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Exploring the relationship between cold medicine abuse and recreational drug use.

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Exploring the Relationship between Cold Medicine Abuse and Recreational Drug Use

by

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HONORS THESIS

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Abstract

Over-the-counter medicines such as cold and cough medications may be abused as an accessible alternative to other recreational drugs in order to obtain a desired 'high.' A lack of literature is currently present, with few studies specifically observing simultaneous drug use and cold and/or cough medicine abuse. Using publicly available data from the 2021 National Survey on Drug Use and Health (NSDUH), the researcher sought to help bridge this gap in knowledge by identifying any risk factor relationship that could exist between cold medicine abuse and commonly used recreational drugs. The observed frequency of recreational drug use (marijuana, phencyclidine, ecstasy, ketamine) was compared against the frequency of cold/cough medicine abuse. Usage frequencies were categorized into "Past-Year," "Prior-to-Past-Year," and "Ever." This study demonstrates, a statistically significant correlation exists between the use of recreational drugs and the abuse of cold/cough medicines. Despite strong evidence which suggests correlation ($p<0.01$) between the two, unaccounted confounders for each drug may diminish the strength of this correlation in comparison. Among individuals who have misused cold medicine at some point, a higher relative proportion of respondents were found to have also at some point used marijuana. Upon further analysis using a logistic regression, historical cold medicine abuse was found to increase the odds of marijuana abuse by a factor of 1.2 holding all other variables constant. Based on these results, a focused study on the abuse of cold medicine and use of marijuana may be of interest. Ideally, such a study would consider frequency of drug use and other factors that are not explored in-depth within the NSDUH survey.

Keywords: cold medicine abuse, dextromethorphan, over the counter (OTC) medicine

Introduction

Cold and cough medicine are commonly used by the public to treat common symptoms associated with them. Over the counter (OTC) medications typically do not present an issue when used as directed, but there remains the possibility of abusing OTC medications for unintended purposes such as recreational use. Common street names that are associated with cold/cough medicine abuse includes 'Robotripping,' 'Robo,' and 'Triple C,' with medication usually being taken orally as a capsule or in its liquid form (U.S. Department of Health and Human Services p. 400).

Recreational use would require a substantial amount of medication to achieve certain effects desired by abusers but doing so is not impossible. Considering the legality and of ease of access to said medicine, it can become an easier drug to abuse when the alternative is a more convoluted, and potentially illegal, method of obtaining drugs. While it remains an overlooked drug target for widespread abuse in comparison to illicit drugs (used interchangeably with recreational drugs), the lack of oversight provides an additional drug for abuse. In addition, dextromethorphan (DXM), which is a common active ingredient in cold medicine, can lead to false negative readings within standard urine tests employed by police as DXM cannot be effectively detected (Martinak et al., 2017). Alternatively, other medications, such as codeine, have also been used to replicate the effects induced by stronger recreational drugs. Long term abuse of codeine cough syrup has an indicated potential to lead to brain damage and result in dependence of it through repeated abuse (Olasunkanmi R & Isreal O, 2019). Continuous use of codeine can also result in the development of gastric ulcers, internal bleeding, and inflammation of the stomach (Olasunkanmi R & Isreal O, 2019). While most codeine-based medications in the United States have experienced restrictions imposed by the FDA and are generally limited to

prescribed individuals, dextromethorphan has not faced the same level of scrutiny (Department

of Justice/Drug Enforcement Administration, 2022; Research, 2023). In more recent years,

dextromethorphan-based cough suppressants have become more prevalent than codeine-based

cough suppressants (Martinak et al., 2017). Though there are many active ingredients that are

present within cold and cough medications, the main focus of this paper will be on DXM as it is

a common ingredient (Stanciu et al., 2016). Important to note is this study's broad usage of the

phrase 'cold medicine abuse' which is used interchangeably with cold/cough medicine for

simplicity.

In the case of dextromethorphan (DXM), which is a common ingredient in cough

medicine, common urine tests do not detect DXM, though it is possible for false-positives to

appear for PCP use at high dosage levels of DXM (Martinak et al., 2017). As a result, additional

tests must be conducted to ascertain the true source of any false positives for PCP, or lack of

results. Given DXM's role as an antagonist of serotonin transporters (SERT), dextromethorphan

toxicity can lead to the development of serotonin syndrome (Oh et al., 2023; Zaremba et al.,

2023). Symptoms of serotonin syndrome range from insomnia, diarrhea, nausea to more severe

symptoms such as a state of delirium or even rhabdomyolysis, though diagnosis with this

syndrome is rare (Foong et al., 2018). More commonly, the main result of excess DXM intake

appears in the form of dextromethorphan toxicity. Among cold/cough medicine abusers, some

have stated their initial enjoyment of the dissociative, euphoric, and intoxicating (alcohol-like)

effect (Alam et al., 2013; Mutschler et al., 2010). There has also been a recorded case study in

which an individual has been reported to have used DXM to suppress their desire for alcohol and

tobacco use. (Kimber & Thompson, 2015)

Toxicity severity can be categorized into four different 'plateaus', with ranges of 100-200mg, 200-500mg, 500-1000mg, and greater than 1000mg exhibiting increasingly alarming symptoms (Antoniou & Juurlink, 2014). In the case of DXM toxicity, symptoms can range from restless and euphoria at low levels of DXM, and can reach extremes to the point of complete dissociation, delusions, and other psychotic effects for intake greater than 1000mg of DXM (Antoniou & Juurlink, 2014). At elevated doses, these symptoms of dextromethorphan based cold/cough medicine toxicity expresses symptoms similar to psychosis associated with phencyclidine (PCP) (Martinak et al., 2017). There have been prior cases of opioid toxidrome, toxicity induced by opioids, recorded. However, this remains a rare manifestation of DXM abuse as opposed to normal DXM toxicity. (Kumar et al., 2023). Long-term effects of DXM abuse suggest it may play a role in cognitive deterioration as seen in one reported case study, though it is possible some effects may be explained by unexplored reasons (Hinsberger et al., 1994). Currently, main methods of treatment for DXM toxicity utilize atypical antipsychotic agents, though this information is mostly based on previous case studies (Zaremba et al., 2023).

Despite the increased prevalence of DXM use, codeine-based cold medicine should still be considered separately as restrictions do not completely prevent its purchase even as a prescribed drug. Given how commonplace it is for individuals to use OTC medications in their lifetime, it is important that everyone follows the instructions listed on cold and cough OTC medicine to avoid misuse and abuse.

As previously described, cold medicine abuse symptoms can mimic the same effects exhibited by other known recreational drugs. It is important, therefore, to identify whether cold can increase the risk of other drug use. The similar effects associated with cold medicine abuse

and recreational drug use helped guide this study's efforts to confirm whether cold medicine

abuse is a statistically significant risk factor for other recreational drug use or not.

Methods

Data used for analysis was collected from the 2021 National Survey on Drug Use and

Health (NSDUH), which consisted of a total of 58,034 records in the public use file (PUF)

though survey collected information from 69,850 individuals. Due to COVID-19, the NSDUH

collected information online and in-person. According to the NSDUH codebook, their final

sample had 54% of interviews completed online, while 45% were completed in person. All

information gathered from the NSDUH is reliant on participant's honesty as all responses are

self-reported, and reflects a snapshot of civilian drug use for 2021(*National Survey on Drug Use*

and Health 2021 (NSDUH-2021-DS0001) | SAMHDA, n.d.). Additionally, it is important to note

that the use of the term 'cold medicine' is used in this context to encompass both cold and cough

medicine as both are combined variables recorded within the survey.

The Substance Abuse and Mental Health Services Administration (SAMHSA) has stated

that 2021 NSDUH results are not comparable to those of previous years given the difference in

methodology used to collect this information. In some instances, missing values were substituted

for through statistical imputation using the predictive mean neighborhood (PMN) or modified

predictive mean neighborhood (modPMN). Variables which were imputed using PMN included

the use of marijuana, basic demographics, and reported income. The modPMN model was used

for imputation within variables such as drug use of hallucinogens and pain relievers. Imputation

of additional variables was conducted with both methods but remained irrelevant in the scope of this analysis.

All analyzed data was sourced from either imputation revised and/or recoded variables per suggestion of the NSDUH codebook. The exception to this comes from the variable IRSEX, which is itself not truly imputation revised by named as such for the sake of consistency and comparison of the study with prior years. In some instances, additional modifications were made by the researcher to create new variables from the revised variables. Variables which were recombined consisted of those responsible for information on race, as well as recency of drug use for marijuana, phencyclidine, ecstasy, and ketamine. Race variables for Native Americans/Alaskan Natives, Native Hawaiians/Pacific Islanders, and Asians were all combined together to form one race. The aforementioned drugs were revised to create a new variable which combined values for drug use "within the past 30 days" and those who were "more than 30 days ago, but within the past 12 months". This new variable acted as a yearly drug use variable. All analysis involving any kind of cold, or cough medicine abuse is limited to abuse of over-the-counter medications as this is the information collected from the NSDUH. Minor discrepancies in reported percentage values may be present due to the decision to round percentages to the nearest hundredth value.

All analyses were conducted with the assistance of statistical program R (R Core Team, 2022) and utilizing the computer software 'R-Studio' (Posit team, 2023) with the additional 'dplyr' (Wickham et al., 2023), 'tidymodels' (Kuhn, Wickham 2020) and 'broom' (Robinson, Hayes, Couch, 2023) packages added for easier analysis. During the creation of this thesis, the NSDUH was updated to include new variables in the publicly available 'R' file. This update is believed to not affect the analysis provided by this study as no variable that was used was listed

within the updated variables. Using 'R-Studio', all relevant chi-square tests and logistic regression tests were conducted.

Demographics

The variable "CATAG3" was selected as the age group category used to categorize responses, consisting of five age groups. This variable is changed from those used in previous years and includes less age categories. Age groups listed by this variable included individuals who were 12-17 years, 18-25 years, 26-34 years, 35-49 years, and 50+ years old. Within the scope of analysis, the researcher used the age groups of 18-25 and 26-34 to analyze the correlation of drug use within these groups specifically. The overall sample was also analyzed.

Respondents' race was categorized into seven different categories. Recoded race variables were separated by Hispanic and Non-Hispanic, with no indication of additional race identity if individual identified as Hispanic (e.g. Hispanic White). Non-Hispanic race variables were present for respondents who identify as 'White', 'Black/African American', 'Native American/Alaskan Native', 'Native Hawaiian/Other Pacific Islander', 'Asian', and those who identified as more than one race.

Income was divided into seven categorical groups by the variable 'IRPINC3', grouped by individuals with an income below $10,000 to those who held an income greater than $75,000. The NSDUH also created a variable, 'POVERTY3', to classify individuals in relation to their poverty classification which the researcher also added to their tables. 'POVERTY3' was first used in the 2015 NSDUH, increasing the maximum income response values though surveyors continue to consider 'POVERTY3' comparable to the previous poverty variable used.

Respondents between the ages of 18 to 22 were excluded from this variable if they were living in a college dormitory at the time of the survey.

Prior to direct comparisons of cold medicine use with recreational drugs, all demographic variables were compared with frequency of cold medicine abuse. All percentages listed in tables are in respect to the size of varying levels of cold medicine abuse as opposed to a demographic's total sample size.

Recreational Drugs

Responses to drug use for marijuana, phencyclidine, ecstasy, and ketamine were used to serve as the representative recreational drugs used in comparison to cold/cough medicine abuse. Across all comparisons, recreational drug use was split into two different forms of measurement – yearly drug use and any recorded instance of drug use. All values used for yearly drug use and any drug use are based on imputation revised values provided by the public file given by the NSDUH. This resulted in some minor discrepancies when compared with manual calculations for yearly drug use as opposed to calculations based on the imputation revised values. These small discrepancies were considered negligible given the differences were miniscule in comparison to the overall sample size.

Results

	All (N = 58034)	Cold Medicine Abuse (Within-Past-Year)	Cold Medicine Abuse (Before-Past-Year)	No Cold Medicine Abuse (Ever)	p-value
Education (N = 58034)		*N = 387 (0.67%)*	*N = 1731 (2.98%)*	*N = 55916 (96.35%)*	*< 0.01*
Below Highschool	4473 (7.71%)	58 (14.99%)	162 (9.36%)	4253 (7.61%)	
Highschool Graduate	11189 (19.258%)	94 (24.29%)	417 (24.09%)	10678 (19.10%)	
Some College/Associate Degree	14251 (24.56%)	94 (24.29%)	561 (32.41%)	13596 (24.32%)	
College Graduate	17378 (29.94%)	75 (19.38%)	468 (27.04%)	16835 (30.11%)	

		N = 387 (0.67%)	N = 1731 (2.98%)	N = 55916 (96.35%)	
12-17 Years Old	10743 (18.51%)	66 (17.05%)	123 (7.11%)	10554 (18.87%)	
Race (N = 58034)		*N = 387 (0.67%)*	*N = 1731 (2.98%)*	*N = 55916 (96.35%)*	*< 0.01 (Exp. N<5)*
Non-Hispanic – White	34791 (59.95%)	193 (49.87%)	1158 (66.90%)	33440 (59.80%)	
Non-Hispanic – African American	6743 (11.62%)	59 (15.25%)	134 (7.74%)	6550 (11.71%)	
Non-Hispanic – Other Race(s)	6571 (11.32%)	47	184	6340	
Hispanic	9929 (17.11%)	88 (22.74%)	255 (14.73%)	9586 (17.14%)	
Income (N = 58034)		*N = 387 (0.67%)*	*N = 1731 (2.98%)*	*N = 55916 (96.35%)*	*< 0.01*
<$10,000	21956 (37.83%)	171 (44.19%)	497 (28.71%)	21288 (38.07%)	
$10,000 - $19,999	8137 (14.02%)	63 (16.28%)	304 (17.56%)	7770 (13.9%)	
$20,000 - $29,999	5712 (9.84%)	43 (11.11%)	234 (13.52%)	5435 (9.72%)	
$30,000 - $39,999	4718 (8.13%)	30 (7.75%)	181 (10.46%)	4507 (8.06%)	
$40,000 - $49,999	3909 (6.74%)	22 (5.68%)	134 (7.74%)	3753 (6.71%)	
$50,000 - $74,999	5937 (10.23%)	23 (5.94%)	188 (10.86%)	5726 (10.24%)	
>$75,000	7665 (13.21%)	35 (9.04%)	193 (11.15%)	7437 (13.3%)	
Poverty Classification (N = 57990)				*N = 55872 (96.35%)*	*< 0.01*
Living In Poverty	9965 (17.17%)	96 (24.80%)	304 (17.56%)	9565 (17.12%)	
Income up to 2X the Threshold	11130 (19.18%)	83 (21.45%)	382 (22.07%)	10665 (19.09%)	
Income more than 2X Threshold	36895 (63.57%)	208 (53.75%)	1045 (60.37%)	35642 (63.79%)	
Age Groups				*N= 55916*	*< 0.01*
12 – 17 Years Old	**10753 (18.53%)**	66 (17.05%)	123 (7.11%)	10554 (18.87%)	
18 – 25 Years Old	**13979 (24.09%)**	123 (31.78%)	416 (24.03%)	13440 (24.04%)	
26 – 34 Years Old	**9588 (16.52%)**	47 (12.14%)	443 (25.59%)	9098 (16.27%)	
35 – 49 Years Old	**12561 (21.64%)**	100 (25.84%)	502 (29.00%)	11959 (21.39%)	
50+ Years Old	**11163 (19.24%)**	51 (13.18%)	247 (14.27%)	10865 (19.43%)	
Sex				*N= 55916*	*<0.01*
Male	26391 (45.48%)	191 (49.35%)	922 (53.26%)	25278 (45.21%)	
Female	31643 (54.52%)	196 (50.65%)	809 (46.74%)	30638 (54.79%)	

Table 1. Demographic information of respondents who have ever taken cold medicine (Within the past year or prior) and those who have not. Categorical variables were transferred to matrices based on prior cold medicine abuse. Chi-square tests were run for each demographic's matrix to obtain respective p-values.

Table 1 depicts whether the demographic information that was analyzed was found to have a statistically significant effect on ever abusing over-the-counter cold medicine. Among individuals who reported abusing cold medicine within the past year, a majority (44.19%) reported an income level less than $10,000. In comparison to peers with similar incomes who

have never abused OTC cold medicine (38.07%), individuals who have abused cold medicine

within the past year are more likely to fall under this lowest income level.

Among individuals who have recently (within the past year) abused cold medicine, a

greater proportion of abusers were between the ages of 18-25 years (31.78%). This age group is

overrepresented when considering that the overall proportion of respondents was 24.09%. To a

lesser extent, a similar comparison is seen between the ages of 35-49 in which this age group

makes up 25.84% of all past-year cold medicine abusers, but only 21.64% of the total

respondents. Following a chi-square test, the age-group of respondents was found to be a

statistically significant factor in considering prior cold medicine abuse.

Revised Variables – Drug Use (General)					
	All	Cold Medicine Abuse (Before Past Year)	Cold Medicine Abuse (Within Past Year)	No Cold Medicine Abuse (Ever)	p-value
Marijuana Use (N = 58034)	*58034*	*1731*	*387*	*55916*	*p < 0.001*
Used Marijuana (Ever)	25530 (43.99%)	1441 (83.25%)	248 (64.08%)	23825 **23841** (42.64%)	
- Within Past Year*	12528 (21.59%)	882 (50.95%)	166 (42.89%)	11480 (20.53%)	
- Prior to Past Year*	13002 (22.40%)	559 (32.29%)	82 (21.19%)	12361 (22.11%)	
Never Used Marijuana	32504 (56.01%)	290 (16.75%)	139 (35.92%)	**32075** (57.36%)	
PCP Use (N = 58034)	*58034*	*1731*	*387*	*55916*	*p < 0.001*
Used PCP	824 (1.42%)	128 (7.39%)	15 (3.88%)	680 **681** (1.22%)	
- Within Past Year*	37 (0.06%)	5 (0.29%)	4 (1.03%)	28 (0.05%)	
- Prior to Past Year*	787 (1.36%)	123 (7.11%)	11 (2.84%)	653 (1.17%)	
Never Used PCP	57210 (98.58%)	1603 (92.61%)	372 (96.12%)	55212 **55235** (98.78%)	
Ecstasy Use (N = 58034)	*58034*	*1731*	*387*	*55916*	*p < 0.001*
Used Ecstasy	4581 (7.89%)	700 (40.44%)	72 (18.60%)	3803 **3809** (6.81%)	
- Within Past Year*	558 (0.96%)	68 (3.93%)	30 (7.75%)	460 (0.82%)	
- Prior to Past Year*	4023 (6.93%)	632 (36.51%)	42 (10.85%)	3349 (5.99%)	

Never Used Ecstasy	53453 (92.11%)	1030 **1031**** **(59.56%)**	315 (81.40%)	52090 **52107**** **(93.19%)**	
Ketamine Use (N = 58034)	*58034*	*1731*	*387*	*55916*	*p < 0.001*
Used Ketamine	973 (1.68%)	220 (12.71%)	26 (6.72%)	725 **727**** **(1.30%)**	
- Within Past Year*	154 (0.27%)	27 (1.56%)	7 (1.81%)	120 (0.21%)	
- Prior to Past Year*	819 (1.41%)	193 (11.15%)	19 (4.91%)	607 (1.09%)	
Never Used Ketamine	57061 (98.32%)	1508 **1511** (87.29%)**	361 (93.28%)	55152 **55189**** **(98.70%)**	

Table 2. Drug use information among all respondents, including any record of drug use and past-year record of drug use. Categorical variables were transferred to matrices based on prior cold medicine abuse (recreational drug use matrix). Chi-square tests were conducted for each recreational drug use matrix to obtain respective p-values.

The most popular choice of drug among respondents that have abused cold medicine is marijuana among individuals that have either abused cold medicine within the past year or prior to that. Approximately 42.89% of people who reported cold medicine abuse within the past year simultaneously reported having at some point within the same year also using marijuana. Across all observed drugs of interest was a significant difference between individuals who ever used the recreation drugs listed in Table 2 (marijuana, phencyclidine, ecstasy, ketamine) and any prior experience with abusing cold medicine.

Variables	Odds Ratio (95% CI)
(Intercept)	1.047 (1.039 - 1.054)
Marijuana (Ever Used)	1.03 (1.027 - 1.033)
Phencyclidine (Ever Used)	1.054 (1.04 - 1.067)
Ecstasy (Ever Used)	1.106 (1.099 - 1.113)
Ketamine (Ever Used)	1.120 (1.106 - 1.135)
Education	0.996 (0.995 - 0.997)
Income	0.998 (0.997 - 0.999)
Sex	0.991 (0.988 - 0.994)
Race	1.000 (1.000 -1.001)

Table 3. Overall odds of ever abusing cold medicine based on historic use of illicit drugs and demographics computed utilizing a multiple logistic regression model.

Table 3 reflects the demographic and illicit drug use variables used to identify any increased or decreased odds that any respondent would have abused cold medicine at any point in their life. Individuals which at some point used ketamine had 12% increased odds of having also abused cold medicine in their lifetime holding all other variables constant. To a similar extent, participants that recorded any ecstasy use faced 10.6% increased odds of abusing cold medicine at some point compared to those who never used ecstasy.

Variables	Odds Ratio (95% CI)
(Intercept)	1.011 (1.008 - 1.014)
Marijuana (Used ≤ 1 Year)	1.006 (1.004 - 1.008)
Phencyclidine (Used ≤ 1 Year)	1.081(1.053 - 1.110)
Ecstasy (Used ≤ 1 Year)	1.040 (1.032 - 1.047)
Ketamine (Used ≤ 1 Year)	1.014 (1.000 - 1.027)
Education	0.999 (0.998 - 0.999)
Income	0.999 (0.999 - 1.000)
Sex	0.999 (0.998 - 1.000)
Race	1.000 (1.000 -1.001)

Table 4. Odds of abusing cold medicine within the past year given past-year recreational drug use and demographic information. All odds ratios were obtained using a multiple logistic regression model.

As seen in Table 4, a logistic regression was produced to display the odds of abusing cold medicine within the past year based on illicit drug use within the same year. Across all instances, recreational drug use was found to increase the odds of having also abused cold/cough medicine within the same year. Holding all other predictors constant, phencyclidine use was found to increase the odds of abusing cold medicine in that year by a factor of 1.08 across all age groups. Ecstasy use increased the odds of abusing cold medicine by a factor of 1.04 holding all other variables constant.

Outcomes	Odds Ratio (95% CI)
Marijuana (Ever Used)	1.203 (1.179 – 1.228)
Phencyclidine (Ever Used)	1.049 (1.043 – 1.054)
Ecstasy (Ever Used)	1.021 (1.016 – 1.026)
Ketamine (Ever Used)	1.183 (1.171 – 1.195)

Table 5. Odds ratio for illicit drug use given any history of cold medicine abuse among the overall population. Multiple logistic regression models were individually conducted for each outcome, with other drug use variables (including cold medicine abuse) and demographic information used in previous logistic models held constant (not shown).

Any recorded history of cold medicine abuse was compared to other historical use of illicit drugs, including marijuana, phencyclidine, ecstasy, and ketamine. Reported instances of cold medicine abuse most heavily impact historical marijuana use, increasing the odds that individuals have used marijuana by a factor 1.203 as seen in Table 5.

Age Group 2 – Revised Variables – Drug Use					
	All	Cold Medicine Abuse (Before Past Year)	Cold Medicine Abuse (Within Past Year)	No Cold Medicine Abuse	p-value (Ever vs Never)
Marijuana Use	**13979**	**416**	**123**	**13440**	**p < 0.01**
Used Marijuana (Ever)	6867 (49.12%)	371 (89.18%)	88 (71.54%)	6408 (47.68%)	
- Within Past Year*	4747 (33.96%)	275 (66.11%)	66 (53.66%)	4406 (32.78%)	
- Prior to Past Year*	2125 (15.20%)	96 (23.08%)	22 (17.89%)	2007 (14.93%)	
Never Used Marijuana	7107 (50.84%)	45 (10.82%)	35 (28.46%)	7027 (52.28%)	
PCP Use	**13979**	**416**	**123**	**13440**	**p < 0.01 (N < 5)**
Used PCP	85 (0.61%)	20 (4.81%)	4 (3.25%)	61 (0.45%)	
- Within Past Year*	13 (0.09%)	1 (0.24%)	1 (0.81%)	11 (0.08%)	
- Prior to Past Year*	72 (0.52%)	19 (4.57%)	3 (2.44%)	50 (0.37%)	
Never Used PCP	13894 (99.39%)	396 (95.19%)	119 (96.75%)	13379 (99.55%)	
Ecstasy Use	**13979**	**416**	**123**	**13440**	**p < 0.01**
Used Ecstasy	1135 (8.12%)	159 (38.22%)	28 (22.76%)	948 (7.05%)	
- Within Past Year*	265 (1.90%)	30 (7.21%)	16 (13.01%)	219 (1.63%)	
- Prior to Past Year*	870 (6.22%)	129 (31.01%)	12 (9.76%)	729 (5.42%)	
Never Used Ecstasy	12844 (91.88%)	257 (61.78%)	95 (77.24%)	12492 (92.95%)	
Ketamine Use	**13979**	**416**	**123**	**13440**	**p < 0.01 (N < 5)**
Used Ketamine	227 (1.62%)	45 (10.82%)	8 (6.50%)	174 (1.29%)	
- Within Past Year*	65 (0.46%)	12 (2.88%)	4 (3.25%)	49 (0.36%)	
- Prior to Past Year*	162 (1.16%)	33 (7.93%)	4 (3.25%)	125 (0.93%)	
Never Used Ketamine	13752 (98.38%)	371 (89.18%)	115 (93.50%)	13266 (98.71%)	

Table 6. Drug use information among respondents between the ages of 18-25, including historical and yearly use of illicit drugs. Categorical variables were formatted to drug-use matrices based on prior cold medicine abuse. Using these drug-use matrices, chi-square tests were conducted to identify p-values for each recreational drug.

Table 6 displays all illicit drugs of interest as statistically significant with 99% confidence. Among all drugs of choice for individuals that have abused cold medicine within the past year, marijuana is the most used drug within the same given year.

Discussion

A relative comparison between the three variables for cold medicine abuse displays some notable, and statistically significant, differences between each group. As seen in Table 1, a higher relative proportion of individuals who have abused cold medicine within the past year were adults with an education equivalent to or below the high school level (14.99% and 24.29%). When compared to the proportion of adults with an education level below high or at a high school level that make up the sample (7.71% and 19.28%), we see a larger proportion of individuals have abused cold medicine within the past year than would be generally expected. In comparison, the relative representation of individuals with the same educational credentials is lower when considering the composition of the overall respondent size. This suggests that among the group of people who have abused cold medicine in the past year, a larger proportion of individuals have only managed to graduate high school in comparison to the overall population. Other statistically significant differences that are presented within Table 1 suggest an overrepresentation of all listed categorical variables, which follow the same pattern displayed by education level. A literature review of dextromethorphan (DXM) reflects young adults as one of the most represented users of DXM, for which we see a similar trend between the relative proportion of individuals that abuse cold medicine and those that do not (Schifano et al., 2021).

From the variables presented in Table 1, individuals 18-25 years old were subjected to further analysis due to their higher relative proportion of respondents that abused cold medicine in the past year. Reflected in Table 6 are all relevant proportions of recreational drug use across

the age group for which a statistically significant difference is present. In addition, an odds ratio

for any cold medicine abuse based on drug use within the past year was also created through

Table 4. The new odds ratio for this age group indicates ecstasy as a more influential variable in

comparison to the other drugs, but also introduces phencyclidine as the drug which most

increased the odds of cold medicine abuse by a factor of 1.08 holding all other variables

constant.

As seen in Table 2, among individuals who have abused cold medicine within the past

year, the most popular recreational substance used was marijuana, mirroring previous literature

which suggests marijuana as one of the most commonly abused drugs among dextromethorphan

(DXM) abusers (Stanciu et al., 2016; Ziaee et al., 2005). However, marijuana use itself does not

influence the odds an individual will abuse cold medicine in comparison to other recreational

drugs such as ecstasy or ketamine. Given that the effects seen with DXM abuse vary by dosage,

it is possible that the dosages participants have taken resemble the dissociative effect that

ketamine can have or the effects of ecstasy more closely (Department of Justice/Drug

Enforcement Administration, 2022; Orhurhu et al., 2024). Seen in Table 3, any recorded instance

of marijuana use was found to increase the odds an individual would abuse cold medicine by

only a factor of 1.03 assuming all other predictors remain constant. In response, similar logistic

models were used to identify the odds at which other recreational drug use increased given cold

medicine abuse. In doing so, cold medicine abuse was found to have a greater effect on the odds

of recreational drug use for marijuana and ketamine, while still remaining a significant variable

when considering phencyclidine and ecstasy use.

Respondents who participated in the NSDUH were given the opportunity to provide the

specific cold/cough medication they took. This information was available but not used within

this study as some responses were unspecific or unclear and would otherwise have prevented accurately identifying present active ingredients. Additionally, due to time constraints associated with the development of this thesis individually confirming each listed medication appeared unreasonable.

Future Outlook

While cold medicine does not appear to act as a strong risk factor for other drug use by itself, the rates at which it is used in cooccurrence with other drug use provides an interesting question to ask. Viewing its concurrent use with alcohol and marijuana is preferred as more case studies have identified prior concomitant drug use between DXM and the listed drugs (Schifano et al., 2021). Alternatively, despite the existence of some treatment options for DXM abuse using atypical antipsychotics, it remains important to help centralize known treatment options for cold medicine abuse for which a literature review would be helpful (Zaremba et al., 2023).

Conclusion

The purpose of this study was to elucidate any potential relationship that exists between cold medicine abuse and other illicit drug use. While the focus of the study was identifying cold medicine's ability to act as a 'gateway drug,' other variables which may influence the odds of abusing cold medicine were also considered. In the process, sociodemographic variables such as education, race, income, age, and sex were considered alongside all illicit drugs of interest in the event that any given demographic factor may increase the odds of cold medicine abuse.

Based on the results that were presented from this analysis, the odds that an individual uses marijuana within a given year increases by a factor of 1.2 given that the individual has also abused cold medicine in the same year. A similar increased odds value is seen for ketamine,

though the same effect is not seen within phencyclidine and ecstasy. Given more time, more

factors would be heavily considered within an analysis of the data set provided by the NSDUH.

Given that some variables were statistically significant under a chi-square test, but not to the

same extent when conducting odds ratios, it may be possible some confounding factors that were

not considered have influenced these findings. In particular, considering alcohol as a substance

of interest would ideally be considered for a future repeated study of cold medicine abuse.

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