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Prediction of periconception alcohol use

**Longitudinal prediction of periconception alcohol use: A 20-year prospective cohort study across adolescence, young adulthood and pregnancy.**

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## Abstract

**Background and Aims:** Alcohol consumption is common in adolescence and young adulthood, and may continue into pregnancy, posing serious risk to early fetal development. We examine the frequency of periconception alcohol use (prior to pregnancy awareness) and the extent to which adolescent and young adult alcohol use prospectively predict periconception use. **Design:** A longitudinal, population-based study. **Setting:** Victoria, Australia. **Participants:** A total of 289 women in trimester three of pregnancy (age 29-35 years; 388 pregnancies). **Measures:** The main exposures were binge ( $\geq 4.0$  standard drinks (SDs) /day) and frequent ( $\geq 3$  days/week) drinking in adolescence (14-19 years) and young adulthood (20-29 years). Outcomes were frequency ( $\geq 3$  days/week,  $\geq$ monthly, never) and quantity ( $\geq 4.0$  SDs,  $\geq 0.5$  &  $< 4.0$  SDs, none) of periconception drinking. **Findings:** Alcohol use was common in young adulthood prior to pregnancy (72%) and in the early weeks of pregnancy (76%). The proportions drinking on most days and binge drinking were similar at both points. Reflecting a high degree of continuity in alcohol use behaviours, most women who drank periconceptionally, had an earlier history of frequent (77%) and/or binge (85%) drinking across the adolescent or young adult years. Young adult binge drinking prospectively predicted periconception drinking quantity (odds ratio (OR) 3.7, 95% confidence interval (CI) 1.9-7.4), compared with women with no prior history. Similarly, frequent young adult drinking prospectively predicted frequent periconception drinking (OR 30.7, 95% CI 12.3-76.7). **Conclusions:** Women who engage in risky (i.e., frequent and binge) drinking in their adolescent and young adult years are more likely to report risky drinking in early pregnancy, prior to pregnancy recognition, than women with no prior history of risky drinking.

**Key Words:** Alcohol, periconception, conception, pregnancy, longitudinal.

## Introduction

Over the past 50 years women's alcohol use has steadily increased<sup>1,2</sup> bringing a growing contribution to their disease burden<sup>3</sup>. There has been a closing of the consumption gap between males and females, most evident in recent cohorts, particularly in young adults entering the reproductive years<sup>4</sup>. National representative data in the US has identified increases among women in past 12 month alcohol use (16% increase), high risk drinking (58% increase in 4+ drinks in a day, at least weekly in past 12 months) and 12-month DSM-IV alcohol use disorders (84% increase) in recent decades<sup>1</sup>. In particular, among women of reproductive age, in the 18-25 and 26-34 age categories, rates of current alcohol use (past 30 days; 58% and 60% of females, respectively) and binge drinking ( $\geq 5$  drinks per occasion; 33% and 26% of females, respectively) are high<sup>5</sup>. The widespread consumption of alcohol among women is likely to be linked to extended education and workforce engagement, greater disposable income and delays in marriage and parenthood<sup>6</sup>.

In young women, these high levels of alcohol use coincide with the childbearing years<sup>3</sup>. Whilst pregnancy is a transition period when many women cease using alcohol<sup>7</sup>, estimates suggest that a proportion of women continue to drink alcohol when pregnant<sup>8-11</sup>. A recent meta-analysis of general population studies in Canada and the U.S. indicated that 10% and

## Prediction of periconception alcohol use

15% of women consume alcohol in pregnancy, respectively<sup>8</sup>. Higher rates have been reported elsewhere, ranging from 20-80 percent in Ireland, and from 37-80 percent in Australia, the U.K. and New Zealand<sup>9,10</sup>. This is despite growing community understanding that heavy maternal alcohol use in pregnancy predicts short- and long-term harms for offspring, including Fetal Alcohol Spectrum Disorder (FASD) and related birth deficits, developmental disorders and behavioural problems<sup>12,13</sup>.

Alcohol use is most common in the early weeks of pregnancy, prior to pregnancy recognition, often referred to as *periconception*. Longitudinal studies indicate that up to 60% of women report some alcohol consumption in this period, with many reporting heavy drinking<sup>14,15</sup>. Failure to recognise a pregnancy is a likely contributor with most women unaware of pregnancy until around 5.5 weeks post-conception<sup>16</sup>, and initiation of prenatal care typically occurring around 9-weeks gestation<sup>17</sup>. Importantly, maternal alcohol use in the periconception phase is likely to be aetiologically significant given that very early pregnancy is characterised by extensive epigenetic programming<sup>18</sup> and development of the brain and other organs<sup>19</sup> that may be disrupted in FASD.

Prenatal drinking change is influenced by multiple factors and social norms<sup>7</sup>. Importantly, however, research suggests that women who consume alcohol in the early weeks of pregnancy, prior to pregnancy awareness, may have different characteristics to women who continue to consume alcohol after pregnancy awareness<sup>14,20-22</sup>. Characteristics associated with periconception alcohol use in prior studies include pre-pregnancy alcohol use<sup>14,21,22</sup> and smoking<sup>14,21,22</sup>, younger<sup>22</sup> or older<sup>14</sup> maternal age, single parent status<sup>22</sup>, higher socio-economic status<sup>14,22</sup>, English speaking background<sup>14</sup>, and first pregnancy<sup>14,22</sup>. Notably,

## Prediction of periconception alcohol use

however, few prospective studies have examined the characteristics of young adult women who go on to drink alcohol in the periconception phase of pregnancy; yet prevention and early intervention messages might be targeted before pregnancy, in the young adult years, just prior to the peak age of conception.

It is also notable that few studies worldwide have tracked cohorts prospectively from adolescence and young adulthood into the periconception period specifically. Most existing studies of periconception drinking have assessed alcohol use in the recent pre-pregnancy period (e.g., in the weeks to months before conception)<sup>21 22</sup>. Yet understanding earlier patterns, from initiation of alcohol use in adolescence through the young adulthood years, holds considerable promise for informing intervention at the earliest opportunity to mitigate both risk in alcohol-related harm to young women, as well as the risk of drinking in early pregnancy and potential harm to the fetus.

In this study we longitudinally examined continuities in maternal alcohol consumption from 15-years years prior to conception through to the periconception period of pregnancy. The specific aims were to examine: (1) the extent to which women modified their drinking with pregnancy awareness; (2) the extent to which patterns of alcohol use prior to pregnancy, in adolescence to young adulthood, prospectively predicted continued drinking into the periconception period; and, (3) the young adult predictors of consuming alcohol in the periconception period.

## **Methods**

### ***Participants***

The Victorian Intergenerational Health Cohort Study (VIHCS) is a prospective study of preconception predictors of child health<sup>23</sup>. It arose from a study commencing in 1992 in Victoria, Australia (The Victorian Adolescent Health Cohort Study; VAHCS)<sup>24</sup>. A sample of 1,943 mid-secondary school students (1,000 female) was selected via a two-stage random cluster sampling design and assessed six-monthly during adolescence (VAHCS Waves 1-6: mean age 14.9-17.4 years), and three times in young adulthood (VAHCS Waves 7-9: 20.7, 24.1, and 29.1 years). VIHCS began in 2006 during the ninth wave of VAHCS. Between 2006 and 2013 (participant age 29-35 years), encompassing the median maternal age for Australian births<sup>25</sup>, VAHCS participants were screened six-monthly for pregnancies and live births. Participants reporting a pregnancy or recently born child were invited to participate in VIHCS. Those currently pregnant were invited to participate from VIHCS wave 1 (third trimester of pregnancy); those whose child had recently been born were invited to participate from VIHCS wave 2 / 3 (two months and one year postpartum) onwards. This strategy allowed us to maximize the number of births included in the VIHCS cohort for future follow-up.

VAHCS participants' parents or guardians provided informed written consent at recruitment into VAHCS, and participants provided informed verbal consent at every subsequent VAHCS and VIHCS wave. Protocols were approved by the human research ethics committee at the Royal Children's Hospital, Melbourne.

#### *Sampling and ascertainment of pregnancies*

Our analysis sample included 289 women with 388 pregnancies who participated in VIHCS wave 1 (during their third trimester of pregnancy). The flow of VIHCS participants is

## Prediction of periconception alcohol use

presented in supplementary Figure A. Baseline characteristics of those screened, identified as eligible, recruited to VIHCS, and participating in the trimester three assessment broadly matched those of the original adolescent cohort (VAHCS)<sup>23</sup>. Participating women were on average 32 years old when their first child included in VIHCS was born (standard deviation=2; range 29-36). Of the 388 pregnancies, 256 (67%) were first-born (see supplementary Table F).

### **Measures**

#### *Alcohol consumption in adolescence and young adulthood*

In VAHCS, during waves 1-9, alcohol use was assessed using an alcohol diary, in which participants reported on past week consumption. During adolescence (Waves 1-6), participants reported on their alcohol consumption on each day in the seven days prior to the survey. During young adulthood (Waves 7-9), participants reported their alcohol consumption on four of the past seven days (Friday, Saturday, Sunday, and the most recent weekday when drinking occurred). Standard drinks (SDs; 10g alcohol) were calculated for each day.

Measures of *frequent drinking* (having consumed alcohol  $\geq 3$  days in a diary week, at any wave) and *binge drinking* (having drunk  $\geq 4$  SDs on at least one day in the diary week, at any wave) were calculated for adolescence and young adulthood. For supplementary analyses we also calculated measures of adolescent and young adult *heavy binge drinking* (having drunk  $>11$  SDs on any day in the diary week, at any wave); and young adult *alcohol use disorder* (AUD) (DSM-IV diagnosis of alcohol dependence and/or abuse, Composite International

Prediction of periconception alcohol use

Classification of Diseases Interview (CIDI)<sup>26</sup>). See supplementary Table A for more information on the calculation of the alcohol measures.

Measures of *continuity of frequent drinking, binge drinking and heavy binge drinking from adolescence to young adulthood* were defined as none, adolescent only, young adult only, or both adolescent and young adult.

### 2.2.2 Preconception young adult characteristics

We also examined the following young adult preconception characteristics, assessed at the most proximal preconception assessment (VAHCS Wave 9, age 29 years): (1) drinking frequency (never = <monthly or no consumption;  $\geq$ Monthly =  $\geq$ monthly or <3 days/week; and frequent =  $\geq$ 3 days/week); (2) drinking quantity (none = no consumption; low to moderate =  $\geq 0.5$  & <4.0 SDs; and heavy =  $\geq 4.0$  SDs); (3) AUD diagnosis (no/yes); (4) binge drinking ( $\geq 4$  SDs; no/yes); (5) daily smoking (no/yes); (6) weekly personal income (\$1-499; \$500-999; and  $\geq$ \$1000); (7) relationship status (single; boyfriend/girlfriend; and married/De Facto), unplanned pregnancy (no/yes); (8) maternal education (high school only; vocational; and university); (9) primiparity (no/yes); and (10) symptoms of maternal psychiatric disorder (depression or anxiety on the CIDI<sup>26</sup> or the 12-item self-report General Health Questionnaire (GHQ-12)<sup>27</sup>; absent/present).

#### *Periconception and pregnancy alcohol consumption*

Pregnant women completed a computer-assisted telephone interview in trimester three. Drinking prior to pregnancy recognition was measured by asking: *'just before finding out you were pregnant, about how often did you drink alcohol?'* and *'on the days that you drank alcohol, what was the average number of standard drinks that you had in a single*

## Prediction of periconception alcohol use

*day?*'. Continuous responses were re-coded for *frequency* (Never = no consumption;  $\geq$  Monthly =  $\geq$ monthly but  $<3$  days/week; and  $\geq 3$  days/week =  $\geq 3$  days per week); and, *quantity per drinking session* (to none = no consumption; low to moderate =  $\geq 0.5$  &  $<4.0$  SDs; heavy =  $\geq 4.0$  SDs; see supplementary Table A for more information). Participants were also asked about drinking frequency at preconception, post-pregnancy awareness, and trimester three.

### *Demographic factors*

Demographic adjustment factors included: *maternal parents' highest level of education* (less than Year 12; Year 12, certificate or diploma; or tertiary qualification); *maternal parents separated or divorced* (yes or no); and, *maternal country of birth* (Australian-born versus non-Australian-born).

### *Statistical analysis*

Data were analysed using Stata version 15<sup>28</sup>. First, the frequency and quantity of drinking before and during pregnancy were assessed. Multinomial logistic regression analyses were then used to investigate, separately, the prospective association of frequent and binge drinking in adolescence and young adulthood with periconception alcohol use (frequency and quantity). We also conducted sensitivity analyses examining the association of heavy binge drinking and AUD diagnosis with periconception alcohol use (frequency and quantity). All models were run unadjusted and then adjusted for maternal/paternal education, divorce status and maternal country of birth. We further conducted a set of univariable multinomial logistic regression analyses to examine maternal young adult predictors of periconceptional drinking. All regression models employed a robust variance estimate,

## Prediction of periconception alcohol use

adjusting for within-family correlation. Missing data were handled using multiple imputation (MI), specifically Fully Conditional Specification (FCS) with logistic regression for binary variables and multinomial regression for categorical variables. 20 datasets were imputed, reflecting the proportion of covariates with missing data. Descriptive frequency estimates were generated by multiplying MI proportion estimates by known sample sizes. Information on variable-level missingness is provided in supplementary Table G. It is noted that as the statistical analyses were not pre-registered the results should be considered exploratory.

## Results

### *Maternal preconception drinking patterns*

Table 1 shows the frequency and proportion of women reporting binge and frequent drinking in adolescence and young adulthood. Around two thirds (72%) reported binge drinking ( $\geq 4$  drinks in a day) at least once in at least one adolescent or young adult wave while around one third (35%) reported frequent drinking ( $\geq 3$  days a week). Notably, over half ( $n=182$ , 63%) reported binge drinking in young adulthood (35% young adult only; 28% adolescent and young adult), and 32% ( $n=92$ ) reported frequent drinking in young adulthood (26% young adult only; 6% adolescent and young adulthood). Rates of adolescent-limited binge and frequent drinking were low.

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INSERT TABLE 1 HERE

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## Prediction of periconception alcohol use

### *Drinking before and after pregnancy recognition*

Table 2 shows patterns of alcohol consumption from preconception into pregnancy. A total of 71% of women reported drinking at least monthly at wave 9 (age 29 years; the most proximal preconception assessment), and this proportion remained high (76%) early in pregnancy (prior to pregnancy recognition). Almost one in five (16%, 95% CI 13-20%) reported frequent use early in pregnancy, prior to pregnancy recognition, consuming alcohol three or more days per week. A similar proportion (17%, 95% CI 13-21%) reported high quantity drinking during this time, consuming four or more SDs per occasion.

There was a marked decrease in alcohol use following pregnancy recognition; with 11% (95% CI 8-14%) of women drinking at least monthly post-pregnancy recognition (on average 4.6 weeks gestation, standard deviation 1.3; range 1-10 weeks), increasing to 18% (95% CI 14-22%) in trimester three.

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INSERT TABLE 2 HERE

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### *Periconception drinking in women with a history of binge drinking*

Table 3 shows the risk and quantity of alcohol consumption in the periconception period (none,  $\geq 0.5$  &  $< 4.0$  SDs, and  $\geq 4.0$  SDs), stratified by binge drinking history in adolescence and young adulthood. Of those who reported binge drinking in young adulthood (n=237), 20% continued to binge drink in early pregnancy, with 84% reporting at least some periconceptional alcohol consumption. The odds of high quantity periconception drinking

## Prediction of periconception alcohol use

were increased in women with any young adult binge drinking, regardless of whether onset was adolescent or young adult (OR 3.7, 95% CI 1.9-7.4), relative to those with no young adult binge drinking. Risks were highest in women who reported binge drinking in young adulthood only (OR 8.2, 95% CI 3.3-20.4). There was some evidence of adolescent-limited associations (OR 3.8, 95% CI 1.2-12.1). Notably, 85% of the 67 women reporting higher quantity drinking in early pregnancy ( $\geq 4$  drinks per occasion) had also reported a history of preconception binge drinking.

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INSERT TABLE 3 HERE

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### *Periconception drinking in women with a history of frequent drinking*

Table 4 shows the frequency and risk of alcohol consumption in the periconception period, stratified by adolescent and young adult frequent drinking. Of those who were frequent drinkers in their young adult years (n=121), 40% continued to drink frequently ( $\geq 3$  days per week) into early pregnancy, and 92% continued to consume alcohol at least monthly in early pregnancy. Compared to women with no history of frequent drinking, the odds of frequent periconception drinking were increased in women who reported frequent drinking in young adulthood (OR 30.7, 95% CI 12.3-76.7), with effect sizes similar whether young adult-limited or continuing from adolescence. There was negligible evidence of adolescent-limited associations. Notably, 77% of the 64 women who reported frequent periconception

Prediction of periconception alcohol use

drinking ( $\geq 3$  days per week) had a history of frequent drinking in adolescence or young adulthood.

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INSERT TABLE 4 HERE

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*Young adult predictors of alcohol consumption in the periconception period*

Results of the unadjusted regression analyses identified five predictors of frequent periconception drinking (see Figure B and supplementary Table B). Women who were categorised as a higher quantity, binge or frequent drinker, and women having alcohol dependence/abuse in the period prior to pregnancy (wave 9), were more likely to report frequent ( $\geq 3$  weekly) alcohol use early in pregnancy. Women in their first pregnancy were also more likely to report frequent periconception alcohol use. Predictors were similar for higher quantity periconception drinking (see Figure C and supplementary Table C) and included women who were categorised in young adulthood as a higher quantity, binge or frequent drinker, women in their first pregnancy and daily smokers.

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INSERT FIGURES B AND C HERE

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*Sensitivity analyses: Periconception drinking in women with histories of heavy binge drinking and alcohol use disorder*

## Prediction of periconception alcohol use

We conducted a series of sensitivity analyses to examine risk for periconception drinking associated with more problematic patterns of alcohol use in adolescence and/or young adulthood. Supplementary Tables D and E present analyses for women with heavy binge drinking ( $\geq 11$  drinks in a day) and AUD (dependence and/or abuse) before pregnancy. Young adult AUD was associated with an increase in the odds of frequent and high quantity periconception drinking (ORs ranging from 2.3-6.5). Similarly, heavy binge drinking in young adulthood (whether adult-onset or continuing from adolescence), was associated with an increase in the odds of frequent and higher dose periconception drinking (ORs ranging from 0.6-5.0). There was no evidence of an association between adolescent-limited heavy binge drinking and periconception drinking.

## Discussion

Over the past 50 years alcohol use in women across the childbearing years has increased in many high-income countries<sup>1,2</sup>. In this longitudinal sample of Australian women, alcohol consumption prior to pregnancy was very common. Over a third of women drank alcohol frequently across the preconception young adult years, and two thirds had a history of binge drinking at some point across adolescence and young adulthood. Around three quarters of women used alcohol in early pregnancy, before pregnancy awareness. In contrast, only a little over one in ten continued to use alcohol after pregnancy recognition at around six weeks gestation and mostly at very low levels. Levels of frequent drinking (16%) were similar in early pregnancy to those found at the last point of data collection before pregnancy, and levels of binge drinking (17%) only minimally lower. Moreover, of those who drank

## Prediction of periconception alcohol use

frequently or at heavier doses in early pregnancy, around three quarters had a history of frequent or binge drinking across their young adult years, prior to pregnancy. Frequent and heavy use of alcohol had become the norm for this cohort of young women prior to pregnancy, with more than half of frequent drinkers and almost a third of binge drinkers continuing to drink in early pregnancy. Importantly, frequent and high-dose drinking in young women during the preconception years of adolescence and young adulthood substantially increased the odds of alcohol use in the periconception phase of pregnancy. Indeed, the clearest proximal predictor of frequent drinking in early pregnancy was a mother's prior pattern of risky drinking (i.e., frequent/binge/heavy drinking, AUD). Together, these findings underscore a need for a stronger focus on reducing risky drinking in young adulthood, extending back to adolescence, when alcohol use is typically first initiated<sup>29</sup>.

The risk for periconception drinking was further increased when a pregnancy was unplanned<sup>14</sup>. The rates of unplanned (either unintended or mistimed pregnancies) are high in many high-income countries. In the U.S. alone, it has been estimated that approximately half of all pregnancies are unplanned (i.e., mistimed or unwanted)<sup>30</sup>. Unintended pregnancies have been previously linked with a late recognition of pregnancy further heightening the likelihood of continued drinking<sup>31</sup>. Such findings suggest that effective provision of contraception, including the provision of long acting reversible contraception is likely to be an important element in reducing the likelihood of periconceptional alcohol consumption.

Once women became aware of their pregnancy, rates of drinking dropped markedly in this cohort: from 76% to 12% (11% of whom drank monthly or less). These results are consistent with literature in Australia and internationally<sup>14,15</sup>. Prior research has shown that

## Prediction of periconception alcohol use

health-related behaviour change is considerable following pregnancy awareness, including reductions in alcohol consumption<sup>32</sup>. This is a period of transition when women are more likely to make lifestyle changes to ensure the healthy growth of their developing fetus<sup>7</sup>. Our results reinforce the importance of early pregnancy diagnosis and the salience of public health messaging at this time to further promote and maintain reductions in women's drinking throughout pregnancy.

Heavier drinking patterns, consistent with those reported by women of childbearing age who are not pregnant<sup>33</sup>, are also associated with unplanned pregnancy<sup>34</sup>, suggesting continuity of earlier, more harmful preconception drinking patterns, into the periconception period. In our study, women with a history of heavy binge drinking or AUD in young adulthood had odds of periconception drinking markedly higher (odds ratios ranged from 5.0-6.5) than women with no history of these drinking patterns. Health professional and education messages are thus especially important among heavier drinkers, including the safe use of contraception and early pregnancy diagnosis.

### *Limitations*

Whilst attrition was very low in VAHCS given the 20-year timeframe of the study (14%) and the VIHCS sample remained similar to the original VAHCS cohort on measured demographic and substance use factors at baseline in adolescence<sup>23</sup>, samples may differ on unmeasured characteristics. We also note that women who did not participate in VIHCS wave 1 (and were therefore not included in this analysis) had slightly lower rates of preconception drinking, tertiary education, and parity, than included women, though characteristics of the analysis sample were overall similar to those of the full VIHCS cohort. Although we used

## Prediction of periconception alcohol use

multiple imputation to reduce potential biases within the achieved sample, it cannot be guaranteed to fully eliminate potential biases arising due to differential attrition. As such, some residual bias remains possible.

Data on alcohol use in pregnancy were obtained via self-report, which may be influenced by (recent) recall bias. Yet reports of maternal alcohol use obtained during pregnancy are more valid than retrospective reports obtained after pregnancy<sup>35</sup>. Self-reported alcohol consumption may also be under-estimated due to stigma associated with pregnancy drinking. Yet prior studies show high concordance of birth records<sup>36</sup> and (random) biological samples<sup>37</sup> with maternal self-report data on substance use in pregnancy, suggesting that under-reporting due to stigma is likely to be minimal.

We also note that women becoming pregnant at a mean age 32 years may have lower rates of alcohol consumption than women who are pregnant at younger or older ages<sup>38</sup>. Whilst this may affect the strength and generalisability of the results, alcohol use was highly prevalent in the cohort, and strong associations were identified, suggesting that our findings are robust. Future research is nonetheless warranted in women of younger and older ages.

Finally, the results of the current study may be limited in their generalisability beyond the Australian context. Yet research on the prevalence and patterns of drinking in other cultures suggests that our results are likely to have international relevance. Estimates of the prevalence of alcohol use in pregnant women in the UK, New Zealand, and a number of European countries are similar (or higher) than Australia<sup>9,10</sup>. U.S. estimates, whilst somewhat

## Prediction of periconception alcohol use

lower<sup>39</sup>, show similar trend increases in alcohol use among women into the childbearing years<sup>5</sup>; as well as in the high rates of estimated drinking prior to pregnancy awareness<sup>40</sup>.

## Conclusions

Continuation of maternal alcohol use into the first six weeks of pregnancy, prior to pregnancy awareness, is common. Women with patterns of binge and frequent drinking established well before pregnancy, in the adolescent and young adult years, were most likely to report risky levels of periconceptional drinking (i.e., binge and frequent drinking). Multifaceted public health initiatives focussed on the years before pregnancy are thus needed to prevent alcohol use in the early periconception phase of pregnancy. This could be implemented through greater emphasis on alcohol use in preconception health care and family planning. Importantly, there is a pressing need to reverse recent trends to riskier alcohol consumption in young women, particularly frequent drinking, which carries the greatest risks for continued drinking into the periconception period. A greater emphasis on alcohol use in early preconception health care is warranted but action should also extend to tackling the social norms and industry drivers that underpin the recent shifts in young women's alcohol use.

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Prediction of periconception alcohol use

**Contributors' Statement:** Delyse Hutchinson and Liz Spry had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

*Concept and design.* Delyse, Hutchinson, Elizabeth Spry, George Patton, Craig Olsson.

*Acquisition, analysis, or interpretation of data.* All authors.

*Drafting of the manuscript.* All authors.

*Critical revision of the manuscript for important intellectual content.* All authors.

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*Supervision.* Elizabeth Spry, Delyse Hutchinson, George Patton, Craig Olsson.

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## Prediction of periconception alcohol use

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### Periconception frequency of alcohol use

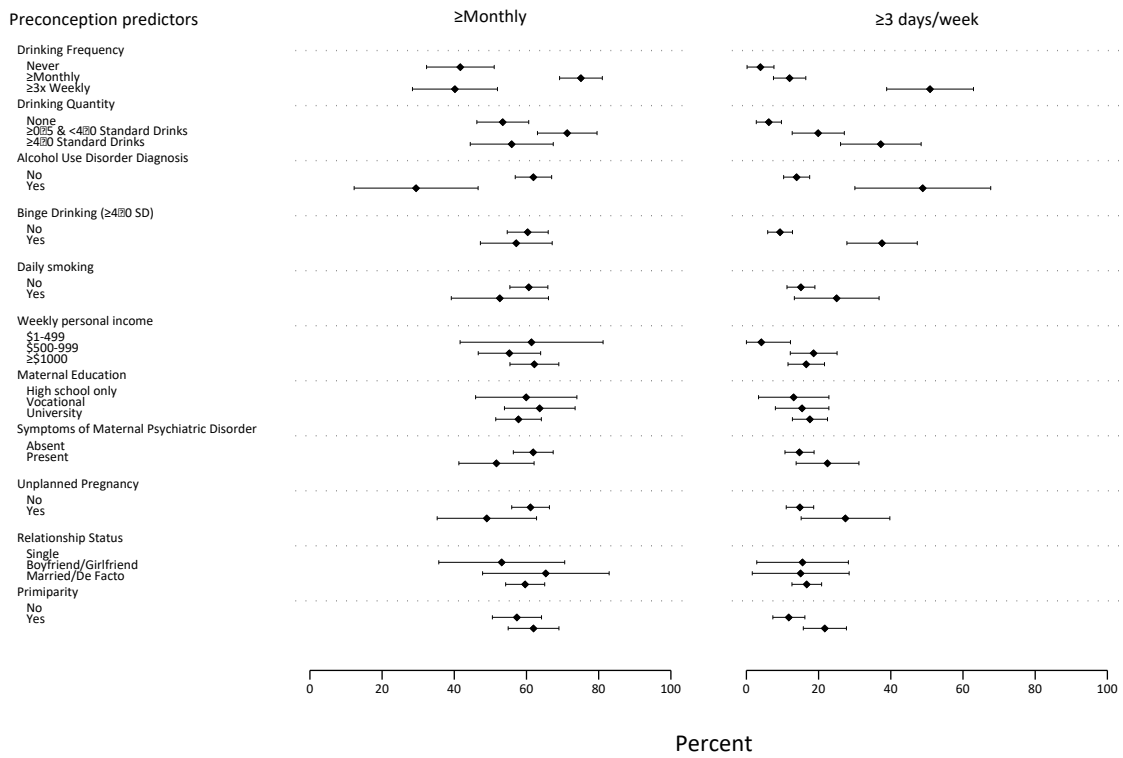


Figure B. Forest plot of estimated prevalence of periconception drinking frequency by preconception predictors (N=388).

### Periconception quantity of alcohol use

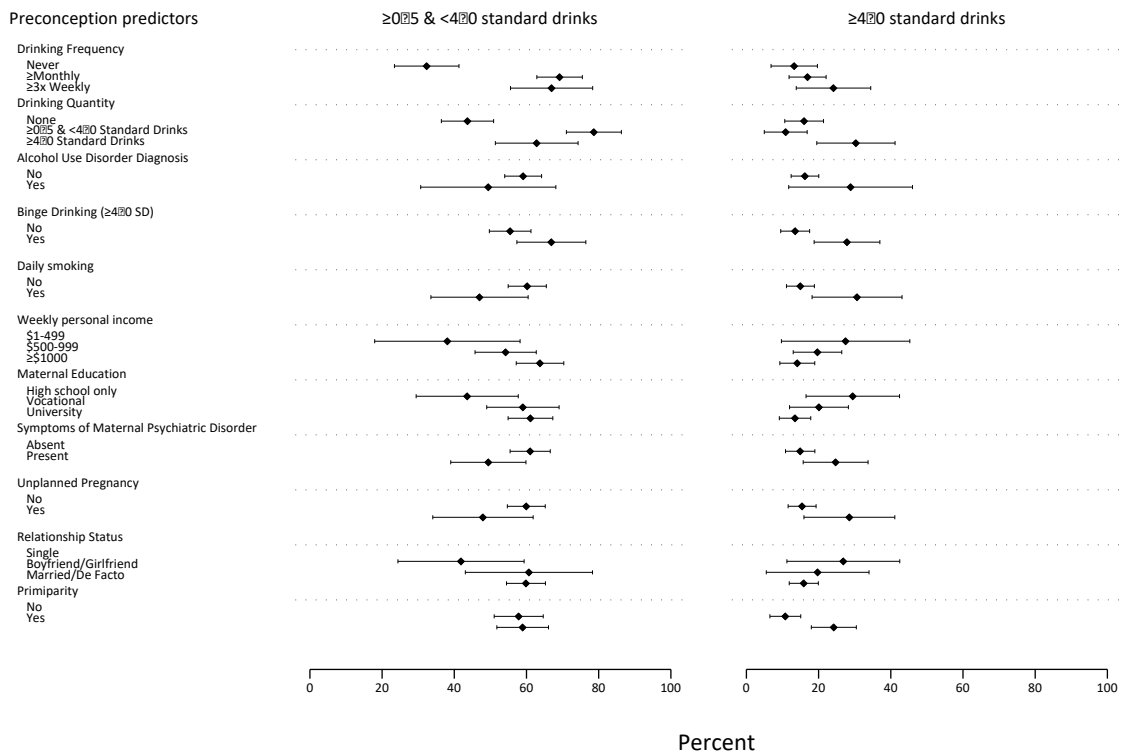


Figure C. Forest plot of estimated prevalence of periconception drinking quantity by preconception predictors (N=388).