Received: 25 March 2021 | Revised: 9 June 2021 | Accepted: 18 June 2021

DOI: 10.1002/hup.2803

RESEARCH ARTICLE

WILEY

Co-ingestion of prescription drugs and alcohol in US adults aged 50 years or older

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Funding information
National Institute on Drug Abuse, Grant/Award Numbers: R01DA042146, R01DA031160

Abstract

Objective: To examine prevalence of past-month prescription drug misuse (PDM) and alcohol co-ingestion and its correlates in adults age 50 or older.

Methods: Data were from the 2015–2018 US National Survey on Drug Use and Health (n = 35,190). PDM-alcohol co-ingestion was defined as prescription opioid, tranquilizer/sedative, or stimulant misuse while "drinking alcohol or within a couple of hours of drinking." Co-ingestion prevalence was estimated, and logistic and negative binomial regressions examined the sociodemographic, physical health, mental health, substance use, and substance use disorder (SUD) correlates of co-ingestion.

Results: Over 344,000 adults aged 50 years or older (0.3%) engaged in past-month PDM-alcohol co-ingestion, or 27.4% of those with past-month PDM. Past-month co-ingestion was linked to greater past-month alcohol use frequency and elevated adjusted odds ratios (aORs) for all examined substance use outcomes (e.g., non-PDM SUD aOR = 21.8; 49.7% prevalence rate). The aOR for suicidal ideation was 506% higher in those with co-ingestion than those without past-year PDM.

Conclusions: US adults aged 50 years or older with past-month PDM-alcohol co-ingestion are at high risk for SUD and concerning mental health symptoms. Screening for mental health and substance use treatment is warranted among aging adults with signs of PDM, especially involving co-ingestion.

KEYWORDS
alcohol, older adults, prescription opioid, stimulant, tranquilizer

1 | INTRODUCTION

Prescription drug misuse (PDM) is use of a psychoactive, controlled prescription medication, such as opioid or tranquilizer/sedative medication, without a prescription or in a way not intended by the prescriber. PDM is associated with mood and anxiety disorders, suicidality, poorer health, binge or heavy alcohol use, illicit drug use, and substance use disorders (SUDs) (Carmona et al., 2020; Ford, 2019; Martins et al., 2012; Palamar et al., 2019; Votaw et al., 2019), and it is relatively common, with 6.2% of the United States (US) population engaged in past-year PDM in 2018 (Substance Abuse & Mental Health Services Administration, 2019).

A further key consequence of opioid or tranquilizer/sedative PDM is overdose (Fox et al., 2018; Haukka et al., 2018), rates of which remain very high in the US (National Institute on Drug Abuse; NIDA, 2019), Canada (Belzak & Halverson, 2018), and Australia (United Nations Office on Drugs and Crime [UNODC], 2019), with evidence of increased rates elsewhere (European Monitoring Centre for Drugs & Drug Addiction, 2019; UNODC, 2019). Fatal overdose

often involves co-ingestion of opioid and/or tranquilizer/sedative medication with alcohol or other drugs (NIDA, 2019; UNODC, 2019), highlighting the importance of PDM-involved co-ingestion.

Most controlled medication PDM research has occurred in adolescents (12–17 years) and young adults (18–25 years). In contrast, PDM in adults age 50 years and older have received much less attention, despite evidence of similar increases in PDM prevalence to peaks in the early or middle 2010s (Glei et al., 2020), and greater potential individual consequences from PDM because of age-related pharmacokinetic and pharmacodynamic alterations (Maree et al., 2016; Wu & Blazer, 2011).

One specific area lacking data in adults age 50 years and older is the simultaneous co-ingestion of a controlled prescription drug (i.e., opioid, stimulant, tranquilizer/sedative) and alcohol, which heightens the risk for severe consequences, especially when opioid or tranquilizer/sedative medication is involved (Fox et al., 2018; Haukka et al., 2018). In adolescents, three studies (McCabe et al., 2015; McCabe et al., 2012; Schepis et al., 2016) examined PDM-involved co-ingestion separately by medication class and found that between 31.3% (stimulants) and 41.6% (tranquilizers) of adolescents with PDM engage in past-year alcohol co-ingestion. In total, roughly 2% of adolescents engage in controlled medication-alcohol co-ingestion. PDM-alcohol co-ingestion rates were higher in a college sample, at 6.9% (McCabe et al., 2006). Other research examining past-month or 14-day concurrent PDM and alcohol use suggests that it is common in adolescents, college young adults, and across the population and associated with higher-risk correlates, such as heavy alcohol use, criminal behavior, and mental health symptoms (Grigsby & Howard, 2019; Osborne et al., 2019; Schepis, Acheson, et al., 2019).

2 | AIMS

Thus, while PDM-involved co-ingestion is linked to concerning correlates, no research has examined co-ingestion in adults age 50 years or older. To address this gap in the literature, our aims were to: (1) quantify the prevalence of PDM-alcohol co-ingestion in adults age 50 years or older, and in younger age groups for comparison; (2) provide data on controlled medication PDM and alcohol use characteristics (e.g., frequency of past past-month PDM or alcohol use) between adults age 50 or older with and without co-ingestion; and (3) establish the sociodemographic, physical health, mental health, and substance use correlates of co-ingestion in adults age 50 or older. As noted below, the prevalence of prescription stimulant-alcohol co-ingestion is very low in adults 50 and older, preventing analyses of the PDM and alcohol use characteristics and correlates of those engaged in prescription stimulant-alcohol co-ingestion (research aims 2 and 3, above) due to low statistical power. To achieve these aims, we used the pooled 2015–2018 National Survey on Drug Use and Health.

3 | METHODS

The NSDUH is an annual survey with an independent, multistage area probability sampling design. Person-level weights provide unbiased and nationally representative estimates for the US population. All sensitive topics were assessed by audio computer-assisted self-interviewing (ACASI) to maximize honesty. Skip-outs and consistency checks based on previous responses are used to maximize data completeness and accuracy. For 2015–2018, the weighted screening response rate was from 73.3%–79.7%, and the weighted interview rate was from 66.6%–69.7%, similar to other recognized nationally representative studies on substance use (Grant et al, 2014). The Research Triangle International IRB provided oversight of the NSDUH (Center for Behavioral Health Statistics & Quality, 2017a), and the first author's IRB exempted this work from further oversight. More information on the NSDUH is available elsewhere (Center for Behavioral Health Statistics & Quality, 2017a).

3.1 | Participants

The 2015–2018 NSDUH public use files contained data on 223,632 US individuals, with sociodemographic characteristics captured in Table 1.

3.2 | Measures: controlled medication prescription drug misuse (PDM)

3.2.1 | Past-year and past-month PDM

Among those with any lifetime medication use from a specific class (e.g., prescription opioids), PDM is assessed. It is defined as opioid, stimulant, or tranquilizer/sedative use: "in any way a doctor did not direct…including: without a prescription of your own; in greater amounts, more often, or longer than you were told to take it; in any other way a doctor did not direct." PDM is assessed separately by medication class, with tranquilizers and sedatives combined here because of low prevalence rates of sedative PDM. Past-year, and past-month PDM are assessed by asking about timing of the most recent PDM episode among those with lifetime PDM from a controlled medication class.

3.2.2 | Past-month PDM-alcohol co-ingestion

Participants with past-month controlled medication PDM are asked about PDM-alcohol co-ingestion via: "During the past 30 days, did you use [medication class] in any way a doctor did not direct you to use [medication class] while you were drinking alcohol or within a couple of hours of drinking?" Participants with missing data were imputed to have no co-ingestion if they did not engage in past-month alcohol use and/or past-month PDM. Two separate past-month co-

TABLE 1 Sociodemographics by age group (n = 226,632)

	12–17 years	18–25 years	26–34 years	35–49 years	50–64 years	65 years and older
Sample size	54,791	55,588	35,366	45,385	20,305	14,885
	%	%	%	%	%	%
Sex, male	50.9	50.2	49.6	49.0	48.3	44.8
Race/ethnicity						
Caucasian	52.9	54.3	56.3	58.9	69.1	77.1
African-American	13.7	14.1	13.0	12.4	11.6	9.0
Hispanic/Latinx	23.8	21.9	20.5	19.5	12.3	8.2
Asian-American	5.4	6.2	7.2	7.0	4.4	3.4
American Indian	0.6	0.7	0.6	0.6	0.6	0.4
Hawaiian/Pacific Islander	0.4	0.4	0.4	0.4	0.3	0.2
Multiracial	3.2	2.4	1.9	1.3	1.6	1.6
Household income						
<$25,000	15.6	27.7	15.6	12.8	14.9	16.9
$25,000–49,999	27.8	32.2	32.8	25.7	24.9	36.7
$50,000–74,999	14.3	13.8	17.9	15.3	15.7	17.3
≥$75,000	42.3	26.3	33.7	46.2	44.6	29.2
Sexual identity minority	N/A	10.4	7.4	4.0	3.2	1.8
County metro area						
Large metro area	56.4	55.6	59.6	58.8	54.3	49.9
Small metro area	29.4	31.4	28.5	28.1	29.8	32.0
Nonmetro	14.2	13.0	11.9	13.2	15.9	18.1
Education						
In school	90.4	44.4	11.4	5.3	1.9	1.1
Less than high school	9.6	7.5	9.7	11.9	12.3	15.1
High school graduate	0.0	21.7	19.9	20.3	25.7	27.7
Some college	0.0	15.5	26.4	27.6	28.6	25.6
College graduate	0.0	10.9	32.7	34.9	31.4	30.5

Note: All % values are weighted percentages; Sexual identity is not assessed in adolescents.
Abbreviation: CBSA, core-based statistical area.
Data source: 2015–2018 NSDUH.

ingestion measures were used: (1) co-ingestion among the total sample, and (2) co-ingestion among the subset of participants engaged in past-month PDM.

PDM characteristics were past-month PDM frequency, nonphysician PDM source use, and PDM with any motives not aligned with the medication's indication, captured in those with past-month PDM. PDM sources and motives are assessed for the most recent episode. Sources were dichotomized as physician source only/non-physician source, and motives were classified as PDM with only motives aligned with the medication's indication (i.e., self-treatment only in other PDM research) or PDM with any motives not aligned with the medication's indication (i.e., any recreational motives in other PDM research). Please see Table S1 in supplementary information material for more detail. The division of PDM motives into those aligned with the medication's indication, such as pain relief for opioid PDM or promotion of sleep or relaxation for tranquilizer/sedatives, and those motives that are not is common in research on PDM (Ashrafioun et al., 2019; Dupont et al., 2008; McCabe et al., 2009; Schepis, De Nadai, et al., 2020; Votaw et al., 2019). PDM with any motives not aligned with the medication's indication motives and nonphysician sources are linked to mental health and substance use problems in adults age 50 or older (Schepis & McCabe, 2019; Schepis, Wastila, et al., 2020). Stimulant PDM characteristics were not evaluated due to very low rates of stimulant-involved co-ingestion in adults age 50 and older.

3.3 | Measures: correlates

For all correlates, please see online-only Table S1 in supplementary information material for specific questions and response choices that compose the items or scales.

Sociodemographic variables were sex, race/ethnicity, age group, sexual identity, household income, educational attainment, and metro area size/population density. "Religiosity" was derived from summed questions on religious engagement, from Grucza et al. (2016). Religiosity has a high internal consistency and variance explained (R^2) in item-response theory analyses (Grucza et al., 2016).

Physical health correlates were self-reported poor/fair health, current insurance status, overweight/obese status (per body mass index), difficulties with activities of daily living (ADLs), and past-year inpatient hospitalization. Difficulties with ADLs was a four-item scale from Ford et al. (2018), which has been linked to PDM.

Mental health correlates were (all past-year) major depression, suicidal ideation, serious psychological distress (SPD), and mental health treatment. Major depression was from the DSM-IV (American Psychiatric Association, 2000), with high interrater and test-retest reliability (Zanarini & Frankenburg, 2001). SPD was from the K6 assessment of non-specific psychological distress (Kessler et al., 2003).

Substance use correlates were past-month binge alcohol use, past-year marijuana use, past-year non-marijuana drug use (i.e., heroin, cocaine, hallucinogens, methamphetamine, and inhalants), and past-year SUD. Two past-year SUD variables were used: DSM-IV substance abuse or dependence from alcohol, marijuana, cocaine, heroin, hallucinogen, inhalant, or methamphetamine use, and SUD from prescription opioid, tranquilizer, sedative, and stimulant misuse. Past-month binge alcohol is four or five alcoholic drinks (for females and males, respectively) during one occasion (National Institute of Alcohol Abuse & Alcoholism, 2004).

3.4 | Data analyses

Analyses were conducted in Stata 16.1, using the *svy* commands and *verep* and *vestr* complex survey design variables. Per guidelines (Center for Behavioral Health Statistics & Quality, 2017b), adjusted-person level weights (weight/4) were used for pooled data. Robust variance estimates came from the Taylor series approximation, with adjusted degrees of freedom. Initially, prevalence rates of any past-month controlled medication PDM and past-month opioid, tranquilizer/sedative, or stimulant PDM were estimated by age group, with 95% confidence intervals (95% CIs) for all prevalence estimates. We estimated three key prevalence rates: (1) past-month PDM across all participants; (2) past-month PDM-alcohol co-ingestion across all participants; and (3) co-ingestion among only those with past-month PDM. These were computed by age group, both for aggregated PDM and by medication class.

Further analyses were conducted in adults aged 50 years or older and did not examine stimulant PDM, given low stimulant PDM co-ingestion prevalence. First, we examined prevalence and 95% CIs of endorsement of PDM with any motives not aligned with the medication's indication and non-physician source use, separately for opioid, tranquilizer/sedative, or any PDM and only in those with past-month PDM. Those with and without co-ingestion were compared using logistic regression, controlling for age group (50–64 vs. 65 or older), sex, race/ethnicity, sexual identity, educational attainment, metro area size, and household income.

Second, bivariable logistic regression examined adjusted odds of the sociodemographic, physical health, mental health, and substance use variables by a four-level independent variable: (1) no past-year controlled medication PDM; (2) past-year but not past-month PDM; (3) past-month PDM without co-ingestion; and (4) past-month PDM with co-ingestion. No past-year PDM was set as the reference group. Finally, the same independent variable was used to examine differences in religiosity, past-month frequency of opioid PDM (in those with past-month opioid PDM), past-month frequency of tranquilizer/sedative PDM (in those with past-month tranquilizer/sedative PDM), and past-month alcohol use frequency. Differences in the four-level PDM variable were compared via negative binomial regressions. Zero-inflated negative binomial regressions were used for alcohol use frequency, given the high number of participants with no days of alcohol use, which varied by PDM status (50.2% of the entire sample, 47.5% of those with past-year but not past-month PDM, 6.5% of those with past-month PDM). These analyses also controlled for age group, sex, race/ethnicity, sexual identity, educational attainment, metro area size, and household income; analyses of sociodemographic correlates of the four-level PDM co-ingestion variable did not control for the variable under examination (e.g., analyses of male sex as a correlate did not control for sex).

4 | RESULTS

Among those 50 years of age or older, 3.5% (95% CI = 3.3%–3.8%) engaged in past-year controlled medication PDM, 1.1% (95% CI = 1.0%–1.3%) engaged in past-month PDM, and 0.3% (95% CI = 0.3%–0.4%) engaged in PDM-alcohol co-ingestion (not included in the tables or figures). Among only those with past-month PDM, 27.4% engaged in co-ingestion. An estimated 1256,475 adults age 50 or older engaged in past-month PDM, and an estimated 344,282 engaged in past-month PDM-alcohol co-ingestion (not included in the tables or figures). Per Table 2, adults in the 50–64 year cohort had higher prevalence rates of past-month PDM and co-ingestion across medication classes than those age 65 and older.

Further analyses were exclusively in adults age 50 years or older. Per Table 3, among those with past-month controlled medication PDM, prevalence rates of PDM with any motives not aligned with the medication's indication for opioid or any PDM were significantly higher in those with co-ingestion (opioid PDM no co-ingestion: 35.2%, co-ingestion: 56.1%, $p = 0.024$; any PDM no co-ingestion: 34.5%, co-ingestion: 54.1%, $p = 0.02$). Also, non-physician source use

TABLE 2 Prevalence of past-month PDM/Alcohol Co-Ingestion by age group (n = 226,632)

	12–17 years	18–25 years	26–34 years	35–49 years	50–64 years	65 or older
Sample size	54,791	55,588	35,366	45,385	20,305	14,885
Opioid co-ingestion	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Any opioid PDM	0.9 (0.8–1.0)	1.9 (1.7–2.1)	2.0 (1.8–2.2)	1.3 (1.2–1.5)	1.1 (0.9–1.2)	0.3 (0.2–0.4)
Opioid PDM with alcohol co-ingestion	0.2 (0.1–0.2)	0.6 (0.5–0.7)	0.7 (0.6–0.8)	0.4 (0.3–0.5)	0.3 (0.2–0.4)	0.04 (0.02–0.1)
% With past-month PDM engaged in alcohol co-ingestion	18.5 (15.1–22.6)	33.9 (30.1–37.9)	36.3 (32.3–40.5)	30.2 (25.8–35.1)	30.1 (23.4–37.9)	14.8 (6.3–30.8)
Tranquilizer-sedative co-ingestion	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Any tranquilizer-sedative PDM	0.5 (0.5–0.6)	1.6 (1.4–1.7)	1.2 (1.0–1.4)	0.8 (0.7–0.9)	0.5 (0.4–0.6)	0.3 (0.2–0.5)
Tranquilizer-sedative PDM with alcohol co-ingestion	0.2 (0.1–0.2)	0.7 (0.6–0.8)	0.5 (0.4–0.6)	0.3 (0.2–0.3)	0.2 (0.1–0.3)	0.04 (0.02–0.1)
% With past-month PDM engaged in alcohol co-ingestion	28.3 (21.1–36.9)	44.7 (40.2–49.3)	40.1 (35.4–43.9)	37.0 (30.6–43.9)	33.3 (24.0–44.0)	14.8 (5.7–33.5)
Stimulant co-ingestion	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Any stimulant PDM	0.4 (0.4–0.5)	2.0 (1.9–2.2)	1.3 (1.1–1.5)	0.5 (0.4–0.6)	0.2 (0.1–0.2)	0.02 (0.01–0.07)
Stimulant PDM with alcohol co-ingestion	0.1 (0.05–0.1)	0.8 (0.7–0.9)	0.6 (0.5–0.8)	0.2 (0.1–0.2)	0.04 (0.02–0.08)	No cases
% With past-month PDM engaged in alcohol co-ingestion	16.1 (10.5–23.9)	40.8 (37.4–44.3)	50.0 (43.4–56.3)	34.6 (26.9–43.2)	25.3 (12.8–43.7)	Not applicable
PDM co-ingestion	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Any PDM	1.5 (1.4–1.7)	4.5 (4.3–4.7)	3.7 (3.4–3.9)	2.2 (2.1–2.4)	1.5 (1.3–1.8)	0.6 (0.4–0.8)
Any PDM with alcohol co-ingestion	0.3 (0.2–0.4)	1.8 (1.6–2.0)	1.5 (1.4–1.7)	0.7 (0.6–0.8)	0.5 (0.4–0.6)	0.1 (0.04–0.2)
% With past-month PDM engaged in alcohol co-ingestion	19.1 (15.5–23.3)	40.2 (37.8–42.5)	41.0 (37.8–44.3)	33.4 (29.3–37.7)	31.4 (25.4–38.0)	14.5 (7.7–25.8)

Note: All % values are weighted percentages; 95% CI = 95% confidence interval of the point prevalence estimate.

Data Source: 2015–2018 National Survey on Drug Use and Health (NSDUH).

TABLE 3 Past-month *prescription* opioid or tranquilizer/sedative *motives and sources by* co-ingestion *with alcohol* status in adults age 50 and older (n = 35,190)

	Misuse without alcoholco-ingestion	Misuse with alcoholco-ingestion	p[a]
Opioid PDM	% (95% CI)	% (95% CI)	
PDM with any motives not aligned with the medication's indication	35.2 (27.4–43.7)	56.1 (41.6–69.7)	**0.024**
Nonphysician source	40.8 (32.0–50.3)	68.2 (55.0–79.0)	**0.003**
Tranquilizer/sedative PDM			
PDM with any motives not aligned with the medication's indication	22.3 (14.3–33.0)	30.9 (16.6–50.1)	0.52
Nonphysician source	53.1 (40.3–65.4)	56.3 (41.0–70.5)	0.39
Any PDM			
PDM with any motives not aligned with the medication's indication	34.5 (28.0–41.5)	54.1 (41.7–66.1)	**0.02**
Nonphysician source	47.7 (40.3–55.3)	64.8 (54.9–73.5)	0.056

Note: Stimulant PDM characteristics were not evaluated due to very low rates of stimulant-involved co-ingestion in adults age 50 and older. All % values are weighted percentages; 95% CI = 95% confidence interval of the point prevalence estimate.

[a]p-values were based on logistic models adjusted for age category, race/ethnicity, sex, sexual identity, educational status, population density, and household income.

Data Source: 2015–2018 National Survey on Drug Use and Health (NSDUH).

was significantly higher in those with opioid-alcohol co-ingestion (56.1% vs. 35.2%, $p = 0.024$).

For sociodemographic, physical health and mental health correlates, there were few differences between the groups engage in some level of controlled medication PDM (see Table 4). Notably, *all* mental health correlates were more likely in those with some level of PDM. In particular, adjusted odds of suicidal ideation were at least 332% greater in those with some PDM, versus no past-year PDM, with the greatest adjusted odds ratio (aOR) in those with co-ingestion (aOR = 6.06, or 506% greater). For physical health, poor/fair self-reported health (aORs = 1.49–2.29), difficulties with ADLs (aORs = 1.83–2.43), and past-year hospitalization (aORs = 1.66–2.05) all evidenced greater adjusted odds in those with some PDM, versus those with no past-year PDM. Co-ingestion was strongly associated with sexual identity minority status, with 356% greater odds. Also, religiosity (not captured in the tables or figures) was significantly lower in those with any PDM (mean range: 8.8–10.5) than those without PDM (11.4), with levels in the co-ingestion group significantly lower than other groups.

In contrast, adjusted odds of all substance use correlates were significantly higher in those with past-month controlled medication PDM-alcohol co-ingestion than other groups (Table 4). Adjusted odds varied from 9.78 for binge alcohol use to 21.76 for past-year non-PDM SUD. Indeed, 49.7% (95% CI = 37.0%–62.4%) of those with co-ingestion had a past-year SUD. Adjusted odds of SUD from PDM were similar among those with past-month PDM (without co-ingestion = 2.03, with co-ingestion = 2.70), versus those with past-year but not past-month PDM. Also, adjusted odds of the substance use outcomes were at least 850% higher in those with co-ingestion, versus those without past-year PDM. While past-month frequency of opioid (no co-ingestion mean = 6.7; co-ingestion = 8.1) or tranquilizer/sedative PDM (no co-ingestion mean = 6.1; co-ingestion = 8.7) did not vary by co-ingestion status, past-month frequency of alcohol use significantly varied by PDM status (see Figure 1). Those with past-month co-ingestion had a significantly greater number of days of alcohol use (opioid = 15.3, tranquilizer/sedative = 17.6) than other groups ($ps < 0.001$).

5 | DISCUSSION

First, prevalence rates of co-ingestion decreased with aging, with the lowest rates in those age 65 years or older, at 0.6%. Of those 50–64 years of age 1.5% engaged in past-month co-ingestion, and over 344,000 adults age 50 and older engaged in past-month PDM-alcohol co-ingestion. Across the lifespan, adults age 65 and older had the lowest rates of both past-month PDM and PDM-alcohol co-ingestion. Adults in the 50–64 cohort were closer to the 35–49 age group in terms of co-ingestion prevalence than adults age 65 and older, and future research should investigate whether this is a cohort effect or characteristic of that age range, given evidence of cohort effects in opioid PDM and other substance use (Boeri, 2018; Wall et al., 2018). Finally, the very low rates of stimulant PDM in those age 65 and older are consistent with older NSDUH data and suggest that stimulant PDM is a less important issue in older adults (Schepis & McCabe, 2016).

For PDM characteristics, PDM with any motives not aligned with the medication's indication were more common in those with opioid-alcohol or any PDM-alcohol co-ingestion, as were use of non-physician sources in those with opioid-alcohol co-ingestion. PDM with any motives not aligned with the medication's indication is consistently associated with elevated prevalence rates of other substance use and mental health problems (Compton et al., 2018; Schepis, De Nadai, et al., 2020), as is use of non-physician opioid or tranquilizer/sedative sources (Han et al., 2017; Schepis, Wilens, & McCabe, 2019). Notably, past-month frequency of opioid or tranquilizer/sedative PDM did not significantly differ by co-ingestion status in those age 50 years and older, but frequency of past-month alcohol use and prevalence of binge alcohol use did. Thus, co-ingestion marks greater frequency and severity of alcohol use, as previously found in older adolescents (McCabe et al., 2017). When combined with a wealth of international findings linking PDM and other substance use (Baggio et al., 2014; Blanco et al., 2018; Fischer et al., 2006), this reinforces a need to screen for all substances when PDM is detected.

Finally, controlled medication PDM-alcohol co-ingestion among adults age 50 years or older was linked to sexual identity minority status, white race/ethnicity, poorer health, difficulties with ADLs, psychopathology, and other substance use outcomes. Links between co-ingestion and white race/ethnicity, physical health problems, and psychopathology seemed to be primarily a function of engagement in *any* PDM, given the lack of significant differences among subgroups engage in PDM (see Table 4). Adjusted odds of sexual identity minority status were much higher than in those with past-year but not past-month PDM, and sexual minorities may be much more likely to engage in co-ingestion; this finding needs replication and suggests the importance of future research examining co-ingestion in targeted groups (e.g., bisexual males, lesbian females).

In contrast, *all* substance use outcomes were significantly more likely in those with past-month co-ingestion than any other group, including those with past-year controlled medication PDM or no past-month co-ingestion. Thus, PDM-alcohol co-ingestion appears to be a marker of greater engagement in substance use. Most strikingly, adults age 50 and older who engage in past-month co-ingestion had 20.8 times greater adjusted odds of a DSM-IV non-PDM SUD diagnosis (49.7% prevalence rate), as compared to those without past-year PDM (3.3%). While still elevated, adjusted odds of a non-PDM SUD diagnosis among those with past-year and past-month PDM without co-ingestion were significantly lower (aORs of 4.59 and 4.01, respectively). In contrast, SUD from PDM was primarily a function of more recent PDM, as there were no differences in adjusted odds by co-ingestion status versus those with past-year but not past-month PDM.

TABLE 4 Correlates of past-month any PDM/alcohol co-ingestion in adults age 50 or older (n = 35,190)

	Past-year but not past-month PDM	Past-month PDM without alcohol co-ingestion	Past-month PDM with alcohol co-ingestion
Correlates			
Sociodemographic correlates	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Male sex	1.20 (1.01–1.43)*	0.88 (0.64–1.19)	1.48 (0.94–2.31)
Caucasian ethnicity	1.24 (1.03–1.51)*	1.94 (1.36–2.79)***	1.88 (1.00–3.53)**
Sexual identity minority	1.59 (1.05–2.42)*	1.81 (0.89–3.66)	4.56 (2.41–8.62)***
Poverty	1.26 (1.01–1.59)*	1.35 (0.89–2.05)	1.74 (1.09–2.75)*
Large metro area	1.25 (1.06–1.44)**	1.23 (0.88–1.71)	1.08 (0.67–1.74)
College graduate	0.90 (0.72–1.13)	1.39 (0.97–1.99)	0.81 (0.42–1.55)
Physical health correlates			
Self-reported poor or fair health	1.49 (1.20–1.86)***	1.64 (1.15–2.33)**	2.29 (1.29–4.07)**
Currently uninsured	1.34 (0.92–1.96)	1.01 (0.56–1.79)	1.05 (0.39–2.83)
Overweight/Obese	0.97 (0.80–1.19)	1.12 (0.80–1.57)	0.52 (0.32–0.84)**
Difficulties with ADLs[a]	1.83 (1.47–2.27)***	2.43 (1.78–3.32)***	2.23 (1.38–3.61)**
Past-year inpatient hospitalization	1.66 (1.28–2.15)***	1.80 (1.20–2.69)**	2.05 (1.20–3.51)**
Mental health correlates			
Past-year mental health treatment	2.91 (2.28–3.71)***	3.73 (2.77–5.03)***	3.95 (2.57–6.09)***
Past-year major depression	3.03 (2.25–4.09)***	4.91 (3.26–7.38)***	4.13 (2.38–7.14)***
Past-year serious psychological distress	4.02 (3.06-5.28)***	4.80 (3.32–6.94)***	4.53 (2.65–7.74)***
Past-year suicidal ideation	4.32 (3.14–5.95)***	5.21 (3.45–7.86)***	6.06 (3.43–10.70)***
Substance use correlates			
Past-month binge alcohol use	2.09 (1.72–2.53)***	1.15 (0.83–1.60)	9.78 (5.57–17.19)***
Past-year marijuana use	3.55 (2.83–4.45)***	4.48 (2.99–6.69)***	11.78 (7.89–17.59)***
Past-year non-marijuana drug use	6.42 (3.91–10.54)***	7.36 (4.54–11.91)***	21.33 (11.88–38.30)***
Past-year DSM-IV nonprescription SUD[b]	4.59 (3.65–5.78)***	4.01 (2.75–5.86)***	21.76 (12.12–39.06)***
Past-year DSM-IV SUD from PDM[c]	1.00 (reference)	2.03 (1.31–3.15)***	2.70 (1.48–4.93)***

Note: The reference group is those without past-year PDM.

Abbreviations: 95% CI, 95% confidence interval of the point prevalence estimate; ADLs, activities of daily living; aOR, adjusted odds ratio (adjusted for age group, sex, race/ethnicity, sexual identity, educational attainment, metro area size, and household income); PDM, past-month prescription drug misuse.

[a]Difficulties with ADLs is the participant endorsing any "serious trouble" with one or more of: (1) concentrating, remembering, or making decisions, (2) walking or climbing stairs, (3) dressing or bathing, and (4) doing errands alone (e.g., doctor's appointment).

[b]Past-year DSM-IV nonprescription SUD denotes substance use disorder (SUD) from one or more of the following substances: alcohol, marijuana, cocaine, heroin, inhalants, hallucinogens, or methamphetamine.

[c]Past-year DSM-IV SUD from PDM captures SUD from one or more of prescription opioid medication, prescription stimulant medication, prescription tranquilizer medication, or prescription sedative medication; given that those without past-year PDM cannot have such SUD, the reference group was set to past-year but not past-month PDM.

*denotes $p \leq 0.05$; ** denotes $p \leq 0.01$; *** denotes $p \leq 0.001$.

Data Source: 2015–2018 National Survey on Drug Use and Health (NSDUH).

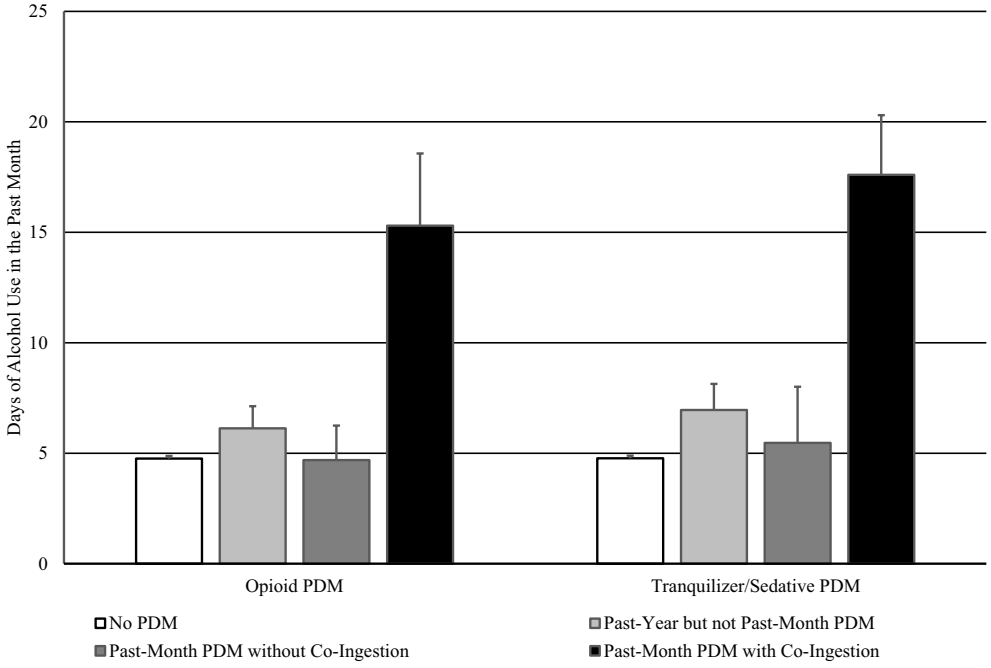

FIGURE 1 Frequency of alcohol use among adults age 50 years and older by PDM/co-ingestion status. Bars represent 95% confidence intervals of the mean estimate. Sample sizes were as follows for the opioid PDM groups: No PDM: 34,384; Past-year but not past-month PDM: 583; Past-month PDM without co-ingestion: 197; Past-month PDM with co-ingestion: 63. For tranquilizer/sedative PDM, sample sizes were: No PDM: 34,734; Past-year but not past-month PDM: 344; Past-month PDM without co-ingestion: 110; Past-month PDM with co-ingestion: 40

5.1 | Clinical implications

To prevent controlled medication PDM-alcohol co-ingestion, adults aged 50 or older should be counseled about the dangers of PDM-alcohol co-ingestion. This can be incorporated into the larger educational component about proper medication use and storage and potential side effects when the medication is prescribed. Pharmacists have an important role to play in such counseling as well, with evidence suggesting that verbal education is effective, especially in those with lower health literacy (Wali et al., 2016). Furthermore, adults age 50 or older with signs of recent PDM (e.g., early refill requests, inconsistent pill counts) should be screened for problematic alcohol and other substance use, especially those who also have endorsed regular alcohol use. The recent US Preventive Services Task Force statement recommends substance use screening for all adults (Krist et al., 2020), and our findings reinforce that more involved screening may be needed covering a broad scope of substances including alcohol. This could combine more general tools that assess PDM (e.g., World Health Organization's ASSIST tools: Humeniuk et al., 2010a; Humeniuk et al., 2010b); TAPS: McNeely et al., 2016) with more intensive alcohol use screening, like the AUDIT (Reinert & Allen, 2002). In those aging adults with signs of PDM or PDM-alcohol co-ingestion, multidisciplinary treatment is likely necessary, given the high co-occurring rates of mental health concerns and SUD found in those with PDM and especially in those with co-ingestion. Such treatment will likely include addiction, behavioral health, psychiatric, and other clinical specialists, depending on the specific presentation.

5.2 | Limitations

Cross-sectional data do not allow for causal inferences on relationships between correlates and co-ingestion. Self-report bias is likely, as is self-selection bias, given that a minority of participants refused to take part in the NSDUH. Still, self-report substance use data are believed to be reliable and valid (Johnston & O'Malley, 1985; O'Malley et al., 1983). Furthermore, the NSDUH attempts to limit bias by weighting to correct for non-response, ACASI methods, and medication picture and trade and generic medication name use (Center for Behavioral Health Statistics & Quality, 2014). The results cannot be generalized to nonassessed populations, including those who are institutionalized or in the military. Also, despite efforts to increase participation among those living in nursing facilities and other controlled access dwellings, the NSDUH undersamples this subgroup (Cunningham et al., 2015). Finally, many analyses combined the 50– 64 year and 65 and older cohorts due to limited sample sizes engaged in co-ingestion, and future research should strive to examine them separately.

6 | CONCLUSION

These results highlight those engaged in PDM-alcohol co-ingestion as a very high-risk group for other substance use and SUD. As compared to previous research on past-year opioid (Mowbray &

Quinn, 2015) or tranquilizer/sedative PDM (Schepis et al., 2018) that examined adults age 50 and older, prevalence of SUD, binge alcohol use and marijuana use were higher among those with co-ingestion versus those samples. When combined with our findings that those with co-ingestion had significantly higher aORs of SUD and drug use and greater alcohol use involvement, it appears that co-ingestion in adults age 50 or older marks significant substance use involvement.

This research also highlights a need for further study on the correlates of PDM-alcohol co-ingestion in younger age groups and sociodemographic characteristics of those engaged in co-ingestion, as these groups had higher rates of past-month PDM and PDM co-ingestion than adults age 50 and older. To summarize, this research highlights adults age 50 and older who engage in past-month PDM-alcohol co-ingestion as very likely to have concurrent psychopathology, other substance use, and SUDs. Screening for psychopathology and SUD is needed in all aging adults with PDM, but the greatest substance use treatment needs are likely in those with co-ingestion, given their significantly elevated adjusted odds versus those with PDM but no co-ingestion.

ACKNOWLEDGMENTS

This work was supported by R01DA042146 and R01DA031160 from the National Institute on Drug Abuse (NIDA). The NSDUH was funded by the Substance Abuse and Mental Health Services Administration (SAMHSA). The content is the authors' responsibility and does not necessarily represent the views of NIDA or SAMHSA.

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the US Substance Abuse and Mental Health Data Archive at https://www.datafiles.samhsa.gov/data-sources, reference numbers NSDUH-2015-DS0001, NSDUH-2016-DS0001, NSDUH-2017-DS0001, NSDUH-2018-DS0001, and NSDUH-2019-DS0001.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Schepis, T. S., Ford, J. A., & McCabe, S. E. (2021). Co-ingestion of prescription drugs and alcohol in US adults aged 50 years or older. *Human Psychopharmacology: Clinical and Experimental*, *36*(6), e2803. https://doi.org/10.1002/hup.2803