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# Trajectories and predictors of alcohol consumption over 21 years of mothers' reproductive life course

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## ABSTRACT

Introduction: Little is known about the patterns of women's alcohol consumption over their reproductive life course. This study identifies trajectories of alcohol consumption by mothers over 21 years of their reproductive life course and examines baseline predictors of these trajectories.

Methods: Data were obtained from a prospective cohort study of 3715 women in Brisbane, Queensland, Australia over 21 years of follow-up. Women's alcohol consumption was measured by frequency and quantity of use across the surveys. Potential predictors and confounding variables were assessed at baseline. Group based-trajectory modelling was used to identify typical drinking trajectories over the maternal reproductive life course. Multinomial logistic regression was employed to examine predictors associated with these trajectories.

Results: Four trajectories of alcohol consumption were indentified for mothers over the 21-year period. These trajectories included abstainers (11.9%), low-stable drinkers (58.0%), moderate-escalating drinkers (25.3%), and heavy-escalating drinkers (4.8%). After adjustment for significant covariates, membership of the abstaining trajectory was predicted by lower family income, being married, and high frequency of church attendance while membership of the heavier-escalating trajectory was associated with women who were not currently married, never went church and had unhealthy lifestyle behaviours.

Conclusions: Patterns of women's alcohol consumption exhibit a high level of stability for abstainers and women who drink at low levels. After the birth of their child, there are some changes in alcohol consumption for the moderate and heavy-escalating alcohol consumption groups. Low risk patterns of consumption are associated with variables which generally reflected a low risk behaviour lifestyle. Intervention programmes should particularly target women engaging in the heavy-escalating alcohol consumption group as this group increase their consumption shortly after the birth of their child. There is a need to understand more about the social and health consequences to mothers and their children of being in the moderate and heavy-escalating drinking trajectory groups.

## 1. Introduction

The pattern of maternal alcohol consumption over the reproductive life course is greatly understudied. Research involving women's use of alcohol has tended to focus on short periods of their lives, generally during pregnancy (Anderson et al., 2013; Maloney et al., 2011; Liu, Mumford & Petras, 2014) or old age (Brennan et al., 2011; Molander, Yonker & Krahn, 2010), with little interest in the maternal reproductive life course. The reproductive life course stage for women involves a period of relatively good health but with numerous competing commitments. Childrearing may be the central activity during this period but the formation and maintenance of a dyadic partnership, the initiation and development of a career, the maintenance and enhancement of social networks, and major transitions involving the death of parents, marital breakdown, and the growing independence of children are all characteristic exposures during the reproductive life course (Mishra, Cooper & Kuh, 2010; Evans, 1985; Neve, Lemmens & Drop, 2000). There is a need to know more about how women transition through this life stage.

### 1.1. The changes of women's alcohol consumption

Much of what is known about alcohol consumption over a mothers' reproductive life is derived from cross-sectional studies

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involving comparisons of alcohol consumption by different age groups (Geels et al., 2013; Wilsnack, 2012). The evidence shows that high levels of drinking are common in younger women, and that alcohol consumption levels decline in middle and old age (Wilsnack, 2012; Roche & Deehan, 2002; Australian Institute of Health and Welfare, 2010). Some longitudinal studies examining alcohol consumption by women have identified multiple drinking trajectories, including patterns of stable consumption, increasing consumption, decreasing consumption, and a curvilinear pattern (Brennan et al., 2011; Platt, Sloan & Costanzo, 2010; Powers & Young, 2008; Gee et al., 2007; Cook et al., 2013). This line of studies has contributed important information about the multiple trajectories of alcohol consumption by women as they progress through their life stages. Longitudinal studies have focused on either middle-aged or older women (Brennan et al., 2011; Platt et al., 2010; Powers & Young, 2008) or non-population-based samples (Cook et al., 2013). Relatively few have examined the development trajectory of maternal alcohol consumption over women's reproductive life course.

### 1.2. Characteristics associated with the changes of women's alcohol consumption

Previous studies have suggested that changes in alcohol consumption by reproductive aged women are associated with family-related characteristics such as income, marital status, the number of children, religiosity, and childrearing/parenthood (Ahlström, Bloomfield & Knibbe, 2001; Kuntsche, Knibbe & Gmel, 2012; Paradis, 2011; Bachman et al., 2013). According to these studies, being married, having child/children, and taking parental responsibility limit the opportunities that women may have for recreational drinking or becoming heavy drinkers. However, there are some gaps in knowledge which this paper aims to address. For example, there is little explicit information about alcohol consumption over the whole period of childrearing. Much of the literature has focused on the foetal outcomes of alcohol consumption in pregnancy. Few if any look at the whole period the child is reared. Some studies suggest that women with fewer children are more likely to be abstainers (Neve et al., 1996; Hotham et al., 2008; Tamaki et al., 2008). There is also the suggestion that having and rearing more children may be stressful and lead to higher levels of what is sometimes described as self-medication with alcohol (Tran, Najman & Hayatbakhsh, 2014; Perkin et al., 1993; Alati et al., 2005).

We use prospectively collected data involving a sample of reproductive aged-women in Brisbane, Queensland, Australia with 21 years of follow-up to (i) identify typical trajectories of alcohol consumption exhibited by mothers over their reproductive life course; and (ii) document the predictors of these trajectories.

## 2. Materials and methods

### 2.1. Data source

Data were taken from the Mater-University of Queensland Study of Pregnancy (MUSP), a prospective pre-birth cohort study of 6753 women who gave birth to a live singleton baby at one of the two major public obstetric hospitals in Brisbane between 1981 and 1984. Details of the study have been described elsewhere (Najman et al., 2014). Women, who participated in the study at their first prenatal visit (Time 1), approximately 18 weeks' gestation with standard deviation (*S.D.*)=5.83, were asked about their alcohol consumption, social demographic characteristics, life style behaviours, and other health related information. These mothers were followed-up at 6 months (Time 2), and then at 5 (Time 3), 14 (Time 4), and 21 years (Time 5) after the birth of their baby. Ethics committees from the
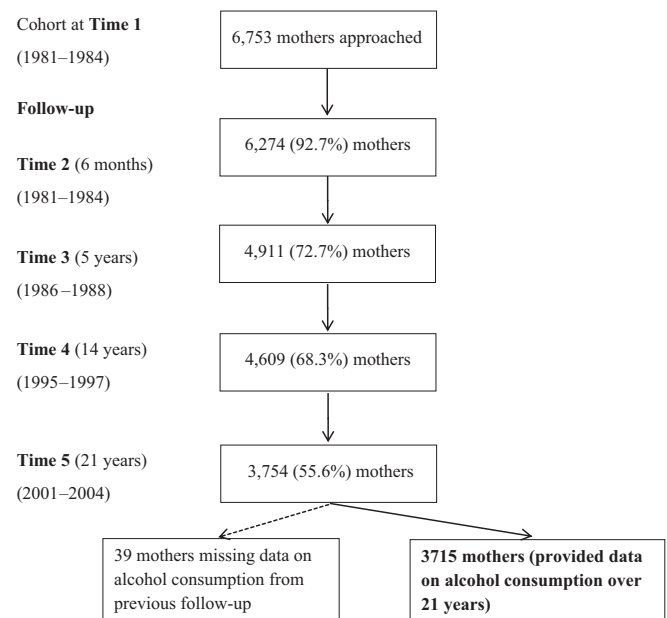


**Fig. 1.** Flow chart – sampling frame and retention rate.

Mater Hospital and The University of Queensland approved each phase of the study.

Of the 3754 mothers at Time 5 (21 years), 2976 had provided complete alcohol consumption data over five time points; and 739 had provided alcohol consumption data for four of the five time points. We conducted a series of sensitivity analyses which compared the results from the sample of 2976 mothers with the results from the sample of 3715 mothers. The analyses produced similar results for the two samples suggesting there was no difference between them. This study is based on the sample of 3715 women from all consecutive women giving birth in a public hospital over a three-year period (between 1981 and 1984) who were followed up over 21 years. Fig. 1 provides details and a flow-chart of the retention rate of the sample. Mean age of mothers at recruitment time was 25.5 (*S.D.*=5.03). Of the women in this sample, about 64.0% had completed high school while 20.0% were in tertiary education, and 16% had not finished high school. Some 80.0% of women were married and about 30.0% of women were living in a family at or below poverty ($10,399 or less per year at the time of recruitment). At baseline, about 4.7% of women met the criteria for depression and 11.0% of women were found to meet the criteria for anxiety. About 88.0% of mothers had healthy lifestyle behaviours; 2.0% of women met the criteria for a high level of adversity at their first clinic visit.

### 2.2. Measures

#### 2.2.1. Alcohol consumption

In this study, a frequency and quantity question to measure the mothers' alcohol consumption was repeated across five time points. Alcohol consumption at Time 1 (pre-pregnancy) was retrospectively assessed at the first prenatal visit; while post-birth, consumption at Time 2 (6 months), Time 3 (5 years), Time 4 (14 years), and Time 5 (21 years) was assessed from the mother's self-report. At each survey, the women were asked how often they drank alcohol[1] and how much alcohol they consumed on each

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[1] Alcohol questions all asked about current usual consumption with the exception of the baseline questionnaire which asked about usual consumption prior to pregnancy.

occasion. Six pre-specified response options, ranging from never to daily alcohol consumption and from none to seven or more standard drinks, were provided. Guidelines from the Australia National Health and Medical Research Council in 2009 (NHMR, 2009) suggest that women's alcohol consumption should be calculated on the basis of weekly alcohol consumption of a standard drink (containing 10 g of pure alcohol). In the present study, alcohol consumption scores were estimated using a method described by Dawson (Dawson, 2003): multiplying the mid-point estimation of frequency by the mid-point of quantity. For consistency with other studies (Powers & Young, 2008; French et al., 2014), respondents' levels of alcohol consumption were categorised as non-drinkers (never drink), occasional drinkers ( < 1 drink per week), moderate drinkers (from 1 to 14 drinks per week), and heavy drinkers ( > 14 drinks per week).

### 2.2.2.  Measure of predicting variables
*2.2.2.1. Socio-economic characteristics and church attendance.* Socio-economic characteristics were assessed by marital status and family income. Respondents reported one of four categories for their marital status: single, married, living together, or separated/divorced/windowed. However, we collapsed marital status into three categories: single, living together/separated/divorced/ widowed, and married (reference group). This grouping was due to the small proportion of separated/divorced/windowed women (2.2%) and the different socio-economic characteristics between those who reported living together and those who were married (Khoo, 1987). Family income was measured as low, $10,399 or less; and medium-high, $10,400 or more (reference group). The threshold of $10,399 or less is estimated to be at around the poverty level in the period 1981–1983 (Najman et al., 2004). Church attendance was measured as weekly/monthly (reference group), less than once a month, and never.

*2.2.2.2. Stressful life events/adversity.*  In this study, the measure of a women's stressful life events was derived from a modification of the social readjustment rating scale of Holmes and Rahe (1967). Stressful life events were measured at the baseline by a series of items referring to events that women and their partners may have experienced within the past six months: major job changes, problems with police, housing problems, financial problems, health problems, loss of relatives, serious troubles at work, serious disagreement with partners, and marital breakdown. Adversity was classified on the basis of average scores: low adversity (0–2 events) and high adversity (3+ events); the reference group was low adversity.

*2.2.2.3. Health related lifestyle.* Health related lifestyle was measured using questions adapted from Breslow's lifestyle index (Belloc, Breslow & Hochstim, 1971) which has been validated and widely used in previous studies (Haruyama et al., 2012; Noguchi et al., 2015; Breslow & Enstrom, 1980). These questions and possible responses were scored as follow: (1) how many hours sleep did you usually get a night? (6 h or less and 7 h=1; 8 h and 9 h or more=0); (2) how often did you eat breakfast and (3) how often did you eat in between your regular meals? (rarely or never=1, sometimes and almost every day=0); (4) how often were you involved in any physical activities including active sport, swimming/taking long walks, week-end trips in car, gardening, and physical exercise? (often and sometime=0, and never=1); (5) how many hours a day did you watch television (never, less than 1 h, 1–3 h, 3–5 h=0; 5–7 h and more than 7 h=1); (6) how many times a week did you smoke cigarettes (not at all=0; once, every few days, and every day=1); and (7) maintenance of proper weight, body mass index (BMI). BMI (kg/m$^2$) between 18.5 and less than 25 was scored 0, and BMI less than 18.5 or 25 or more was

coded as 1 (World Health Organisation, 2000; Doherty et al., 2006). The Breslow's lifestyle index scores were added to generate a composite variable of healthy lifestyle ranging from 0 to 7. These scores were categorised into three groups: good (0–2), the reference group; average (3); and poor (4+).

*2.2.2.4. Mental health problems.* Women's mental health at baseline was assessed using the short form of the self-reported Delusions-Symptoms-States Inventory (DSSI) (Bedford & Foulds, 1978). Seven symptoms were used to evaluate maternal depression (Cronbach's $\alpha=0.787$) and anxiety (Cronbach's $\alpha=0.763$). For the purpose of this study, women were classified as depressed or anxious if they reported four or more of seven symptoms related to depression or anxiety, respectively. This approximates the clinical cut-off implied by Bedford and Foulds (1978).

*2.2.2.5. Birth outcomes.* We included three variables representing birth outcomes. Birth outcome information was obtained by obstetricians who both worked at the hospital and were study investigators. Birth weight was categorised as normal (2500 g or more), the reference; and low birth weight (2499 g or less). Gestation was dichotomised, into normal as the reference group (37 weeks or more) and preterm (36 weeks or less). Time to establish respiration was categorised as less than 3 min (reference group) and 3 min or more.

### 2.2.3.  Covariates
Maternal age, education level, and parity are covariates that may modify patterns of maternal alcohol consumption as well as the association between alcohol consumption trajectories and potential predictors. In our study, mothers were asked their date of birth at Time 1. Age was scored to the nearest year. Mother's education was self-reported at recruitment and reflected the highest level of education attained. These levels were classified as: incomplete high school, completed high school only, and completed post high school education (college/university and other technical and further education training, TAFE). Parity was measured on the basis of number of live-born children women reported at their obstetrical visit at Time 1 and subsequent births reported at each follow-up.

### 2.3.  Data analysis

The analysis was carried out in four stages using STATA/SE 13.0. The first stage involved identifying distinct groups of individuals with a similar pattern of alcohol consumption over time. Group-based trajectory modelling developed by Nagin (Nagin, 2005) was employed in this stage. The overview and technical application of group-based trajectory models have been described elsewhere (Nagin & Odgers, 2010). Briefly, group-based trajectory models are the application of specialised finite-mixture models which assume that a population is composed of a mixture of distinct groups, defined by their developmental trajectories. In this study, we employed the censored normal model (Jones & Nagin, 2013) to estimate the developmental trajectories of alcohol consumption over the mothers' reproductive life course. To reduce the effects of the skewed distribution of alcohol consumption score, square root transformation was applied to alcohol data, consistent with other studies (Bobo et al., 2013). We first used the unadjusted model to identify the optimal number of trajectory groups. The best fitting model was selected using the criteria of Bayesian Information Criterion (BIC) and the requirement of minimum mean posterior probability of group (0.70 or greater in all groups). These criteria were also considered together with previous knowledge on women's alcohol consumption (Xie, Drake & McHugo, 2006). Then, as suggested by previous studies (Jones & Nagin, 2007, 2012),

maternal age at Time 1 and parity were added to the model. We included maternal age at Time 1 as a fixed covariate in the adjusted model since age is synchronous with the time variable in our data. However, parity at each time point was added as a time-varying covariate in the adjusted model. The BICs of unadjusted and adjusted models were compared to select the best fit model for further analyses.

At the second stage, we assessed collinearity to examine the correlations among predicting variables. The variance inflation factor (VIF) ranging from 1.01 to 1.46 indicated that no collinearity was involved. All predicting variables are included in further analyses.

To identify the independent impact of each predicting variable on trajectories of maternal alcohol consumption over the life course, multivariate multinomial logistic regression was used in the third stage of the analyses. We first examined the bivariate associations between drinking trajectories and baseline predictors. Then, predictors that were statistically significant in bivariate analyses were retained for the multivariate model where we controlled other significant predictors and age and educational levels as covariates. A $p$-value of $< 0.05$ was adopted as a significance threshold for all analyses.

Of the cohort of 6753 women recruited at pre-pregnancy, the retention rate at the 21 year follow-up was 55.0%. To assess how attrition may affect our results, we used a multivariate logistic regression model with baseline predictors to predict those who were lost to follow-up. Assuming their data is missing at random (Sterne et al., 2009), we used multiple imputation produced by STATA to impute missing data from predicting variables, covariates, and outcomes. Initially, we used 20 cycles of imputation for the analyses of imputed data. Subsequently, sensitivity analysis was employed by repeating the whole process using 50 cycles of imputation.

## 3. Results

### 3.1. Women's trajectories of alcohol consumption

Results from the unadjusted model suggested that, like previous studies, we could identify from two to four possible maternal alcohol-consumption trajectory groups. BIC was improved (moves closer to 0) as the number of groups increased in the model ($BIC_2 = -25,349.87$ and $BIC_3 = -24,750.79$). The BIC for the four-group model ($BIC_4 = -24,350.75$) was closest to 0 suggesting that the four-group model fitted our sample best. The posterior probabilities for the four-group model which ranged from 0.77 to 0.90 also suggested a good fit. The distribution of membership in each group is presented in Table 1.

Adjusting maternal age at pre-pregnancy as a fixed covariate and parity as a time-varying covariate further improved the model fit ($BIC = -22,490.34$; posterior probabilities range from 0.86 to 0.90). The adjustment slightly changed membership numbers in each group (more details in Table 1). The fitted model showed distinct alcohol consumption trajectories. We selected the four-group model with two covariates as our final model for further analyses.

Fig. 2 presents the four-group trajectories of maternal alcohol consumption over 21 years. The bottom line was labelled the 'abstainers group', which included women who reported no alcohol consumption or drank minimally on each occasion over the five intervals. This group was estimated to comprise 11.9% of the sample with mean posterior probability=0.86. The lower middle line was named the 'low-stable group', consisting of 58.0% of the sample, with average posterior probability of membership=0.90. Women in this trajectory group consumed very low levels of alcohol across all phases of the study. The average alcohol

**Table 1**

Characteristics of four-group drinking trajectories in unadjusted and adjusted model.

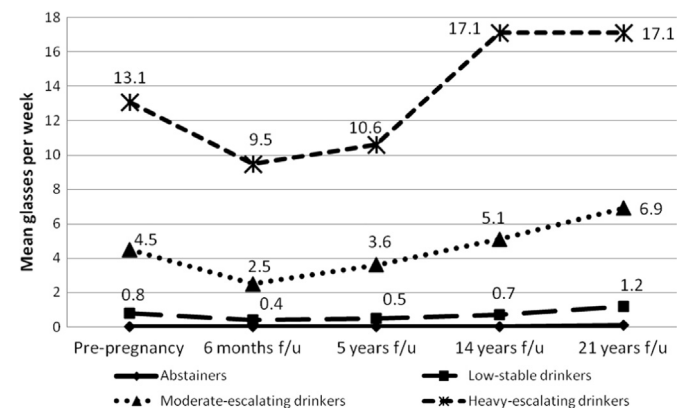| Parameters | Four-group model of maternal alcohol consumption trajectory | |
| --- | --- | --- |
| | *Unadjusted model* | *Adjusted model* |
| **Frequency – *N* (%)** | | |
| Group 1 | 472 (12.7%) | 441 (11.9%) |
| Group 2 | 2159 (58.1%) | 2155 (58.0%) |
| Group 3 | 936 (25.2%) | 940 (25.3%) |
| Group 4 | 148 (4.0%) | 179 (4.8%) |
| **BIC** | BIC= −24,350.75 | BIC= −22,490.34 |
| **Mean posterior probability** | | |
| Group 1 | 0.86 | 0.86 |
| Group 2 | 0.90 | 0.90 |
| Group 3 | 0.82 | 0.86 |
| Group 4 | 0.77 | 0.89 |



**Fig. 2.** Mean maternal alcohol consumption per week of each drinking trajectory over time points.

consumption of the low-stable group ranged from 0.4 to 1.2 glasses per week. The upper middle line was called the 'moderate-escalating group', comprising 25.3% of the sample, mean posterior probability=0.86. Women in this trajectory group consumed about 4.5 standard drinks per week at pre-pregnancy. They reduced their consumption to 2.5 glasses per week when they were pregnant; then slowly increased their consumption but still at a low-moderate level of alcohol consumption at 5 and 14 years after the birth of their baby. At 21 years, their weekly average alcohol consumption was the equivalent of 6.9 glasses per week. The top line in Fig. 2 was named the 'heavy-escalating group' comprising about 4.8% of the sample, the mean posterior probability=0.89. This group included only a small proportion of the sample, however, the pattern of alcohol consumption among this group changed very much over time. Women in this group were those who consumed an average of almost two glasses a day (13.1 standard glasses per week) at pre-pregnancy. They reduced their consumption to 9.5 glasses a week during pregnancy; then had slightly increased alcohol consumption at the five-year follow-up. From Year 5 to Year 14, these women sharply escalated their alcohol consumption from a moderate level (10.6 at Year 5) to a heavy level (17.1 at Year 14). From Year 14 to Year 21, the mean level of alcohol consumption among the heavy-escalating group did not change.

### 3.2. Predictors of membership in different trajectories of alcohol consumption

Baseline predictors of trajectories of maternal alcohol consumption over the 21 year period were examined using bivariate

**Table 2**
Bivariate multinomial logistic regression between alcohol consumption trajectories and baseline predicting variables.

| Predicting variables[a] | N (%) | Trajectories of alcohol consumption up to 21 years follow-up surveys | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Low-stable drinkers[b] | Abstainers | | Moderate-escalating drinkers | | Heavy-escalating drinkers | |
| | | Ref. (%) | %[c] | OR (95% CI) | % | OR (95% CI) | % | OR (95% CI) |
| **Family income** | | | | | | | | |
| $10, 400 or more | 2468 (69.9) | 58.0 | 10.5 | 1.0 | 26.6 | 1.0 | 4.9 | 1.0 |
| $10, 390 or less | 1064 (30.1) | 58.5 | 14.8 | 1.4 (1.1–1.7) | 21.9 | 0.8 (0.7–0.9) | 4.8 | 1.0 (0.7–1.4) |
| **Marital status** | | | | | | | | |
| Married | 2950 (79.9) | 58.5 | 13.2 | 1.0 | 23.8 | 1.0 | 4.4 | 1.0 |
| Single | 309 (8.4) | 56.3 | 5.8 | 0.4 (0.3–0.7) | 33.0 | 1.4 (1.1–1.9) | 4.8 | 1.1 (0.6–2.0) |
| Ling together/Sep/Div/Wid | 431 (11.7) | 56.4 | 6.3 | 0.5 (0.3–0.7) | 29.7 | 1.3 (1.0–1.6) | 7.6 | 1.8 (1.2–2.7) |
| **Church attendance** | | | | | | | | |
| Weekly/Monthly | 710 (19.3) | 53.0 | 28.0 | 1.0 | 16.6 | 1.0 | 2.4 | 1.0 |
| Less than once a month | 765 (20.8) | 62.6 | 7.8 | 0.2 (0.2–0.3) | 25.9 | 1.3 (1.0–1.7) | 3.4 | 1.3 (0.7 –2.4) |
| Never | 2209 (59.9) | 57.9 | 8.1 | 0.3 (0.2–0.3) | 27.9 | 1.5 (1.2–1.9) | 6.0 | 2.3 (1.4–3.8) |
| **Maternal depression** | | | | | | | | |
| Non-depressed | 3474 (95.3) | 58.1 | 11.7 | 1.0 | 25.3 | 1.0 | 4.9 | 1.0 |
| Depressed | 172 (4.7) | 28.1 | 12.8 | 1.1 (0.7–1.7) | 25.6 | 1.0 (0.7–1.4) | 3.5 | 0.7 (0.3–1.6) |
| **Maternal anxiety** | | | | | | | | |
| Non-anxious | 3259 (89.3) | 58.3 | 11.6 | 1.0 | 25.2 | 1.0 | 4.9 | 1.0 |
| Anxious | 392 (10.7) | 56.2 | 13.5 | 1.2 (0.9–1.7) | 25.8 | 1.0 (0.8–1.3) | 4.6 | 1.0 (0.6–1.6) |
| **Healthy lifestyle behaviour** | | | | | | | | |
| Good (0–2) | 2421 (70.2) | 58.2 | 12.6 | 1.0 | 25.1 | 1.0 | 4.1 | 1.0 |
| Moderate (3) | 660 (19.1) | 57.6 | 9.8 | 0.8 (0.6–1.1) | 26.8 | 1.1 (0.9–1.3) | 5.8 | 1.4 (0.9–2.1) |
| Bad (4+) | 370 (10.7) | 59.4 | 7.3 | 0.6 (0.4–0.9) | 25.7 | 1.0 (0.8–1.3) | 8.6 | 2.1 (1.4–3.2) |
| **Maternal adversity** | | | | | | | | |
| Low (0–2) | 2659 (77.7) | 58.4 | 11.8 | 1.0 | 25.2 | 1.0 | 4.5 | 1.0 |
| High (3+) | 761 (22.3) | 57.6 | 11.8 | 1.0 (0.8–1.3) | 25.2 | 1.0 (0.8–1.2) | 5.4 | 1.2 (0.8–1.7) |
| **Child's birth weight** | | | | | | | | |
| Normal (2500 g or more) | 3543 (95.4) | 58.1 | 11.9 | 1.0 | 58.1 | 1.0 | 4.7 | 1.0 |
| Low birth weight (2499 or less) | 171 (4.6) | 56.1 | 11.1 | 7.0 (0.6–1.6) | 56.1 | 1.0 (0.7–1.4) | 8.2 | 1.8 (1.0–3.2) |
| **Child's gestation** | | | | | | | | |
| Normal (37 weeks or more) | 3557 (95.7) | 58.2 | 11.9 | 1.0 | 25.2 | 1.0 | 4.7 | 1.0 |
| Premature (36 weeks or less) | 158 (4.3) | 54.4 | 10.8 | 1.0 (0.6–1.6) | 27.2 | 1.1 (0.8–1.7) | 7.6 | 1.7 (0.9–3.2) |
| **Child's respiration time** | | | | | | | | |
| Less than 3 min | 3442 (96.4) | 57.7 | 12.0 | 1.0 | 25.5 | 1.0 | 4.7 | 1.0 |
| 3 min or more | 127 (3.6) | 60.6 | 8.7 | 0.7 (0.4–1.3) | 23.6 | 0.9 (0.6–1.3) | 7.1 | 1.4 (0.7–2.9) |

[a] Assessed at baseline survey unless otherwise indicated.
[b] Reference group.
[c] The percentage with trajectory of alcohol consumption within each category.

and multivariate multinomial logistic regression analyses, with the low-stable trajectory group as the reference category. As shown in Table 2, the bivariate association between each predictor and maternal alcohol consumption trajectories is presented. Membership of the abstaining trajectory was predicted by mothers who were married, had a low family income, had a healthy lifestyle, and who went to church more often. Membership of the moderate-escalating trajectory group was predicted by those who had higher income, were unmarried, and who less often or never went to church. Women who were unmarried, had an unhealthy lifestyle, reported never going to church, and had a low birth-weight child were significantly more likely to be members of the heavy-escalating alcohol consumption group.

Table 3 presents multivariate multinomial logistic regression analyses, controlling for the influence of other significant predictors in bivariate analyses and covariates. Adjustment did not significantly change the magnitude of associations between predicting variables and membership of the moderate-escalating group. However, after adjustment, healthy lifestyle behaviour and low birth weight of their child were no longer significantly associated with membership of the abstainer and heavy-escalating

groups, respectively. Other predicting variables which were statistically significant in bivariate associations for abstainers and the heavy-escalating group remained independently significant.

Table 4 presents the results following the attrition analyses. Results from the multivariate logistic regression model showed that mothers who were lost to follow-up were more likely to be young, had a lower educational level, lower family income, were more often unmarried, had higher rates of anxiety, and reported unhealthy lifestyle behaviours more often. Multiple imputation analyses indicated that there were no substantive differences in the analyses of completed cases ($n=3715$) and multiple imputed cases ($n=6735$), suggesting that our findings do not reflect selection bias.

## 4. Discussion

The maternal cohort was recruited early in pregnancy and followed up over a 21 year period. We found four distinct trajectories of alcohol consumption by women over their reproductive life course. The largest trajectory group comprised low-stable

**Table 3**

Multivariate multinomial logistic regression between alcohol consumption trajectories and baseline predicting variables adjusted for maternal educational levels and other significant predictors.

| Predicting variables | Trajectories of alcohol consumption up to 21 years follow-up surveys | | | |
|---|---|---|---|---|
| | Low stable drinkers[a] | Abstainers | Moderate-escalating drinkers | Heavy-escalating drinkers |
| | Ref. (%) | OR (95% CI) | OR (95% CI) | OR (95% CI) |
| **Gross family income** | | | | |
| $10 400 or more | 1.0 | 1.0 | 1.0 | 1.0 |
| $10 390 or less | 1.0 | 1.8 (1.4–2.3) | 0.8 (0.6–0.9) | 0.8 (0.5–1.1) |
| **Marital status** | | | | |
| Married | 1.0 | 1.0 | 1.0 | 1.0 |
| Single | 1.0 | 0.5 (0.3–0.8) | 1.3 (1.0–1.8) | 0.8 (0.4–1.6) |
| Ling together /Sep/Div/Wid | 1.0 | 0.7 (0.4–1.1) | 1.2 (0.9–1.6) | 1.6 (1.0–2.4) |
| **Church attendance** | | | | |
| Weekly/ Monthly | 1.0 | 1.0 | 1.0 | 1.0 |
| Less than once a month | 1.0 | 0.2 (0.1–0.3) | 1.2 (0.9–1.6) | 1.1 (0.5–2.0) |
| Never | 1.0 | 0.2 (0.2–0.3) | 1.6 (1.2–2.0) | 1.9 (1.1–3.3) |
| **Healthy lifestyle behaviours** | | | | |
| Good (0–2) | 1.0 | 1.0 | 1.0 | 1.0 |
| Moderate (3) | 1.0 | 0.9 (0.7–1.3) | 1.0 (0.8–1.3) | 1.3 (0.8–1.9) |
| Bad (4+) | 1.0 | 0.7 (0.4–1.1) | 1.0 (0.8–1.3) | 1.7 (1.1–2.6) |
| **Child birth weight** | | | | |
| Normal (2500 g or more) | 1.0 | 1.0 | 1.0 | 1.0 |
| Low birth weight (2499 or less) | 1.0 | 1.0 (0.6–1.4) | 0.9 (0.6–1.4) | 1.7 (0.9–3.3) |

[a] Reference group.

**Table 4**

Multivariate attrition analyses predicting those who were lost to follow-up at 21 years.

| Predicting variables[a] | Odds of being lost to follow-up | |
|---|---|---|
| | Unadjusted | Adjusted[b] |
| | OR (95% CI) | OR (95% CI) |
| **Maternal age** | | |
| 25 years or less (ref.) | 1.0 | 1.0 |
| 26 years or more | 0.7 (0.6–0.8) | 0.8 (0.7–0.9) |
| **Maternal education** | | |
| Post high (ref.) | 1.0 | 1.0 |
| Complete high | 1.3 (1.2–1.5) | 1.3 (1.1–1.5) |
| Incomplete high | 1.8 (1.5–2.1) | 1.5 (1.2–1.8) |
| **Family income** | | |
| $10 400 or more (ref.) | 1.0 | 1.0 |
| $10 390 or less | 1.6 (1.4–1.8) | 1.2 (1.0–1.3) |
| **Marital status** | | |
| Married (ref.) | 1.0 | 1.0 |
| Single | 2.0 (1.7–2.3) | 1.3 (1.0–1.8) |
| Ling together /Sep/Div/Wid | 1.9 (1.7–2.2) | 1.6 (1.3–1.9) |
| **Parity groups** | | |
| No previous baby (ref.) | 1.0 | 1.0 |
| Had at least one baby | 1.0 (0.9–1.1) | 1.0 (0.9–1.1) |
| **Church attendance** | | |
| Weekly/monthly (ref.) | 1.0 | 1.0 |
| Less than once a month | 1.0 (0.8–1.1) | 0.9 (0.7–1.0) |
| Never | 1.1 (1.0–1.3) | 0.9 (0.7–1.0) |
| **Maternal depression** | | |
| Non-depressed (ref.) | 1.0 | 1.0 |
| Depressed | 1.6 (1.3–2.0) | 1.9 (0.7–1.4) |
| **Maternal anxiety** | | |
| Non-anxious (ref.) | 1.0 | 1.0 |
| Anxious | 1.6 (1.4–1.9) | 1.3 (1.0–1.5) |
| **Healthy lifestyle behaviour** | | |
| Good (0–2) (ref.) | 1.0 | 1.0 |
| Average (3–4) | 1.4 (1.2–1.6) | 1.2 (1.0–1.4) |
| Bad (5+) | 1.6 (1.4–1.9) | 1.3 (1.1–1.6) |
| **Maternal adversity** | | |
| Low (0–2) (ref.) | 1.0 | 1.0 |
| High (3+) | 1.4 (1.3–1.6) | 1.1 (0.9–1.3) |

[a] Assessed at baseline survey unless otherwise indicated.
[b] Model was adjusted for all factors listed. These factors were used in main analyses.

drinkers (58.0%), followed by moderate-escalating drinkers (25.3%), abstainers (11.9%), and heavy-escalating drinkers (4.8%). Our study did not identify the decreasing or curvilinear pattern found in other research (Brennan et al., 2011; Powers & Young, 2008).

The four trajectories found in this study exhibit evidence of a high level of stability for abstainers and low-stable drinkers, but changeability for moderate and heavy-escalating drinkers over their reproductive life course. Members of the abstainers and the low-stable group consistently did not consume alcohol, or consumed at a very low level, over 21 years. The biggest reduction is observed during the period of pregnancy and delivery among moderate and heavy drinking mothers, consistent with the findings from previous research (Maloney et al., 2011; Bachman et al., 2013; Tran et al., 2014). However, six months after the birth of the baby, alcohol consumption levels among the moderate-escalating groups started to increase but remained at a moderate level at the 5, 14 and 21 year follow-ups; while alcohol consumption in the heavy-escalating group sharply increased at Year 5 from moderate to heavy (17.1 glasses per week) and remained at this drinking level at the 21-year follow-up (Fig. 2). The pattern of alcohol consumption in the heavy-escalating group suggests the need to focus on prevention and intervention with these women after they have given birth as they breastfeed their baby while apparently consuming moderate levels of alcohol (Tran et al., 2014; Giglia &

Binns, 2007). The result also suggests that interventions may be needed during the child-adolescent motherhood period where children may be influenced by their mother's drinking behaviour (Van Der Vorst et al., 2009; Cleveland et al., 2014).

Examinations of baseline predictors associated with four drinking trajectory groups indicate the differences among profiles of abstainers versus moderate and heavy-escalating drinkers. Predictors associated with abstainers are those who had low family income and being married. The results appear inconsistent with some studies (Huckle, You & Casswell, 2010; Karlamangla et al., 2006) but in line with the work from Cerdá and colleagues (Cerdá, Johnson-Lawrence & Galea, 2011). Frequency of religious participation is a protective factor against alcohol consumption (Krause, 2003). This finding may be limited to Australian society as Australians have a low rate of church attendance (Australian Bureau of Statistics, 2013). Our study shows that women with increasing consumption over time tend to be affluent (except for the heavy-escalating group), are more likely to be unmarried, and less religious—consistent with previous studies (Platt et al., 2010; Karlamangla et al., 2006).

This study has some limitations. First, it is possible that maternal age and the number of children women have over their life course might affect patterns of alcohol consumption. We tested the influence of two covariates by adjusting parity as a time-varying covariate and age of mothers at pre-pregnancy as a fixed covariate in the trajectory model. We also conducted sensitivity analyses, identifying possible drinking trajectory groups and stratified by (i) age groups (younger mothers—25 years or less, and older mother—26 years or more), (ii) parity before participating in the study (no previous child and had at least one child), and (iii) the production of age and parity groups. The sensitivity analyses yielded the same results as the one in the adjusted model. It might be of interest to note that those in the abstainers group were the oldest mothers (but only by about a year) who had at least one child before participating in the study; while those in the low-stable and moderate-escalating drinker groups were younger mothers. There did not seem to be much of a difference in subsequent numbers of children among drinking trajectory groups, possibly due to the adjustment of parity in the model. It should be noted that although the present study addresses the baseline predictors of maternal alcohol consumption trajectories after adjusting for some covariates, some predictor variables may impact these trajectories during the life course. Further studies should consider predictors which may impact after the baseline period.

Second, in our study we did not collect participants' alcohol consumption history. We only examined women's alcohol consumption over the previous 12 months at pre-pregnancy; and post-birth at 6 months; and 5, 14, and 21 years. Women in the abstaining trajectory group were those who reported not drinking alcohol over 12 months at each phase of study. Further research should address the patterns of different categories of abstainers as mentioned in previous research (Goldman & Najman, 1984).

Finally, we tested the possibility that loss to follow-up may have biased our findings. Of 6753 mothers who were recruited at baseline, loss to follow-up at the 21-year follow-up was about 45%. Our multiple imputation analyses indicated that loss to follow-up had only minimal impact on findings.

## 5. Conclusion

About one in twenty women is characterised by a pattern of escalating alcohol consumption which extends over the reproductive life course. Intervention programmes might need to target these women as early as possible, perhaps even during their pregnancy. The focus of such an intervention would be on the period following the birth of their child. There is also a need to know more about the social and health consequences to mothers and their children of the mothers being in the moderate and heavy-escalating alcohol consumption trajectory groups.

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