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Spirits purchasing and marijuana use behaviors of risky drinkers in the state of Washington from 2014 to 2016

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ABSTRACT

Background: Few studies have evaluated alcoholic beverage purchasing behaviors, which are relevant to the design and effectiveness of alcoholic beverage control policies. Focusing on spirits purchasing among spirits drinkers, this study compares purchasing behaviors between risky and non-risky drinkers and across drinking patterns among those observed drinking at both levels.

Methods: A rolling panel of 794 spirits drinkers in the state of Washington were surveyed between two and five times at 6-month intervals during 2014, 2015 and 2016 regarding their alcohol use, spirits purchasing and marijuana use frequency. Purchasing behaviors assessed for spirits were the frequency of purchasing and the travel time, unit cost, bottle size and store type from the respondents most recent purchase. Alcohol use was categorized at each measurement as risky or not using US NIAAA guidelines.

Results: Risky drinkers were more likely to purchase spirits, purchase spirits more frequently, purchase larger spirits containers and use marijuana occasionally, but not frequently. Among drinkers who were risky only in some survey waves, during risky waves they were more likely to purchase more frequently, pay less per liter for spirits purchased, buy larger sized containers of spirits and use marijuana occasionally.

Conclusions: Drinkers chose to purchase lower cost spirits in larger containers when they were drinking more heavily compared to times when they were drinking within US low-risk guidelines. Findings also support complementarity between heavier drinking and marijuana use among spirits drinkers in a state with legal recreational marijuana sales.

1. Introduction

Purchasing behaviors are an important but under-researched aspect of drinking and heavy drinking, especially relevant to selecting alcohol policy responses. Which stores these drinkers choose to patronize, how often they buy and what products they purchase are all potentially affected by policies targeting availability, price and marketing and would be expected to impact drinking through changes in purchased volume of ethanol (Cukier and Wettlaufer, 2017; Zhao and Stockwell, 2017; Zhao et al., 2013). Few studies have considered the purchasing behaviors of heavy drinkers and none has utilized a longitudinal sample to compare behaviors across differing amounts of alcohol use for individual drinkers. A study of heavy drinkers in Scotland found that 90% of their alcohol was bought for off-premise consumption and that they focused on the cheapest beverage types and brands (Gill et al., 2015). Similarly, a diary study of Irish drinkers found that those purchasing the lowest cost drinks were heavy drinkers with lower incomes and that these were most off-premise purchases (Cousins et al., 2016). In the US, a study of all drinkers found that heavier drinkers were more likely to drink spirits and that the heaviest drinkers reported spending less per drink than others, suggesting substitution to lower cost products or contexts (Kerr and Greenfield, 2007). A survey of alcohol purchasing behaviors in Australia found that heavier drinkers and lower income groups bought cheaper products; however, younger drinkers tended to purchase more expensive products (Jiang et al., 2017). The most common store types in that study were large liquor stores and smaller liquor stores, which together accounted for 85% of purchases.

Our study of the privatization of the Washington Liquor Monopoly in June of 2012 included a longitudinal survey of drinkers, focusing primarily on spirits drinkers, during the 2014 to 2016 period and offers a unique opportunity to study spirits purchasing behavior under a licensed system with a variety of store types offering spirits (Greenfield et al., 2018). Our research on this privatization has found that prices increased from spring of 2012 to early 2014 by 15% on average for 750 mL spirits bottles with wide variation across brands, container sizes and store types (Kerr et al., 2015). It has long been recognized that the

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prices of alcoholic beverages vary widely by type, brand, and especially between on and off-premise contexts, creating significant opportunities for quality, type and context substitution (Treno et al., 1993). In Washington these price increases after privatization worked against an increase in availability, stores selling spirits rose from 333 to around 1,600, resulting in little change in spirits or total alcohol intake per person from before to after privatization (Kerr et al., 2018a). Quality substitution may have also played a role (Gruenewald et al., 2006), and a reduction in the beer tax in 2013 may also have led to a shift to beer, which was taxed by the state at a much lower rate (Ye and Kerr, 2016).

Washington also legalized recreational marijuana use in 2012, with retail stores opening in July of 2014 (Kerr et al., 2018b). Data collection for the panel sample occurred after legalization and, with the exception of the first survey, after retail stores had opened. Marijuana and alcohol co-use have been associated with higher levels of use of both substances, and increased consequences of use (Yurasek et al., 2017). Co-use has also been associated with increased risk of alcohol use disorders and the persistence of these (Weinberger et al., 2016). Studies differentiating simultaneous and separate co-use have found that increased risk of alcohol problems is associated with simultaneous co-use only when drinking patterns and other individual characteristics are controlled (Subbaraman and Kerr, 2015). A recent study considered co-use among military veterans using a 180-day Timeline Followback assessment and found that heavy drinking was more likely on days when marijuana was also used (Metrik et al., 2018), suggesting complementarity between the substances where the use of one increases the likelihood of using the other and/or the amount used. A review of studies evaluating relationships between changes in alcohol and cannabis use over time reported mixed findings with evidence of both substitution and complementarity, further emphasizing the need for longitudinal studies of these relationships (Subbaraman, 2016).

Here a panel of spirits drinkers with at least two and as many as five measurement points at six-month intervals provided data on drinking, cannabis use and spirits purchasing behaviors. Classifying past-month drinking as risky versus being within US guidelines at each point we identify groups of drinkers who are always risky, never risky and with mixed levels. We then compare purchasing behaviors regarding travel time, frequency of purchasing, unit cost, bottle size and store type, as well as marijuana use frequency between these groups combining all measurement points and, among the mixed level group, between risky and within guidelines measurement points within individuals. As regards purchase occasions, risky drinkers and mixed drinkers when drinking at risky levels are expected to have on average, shorter travel times, more frequent buying, lower unit cost and larger bottle size. They are also expected to be more likely to use marijuana and to do so more frequently.

2. Materials and methods

2.1. The panel data sample

The Washington liquor privatization survey series includes both cross-sectional and panel data. Six repeated cross-sections were collected at six-month intervals between January 2014 and December 2016. Selected respondents from the first four cross-sectional surveys were followed every six months for 1–4 waves. These comprise the panel data sample for the current analysis. List-assisted dual-frame Random Digit Dial procedures were used to recruit the samples, for ages 18 and older, with about 40% from mobile phones at each survey. The American Association for Public Opinion Research (AAPOR2) co-operation rates (The American Association for Public Opinion Research, 2011) were: 50.8% (landline) and 59.5% (mobile) for cross-sectional survey 1; 45.8% (landline) and 62.4% (mobile) for survey 2; 43.7% (landline) and 61.5% (mobile) for survey 3; 41.7% (landline) and 59.6% (mobile) for survey 4.

The flow chart in Fig. 1 illustrates the sampling process utilized in acquiring the panel data, showing the number of respondents for the four baseline cross-sectional samples and their respective follow-up samples, as well as the months when each survey interview was conducted. The panel survey follow-ups were conducted concurrently with cross-sectional surveys 2–5 from the Fall of 2014 to the Spring of 2016. Of all 3491 individuals from the first four cross-sectional samples, only current (past year) spirits drinkers or current marijuana users who also drank any type of alcohol in the past year were defined as eligible for follow-up, resulting in the total 1922 eligible respondents from the cross-sectional baseline samples. The resulting panel data set includes 794 individual respondents with at least two, but up to five observations each. In Fig. 1 the numbers of unique respondents can be seen in the n's for the first panel follow-up of each cross-sectional sample, seen to the right of each solid arrow. Despite substantial panel attrition between follow-ups, numbers followed for each 6-month period increase over time and range from 270 to 522. There were 212 respondents with at least four consecutive surveys and 427 with at least three surveys. Participants in the baseline cross-sectional surveys were issued $10 dollar gift cards at survey completion. To enhance retention in the panels, eligible survey respondents were told that they would be issued gift cards in increasing amounts from $25 for the first follow-up to $40 for the fourth. Protocols were approved by the Public Health Institute IRB (#I13-010).

2.2. Measures

2.2.1. Risk drinking status

For all baseline and follow-up waves, respondents at each time point were asked about their drinking behavior for all alcoholic beverages combined during the last 30 days. Volume consumption was constructed by multiplying respondents' usual frequency "considering all types of alcoholic beverages, on how many days during the past month, that is the past 30 days, did you have at least one drink of any alcoholic beverage", with answers ranging from 0 to 30 and their usual quantity "on the days that you drank in the past 30 days, how many drinks did you drink on average". One standard (14 g) drink was defined as a 12 ounce bottle/can of beer, a 5-ounce glass of wine, or 1.5 ounces of liquor. Respondents were also asked the maximum number of drinks in any day during the last 30 days. Based on the US NIAAA drinking guidelines (Dawson et al., 2004), dichotomous risky drinking status at each time point was defined as having two or more drinks per day on average *or* maximum drinking of at least five drinks a day for men, and having one or more drinks per day on average *or* maximum drinking of at least four drinks a day for women.

2.2.2. Risky drinking temporal profile

Was then designated for individual respondents by examining their risky drinking status across waves. Of the 794 individuals in the panel data sample, with 2–5 observations over time, each person was classified into one of the three categories: 1) Always risky, those who were involved in risky drinking in all observed waves, 2) Never risky, who were non-risky drinkers (or non-drinkers) across all waves, and 3) Mixed drinking, who were risky drinkers at least once and non-risky drinkers (or non-drinkers) at least once.

2.2.3. Current spirits drinkers

Were first defined before spirits purchase behavior questions were asked. Respondents were asked "how often do you usually have drinks containing liquor, including scotch, bourbon, gin, vodka, rum and so on", with 10 response options ranging from "more than once a day", "once a day", to "never had whisky or liquor". Those who answered "less than once a month but at least once a year" or more frequent were defined as current (i.e., 12-month) spirits drinkers. Spirits drinkers were then asked "thinking about your most recent liquor purchase at a store, when was the last time you purchased liquor at a store", with 10 response options ranging from "today", "yesterday" to "Never within the

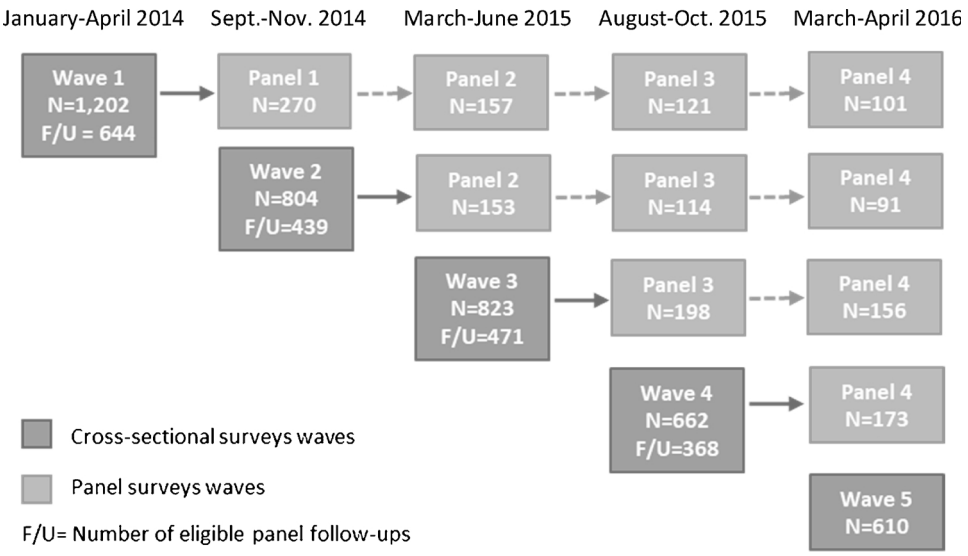

Fig. 1. Diagram of the Washington survey panel process from the eligible sample in each cross-sectional Wave to participating respondents at each Panel survey. January–April 2014 Sept.–Nov. 2014 March-June 2015 August–Oct. 2015 March–April 2016.

past year". Those who purchased spirits within the prior year were then defined as *current spirits purchasers*.

2.2.4. Current spirits purchasing behaviors

At each wave, the following spirits purchasing behavior measures were assessed in terms of the most recent occasion: travel distance, purchase frequency, purchasing cost, bottle size and store type. *Travel distance* was based on a question asking "how long does it typically take you to get from your home to the store where your last liquor purchase occurred?" with response options of "less than 5 min", "5–10", "10–15", "15–20" and "20 min or more", coded to 2, 7, 12, 17 and 25 min, respectively, in the analysis. *Purchase days* was based on the question "how often do you typically shop for liquor products?" with response options "daily", "weekly", monthly", every couple of months", "2-4 times per year", and "once a year", coded to 365, 52, 12, 6, 3 and 1 days. Since nobody reported "daily" purchase, the purchase day variable was analyzed in the range of 1–52 days. To evaluate the *spirts purchasing cost* and *bottle size*, spirits purchasers were asked about their experience of last spirits purchase: the type and brand of the liquor, the size and price for each bottle. The response options of bottle size included "750 mL or 'fifth'", "1 L or 'quart'", "1.75 liters or 'half gallon'", "50 mL or 'mini'", "200 mL or 'half pint'", "375 mL or 'pint'". Each purchaser was allowed to provide up to three types of liquor bottles from their last purchase. Spirits purchase cost ($ per liter) was derived dividing the self-reported dollar price by the size of the bottle and the average cost was calculated when multiple bottles were purchased. *Current store type* was elicited from the question "what was the name of the store where your last liquor purchase occurred". It was an open-ended question in the first wave, and starting from Wave 2, the respondents were asked to choose from options such as "Albertsons", "Costco", etc. The answers were recoded into three categories in current analysis: 1) big liquor/wholesale, 2) grocery/drug store/department store, 3) liquor store/distillery/gas station/other.

2.2.5. Marijuana use

Was based on the question "how often have you used marijuana, hash, or pot during the last twelve months", with 6 selection options from "every day or nearly every day" to "never". Two use variables were created for the current analysis: an indicator of any use in the past year and an indicator of at least weekly use among past year users.

We used the following demographic covariates when examining the association between risky drinking status and spirits purchasing behaviors and marijuana use: sex (male and female); age (18–29, 30–49, 50 +); race/ethnicity (non-Hispanic white versus others); education (high school graduate or less, some college, college graduate or higher); household income (annual income no more than $50,000, more than $50,000 but no more than $80,000, and more than $80,000); employment status (full time employed, part time, unemployed, retired, and others); and marital status (married, separated/divorced, widowed, and never married).

2.3. Statistical analysis

Two types of analyses were performed to assess the association between risky drinking and spirits purchase and marijuana use behaviors using the panel data. First, the average measures of purchasing and marijuana use variables across waves were compared between the three groups with different risk drinking profiles: non-risky all waves, risky all waves and mixed drinking across waves. Multinomial logistic regressions were also fitted to predict the likelihood of belonging to Always-risky and Mixed-drinking groups in contrast to the Non-risky group by purchasing and marijuana use behavior variables, controlling for basic demographics. Robust standard errors were generated treating individuals with multiple observations across waves as clusters. Second, we examined whether, for individuals in the mixed drinking group only, change in risky drinking status was related to change in spirits purchase and marijuana use behaviors, by fitting the conditional logistic regressions.

3. Results

Of the 794 individuals in the panel data, excluding 30 people missing the drinking variables, 475 (62.2%) were non-risky across all waves, 122 (16.0%) were risky drinkers in all waves, and 167 (21.9%) were mixed drinkers with both risky drinking and non-risky drinking (including non-drinking) across waves. Table 1 shows the prevalence of baseline demographic measures across the three risky drinking temporal profiles and Chi-square tests for differences. Profiles were not significantly associated with gender, education or family income. Compared to the Non-risky group, people in the Always-risky group were more likely to be younger, non-white, working full time, and never married.

Risky drinking temporal profiles were strongly associated with spirits drinking as expected. The mean prevalence of drinking any

Table 1
Demographic characteristics between groups of different risky drinking temporal profiles (%).

	Non-risky all waves (n = 475)	Risky all waves (n = 122)	Mixed drinking across waves (n = 167)	P
Gender				0.728
Male	48.4	52.5	49.1	
Female	51.6	47.5	50.9	
Age				< 0.001
18–29	8.5	33.1	21.0	
30–49	25.6	31.4	40.1	
50 +	65.9	35.5	38.9	
Race/Ethnicity				< 0.001
White non-Hispanics	92.2	80.3	82.6	
Others	7.8	19.7	17.4	
Education				0.608
High school grad	15.2	19.7	19.9	
Some college	33.0	30.3	31.3	
College grad	51.8	50.0	48.8	
Family income				0.634
$0–$50,000	30.4	34.2	36.1	
$50,001–$80,000	34.0	29.1	29.7	
> $80,000	35.6	36.7	34.2	
Employment				< 0.001
Full time	42.9	56.6	44.9	
Part time	14.3	16.4	20.4	
Unemployed	4.4	4.9	6.6	
Retired	29.5	12.3	13.8	
Others	8.8	9.8	14.4	
Marital Status				0.001
Married/live together	60.6	51.6	53.3	
Separate/divorced	20.4	16.4	16.2	
Widowed	6.3	4.1	6.0	
Never married	12.6	27.9	24.5	

spirits during the last 30 day was 53.8% for Non-risky group across waves, in comparison to 85.7% for Always-risky group and 77.2% for Mixed-drinking group. Furthermore, when respondents did drink spirits, mean spirits volume consumed (total drinks during last 30 days) was 19.8 drinks across waves for Always-risky group, compared to 11.4 drinks for Mixed-drinking group and 5.4 drinks for Non-risky group (Results not shown).

Table 2 summarizes results on spirits purchasing and marijuana use behaviors averaged across waves for the three different risk drinking profile groups. For example, the Non-risky group were spirits purchasers (last year) 59.7% of time across waves. When they purchased spirits, they spent 12.8 min on average traveling to the store, their purchasing frequency had a mean of 4.7 days last year and their average purchase cost was $30 per liter. They were more likely to purchase 750 ML bottles (62.3%) than to purchase 1 L or larger bottles (30.6%) and they were more likely to purchase spirits in grocery stores, drug stores or department store (58.5%) than at liquor superstores or wholesale stores (24.3%) or gas stations or other venues (17.2%). Comparing the three groups of different risk drinking temporal profiles, the Always-risky and Mixed-drinking groups were more likely to be spirits purchasers than Non-risky group and to purchase spirits more frequently. The Always-risky group also had significantly fewer travel minutes than the Non-risky group. No significant differences were observed between the groups on spirits purchasing costs, bottle size or store type chosen. The Always-risky and Mixed-drinking groups were less likely to have never used marijuana in the past year than the Non-risky group.

Table 3 shows the results from multinomial logistic regressions predicting the risky drinking profiles, with the Non-risky group as reference. Predictor variables were spirits purchasing and marijuana use behaviors across waves, which were entered one at time into the models. Gender, age, marital status and employment status were controlled in all models, as these were related to the risk drinking profiles.

Table 2
Spirits purchase behaviors and marijuana use for risky drinking temporal profile groups (%).

	Non-risky (all waves)	Always Risky (all waves)	Mixed drinking (across waves)
Spirits purchasers (%)	59.7	81.3***	82.3***
Travel minutes[a], mean (se)	12.8 (0.4)	11.1 (0.7)*	11.4 (0.5)
Purchase days (1-52)[b], mean (se)	4.69 (0.23)	11.51 (0.89)***	6.84 (0.42)***
Purchase cost ($/liter)[a], mean (se)	30.0 (0.9)	32.3 (1.5)	32.9 (1.6)
Bottle size (%)[a]			
750 ML	62.3	64.1	58.8
1 L or larger	30.6	29.9	32.4
< 750 ML	7.1	6.0	8.8
Store type (%)[a]			
Liquor super/wholesale	24.3	19.3	28.9
Grocery/drug/dept store	58.5	58.9	51.2
Gas station and others	17.2	21.8	19.9
Marijuana use (%)			
Never last year	74.2	51.2***	63.2**
< weekly, but at least once	10.7	26.6	18.4
At least weekly	15.1	22.2	18.4

[a] Among spirits purchasers only.
[b] Ranging from "once per year" (1 day) to "weekly" (52 days).
*** $p < 0.001$.
** $p < 0.01$.
* $p < 0.05$, comparison with "Non-risky all waves" group in each instance.

Table 3
Relative risk ratios (RRRs) and 95% confidence intervals (CIs) from multinomial logistic regression predicting risky drinking temporal profile (ref. Non-risky all waves) by spirits purchasing behavior and marijuana use variables (entered separately).

	Risky-all-waves	Mixed drinking
Spirits purchaser	2.93 (1.91, 4.49)***	3.32 (2.32, 4.74)***
Spirits purchasing travel minutes[2]	0.99 (0.96, 1.02)	0.99 (0.97, 1.02)
Spirits purchasing days (1-52) [2,3]	1.08 (1.05, 1.12)***	1.05 (1.02, 1.08)**
Spirits purchasing cost (in $10/liter) [2]	1.04 (0.95, 1.36)	1.05 (0.96, 1.15)
Spirits purchasing size (ref. 750 ML) [2]		
1 L or larger	1.29 (0.83, 2.00)	1.48 (1.00, 2.19)*
< 750 ML	0.82 (0.39, 1.71)	1.18 (0.68, 2.05)
Spirits store (ref: Grocery/drug/dept store) [2]		
Liquor super/wholesale	1.12 (0.66, 1.90)	1.91 (1.19, 3.09)**
Gas station and Others	1.79 (1.04, 3.06)*	1.71 (1.09, 2.68)*
Marijuana use last year (ref: no use)		
< weekly, but at least once	2.74 (1.74, 4.35)***	1.56 (1.01, 2.52)*
At least weekly	1.71 (0.98, 3.00)	1.12 (0.68, 1.84)

[1]Adjusting for gender, age, race, marital status and employment status.
[2] Among spirits purchasers only.
[3] Ranging from "once per year" (1 day) to "weekly" (52 days).
* p < 0.05.
** p < 0.01.
*** P < 0.001.

Compared to the Non-risky group, the Always-risky and Mixed-drinking groups were more likely to be spirits purchasers and to purchase spirits more often. Mixed drinkers were more likely to purchase 1 L and larger bottles compared to Non-risky drinkers. Mixed drinkers were also more likely to purchase from liquor superstores and wholesale stores than grocery/drug/department stores. Always-risky and Mixed-drinkers also preferred to purchase spirits in gas stations and other types of outlets compared to Non-risky drinkers. Last, both Always-risky and Mixed-drinkers were more likely than the Non-risky group to be less than weekly marijuana users, while no significant differences were found for at least weekly marijuana use.

Table 4
Odds ratios (ORs) and 95% confidence intervals (CIs) predicting risky drinking status at each wave among Mixed drinkers only from spirits purchasing behaviors and marijuana use variables (entered separately).

	ORs (CIs)
Spirits purchaser	1.47 (0.76, 2.83)
Spirits purchasing travel minutes[a]	1.03 (0.99, 1.07)
Spirits purchasing days [a,b]	1.07 (1.02, 1.12)*
Spirits purchasing cost (in $10/liter) [a]	0.85 (0.74, 0.998)*
Spirits purchasing size (ref. 750 ML) [a]	
1 L or larger	2.76 (1.40, 5.46)**
< 750 ML	0.87 (0.34, 2.25)
Spirits store (ref: Grocery/drug/dept store)[a]	
Liquor super/wholesale	1.05 (0.44, 2.54)
Gas station and Others	0.88 (0.42, 1.85)
Marijuana use last year (ref: no use)	
< weekly, but at least once	2.45 (1.13, 5.30)*
At least weekly	3.02 (0.92, 9.95)

[a] Among spirits purchasers only.
[b] Ranging from "once per year" (1 day) to "weekly" (52 days).
* $p < 0.05$.
** $p < 0.01$.

Finally, conditional logistic regressions estimated among the Mixed-drinkers only to evaluate associations between risk drinking status at a given time and spirits purchasing and marijuana use behaviors at the same time. This within-person modeling allows us to examine how temporal changes in risky drinking affect changes in spirits purchase behaviors and marijuana use frequency. As shown in Table 4, risky-drinking status (at a given time) was significantly associated with purchasing spirits more often, paying less per liter of spirits purchased, buying larger sized bottles (1 L and larger, mainly 1.75 L) and using marijuana on a less than weekly basis at the same time.

4. Discussion

These analyses are the first to consider changes in purchasing behaviors for individual spirits drinkers when they are drinking at risky levels compared to when they are drinking a lower level. Results indicate that when drinking more heavily spirits purchasers buy more frequently, spend less per liter on spirits and buy larger sized bottles such as 1.75 L bottles holding 40 standard drinks. Spirits drinkers were also found to be more likely to use marijuana than at times when they were drinking at a non-risky level, suggesting complementarity between marijuana use and risky drinking. Results comparing groups of spirits drinkers who always drank at the risky level to those who never did also found more frequent spirits purchasing among the risky drinkers and a higher likelihood of less than weekly marijuana use. Weekly marijuana use was not significantly different between the groups, although this was more prevalent in the risky drinking group than in the non-risky group. The weekly marijuana estimates also showed a very wide confidence interval suggesting variability in this group and a need for more detailed study of these more frequent users.

Findings of reduced spending and larger bottle sizes, which tend to cost less on a per liter basis (Kerr et al., 2015), suggest that these drinkers seek to lower the cost drinking when they drink more by taking advantage of size discounts and possibly through quality substitution and other means such as context substitution. These behaviors are consistent with the motivation behind alcohol taxation on a standard drink basis and minimum unit pricing policies that seek to reduce drinker's ability to seek lower cost alcohol (Thomas et al., 2017). Minimum pricing for spirits would affect larger containers of lower quality products the most and would limit drinker's substitution to these products when drinking more heavily. Studies have shown that changes in minimum unit prices reduce alcohol-related harms including consumption (Stockwell et al., 2012) and alcohol-attributed mortality (Zhao and Stockwell, 2017).

Results regarding marijuana use indicate that drinking at levels exceeding NIAAA low-risk guidelines some or all of the time is associated with being an occasional marijuana user, but not a frequent marijuana user and that marijuana use and risky drinking are complements among spirits drinkers. While we have not yet fully explored relationships between alcohol and marijuana use measures in this data, as we have only considered one drinking threshold and marijuana use frequency, this finding adds to the limited literature in this area with the first findings from a longitudinal sample in an environment with legal recreational cannabis. Importantly, we did not consider differences between recreational users and those with medical recommendations, who have been found to drink less and to have fewer alcohol related problems, controlling for alcohol patterns (Subbaraman and Kerr, 2018). Future analyses will consider simultaneous co-use, additional alcohol measures such as monthly number of drinks and heavy drinking days, details of marijuana use such as methods of ingestion, amount used and time spent under the influence as well as the experience of alcohol and marijuana-related problems. Complementarity between risky drinking and marijuana use among spirits drinkers who sometimes drink at risky levels is important because it implies that factors that reduce or increase one of the behaviors would tend to affect the other in the same direction such that reduced alcohol taxes would increase marijuana use along with risky drinking, for example (Subbaraman, 2016).

This study has a number of limitations including a small sample size, self-reported measures of drinking and marijuana use and detailed measures of spirits purchasing behaviors that may have been difficult to remember or characterize. There are also no details on beer or wine purchasing behaviors that may have been affected by changing drinking levels. The environment is Washington includes legal recreational marijuana and a variety of spirits outlet types that, while similar to some states like California, may limit generalizability to other US states. The data on individual's purchasing come from between 2 and 5 consecutive measurement points over two and half years such that the timing of these observations varies.

5. Conclusions

This study has demonstrated that spirits drinkers choose to purchase lower cost spirits in larger containers when they are drinking more heavily compared to times when they are drinking within US low-risk guidelines. This finding highlights the need for policies targeting lower cost products such as taxation on a standard drink basis or minimum unit pricing (Thompson et al., 2017). Findings also support complementarity between heavier drinking and marijuana use among spirits drinkers in a state with legal recreational marijuana sales. Simultaneous co-use has been shown to increase risks for alcohol-related problems (Subbaraman and Kerr, 2015) and further research is needed to understand the range of associated risks, to identify the most harmful patterns or circumstances and to develop prevention and harm reduction policies, programs and messages around co-use (Yurasek et al., 2017).

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Contributors

Drs. Kerr and Greenfield and Mr. Ye were all involved in the conceptualization of the study, the design of the surveys and analytic plans. Mr. Ye was primarily responsible for the analyses and descriptions of

the methods and results. Dr. Greenfield participated in the interpretations of the results and paper writing. Dr. Kerr was primarily responsible for the manuscript overall. All authors read and approved final manuscript.

Conflict of interest

Drs. Kerr and Greenfield have received contracts and travel support from the National Alcohol Beverage Control Association.

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