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Persistent Binge Drinking Predicts Continuing Alcohol Problems in Moderate Drinkers

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ABSTRACT

Objective: Binge drinking ($\geq$ five drinks on the same occasion) is a public health concern. Surprisingly, binge drinkers can be individuals who on-average drink moderately ($\leq$ 7 drinks/week for women and $\leq$ 14 drinks/week for men). Among moderate drinkers, we investigated: (a) persistence in binge drinking across 9 years and (b) the association between persistent binge drinking and concurrent alcohol problems at 9 years.

Methods: Participants were 1,102 U.S. adults who were moderate drinkers. Data were from two waves of the study of Midlife Development in the United States (MIDUS), with a 9-year time lag (2004 through 2015). A mediation model examined the predictive association between binge drinking at baseline and multiple ($\geq$ 2) alcohol problems 9 years later, mediated through persistent binge drinking at 9 years.

Results: Binge drinking at baseline predicted multiple alcohol problems 9 years later mediated through persistent binge drinking at 9 years. Being a binge drinker at baseline increased the odds of binge drinking 9 years later by more than 6 times. In turn, binge drinking at 9 years was associated with more than five times increased odds of experiencing concurrent multiple alcohol problems.

Conclusions: These findings underscore the significance of binge drinking in a large group of adults who often fall below the public health radar. We show that binge drinking among moderate drinkers is persistent across time and that persistence in binge drinking is linked to ongoing multiple alcohol problems. Moderate drinking adults should be included in primary and secondary prevention efforts to reduce binge drinking.

Introduction

Binge drinking ($\geq$ five drinks on the same occasion) is a global public health concern (Zyoud, 2025). In the U.S., binge drinking is increasing among adults (Azagba et al., 2020) and is reported by one in every five employed adults (Shockey & Esser, 2020). During the past 10 years, as young adults have reduced binge drinking, binge drinking among midlife adults has increased to its highest level since 2008 (Patrick et al., 2023). Among working midlife adults in the U.S., binge drinking has increased across all occupational fields (McKetta et al., 2021). Binge drinking has also been increasing among older adults. In a meta-analysis of six U.S. national surveys, Grucza et al. (2018) observed that the largest increase in binge drinking has occurred among adults age 50 and older.

Surprisingly, binge drinkers can be individuals who on-average drink moderately ($\leq$ 7 drinks/week for women and $\leq$ 14 drinks/week for men). This finding reflects the fact that an average moderate level of consumption encompasses divergent underlying patterns of drinking—from consistent low consumption to irregular low consumption with

episodes of binge drinking (Naimi et al., 2013). However, binge drinking in moderate drinkers is not commonly studied. For example, epidemiological research on moderate drinking has traditionally focused only on average level of consumption, neglecting occasions of binge drinking (Naimi et al., 2013; Rehm et al., 2017).

We have found only two studies that directly examined binge drinking among moderate drinkers. In a U.S. national sample of adults 18 years or older, Naimi et al. (2003) found that most (73%) of all binge drinkers were moderate drinkers. Building on the earlier work by Naimi et al., Holahan et al. (2022) found similarly that in a national sample of U.S. adults age 30 and older, moderate drinkers accounted for the majority (71%) of cases of binge drinking.

Two additional studies have considered binge drinking among moderate drinkers more indirectly. Naimi et al. (2023) observed in a U.S. national sample age 18 and older that moderate drinkers accounted for most alcohol-attributable injury deaths. The investigators noted that this finding is consistent with evidence that binge drinking is common among moderate drinkers. O'Dwyer et al. (2019) found that Irish adults age 18 and older who engaged in binge drinking

but were not alcohol dependent experienced more overall alcohol-related social harms compared to alcohol-dependent drinkers. The authors reasoned that individuals who are not alcohol dependent but engage in binge drinking are likely moderate drinkers.

However, earlier studies that addressed binge drinking among moderate drinkers (Holahan et al., 2022; Naimi et al., 2003, 2023; O'Dwyer et al., 2019) looked at an individual's drinking at only a single point in time. Central unanswered questions are whether binge drinking among moderate drinkers is short-lived or persists over time and whether persistence in binge drinking provides a pathway to continuing alcohol problems. These are key public health concerns. If binge drinking is persistent among moderate drinkers and if persistence in binge drinking is linked to continuing alcohol problems, it represents a serious health risk in a large group of adults who often fall below the public health radar.

Extending earlier research that addressed binge drinking among moderate drinkers (Holahan et al., 2022; Naimi et al., 2003, 2023; O'Dwyer et al., 2019), this study addressed this research question among 1,102 U.S. moderate adult drinkers. Specifically, among these moderate drinkers, we examined: (a) persistence in binge drinking across 9 years and (b) the association between persistent binge drinking at 9 years and concurrent alcohol problems at 9 years. We integrated these research questions in a mediation model, testing the effect between binge drinking at baseline and alcohol problems at 9 years, mediated through persistent binge drinking at 9 years. To strengthen inference, we controlled for the potential confounding effect of alcohol problems at baseline on both the binge drinking mediator and the alcohol problems outcome at 9-years. The proposed mediation model is shown graphically in Figure 1.

Methods

Study sample

Data were from two waves of the study of Midlife Development in the United States (MIDUS). The MIDUS study investigated health and well-being in a U.S. national sample of non-institutionalized, English-speaking adults. The study was initiated by the MacArthur Midlife Research Network with funding from the National Institute on Aging.
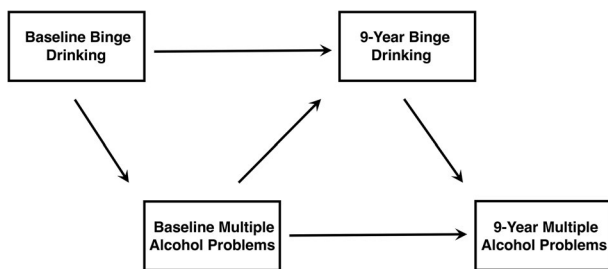

Figure 1. Model showing a mediated relationship between baseline binge drinking and 9-year drinking problems, through persistent binge drinking at 9-years. The model controls for the effect of alcohol problems at baseline on both the binge drinking mediator and the alcohol problems outcome at 9 years.

Baseline data for the current analyses are from wave 2 of the MIDUS study, which introduced the measure of binge drinking in the survey. Follow-up data are from wave 3 of the MIDUS study, 9 years later. Baseline data were collected between 2004 and 2006, and follow-up data were collected between 2013 and 2015. Each wave of data collection used a phone interview followed by a self-administered questionnaire. Oral consent for participation was obtained at first contact. The present study did not require IRB approval because it involved secondary analyses of a publicly available, fully deidentified dataset.

Baseline participants in the present study were 1,102 predominantly middle-age and older U.S. adults aged ≥ 30 years who were current moderate drinkers. Participation rate in the MIDUS study at baseline (excluding mortality) was 75% for the telephone interview and 87% for the additional self-administered questionnaire (Radler & Ryff, 2010). Participation rate in the MIDUS study at 9 years (excluding mortality) was 77% for the telephone interview and 83% for the additional self-administered questionnaire (MIDUS Field Report, 2018). In the present study, of the 1,102 participants at baseline, 682 individuals (62%) provided outcome data at 9 years. Of the 420 baseline participants who failed to follow-up, 79 individuals (19%) died before follow-up data collection and another 23 individuals (5%) died during follow-up data collection.

Moderate vs. heavy drinking

To index a moderate vs. heavy average level of alcohol consumption, respondents were asked: "During the past month, how often did you drink any alcoholic beverages, on the average?" Responses were scaled to average number of drinking days/week. Next, to measure the average number of drinks per drinking day, respondents were asked: "On the days when you drank, about how many drinks did you drink on the average?" One drink was defined as "a bottle of beer, a wine cooler, a glass of wine, a shot of liquor, or a mixed drink." To derive a composite index of average drinks/week, average number of drinking days/week and average number of drinks/drinking day were multiplied.

Moderate drinking was defined based on the U.S. Centers for Disease Control and Prevention, (2025) cutoff for heavy drinking. Specifically, moderate drinking (score = 0) was defined as an average of ≤ 7 drinks/week for women and ≤ 14 drinks/week for men; heavy drinking (score = 1) was defined as an average of > 7 drinks/week for women and > 14 drinks/week for men.

Binge vs. non-binge drinking

To index a binge vs. non-binge pattern of alcohol consumption, participants were asked: "Considering all types of alcoholic beverages, how many times during the past month did you have five or more drinks on the same occasion? An occasion was defined as "drinks in a row, or in a short period of time." For both women and men, the MIDUS surveys indexed a non-binge pattern of drinking as < five drinks

on the same occasion and binge drinking as ≥ five drinks on the same occasion. This is consistent with the definition used at the time in the U.S. National Survey on Drug Use and Health (Center for Behavioral Health Statistics and Quality, 2016). Because number of binge drinking episodes was highly skewed, following previous research with the MIDUS sample (Goldwater et al., 2019; Holahan et al., 2022), a binary measure contrasted no instances of binge drinking (score = 0) with 1-or-more instances of binge drinking (score = 1). In additional sensitivity analyses, following Magidson et al. (2017), we used a continuous measure of number of binge episodes (coded from 0 to 5-or-more because very few individuals reported more than five binge episodes).

Alcohol problems

Alcohol problems in the past 12 months were indexed at baseline and at the 9-year follow-up by the Alcohol Dependence scale of the Composite International Diagnostic Interview-Short Form (Kessler et al., 1998). The scale consists of seven items: experiencing effects of alcohol in a situation that increased chances of getting hurt; emotional or psychological problems from alcohol; desire to use alcohol that you could not resist; month or more when you spent a great deal of time using alcohol; having to use more alcohol to get the same effect; using much larger amounts of alcohol than intended; and experiencing effects of alcohol at work, school, or caring for children. For each item, no problems was given a score of 0 and any problems was given a score of 1.

The MIDUS surveys included six alcohol problems at baseline (use in hazardous situations was not included) and all seven problems at follow-up. Because the number of alcohol problems was highly skewed, following previous research with the MIDUS sample (Glei & Weinstein, 2019; Holahan et al., 2022), we used a binary measure to index multiple alcohol problems. To link our definition of multiple alcohol problems to diagnostic criteria for alcohol use disorder (Kranzler & Soyka, 2018), following Holahan et al. (2022), we used a cutoff of two to index multiple alcohol problems, contrasting ≤ 1 problem (score = 0) with ≥ 2 problems (score = 1). In sensitivity analyses, following Magidson et al. (2017), we used a continuous measure of number of alcohol problems.

Statistical analyses

Binary logistic regression analysis was used to examine the binary measure of multiple alcohol problems. Negative binomial regression analysis was used to examine the continuous measure of number of alcohol problems, which was distributed as a count. Analyses used Mplus Version 8.1 (Muthén & Muthén, 2017) with the maximum-likelihood estimator. Following Goldwater et al. (2019) and Holahan et al. (2022), demographic covariates included baseline age, gender, years of education, and household income, as well as non-White, Hispanic, and marital status. All analyses controlled for the effect of these demographic covariates, as well as for the

effect of baseline alcohol problems, on both the binge drinking mediator and the alcohol problems outcome at 9 years. In statistical analyses, age was scaled in 10-year units and household income was scaled in ten-thousand-dollar units to facilitate interpretation.

Results

Descriptive statistics

At baseline, the study sample included 525 women and 577 men. Mean age was 55.5 years (SD = 12.4). Mean years of education were 14.9 (SD = 2.6), and median household income was $65,750. Non-Whites were 7.8% (86/1102) of the sample and comprised 37 Blacks/African Americans, 11 Native Americans/Alaska Natives, 8 Asians/Pacific Islanders, and 30 other groups. Among participants, 3.6% (40/1102) were Hispanic and 71.3% (786/1102) were married.

At baseline, 16.5% (182/1102) of participants reported binge drinking; at 9 years, 16.6% (110/664) of participants reported binge drinking. At baseline, 7.0% (77/1102) of participants reported multiple alcohol problems; at 9 years, 11.7% (80/682) of participants reported multiple alcohol problems.

Primary analysis of hypothesized model

Following Holahan et al. (2022), analyses were restricted to individuals who reported moderate drinking at baseline (n = 1102). Results of the binary logistic regression analysis testing the hypothesized mediation model, controlling for demographic covariates, are shown in Figure 2 (demographic covariates are not shown to simplify the presentation). Binge drinking was persistent across the 9-year follow-up period. The effect size was strong. Among moderate drinkers, being a binge drinker compared to a non-binge drinker at baseline increased the odds of being a binge drinker 9 years later by 6.36 times (95% CI [3.77, 10.72]). Descriptively, being a binge drinker compared to a non-binge drinker at baseline was associated with an increase in the percentage of binge drinking cases at 9 years from 8.4% to 53.8%.

In turn, persistence in binge drinking at 9 years was linked to concurrent multiple alcohol problems. The effect size was strong. At follow-up, being a binge drinker compared to a
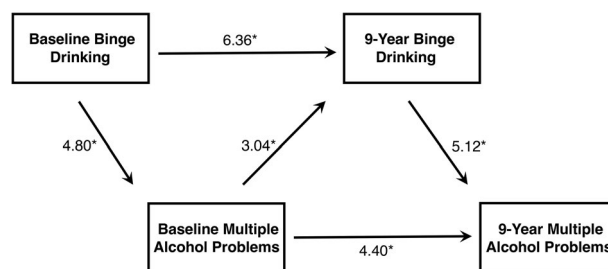

Figure 2. Results in odds ratios for the proposed mediation model showing a mediated relationship between baseline binge drinking and 9-year drinking problems, through persistent binge drinking at 9 years. Covariates (not shown) included age, gender, years of education, household income, non-White status, Hispanic status, and marital status. *p < 0.001.

non-binge drinker was associated with 5.12 times (95% CI [2.66, 9.86]) increased odds of experiencing multiple alcohol problems. Descriptively, being a binge drinker compared to a non-binge drinker at follow-up was associated with an increase in the percentage of concurrent cases of multiple alcohol problems from 7.3% to 40.8%.

The mediated effect ($OR = 1.12$) between baseline binge drinking and 9-year multiple alcohol problems, through persistent binge drinking at 9-years, was statistically significant (χ^2 (1, $N = 1102$) = 18.70, $p < 0.001$). Further, consistent with the proposed mediation model, the direct path between baseline binge drinking and 9-year multiple alcohol problems (not shown in the figure) was not significant ($OR = 1.20$, 95% CI [0.60, 2.37]).

We tested potential moderation by age, gender, non-White status, and Hispanic status. Analyses were conducted separately for each moderator and separately for each mediation path. Neither the path for binge drinking across 9 years nor the path between binge drinking and multiple alcohol problems at follow-up varied significantly (α = 0.05) by age, gender, non-White status, or Hispanic status.

Sensitivity analyses

Continuous measures of binge episodes and alcohol problems

Because binary compared to continuous measures may lose meaningful variance, we repeated the test of the hypothesized model using continuous measures of binge episodes and alcohol problems. We used negative binomial regression for this analysis because the outcome measure of number of alcohol problems was distributed as a count. The analysis was again restricted to moderate drinkers at baseline ($n = 1102$). Using continuous measures of number of binge episodes and number of alcohol problems and controlling for demographic covariates, results of the model test replicated those reported above under the primary analysis of the hypothesized model. Results of the model test are shown in Figure 3 (demographic covariates are not shown to simplify the presentation).

Number of binge episodes was persistent across the 9-year follow-up period. Among moderate drinkers, each one unit increase in number of binge episodes at baseline (0 to 5) increased the number of binge episodes 9 years later by 58% (95% CI [1.45, 1.73]). In turn, persistence in number of binge episodes at 9 years was linked to concurrent number of alcohol problems. At follow-up, each one unit increase in number of binge episodes (0 to 5) was associated with a 25% (95% CI [1.14, 1.45]) increase in number of alcohol problems. The mediated effect between baseline number of binge episodes and 9-year number of alcohol problems, through persistence in number of binge episodes at 9-years, was statistically significant (mediated effect = 1.11, 95% CI [1.06, 1.16]). Consistent with the proposed mediation model, the direct path between baseline number of binge episodes and 9-year number of alcohol problems (not shown in the figure) was not significant ($OR = 0.98$, 95% CI [0.75, 2.16]).
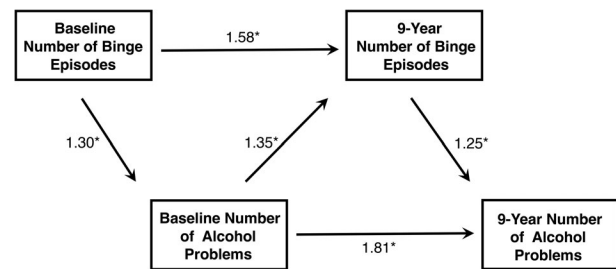

Figure 3. Results in rate ratios for the proposed mediation model showing a mediated relationship between baseline number of binge episodes and 9-year number of drinking problems, through persistence in number of binge episodes at 9 years. Covariates (not shown) included age, gender, years of education, household income, non-White status, Hispanic status, and marital status. *$p < 0.001$.

Controlling for level of alcohol consumption

Because level of alcohol consumption could underlie the predictive effects for binge drinking, we repeated the test of the hypothesized model controlling for average drinks/week at baseline. The analysis was again restricted to moderate drinkers at baseline ($n = 1102$). Among moderate drinkers at baseline, for men, average drinks/week = 4.40 ($SD = 4.22$); for women, average drinks/week = 1.76 ($SD = 1.98$).

Average drinks/week at baseline were related to both binge drinking at 9 years ($OR = 2.24$, 95% CI [1.41, 3.56]) and multiple alcohol problems at 9 years ($OR = 2.94$, 95% CI [1.80, 4.82]). Importantly, however, controlling for average drinks/week and demographic covariates, results of the model test replicated those reported above under the primary analysis of the hypothesized model.

The mediational paths for persistence in binge drinking across 9 years ($OR = 4.76$, 95% CI [2.75, 8.24]) and for persistence in binge drinking at follow-up predicting concurrent multiple alcohol problems at 9 years ($OR = 4.28$, 95% CI [2.17, 8.42]) remained significant at the 0.001 level. In addition, the mediated effect ($OR = 1.09$) between baseline binge drinking and 9-year multiple alcohol problems, through persistent binge drinking at 9-years, remained significant (χ^2(1, $N = 1102$) = 13.01, $p < 0.001$).

Model test with moderate drinkers at baseline and 9 years

To examine the role of continued moderate drinking at 9 years, we repeated the test of the hypothesized model restricting the analysis to individuals who reported moderate drinking at both baseline and at the 9-year follow-up ($n = 610$). Restricting the analysis to individuals who reported moderate drinking at both baseline and at the 9-year follow-up and controlling for demographic covariates, results of the model test replicated those reported above under the primary analysis of the hypothesized model.

The mediational paths for persistence in binge drinking across 9 years ($OR = 4.92$, 95% CI [2.71, 8.93]) and for persistence in binge drinking at follow-up predicting concurrent multiple alcohol problems at 9 years ($OR = 4.23$, 95% CI [1.97, 9.09]) remained significant at the 0.001 level. In addition, the mediated effect ($OR = 1.08$) between baseline binge

drinking and 9-year multiple alcohol problems, through persistent binge drinking at 9-years, remained significant ($\chi^2(1, N=610) = 10.54$, $p=0.001$).

Model test with the full sample of drinkers

To examine the role of binge drinking in the full sample of drinkers, we repeated the test of the hypothesized model using the full sample of both moderate and heavy drinkers ($N=1223$). Using the full sample of both moderate and heavy drinkers and controlling for demographic covariates, results of the model test replicated those reported above under the primary analysis of the hypothesized model.

The mediational paths for persistence in binge drinking across 9 years ($OR=7.90$, 95% CI [4.96, 12.58]) and for persistence in binge drinking at follow-up predicting concurrent multiple alcohol problems ($OR=4.84$, 95% CI [2.64, 8.88]) remained significant at the 0.001 level. In addition, the mediated effect ($OR=1.15$) between baseline binge drinking and 9-year multiple alcohol problems, through persistent binge drinking at 9-years, remained significant ($\chi^2(1, N=1223) = 23.71$, $p<0.001$).

We also tested the potential moderation of 9-year persistence in binge drinking by average drinking level. The interaction between drinking level (moderate vs. heavy) and baseline binge drinking in predicting binge drinking at 9 years was not significant ($OR=1.38$, 95% CI [0.30, 6.47]).

Discussion

Extending previous research that addressed binge drinking among moderate drinkers (Holahan et al., 2022; Naimi et al., 2003, 2023; O'Dwyer et al., 2019), the present results strengthen the evidence that binge drinking among moderate drinkers is a public health concern. We demonstrated that binge drinking is persistent among moderate drinkers. Being a binge drinker at baseline increased the odds of binge drinking 9 years later by more than six times. In turn, we showed that among moderate drinkers, persistence in binge drinking is linked to continuing multiple alcohol problems. Binge drinking at 9 years was associated with more than five times increased odds of experiencing concurrent multiple alcohol problems. In an integrative model, binge drinking at baseline predicted multiple alcohol problems 9 years later mediated through persistent binge drinking at 9 years.

Sensitivity analyses provided important findings that further demonstrated the strength of the effect for persistence in binge drinking among moderate drinkers. In controlling for level of alcohol consumption, we found that baseline binge drinking made a unique contribution in predicting binge drinking 9 years later over and above the significant effect for level of alcohol consumption. In the model test with the full sample of drinkers, we found that the effect for persistence in binge drinking was no less strong in moderate compared to heavy drinkers.

Adults who engage in binge drinking have an increased risk of liver and cardiovascular disease (Molina & Nelson, 2018), breast cancer (White et al., 2017), and alcohol-attributable injury deaths (Naimi et al., 2023). In older adults, binge drinking can exacerbate existing chronic conditions, including diabetes and cardiovascular disease, increase the risk of falls, and interact adversely with medications (Han et al., 2019; Kerr et al., 2024).

Alcohol interventions targeting high-risk drinkers are essential (MacKillop et al., 2022). At the same time, the present results underscore the importance of binge drinking interventions that address the unique needs of moderate drinkers. Our findings are consistent with the "prevention paradox" (Rossow & Romelsjö, 2006), which assert the importance of alcohol interventions targeting the broad population of drinkers in addition to conventional strategies focusing on the higher risk, but smaller, population of heavy drinkers. Findings supporting the prevention paradox have emerged in studies of alcohol-related injury in Norway (Rossow et al., 2013), alcohol-caused deaths in Canada (Sherk et al., 2024), and alcohol-related social harms in Ireland (O'Dwyer et al., 2019). In each of these studies across three countries, most cases of alcohol's health and social harms were concentrated among non-heavy drinkers. Our findings contribute to this research by demonstrating the central role of binge drinking in alcohol's harms in the large population of moderate drinkers.

Alcohol policies focusing on availability and price of alcohol offer an effective strategy that reaches the broad population of drinkers (Xuan et al., 2015). In addition, to reduce heavy drinking occasions among moderate drinkers, national alcohol consumption guidelines need to be sufficiently low and to address both pattern and level of consumption (Sherk et al., 2020).

However, policy interventions alone are unlikely to be sufficient for changing the behavior of moderately drinking older adults, whose drinking habits are rooted in decades of experience (Bareham et al., 2019; Choi et al., 2024). Additionally, many older drinkers have an unrealistic view of moderate drinking. They are predisposed to see themselves as responsible drinkers and prone to rationalize their drinking habits as not risky—even when they engage in binge drinking (Bareham et al., 2019; Choi et al., 2024).

Consistent with these observations, we found among predominantly middle-age and older adults, that more than half of binge drinkers continued to binge drink 9 years later. At the same time, change is possible. Over 40% of binge drinkers were no longer binge drinking at follow-up. Interventions at the individual level can make an essential contribution in helping middle-age and older binge drinkers break through resistance to change.

A significant contribution to such efforts can come from primary care providers, who interact with a broad spectrum of older adults, by screening for per-occasion risky drinking among otherwise moderate drinkers (Krist & Bradley, 2025; Schuckit, 2019). Routine health checks can provide "teachable moments" about alcohol use in the context of older patients' concerns about their health (Bareham et al., 2019). Smith et al. (2009) demonstrated that the National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2005) approved single-question screen for unhealthy alcohol use is sensitive

and specific for identifying unhealthy use of alcohol in primary care patients.

The present findings are correlational and do not provide evidence of causality. In addition, the data were self-report and are subject to recall bias, common method variance, and social desirability. Also, the MIDUS surveys indexed binge drinking as 5 or more drinks on an occasion for both women and men; drinking in women is now more commonly indexed as 4 or more drinks on an occasion. Further, baseline data were collected from 2004 to 2006 and, as in other longitudinal studies, ongoing changes in alcohol use date our findings.

In sensitivity analyses, our findings did not vary significantly by non-White or Hispanic status. Nevertheless, the fact that this study's baseline sample was 89% White, non-Hispanic is a major limitation in generalizing the present findings to minority populations. The study's 9-year attrition is a further limitation. Minority status is a key correlate of attrition in the MIDUS study (Radler & Ryff, 2010), with attrition further increasing underrepresentation of individuals from minority groups.

These findings underscore the significance of binge drinking in a large group of adults who often fall below the public health radar. Extending earlier research that addressed binge drinking among moderate drinkers (Holahan et al., 2022; Naimi et al., 2003, 2023; O'Dwyer et al., 2019), we show that binge drinking among moderate drinkers is persistent across time and that persistence in binge drinking is linked to ongoing multiple alcohol problems. Further, our findings contribute to research on the prevention paradox (O'Dwyer et al., 2019; Rossow et al., 2013; Rossow & Romelsjö, 2006; Sherk et al., 2024), by demonstrating the central role of binge drinking in alcohol's harms among moderate drinkers. Moderate drinking adults, including middle-age and older adults, should be included in primary and secondary prevention efforts to reduce binge drinking (Kerr et al., 2024).

Declaration of interest

Funding

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