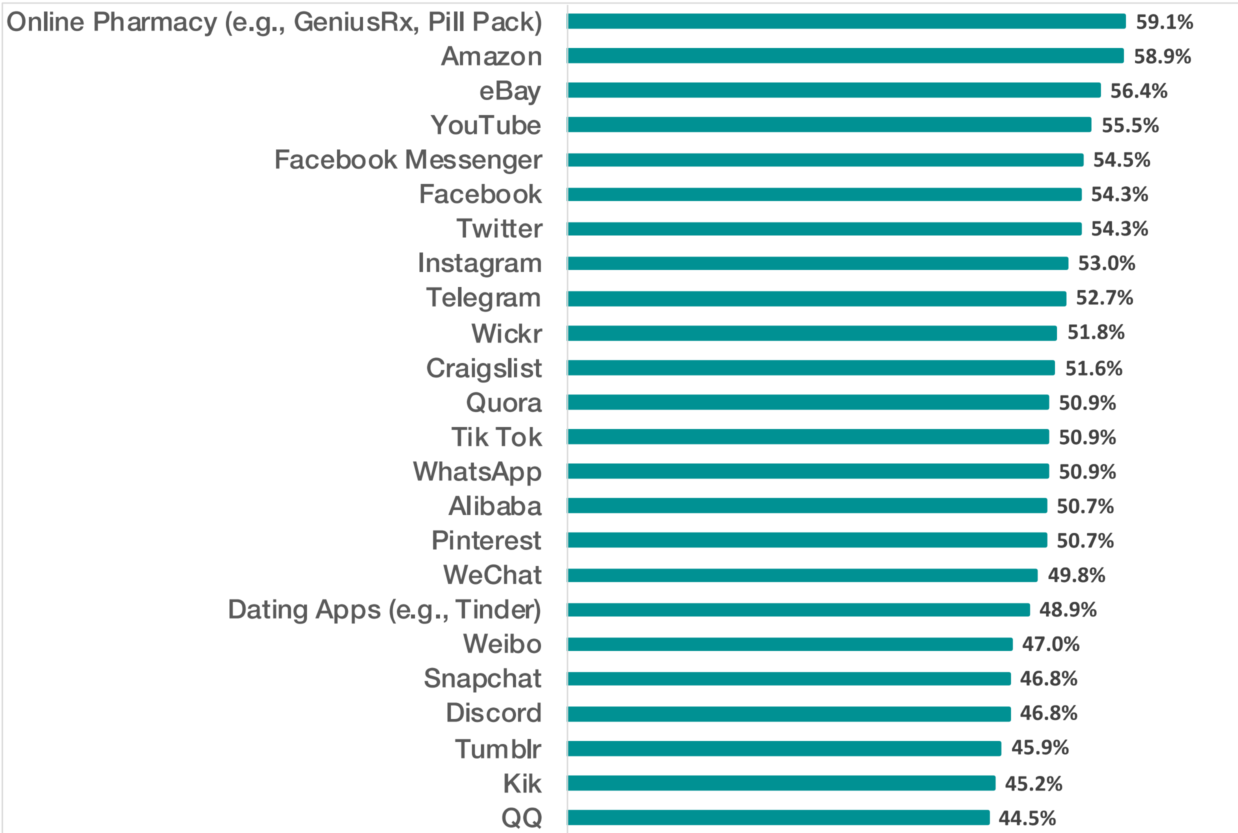
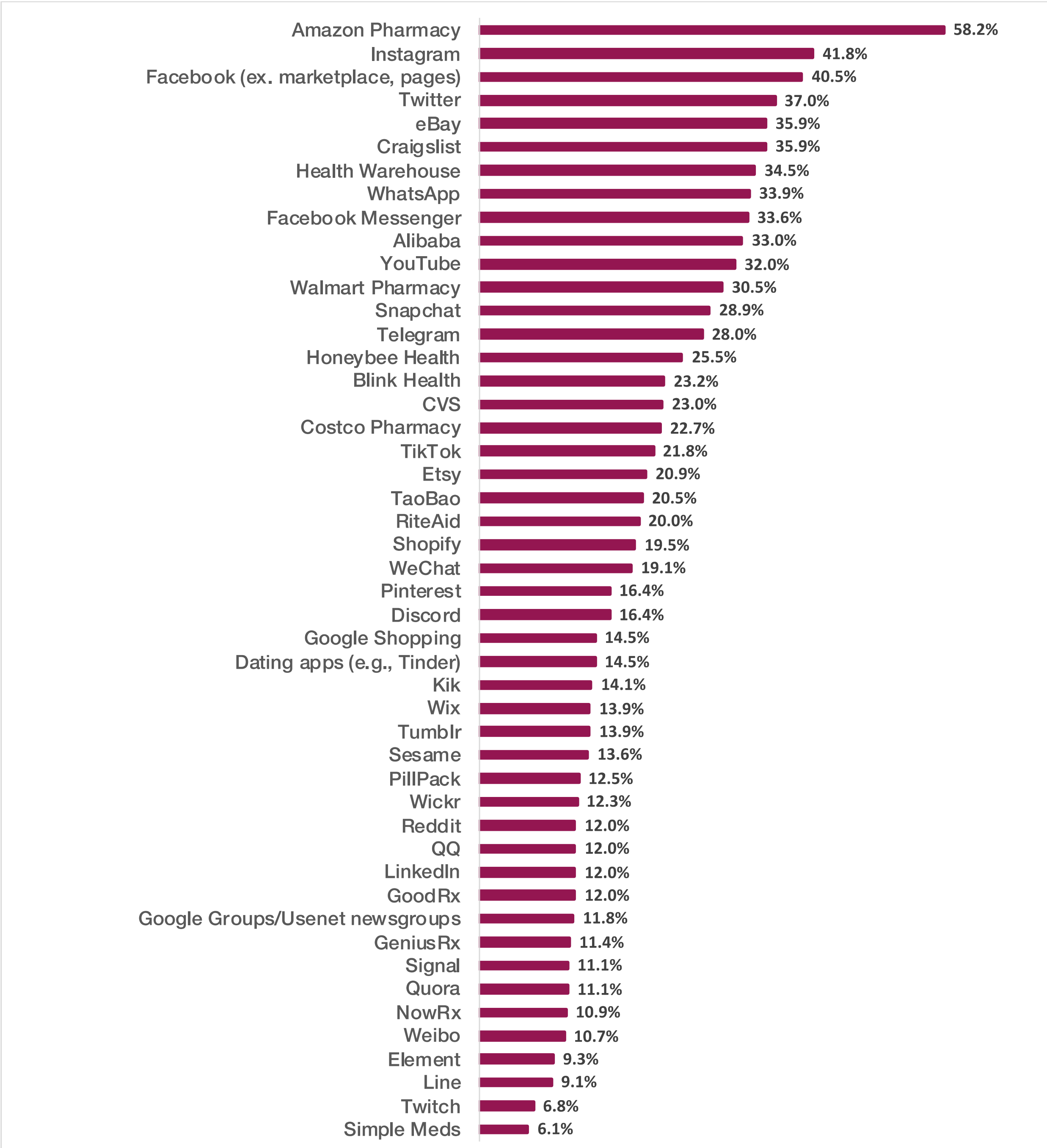


Figure 4. Platforms Used to Purchase Drug or Medicine

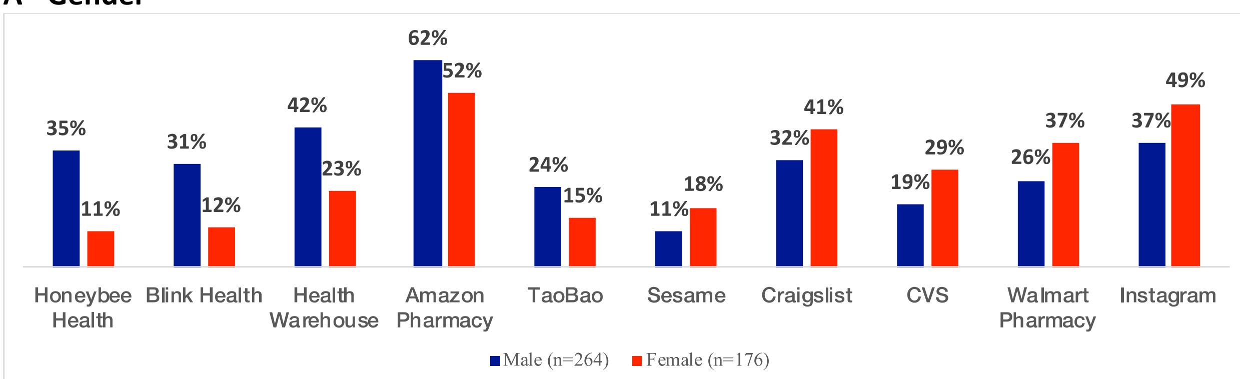


There were also demographic differences in platforms used to purchase a drug. As seen in **Figure 5**, men were more likely than women to have made a purchase on TaoBao, Amazon

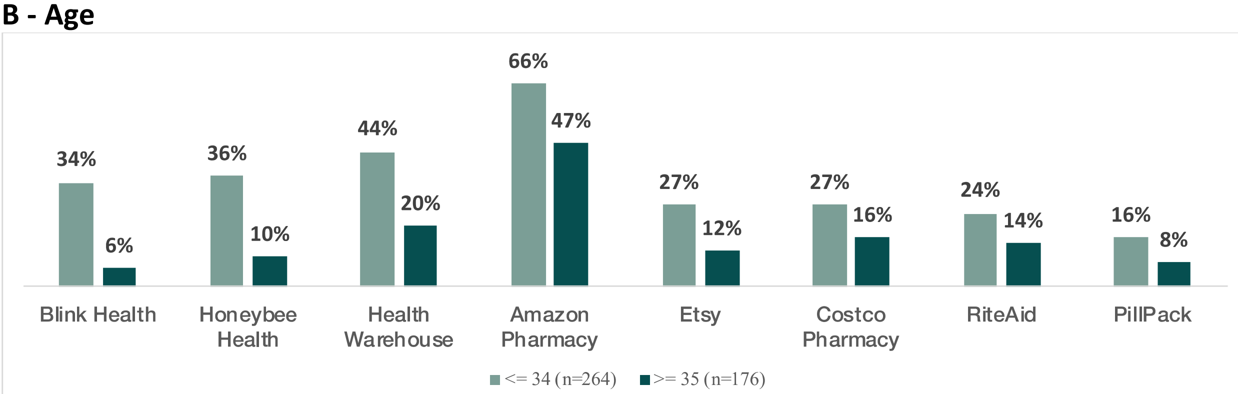
Pharmacy, Health Warehouse, Honeybee Health, and Blink Health while women were more likely to use Craigslist, Walmart Pharmacy, CVS, Sesame, and Instagram (p<.05). Among age groups, respondents 34 or younger were more likely to have made a drug purchase on Etsy, Amazon Pharmacy, Costco Pharmacy, Health Warehouse, RiteAid, Pillpack, Honeybee Health (p<.05) compared to respondents 35 or older. There were no platforms that were more likely to be used by older respondents that showed a statistically significant difference. For income, those who earned $60,000 or higher were more likely to ever purchase a drug on Alibaba, Walmart Pharmacy, Costco Pharmacy, CVS, Facebook, and Twitter compared to those who earned less than $60,000 (p<.05). There were no platforms that lower income respondents used more often than those with higher incomes.

Figure 5. Significant Differences (p<.05) in Drug Purchasing Platforms by Gender, Age, and Income

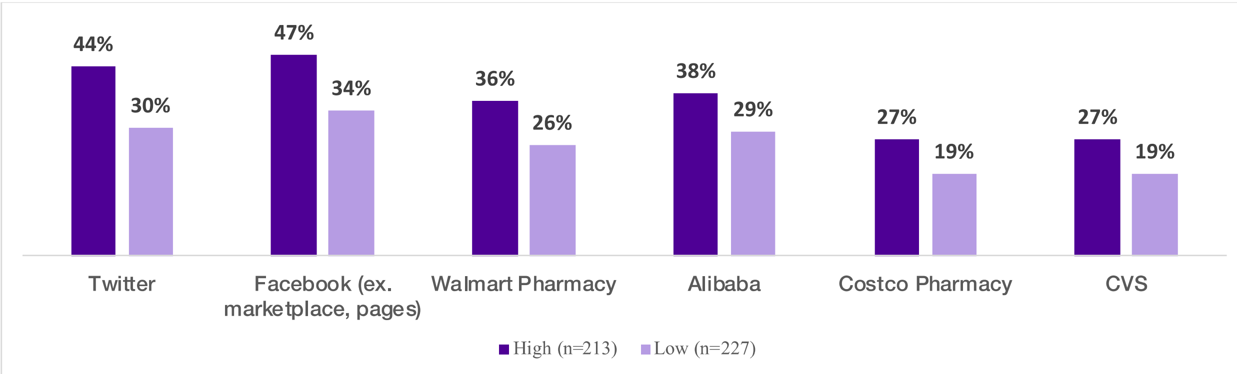
A - Gender



B - Age



C - Income



Conjoint analysis

As shown in **Table 2**, packaging was ranked the most influential tested attribute by a large margin (Avg importance = 43.68, SD = 20.48). Of the different packaging options tested, posts that include drugs displayed in official pill bottles were assessed as the most safe (Avg utility (AU) = 53.93, SD = 94.29). For the other tested attributes, posts were assessed as safer if they advertised multiple drugs compared to only one type of drug (AU = 1.53, SD = 46.80), had a blank profile compared to having an animated face as a profile (AU = 6.25, SD = 43.06), included payment info compared to not having payment info (AU = 4.73, SD = 44.86), and included emojis compared to not having emojis (AU = 3.35, SD = 44.57). Additional comparisons were made assessing if average utility scores for attributes and levels differed based on demographics for gender, age, and income. However, average utility scores remained consistent across all tested sub-groups, indicating that safety evaluations of post features were weighted the same regardless of these relevant demographic differences.

Table 2. Average importance scores and utility scores (zero-centered diffs) for tested attributes and levels.

Attribute	***Average Importances (Std Dev)***	***Levels***	***Average Utilities (Std Dev)***
Packaging	43.68 (20.48)	Drug is displayed as pills with hand	-13.32 (85.91)
		Drug is displayed in official packaging	**53.93 (94.29)**
		No picture of supplies (Blank White/Gray)	-40.61 (105.28)
Offerings	14.94 (11.28)	Advertises only one type of drug (Adderall)	-1.53 (46.80)
		Advertises multiple types of drugs	**1.53 (46.80)**
Profile	13.86 (10.50)	Human face (animated)	-6.25 (43.06)
		Blank profile	**6.25 (43.06)**
Payment	14.11 (11.23)	No payment info	-4.73 (44.86)
		Mentions payment methods (Venmo, paypal, BtC)	**4.73 (44.86)**
Emojis	13.41 (11.81)	**Includes emojis**	**3.35 (44.57)**
		Does not include emojis	-3.35 (44.57)

Note: **Bold** indicates the level with the higher utility score within the attribute

Platform perceptions and conjoint

Count variables were calculated to measure: the number of online platforms that participants rated as "Safe" or "Very safe," the number of online platforms that participants have ever purchased drugs or medication from, and the number of hypothetical posts from the conjoint task that were rated with at least 4 "Probably would be safe." As seen in **Table 3**, 12.3 platforms on average (sd=8.1) out of 24 were perceived as safe, 10.1 platforms on average (sd=10.2) were used to make a drug purchase, and 12.4 posts on average (sd=5.8) out of 21 from the conjoint task were rated as safe by participants. Female participants on average perceived a greater number of platforms as safe (14.1) compared to males (11.1), and this difference was significant (p<.001). Further, female participants tended to purchase from a greater number of platforms (10.7) compared to males (9.7, p<.05). Younger participants on average perceived a greater number of hypothetical social media posts as safe for purchasing drugs (13.6) compared to older participants (10.6, p<.001). Younger participants also tended to purchase drugs on a higher number of online platforms (11.1) compared to those 35 and older (8.6, p<.01). In comparison to participants with low income, high income participants were more likely to rate a greater number of social media posts as safe (13.3 vs 11.8, p<.01), perceive more platforms as safe (13.4 vs 11.5, p<.05), and tend to purchase drugs on a higher number of platforms (11.0 vs 9.3, p<.05).

Table 3. Mean Comparisons of Platform and Post Perceptions by Gender, Age, and Income.

		Gender		**Age**		**Income**	
Count variables *(Range)*	**Overall** *(Std Dev)*	**Male** *(n=264)*	**Female** *(n=176)*	**<= 34** *(n=264)*	**>= 35** *(n=176)*	**High** *(n=213)*	**Low** *(n=227)*
Conjoint Safe Count (0-21)	12.4 (5.8)	12.6	12.1	**13.6*** **	10.6	**13.3** **	11.8
Platform Safe Count (0-24)	12.3 (8.1)	11.1	**14.1*** **	12.7	11.8	**13.4***	11.5
Platform Purchase Count (0-48)	10.1 (10.2)	9.7	**10.7***	**11.1** **	8.6	**11.0***	9.3

Note: Statistically significant differences from Mann-Whitney Test are **bolded** and marked as * = p<.05, ** = p<.01, *** = p<.001

Lastly, correlations were run to examine associations between perceptions and purchasing across online platforms with safety evaluations of drug-selling social media posts from the conjoint exercise. Spearman's rho was used since the tested variables are not normally distributed as shown in a Shapiro-Wilk test ($W_{Conjoint}$ = .954, p<.001; $W_{PlatformS}$ = .923, p<.001; $W_{PlatformP}$ = .819, p<.001). Analysis shows that the number of platforms perceived as safe is moderately correlated with number of platforms purchased from (.41) and the number of social media posts perceived as safe (.31), and these effects are highly significant (p<.001). The number of platforms ever purchased from and number of hypothetical posts perceived as safe also show a small but significant correlation (.11, p<.05). These results increase confidence in the safety ratings from the conjoint exercise since they are correlated with platform safety perceptions, and indicate that safety perceptions and purchasing behavior are associated but still have distinct variance.

Discussion

This study examines drug purchasing behaviors across several online platforms and experimentally tested attributes of drug-advertising social media posts to assess which features convey perceptions of safety. Consistent with previous work (Moureaud et al., 2021), online pharmacies and Amazon were assessed as most safe for purchasing drugs. This indicates that the general category of online pharmacies, which includes legitimate licensed pharmacies and illegal "rogue" cyberpharmacies, were generally deemed the most safe by participants, followed by the world's largest e-commerce marketplace (i.e., Amazon) that is also becoming more invested in telepharmacy (Mackey & Nayyar, 2016). This despite estimates that 96% of online pharmacies fail to adhere to legal and safety requirements (Mackey, 2018). Among the most popular platforms used to purchase drugs from were SNS such as Instagram, Facebook, Twitter, and messaging platforms such as WhatsApp. The common use of platforms that are most directly tied to personal relationships that extend offline and the less frequent use of sites where real life identity can be anonymous (e.g., Reddit, Tumblr) suggests that social relationships may still be a contributing factor for facilitating drug sales transactions within online environments. It is possible that public platforms and personal messaging apps may be used to facilitate transactions between people who may already know each other or who have mutual network connections. In contrast, the information forager framework may be more applicable to virtual spaces where users do not know each other in any other context, which increases the importance of post cues that signal credibility. These platforms may be used when certain drugs are out of reach within a user's personal network and could increase risk associated with the transaction.

Several demographic differences were detected as well when comparing safety perceptions and purchasing behavior. For gender, female participants on average perceived a greater number of platforms as safe for drug purchasing and were more likely to have purchased from a platform compared to males. When examining specific platforms used for drug purchasing, men were more likely to use online pharmacies such as Honeybee Health or Health Warehouse. Women also showed a preference for online pharmacies (e.g., Walmart Pharmacy, CVS), and were more likely to purchase from social networking sites (SNS) such as Instagram and Craigslist. However, there were no significant differences in safety perceptions when evaluating drug-selling social media posts, suggesting that differences in safety perceptions between genders is influenced more by environmental factors of online spaces such as features associated with a given platform. These findings are inconsistent with older work showing that females tend to perceive greater risk associated with drug use (Spigner et al., 1993). However, the higher safety perceptions among females observed in the current study may be partly driven by the sample, which was screened for previous drug use, and also associated with effects showing that females tend to be more active on social networking sites (Kimbrough et al., 2013; Twenge & Martin, 2020) that could subsequently increase comfort with initiating online transactions.

When assessing age, younger participants were more likely to perceive a higher number of social media posts as safe and had purchased from a greater number of platforms compared to participants 35 and older, which is consistent with previous work (Fittler et al., 2018; van der Sanden et al., 2021). Younger participants were also more likely to use online pharmacies for drug purchasing than older participants. These differences in safety perceptions may be due to the greater comfort or familiarity that younger people have with technology and the internet, which can lead to a higher likelihood of making online purchases regardless of it being drug-related. Income also showed a notable influence on engagement with online drug purchasing. Those with high income perceived more posts and platforms as safe and have purchased drugs on a greater number of platforms compared to those with lower income. This effect may be attributed to the fact that those with higher income are more likely to have disposable earnings that can be used for purchasing specific classes of drugs or engage in online purchasing behavior. High income participants also showed a greater tendency than those with low income to purchase drugs from both online pharmacies such as Walmart Pharmacy and SNS such as Twitter and Facebook. These findings are inconsistent with previous work showing that those with low income are more likely to purchase prescription medicine outside of the US (Hong et al., 2020). However, this discrepancy may be due to a greater inclination among those with higher income to use online platforms and legitimate companies for domestic drug purchasing.

Of all 5 tested attributes in the conjoint exercise, packaging was ranked the most influential by a large margin with the most preferred level being drugs displayed in official pill bottles followed by pills being held in a hand. Not including a picture of the supplies was the least preferred level. The average importance for the remaining attributes do not differ by more than 1-2 points, indicating that those attributes are weighted similarly when evaluating post safety. The higher average utility scores for packaging compared to all other attributes and the higher preference for levels with visible drugs indicate that respondents place heavier importance on the visual display of drug supplies when evaluating the safety of making a potential purchase via a social media source. Additionally, the higher scores for packaging remains consistent in sub-group comparisons based on demographics (gender, age, income) indicating that the importance of the visual display of drug supplies is robust across relevant factors. The greater safety perceptions of displays with official packaging may be due to pill bottles conveying higher credibility by allowing the user to see the purported supplies before making a purchase and diminish concerns about counterfeits, or may assure users that the seller has possession of product and is less likely to be an online scammer. Since posts with visual displays of drugs are perceived as safer for making a purchase, moderation interventions should particularly target posts that include images using tools such as image recognition software and deep learning approaches to identify specific controlled drug supplies that are illegal to purchase online, whether as pills or in prescription packaging.

For the offerings attribute, the level with multiple advertised drugs scored higher than only advertising one drug. This suggests that users may perceive dealers who offer multiple types of drugs as more safe or credible due to having a larger inventory. Users may also be conflating this perception with legitimacy, believing that a seller with multiple drug offerings is more likely to not be a scammer or a seller who does not actually possess drugs for sale (e.g., non-delivery scheme). This finding may reflect lack of awareness among online users on the basis that legitimate manufacturers, suppliers, and dispensers do not advertise multiple drug products in social media posts for purchase and that prescription-controlled substances cannot be sold online. Future research should examine how altering combinations of drug types offered in posts can influence safety and legitimacy perceptions.

For the profile attribute, having a blank profile photo scored higher than a profile with an animated face. Due to the discretionary and covert nature of online drug transactions, respondents may feel more at ease with explicit displays of anonymity that can also lessen the risk of getting caught by authorities. When comparing levels for the payment attribute, including payment information was perceived as safer than not including. While providing payment methods increases the risk of getting caught by authorities, the inclusion of payment information could further signal that the dealer is an established seller, therefore increasing user trust. This is similarly an area in need of additional consumer education, as purchasing drugs online using payment processors such as Venmo and Paypal or cryptocurrencies (e.g., Bitcoin) indicates high risk of illegal sale.

Lastly, the level for including emojis had a higher utility score than the level for not including emojis. Recent work has shown that authors of messages (both bots and humans) that use emojis are rated higher in social attractiveness, competence, and credibility compared to authors of text-only messages (Beattie et al., 2020). The addition of emojis in a drug-advertising post might signal to users that the post's author is more relatable and less likely to be a bot, which can subsequently influence safety assessment. Online drug dealers share similar perceptions as emojis are frequently used to advertise drugs across platforms (McCulloch &

Furlong, 2019) and effective use of emojis can be viewed as a sign of professionalism (Demant et al., 2019).

Limitations

There are notable limitations concerning the current study. First, lack of education and awareness among consumers and the general public regarding what drugs are legal to purchase online, what online sources are legal versus those that are illicit, and what constitutes nonmedical or recreational use, has the potential to bias our sample. Further, as typical with conjoint analysis, using hypothetical social media posts makes the tested attributes dependent on the researcher's decisions. Therefore, it is possible that we did not test all relevant features of social media posts related to safety perceptions. Results from conjoint analysis are also dependent on the prompt used in the task, as different elicitation formats can influence estimations of utility scores. While the present study focused on safety evaluations, follow-up research should examine prompts that measure related perceptual dimensions to drug purchasing such as trust and credibility of the post author, product legitimacy, and likelihood to purchase, which would generate more nuanced insights into the types of information scents transmitted by a post. Additionally, this study only tested one type of drug (Adderall, which is a controlled substance) against multiple types of drugs in the offering attribute, however, it is likely that these results are influenced by the type of drug used for the single drug offering. Lastly, importance scores in conjoint analysis are influenced by the number of levels included within tested attributes. While in the current study packaging showed a higher margin of importance, the higher ranking may be partly due to having one more level than the other tested attributes.

Future directions and concluding remarks

The use of conjoint analysis to test user perceptions of social media posts can aide public health interventions such as identifying which posts to prioritize for platform targeting and removal. More specifically, these results can be used to develop metrics that score posts based on how many high ranked features it contains from the conjoint exercise (e.g., posts containing pills in bottles with emojis and payment information) which can guide content moderation, development of algorithmic classification systems for prohibited content, and assist the operation of platform safety teams by identifying posts that are more likely to elicit a sales transaction associated with online drug sourcing. These more targeted approaches could better enable digital harm reduction by prioritizing removal of posts and accounts that are likely harmful to users.

While the current study only tested attributes of hypothetical Instagram posts, future work using a conjoint design should consider how other platforms and platform-specific features can influence the information scents of posts. Previous work already shows that differences in virtual environments can influence how drugs are advertised online. For example, sites with higher word count limits (e.g., Tumblr) had higher concentrations of drug mentions per post and higher variety of drug type mentions compared to platforms limited to shorter message lengths such as Twitter (Haupt et al., 2022). It is also likely that advertising strategies from dealers will adapt to platforms featuring video content such as TikTok. In response, conjoint analysis can be adapted to test how cues that signal safety and credibility for video stimuli differ from written text posts.

The nature of drug purchasing within virtual environments is complex where both the attributes of a post itself and the platform that it resides on influences how users evaluate the safety of a potential transaction. Designing effective solutions for platforms is further complicated when accounting for differences in legal status of drugs across countries and jurisdictions (Fuller et al., 2023). As demonstrated in the current study, approaches such as conjoint analysis can account for some of these complexities and shed light on the risk evaluations of potential drug purchasers. Most importantly, understanding which features of social media posts signal safety for an otherwise high-risk transaction can inform interventions that make online spaces less accessible for conducting illicit drug sales and aide in addressing the ongoing opioid crisis in the US that challenges both communities and digital spaces.

Acknowledgments

The authors would like to thank Sawtooth Software for providing access to the software required to implement this study via their academic grant program.

Disclosure of interest

This research was supported by the National Institute on Drug Abuse (Award 1R21DA050689-01). The funding source did not have involvement in the study design; collection, analysis and interpretation of data; in the writing of the report; nor in the decision to submit the article for publication. Author TKM is an employee 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. TKM is also the CEO and a member of S-3 Research LLC with ownership interest. Authors reports no other conflict of interest associated with this manuscript.

References

Al-Omari, B., Farhat, J., & Ershaid, M. (2022). Conjoint Analysis: A Research Method to Study Patients' Preferences and Personalize Care. *Journal of Personalized Medicine*, *12*(2), Article 2. https://doi.org/10.3390/jpm12020274

Atkyns, R. L., & Hanneman, G. J. (1974). Illicit Drug Distribution and Dealer Communication Behavior. *Journal of Health and Social Behavior*, *15*(1), 36–43. https://doi.org/10.2307/2136924

Bakken, S. A., & Demant, J. J. (2019). Sellers' risk perceptions in public and private social media drug markets. *International Journal of Drug Policy*, *73*, 255–262. https://doi.org/10.1016/j.drugpo.2019.03.009

Baumgartner, J. C., & Radley, D. C. (2021, August 16). *The Drug Overdose Toll in 2020 and Near-Term Actions for Addressing It*. https://doi.org/10.26099/gb4y-r129

Beattie, A., Edwards, A. P., & Edwards, C. (2020). A Bot and a Smile: Interpersonal Impressions of Chatbots and Humans Using Emoji in Computer-mediated Communication. *Communication Studies*, *71*(3), 409–427. https://doi.org/10.1080/10510974.2020.1725082

Boardman, J. D., Finch, B. K., Ellison, C. G., Williams, D. R., & Jackson, J. S. (2001). Neighborhood Disadvantage, Stress, and Drug Use among Adults. *Journal of Health and Social Behavior*, *42*(2), 151–165. https://doi.org/10.2307/3090175

Bohannon, J. (2011). Social Science for Pennies. *Science*, *334*(6054), 307–307. https://doi.org/10.1126/science.334.6054.307

Bohannon, J. (2016). Mechanical Turk upends social sciences. *Science*, *352*(6291), 1263–1264. https://doi.org/10.1126/science.352.6291.1263

Bonnie, R. J., Kesselheim, A. S., & Clark, D. J. (2017). Both Urgency and Balance Needed in Addressing Opioid Epidemic: A Report From the National Academies of Sciences, Engineering, and Medicine. *JAMA*, *318*(5), 423–424. https://doi.org/10.1001/jama.2017.10046

Caruso, E. M., Rahnev, D. A., & Banaji, M. R. (2009). Using Conjoint Analysis to Detect Discrimination: Revealing Covert Preferences From Overt Choices. *Social Cognition*, *27*(1), 128–137. https://doi.org/10.1521/soco.2009.27.1.128

Constine, J. (2018, August 16). Facebook cracks down on opioid dealers after years of neglect. *TechCrunch*. https://techcrunch.com/2018/08/16/facebook-opioid-searches/

Chinburapa, V., & Larson, L. N. (1988). Predicting Prescribing Intention and Assessing Drug Attribute Importance Using Conjoint Analysis. *Journal of Pharmaceutical Marketing & Management*, *3*(2), 3–18. https://doi.org/10.3109/J058v03n02_02

Daniel, T. A., & Camp, A. L. (2020). Emojis affect processing fluency on social media. *Psychology of Popular Media*, *9*(2), 208–213. https://doi.org/10.1037/ppm0000219

De', R., Pandey, N., & Pal, A. (2020). Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice. *International Journal of Information Management*, *55*, 102171. https://doi.org/10.1016/j.ijinfomgt.2020.102171

Demant, J., Bakken, S. A., & Hall, A. (2020). Social media markets for prescription drugs: Platforms as virtual mortars for drug types and dealers. *Drugs and Alcohol Today*, *20*(1), 36–49. https://doi.org/10.1108/DAT-06-2019-0026

Demant, J., Bakken, S. A., Oksanen, A., & Gunnlaugsson, H. (2019). Drug dealing on Facebook, Snapchat and Instagram: A qualitative analysis of novel drug markets in the Nordic countries. *Drug and Alcohol Review*, *38*(4), 377–385. https://doi.org/10.1111/dar.12932

Dwoskin, E. (2018, September 26). Instagram has a drug problem. Its algorithms make it worse. *Washington Post*. WebCite Cache ID 76JUMWJbR. https://www.washingtonpost.com/business/economy/instagram-has-a-drug-problem-its-algorithms-make-it-worse/2018/09/25/c45bf730-bdbf-11e8-b7d2-0773aa1e33da_story.html

Fittler, A., Vida, R. G., Káplár, M., & Botz, L. (2018). Consumers Turning to the Internet Pharmacy Market: Cross-Sectional Study on the Frequency and Attitudes of Hungarian Patients Purchasing Medications Online. *Journal of Medical Internet Research*, *20*(8), e11115. https://doi.org/10.2196/11115

Ge, J., & Gretzel, U. (2018). Emoji rhetoric: A social media influencer perspective. *Journal of Marketing Management*, *34*(15–16), 1272–1295. https://doi.org/10.1080/0267257X.2018.1483960

Green, P. E., Krieger, A. M., & Wind, Y. (2004). Thirty Years of Conjoint Analysis: Reflections and Prospects. In Y. Wind & P. E. Green (Eds.), *Marketing Research and Modeling: Progress and Prospects: A Tribute to Paul E. Green* (pp. 117–139). Springer US. https://doi.org/10.1007/978-0-387-28692-1_6

Green, P. E., & Srinivasan, V. (1990). Conjoint Analysis in Marketing: New Developments with Implications for Research and Practice. *Journal of Marketing*, *54*(4), 3–19. https://doi.org/10.1177/002224299005400402

Haupt, M. R., Cuomo, R., Li, J., Nali, M., & Mackey, T. K. (2022). The influence of social media affordances on drug dealer posting behavior across multiple social networking sites (SNS). *Computers in Human Behavior Reports*, *8*, 100235. https://doi.org/10.1016/j.chbr.2022.100235

Hong, Y.-R., Hincapie-Castillo, J. M., Xie, Z., Segal, R., & Mainous, A. G., III. (2020). Socioeconomic and Demographic Characteristics of US Adults Who Purchase Prescription Drugs From Other Countries. *JAMA Network Open*, *3*(6), e208968. https://doi.org/10.1001/jamanetworkopen.2020.8968

Horiuchi, Y., Markovich, Z., & Yamamoto, T. (2022). Does Conjoint Analysis Mitigate Social Desirability Bias? *Political Analysis*, *30*(4), 535–549. https://doi.org/10.1017/pan.2021.30

Hu, C., Yin, M., Liu, B., Li, X., & Ye, Y. (2021). Identifying Illicit Drug Dealers on Instagram with Large-scale Multimodal Data Fusion. *ACM Transactions on Intelligent Systems and Technology*, *12*(5), 59:1-59:23. https://doi.org/10.1145/3472713

Huang, Q., Chen, X., Huang, S., Shao, T., Liao, Z., Lin, S., Li, Y., Qi, J., Cai, Y., & Shen, H. (2021). Substance and Internet use during the COVID-19 pandemic in China. *Translational Psychiatry*, *11*(1), Article 1. https://doi.org/10.1038/s41398-021-01614-1

Humphreys, K., Shover, C. L., Andrews, C. M., Bohnert, A. S. B., Brandeau, M. L., Caulkins, J. P., Chen, J. H., Cuéllar, M.-F., Hurd, Y. L., Juurlink, D. N., Koh, H. K., Krebs, E. E., Lembke, A., Mackey, S. C., Ouellette, L. L., Suffoletto, B., & Timko, C. (2022). Responding to the opioid crisis in North America and beyond: Recommendations of the Stanford–Lancet Commission. *The Lancet*, *399*(10324), 555–604. https://doi.org/10.1016/S0140-6736(21)02252-2

Junna, L., Moustgaard, H., Tarkiainen, L., & Martikainen, P. (2019). The Association Between Income and Psychotropic Drug Purchases: Individual Fixed Effects Analysis of Annual Longitudinal Data in 2003–2013. *Epidemiology*, *30*(2), 221. https://doi.org/10.1097/EDE.0000000000000956

Kimbrough, A. M., Guadagno, R. E., Muscanell, N. L., & Dill, J. (2013). Gender differences in mediated communication: Women connect more than do men. *Computers in Human Behavior*, *29*(3), 896–900. https://doi.org/10.1016/j.chb.2012.12.005

Korn, J., Vocks, S., Rollins, L. H., Thomas, J. J., & Hartmann, A. S. (2020). Fat-Phobic and Non-Fat-Phobic Anorexia Nervosa: A Conjoint Analysis on the Importance of Shape and Weight. *Frontiers in Psychology*, *11*. https://www.frontiersin.org/articles/10.3389/fpsyg.2020.00090

Knudsen, H. K., & Havens, J. R. (2021). Using conjoint analysis to study health policy changes: An example from a cohort of persons who use drugs. *International Journal of Drug Policy*, *98*, 103425. https://doi.org/10.1016/j.drugpo.2021.103425

Krämer, N. C., Feurstein, M., Kluck, J. P., Meier, Y., Rother, M., & Winter, S. (2017). Beware of Selfies: The Impact of Photo Type on Impression Formation Based on Social Networking Profiles. *Frontiers in Psychology*, *8*. https://www.frontiersin.org/articles/10.3389/fpsyg.2017.00188

Lapowsky, I. (2018, June 27). Tech Companies Deflect Blame for Opioid Crisis Ahead of FDA Summit. *Wired*. WebCite Cache ID 76JU9rYup. https://www.wired.com/story/tech-companies-deflect-blame-for-opioid-crisis-fda-summit/

Li, Y., & Xie, Y. (2020). Is a Picture Worth a Thousand Words? An Empirical Study of Image Content and Social Media Engagement. *Journal of Marketing Research*, *57*(1), 1–19. https://doi.org/10.1177/0022243719881113

Li, J., Xu, Q., Shah, N., & Mackey, T. K. (2019). A Machine Learning Approach for the Detection and Characterization of Illicit Drug Dealers on Instagram: Model Evaluation Study. *Journal of Medical Internet Research*, *21*(6), e13803. https://doi.org/10.2196/13803

Lytvynenko, J. (2018, June 1). *Social Networks Are Losing A Deadly Battle With Illegal Online Pharmacies*. BuzzFeed News. https://www.buzzfeednews.com/article/janelytvynenko/social-networks-are-losing-a-deadly-battle-with-illegal

Liang, B. A., & Mackey, T. (2009). Searching for Safety: Addressing Search Engine, Website, and Provider Accountability for Illicit Online Drug Sales. *American Journal of Law & Medicine*, *35*(1), 125–184. https://doi.org/10.1177/009885880903500104

Mackey, T. K. (2018). Opioids and the Internet: Convergence of Technology and Policy to Address the Illicit Online Sales of Opioids. *Health Services Insights*, *11*, 1178632918800995. https://doi.org/10.1177/1178632918800995

Mackey, T. K., & Kalyanam, J. (2017). *Detection of illicit online sales of fentanyls via Twitter* (6:1937). F1000Research. https://doi.org/10.12688/f1000research.12914.1

Mackey, T. K., Kalyanam, J., Katsuki, T., & Lanckriet, G. (2017). Twitter-Based Detection of Illegal Online Sale of Prescription Opioid. *American Journal of Public Health*, *107*(12), 1910–1915. https://doi.org/10.2105/AJPH.2017.303994

Mackey, T., Kalyanam, J., Klugman, J., Kuzmenko, E., & Gupta, R. (2018). Solution to Detect, Classify, and Report Illicit Online Marketing and Sales of Controlled Substances via Twitter: Using Machine Learning and Web Forensics to Combat Digital Opioid Access. *Journal of Medical Internet Research*, *20*(4), e10029. https://doi.org/10.2196/10029

Mackey, T. K., Li, J., Purushothaman, V., Nali, M., Shah, N., Bardier, C., Cai, M., & Liang, B. (2020). Big Data, Natural Language Processing, and Deep Learning to Detect and Characterize Illicit COVID-19 Product Sales: Infoveillance Study on Twitter and Instagram. *JMIR Public Health and Surveillance*, *6*(3), e20794. https://doi.org/10.2196/20794

Mackey, T. K., Liang, B. A., & Strathdee, S. A. (2013). Digital Social Media, Youth, and Nonmedical Use of Prescription Drugs: The Need for Reform. *Journal of Medical Internet Research*, *15*(7), e2464. https://doi.org/10.2196/jmir.2464

Mackey, T. K., & Nayyar, G. (2016). Digital danger: A review of the global public health, patient safety and cybersecurity threats posed by illicit online pharmacies. *British Medical Bulletin*, *118*(1), 110–126. https://doi.org/10.1093/bmb/ldw016

Mattson, C. L., Tanz, L., Quinn, K., Kariisa, M., Patel, P., & Davis, N. (2021). Trends and Geographic Patterns in Drug and Synthetic Opioid Overdose Deaths—United States, 2013–2019. *MMWR. Morbidity and Mortality Weekly Report*, *70*. https://doi.org/10.15585/mmwr.mm7006a4

McCulloch, L., & Furlong, S. (2019). *DM for details. Selling drugs in the age of social media.* [Report]. Volteface. https://www.drugsandalcohol.ie/31036/

Moeller, K. (2018). Drug Market Criminology: Combining Economic and Criminological Research on Illicit Drug Markets. *International Criminal Justice Review*, *28*(3), 191–205. https://doi.org/10.1177/1057567717746215

Mouratidis, K., & Papagiannakis, A. (2021). COVID-19, internet, and mobility: The rise of telework, telehealth, e-learning, and e-shopping. *Sustainable Cities and Society*, *74*, 103182. https://doi.org/10.1016/j.scs.2021.103182

Moureaud, C., Hertig, J., Dong, Y., Muraro, I. S., & Alhabash, S. (2021). Purchase of prescription medicines via social media: A survey-based study of prevalence, risk perceptions, and motivations. *Health Policy*, *125*(11), 1421–1429. https://doi.org/10.1016/j.healthpol.2021.09.007

Moyle, L., Childs, A., Coomber, R., & Barratt, M. J. (2019). #Drugsforsale: An exploration of the use of social media and encrypted messaging apps to supply and access drugs. *International Journal of Drug Policy*, *63*, 101–110. https://doi.org/10.1016/j.drugpo.2018.08.005

National Institute on Drug Abuse. (2023, February 9). *Drug Overdose Death Rates*. National Institute on Drug Abuse. https://nida.nih.gov/research-topics/trends-statistics/overdose-death-rates

Nguyen, M. H., Gruber, J., Fuchs, J., Marler, W., Hunsaker, A., & Hargittai, E. (2020). Changes in Digital Communication During the COVID-19 Global Pandemic: Implications for Digital Inequality and Future Research. *Social Media + Society*, *6*(3), 2056305120948255. https://doi.org/10.1177/2056305120948255

Oksanen, A., Miller, B. L., Savolainen, I., Sirola, A., Demant, J., Kaakinen, M., & Zych, I. (2020a). Illicit Drug Purchases via Social Media Among American Young People. In G. Meiselwitz (Ed.), *Social Computing and Social Media. Design, Ethics, User Behavior, and Social Network Analysis* (pp. 278–288). Springer International Publishing. https://doi.org/10.1007/978-3-030-49570-1_19

Oksanen, A., Miller, B. L., Savolainen, I., Sirola, A., Demant, J., Kaakinen, M., & Zych, I. (2020b). Social Media and Access to Drugs Online: A Nationwide Study in the United States and Spain among Adolescents and Young Adults. *European Journal of Psychology Applied to Legal Context*, *13*(1), 29–36. https://doi.org/10.5093/ejpalc2021a5

Petersen, M. A., Petersen, I. L., Poulsen, C., & Nørgaard, L. S. (2021). #studydrugs-Persuasive posting on Instagram. *The International Journal on Drug Policy*, *95*, 103100. https://doi.org/10.1016/j.drugpo.2020.103100

Pirolli, P. (2001). Rational Analyses of Information Foraging on the Web. In *Dictionary of World Philosophy*. Routledge.

Pirolli, P., & Card, S. (1999). Information foraging. *Psychological Review*, *106*, 643–675. https://doi.org/10.1037/0033-295X.106.4.643

Rutherford, B. N., Sun, T., Johnson, B., Co, S., Lim, T. L., Lim, C. C. W., Chiu, V., Leung, J., Stjepanovic, D., Connor, J. P., & Chan, G. C. K. (2022). Getting high for likes: Exploring cannabis-related content on TikTok. *Drug and Alcohol Review*, *41*(5), 1119–1125. https://doi.org/10.1111/dar.13433

Shah, N., Li, J., & Mackey, T. K. (2022). An unsupervised machine learning approach for the detection and characterization of illicit drug-dealing comments and interactions on Instagram. *Substance Abuse*, *43*(1), 273–277. https://doi.org/10.1080/08897077.2021.1941508

Shrestha, R., Karki, P., Altice, F. L., Dubov, O., Fraenkel, L., Huedo-Medina, T., & Copenhaver, M. (2018). Measuring Acceptability and Preferences for Implementation of Pre-Exposure Prophylaxis (PrEP) Using Conjoint Analysis: An Application to Primary HIV Prevention Among High Risk Drug Users. *AIDS and Behavior*, *22*(4), 1228–1238. https://doi.org/10.1007/s10461-017-1851-1

Spigner, C., Hawkins, W. E., & Loren, W. (1993). Gender Differences in Perception of Risk Associated with Alcohol and Drug Use Among College Students. *Women & Health*, *20*(1), 87–97. https://doi.org/10.1300/J013v20n01_06

Sun, X., Wagner, A. L., Ji, J., Huang, Z., Zikmund-Fisher, B. J., Boulton, M. L., Ren, J., & Prosser, L. A. (2020). A conjoint analysis of stated vaccine preferences in Shanghai, China. *Vaccine*, *38*(6), 1520–1525. https://doi.org/10.1016/j.vaccine.2019.11.062

Tiku, N. (2018, April 6). One Woman Got Facebook to Police Opioid Sales On Instagram. *Wired*. WebCite Cache ID 76JUWUVmi. https://www.wired.com/story/one-woman-got-facebook-to-police-opioid-sales-on-instagram/

Twenge, J. M., & Martin, G. N. (2020). Gender differences in associations between digital media use and psychological well-being: Evidence from three large datasets. *Journal of Adolescence*, *79*, 91–102. https://doi.org/10.1016/j.adolescence.2019.12.018

van der Sanden, R., Wilkins, C., Romeo, J. S., Rychert, M., & Barratt, M. J. (2021). Predictors of using social media to purchase drugs in New Zealand: Findings from a large-scale online survey. *International Journal of Drug Policy*, *98*, 103430. https://doi.org/10.1016/j.drugpo.2021.103430

van der Sanden, R., Wilkins, C., Rychert, M., & Barratt, M. J. (2022). The Use of Discord Servers to Buy and Sell Drugs. *Contemporary Drug Problems*, *49*(4), 453–477. https://doi.org/10.1177/00914509221095279

Whelan, J., Noller, G. E., & Ward, R. D. (n.d.). Rolling through TikTok: An analysis of 3,4-methylenedioxymethamphetamine-related content. *Drug and Alcohol Review*, *n/a*(n/a). https://doi.org/10.1111/dar.13640

Wilson, L., Loucks, A., Bui, C., Gipson, G., Zhong, L., Schwartzburg, A., Crabtree, E., Goodin, D., Waubant, E., & McCulloch, C. (2014). Patient centered decision making: Use of conjoint analysis to determine risk–benefit trade-offs for preference sensitive treatment choices. *Journal of the Neurological Sciences*, *344*(1), 80–87. https://doi.org/10.1016/j.jns.2014.06.030

Yang, X., & Luo, J. (2017). Tracking Illicit Drug Dealing and Abuse on Instagram Using Multimodal Analysis. *ACM Transactions on Intelligent Systems and Technology*, *8*(4), 58:1-58:15. https://doi.org/10.1145/3011871