

# Parental supply of alcohol and alcohol consumption in adolescence: prospective cohort study

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**Background.** Parents are a major supplier of alcohol to adolescents, yet there is limited research examining the impact of this on adolescent alcohol use. This study investigates associations between parental supply of alcohol, supply from other sources, and adolescent drinking, adjusting for child, parent, family and peer variables.

**Method.** A cohort of 1927 adolescents was surveyed annually from 2010 to 2014. Measures include: consumption of whole drinks; binge drinking (>4 standard drinks on any occasion); parental supply of alcohol; supply from other sources; child, parent, family and peer covariates.

**Results.** After adjustment, adolescents supplied alcohol by parents had higher odds of drinking whole beverages [odds ratio (OR) 1.80, 95% confidence interval (CI) 1.33–2.45] than those not supplied by parents. However, parental supply was not associated with bingeing, and those supplied alcohol by parents typically consumed fewer drinks per occasion (incidence rate ratio 0.86, 95% CI 0.77–0.96) than adolescents supplied only from other sources. Adolescents obtaining alcohol from non-parental sources had increased odds of drinking whole beverages (OR 2.53, 95% CI 1.86–3.45) and bingeing (OR 3.51, 95% CI 2.53–4.87).

**Conclusions.** Parental supply of alcohol to adolescents was associated with increased risk of drinking, but not bingeing. These parentally-supplied children also consumed fewer drinks on a typical drinking occasion. Adolescents supplied alcohol from non-parental sources had greater odds of drinking and bingeing. Further follow-up is necessary to determine whether these patterns continue, and to examine alcohol-related harm trajectories. Parents should be advised that supply of alcohol may increase children's drinking.

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**Key words:** Adolescents, alcohol drinking, cohort studies, epidemiology, longitudinal studies.

## Introduction

Adolescent drinking is associated with developing non-communicable diseases (Patton *et al.* 2012; Swendsen *et al.* 2012), and being the leading risk factor for disability-adjusted life years lost in 10- to 24-year-olds (Gore *et al.* 2011). Surprisingly then, parents are a major source of alcohol consumed by children. Approximately a third of adolescents in US, European and Australian studies (Hearst *et al.* 2007; White & Bariola, 2012; Fuller, 2013) report parental supply. Reasons cited for parental supply include: parental desire to 'socialize' children into responsible

drinking, 'inoculating' them from heavy consumption (Donovan & Molina, 2008; Gilligan *et al.* 2012; Jackson *et al.* 2012); parental concern that peers' parents will provide alcohol anyway (Gilligan *et al.* 2012; Jackson *et al.* 2012; Wadolowski *et al.* 2016); and supply at cultural/religious, or celebratory events (Gilligan *et al.* 2012; Jackson *et al.* 2012). Yet, the quality of evidence on whether parental supply is associated with more, or less, adolescent drinking is compromised by design and analytic limitations.

While a recent review concluded that parental supply was 'generally associated' with increased child drinking (Kaynak *et al.* 2014), that view was qualified by study design limitations. Ignoring the cross-sectional studies – of little assistance in understanding the impact of parental supply – seven cohorts showed associations between parental supply and drinking

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(Kaynak *et al.* 2014). Yet, assessments were limited to one (Shortt *et al.* 2007; Livingston *et al.* 2010) or two follow-up occasions (Jackson *et al.* 1999; Komro *et al.* 2007; Van Der Vorst *et al.* 2010; Danielsson *et al.* 2011; McMorris *et al.* 2011), in quite late adolescence (18–19 years of age; Livingston *et al.* 2010) or in early adolescence [10–12 (Jackson *et al.* 1999), 12–13 (Shortt *et al.* 2007) or 12–14 years of age (Komro *et al.* 2007; McMorris *et al.* 2011)], hampering conclusions about both the development and the sequelae of parental supply. One study did span 13–15 years of age (Jackson *et al.* 1999), and a key study assessed 13–16 years of age (Van Der Vorst *et al.* 2010). Yet, these two studies left unmeasured known predictors of adolescent drinking and potential confounders, including: parental/familial alcohol problems (Jackson *et al.* 1999; Van Der Vorst *et al.* 2010), parental drinking (Jackson *et al.* 1999), child externalizing and other substance use (Van Der Vorst *et al.* 2010) and child age (Jackson *et al.* 1999; Van Der Vorst *et al.* 2010). Incomplete control for demographics and risk factors was noted in all seven cohorts (Kaynak *et al.* 2014).

In this last regard, several other parental (Barnes *et al.* 2000), familial (Nash *et al.* 2005), child (Zernicke *et al.* 2010) and peer (Borsari & Carey, 2001) predictors, suggested by parenting and child socialization research and theory (Oetting & Donnermeyer, 1998; Ajzen, 2002; Real & Rimal, 2007), are associated with adolescent drinking (Fisher *et al.* 2007; Alati *et al.* 2010; Donovan & Molina, 2011; Swendsen *et al.* 2012; Kuperman *et al.* 2013; Rossow *et al.* 2016). Factors such as parental/familial drinking/problems (Donovan & Molina, 2011), family intactness (Donovan & Molina, 2011; Kuperman *et al.* 2013), monitoring of child activities (DiClemente *et al.* 2001), child externalizing/internalizing (Crum *et al.* 2008) and peer substance use (Ary *et al.* 1999) are often unmeasured. Incomplete adjustment does not constitute strong analysis, and creates uncertainty about relationships (McCambridge *et al.* 2011). In addition, when researching associations of parental supply with child drinking, there is also a need to control for alcohol supplied from non-parental sources (other adults, friends, siblings, self-purchased, etc.), referred to hereafter as ‘other supply’. Supply of alcohol from non-parental sources has been associated with greater drinking and negative outcomes than parental supply (Foley *et al.* 2004; Bellis *et al.* 2007; Dietze & Livingston, 2010), raising the potential for differential harms. However, no prospective study has reported how these different sources are associated with adolescent drinking. Overall, the piecemeal picture limits confident conclusions from existing research.

We investigated the associations between exposure to parental supply and other supply of sips or whole drinks of alcohol across four adolescent years

(approximately 12–15 years of age), and two outcomes – consumption of whole drink(s) (drinking) and binge drinking (bingeing; consuming more than four standard drinks on a single occasion, a pattern of drinking that puts the drinker at increased risk of harm; National Health and Medical Research Council, 2009) – using longitudinal mixed-model analytic methods, unadjusted and adjusted for the full range of relevant covariates. Guided by the literature and pre-specified aims (Aiken *et al.* 2015), we hypothesized that while parental supply, other supply, and the covariates would have significant unadjusted associations with these two outcomes, the unadjusted analyses would show parental supply of alcohol to have the greatest odds of drinking and bingeing, given concerns that such provision signals parental permissiveness (Kaynak *et al.* 2014).

## Method

### Design

This longitudinal cohort study is registered (ClinicalTrials.gov: NCT02280551). Institutional review board (IRB), and STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement reporting requirements are met (von Elm *et al.* 2007).

### Sample recruitment and characteristics

In 2010–2011 a cohort of adolescents and parents was recruited from grade 7 classes in Sydney, Hobart and Perth; detailed methods are described elsewhere (Aiken *et al.* 2015). As in similar research (Jackson *et al.* 2012), schools made recruitment materials available to students (either by mail or face-to-face at school), but had no other role. Study information packs were distributed to grade 7 students at participating schools. Parents could submit a form indicating interest in consenting to be in the study, and were eligible to participate if: (a) the child was enrolled in grade 7; and (b) signed parental consent was provided. Of 2017 parents expressing interest in their child participating, 90 were ineligible, resulting in 1927 adolescents in the cohort (see Fig. 1 for details of eligibility and retention); 1910 adolescents provided baseline data, with high retention thereafter (>85%). Adolescents were a mean of 12.9 years of age at baseline, and similar to the Australian population on important demographic measures: 44.9% of adolescents were female (48.7% in the population of 12- to 13-year-olds); there were 2.6 adolescents per household (1.9 in the population); 79.6% of the adolescents lived in two-parent households (81.0% in the population); 73.8% of parents were Australian-born (72.3% in the adult population); 73.4% of parents had post-high

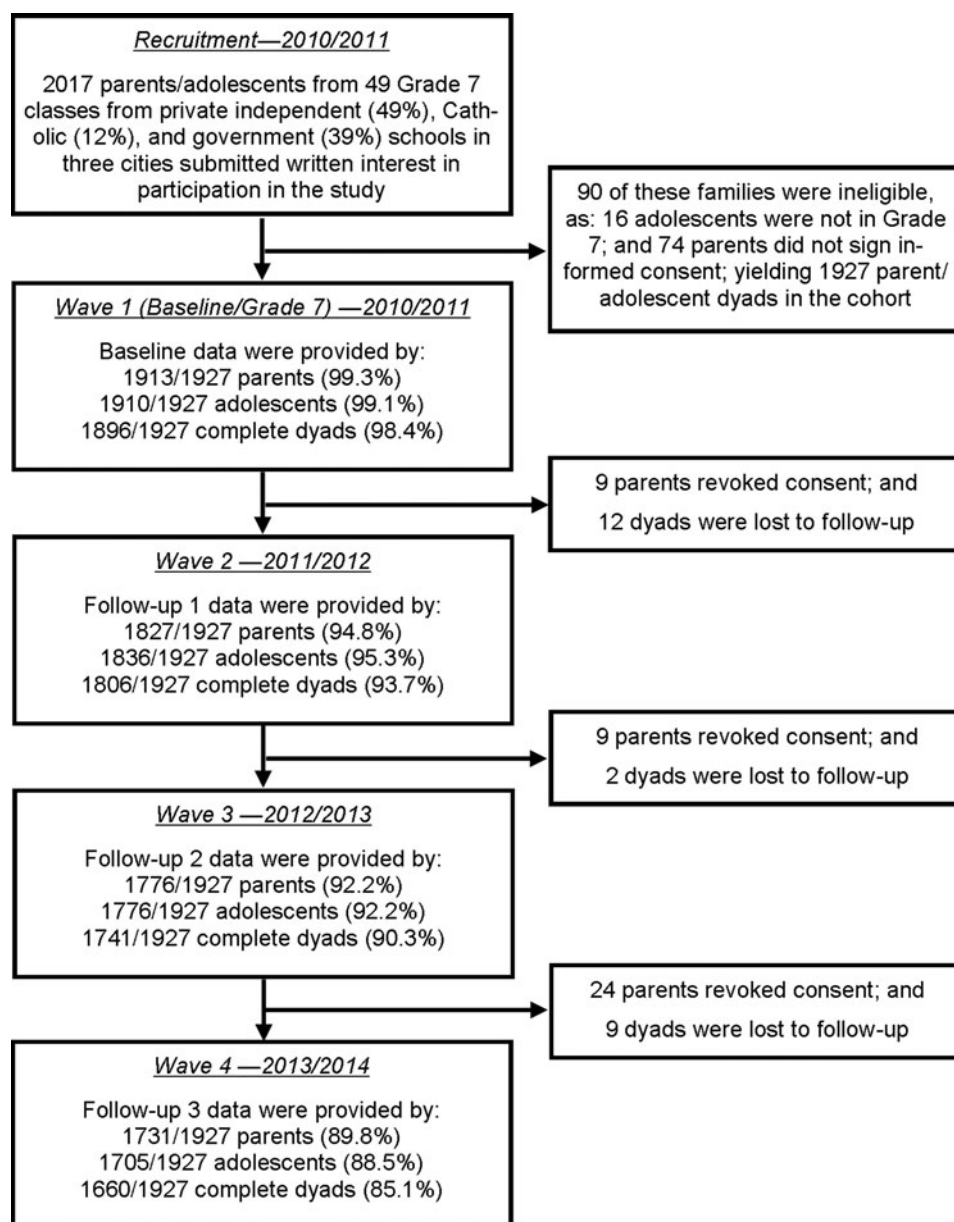


Fig. 1. Time and study flowchart of recruitment and assessment of the cohort ( $n = 1927$ ).

school education (67% in the adult population); 81.2% of parents were employed (80.0% of males and 65% of females in the adult population); median household income was in the same range as in the population (Aiken *et al.* 2015).

Rates of alcohol use in the adolescent cohort, and of parental drinking and supply, were also similar to those in population surveys. National school student samples (past-12-month alcohol use) and our sample (past 12-month alcohol use) had similar drinking: 21.3% of 12-year-olds drank in 2011 *v.* 19.8% of our sample that year; 32.1% of 13-year-olds drank in 2012 *v.* 32.9% of our sample that year (White & Bariola, 2012). School data for 2013 and 2014 are not available,

but other national survey data showed a secular decline of approximately 10% by 2013 in 12- to 17-year-olds ever consuming alcohol (Pennay *et al.* 2015). Applying this secular trend to the school survey data: the national rate of 14-year-olds drinking of 45.9% should decrease to about 35% by 2013 (compared with the rate of 37.3% of 14-year-olds in the cohort by 2013); and from 60.2 to about 50% (compared with our rate of 47.9% of 15-year-olds in the cohort by 2014). Parental supply was reported by 34.7% of 15-year-olds in the cohort (Table 2), compared with 34.9% of 12- to 15-year-olds in population surveys (White & Bariola, 2012). Parental frequency of drinking (2.6% daily, 48.6% weekly, 38.3% less than weekly,

10.5% not in the past 12 months) (Aiken *et al.* 2015) was similar to Australian adult population use (7.7% daily, 41.7% weekly, 33.0% less than weekly, and 7.7% not in the past 12 months), indicating regular alcohol involvement (Australian Institute of Health and Welfare, 2011).

### Measures

#### *Outcome variables [whole standard drink(s) and binge drinking]*

Primary outcomes were: (a) past 12-month consumption of whole standard drink(s) (drinking); (b) binge drinking. A binary variable (no/yes) was constructed to indicate drinking one or more whole standard drink(s) (10 g of alcohol), and consumption of more than four standard drinks (no/yes) on any single occasion (Bush *et al.* 1998) was coded into a binary variable: binge drinking. Current Australian guidelines recommend drinking no more than four standard drinks on a single occasion to reduce the risk of alcohol-related injury; hence binge drinking was coded as consumption as more than four standard drinks on one occasion (National Health and Medical Research Council, 2009). Secondary analyses were conducted of typical quantity consumed on a drinking occasion, and number of drinks consumed in the year.

#### *Exposure variables*

*Parental supply.* Children were asked about who supplied them alcohol (sips or whole drinks) in the past 12 months, including mother, father, other adults, friends, siblings and self-supply. From this, a dichotomous exposure variable was coded indicating those who had received supply of alcohol from parental supply, and those who had not. For a secondary planned dose–response analysis, an exposure variable was coded into a measure of the number of years in which parental supply occurred (0, 1, 2, or 3) (see Statistical analysis).

*Other supply.* Another exposure variable of ‘other supply’ included supply from other adults, friends, siblings or self-supply, compared with adolescents reporting no supply from these sources. Parental supply and other supply were not mutually exclusive, and as supply could be derived from both sources, each source was controlled for separately in analyses.

#### *Covariates*

Covariates identified from the literature as associated with adolescent drinking were measured annually. These variables are fully described in the online Supplementary material, and included: parental

factors [alcohol use (Donovan & Molina, 2011; Swendsen *et al.* 2012), alcohol accessible at home without parental knowledge (Swendsen *et al.* 2012), alcohol-specific rules (Van Der Vorst *et al.* 2005; Van Der Vorst *et al.* 2007), monitoring (Swendsen *et al.* 2012), responsiveness/demandingness/consistency (Alati *et al.* 2010; Donovan & Molina, 2011), religiosity (Donovan & Molina, 2011)]; family factors [one- or two-parent household (Alati *et al.* 2010), family conflict/positive relations (Ary *et al.* 1999), family alcohol problems (Kuperman *et al.* 2013), older siblings (Fisher *et al.* 2007)]; child factors [sex, age in years, or part thereof, at time of survey completion (Fisher *et al.* 2007; Swendsen *et al.* 2012), money to purchase alcohol (Swendsen *et al.* 2012), tobacco use (Kuperman *et al.* 2013), externalizing (Swendsen *et al.* 2012; Kuperman *et al.* 2013), internalizing (Crum *et al.* 2008; Kuperman *et al.* 2013), problems socializing (Achenbach, 1991)]; and peer factors [peer substance use, and peer disapproval of alcohol/tobacco use (Fisher *et al.* 2007; Swendsen *et al.* 2012; Kuperman *et al.* 2013)]. Participants completed annual paper or online questionnaires, forwarded separately to adolescents and parents to minimize reporting biases. Data from 4 years (waves 1 to 4) are included in this study.

### Statistical analysis

#### *Primary*

Logistic regressions (random intercept mixed-effects model controlling for within-respondent and within-school clustering/correlation, and time) determined the relationship between parental supply and other supply and two outcomes: (a) drinking whole standard drinks; and (b) binge drinking, controlling for each source of supply and covariates and collinearity. We analysed 4 years of data, with parental supply (yes/no) from each year used to model the two outcomes in the following years, while controlling for covariates (fully adjusted model). The analysis included paired time periods (period 1 = waves 1–2; period 2 = waves 2–3; period 3 = waves 3–4), with exposures and covariates from each year predicting the outcomes in all the later years. Variables were included in adjusted analyses if they showed unadjusted significance at an  $\alpha$  of 0.05 (five covariates were dropped).

#### *Secondary*

Fixed-effect logistic regressions assessed for a dose–response between number of years in which parental supply occurred (0, 1, 2, or all 3 initial years) and drinking outcomes in the 4th year. Analyses were also conducted using multiple imputation for missing data (online Supplementary Table S1). Sensitivity

analyses tested robustness of the dose–response relationship under three scenarios: (a) complete case analysis (no imputation); (b) all participants with missing outcomes coded as drinkers/bingers; and (c) all participants with missing outcomes coded as non-drinkers. Analyses used Stata 14.1 (Stata Corporation, 2012). Number of drinks consumed in the year and single occasion drinking rates were also examined using negative binomial regression (random intercept mixed-effects). Finally, potential moderating effects between parental supply and four other variables on the primary outcomes were investigated through analysis of interaction terms between parental supply and: child externalizing, family history of alcohol problems, peer substance use, and peer disapproval of substance use.

## Results

### *Sample drinking behaviour over time*

There was a steady increase in consumption of drinks and bingeing across the waves (Table 1). Table 2 provides the sources and mean number of drinks/bingeing consumed by adolescent drinkers, separately for adolescents reporting any parental supply, and those reporting any other supply. Mean consumption was similar across supply source. The main sources of ‘other supply’ were other adults and peers, and the frequency of supply from each ‘other supply’ source is presented in online Supplementary Table S2.

### *Unadjusted analyses*

Unadjusted, parental supply was strongly associated with both drinking whole standard drinks [odds ratio (OR) 5.71, 95% confidence interval (CI) 4.41–7.39] and bingeing (OR 4.66, 95% CI 3.48–6.24) (Table 3). Of the 30 variables analysed, the same six showed no significant unadjusted associations with drinking whole drinks, or bingeing: having older siblings; parent is Australian-born; parent education; parent employment; home access to alcohol; and family history of alcohol problems. These variables were not included in fully adjusted models.

### *Adjusted analyses*

Adjusting for other variables, we still found significant associations between parental supply and drinking whole drinks, but not with bingeing. Parental supply at any wave was associated with doubled odds of drinking at subsequent waves (OR 1.80, 95% CI 1.33–2.45), but was not associated with bingeing (OR 1.12, 95% CI 0.80–1.55). In contrast, other supply of alcohol from non-parental sources was associated with significant increased risk of both outcomes, unadjusted and

adjusted. While supply from other sources was similarly associated with a doubling in the odds of drinking whole drinks (OR 2.53, 95% CI 1.86–3.45), it was associated with a more than tripling in the odds of binge drinking (OR 3.51, 95% CI 2.53–4.87) (online Supplementary Tables S3 and S4). Consistent with this result, adolescents who received alcohol only from other supply sources drank significantly more drinks than adolescents who were supplied alcohol only by their parents (and who were not supplied by other supply sources) ( $F = 30.80, p < 0.001$ ).

Drinking and bingeing were also associated with time, although in different ways. The odds of consuming whole drinks increased by around half in time period 2 (OR 1.45, 95% CI 1.05–2.01), before increasing markedly in time period 3 (OR 4.75, 95% CI 3.32–6.78) (online Supplementary Table S3). In contrast, binge drinking remained steady in time period 2 (OR 1.15, 95% CI 0.79–1.67), but increased significantly in time period 3 (OR 3.13, 95% CI 2.13–4.60) (online Supplementary Table S4).

Secondary analyses showed odds increasing with number of years of parental supply, consistent with a dose–response relationship, although the 95% CIs overlapped. There was an association ( $p = 0.003$ ) between the number of waves of parental supply and drinking in wave 4; those supplied alcohol even once by parents in any of waves 1–3 were more likely to consume whole drinks in wave 4 (OR 1.48, 95% CI 1.03–2.12), and odds of consumption increased among those who were supplied alcohol in 2 years during waves 1–3 (OR 1.92, 95% CI 1.29–2.85), increasing further if supply occurred in all waves 1–3 (OR 2.15, 95% CI 1.21–3.82). Secondary analysis of number of waves of parental supply showed no dose–response relationship for bingeing (online Supplementary Table S5). Finally, the secondary analyses showed similar results for covariates as primary analyses, suggesting robust relationships.

### *Sensitivity analyses*

Analysis of the number of drinks consumed in the year showed a similar pattern to analysis of drinking whole drinks. Parental supply of alcohol was associated with a fourfold increase in the incidence rate of number of drinks [incidence rate ratio (IRR) 3.68, 95% CI 2.30–5.90] with a similar increase associated with other supply (IRR 2.67, 95% CI 1.63–4.35) (online Supplementary Table S6). Number of drinks also showed a strong increase in the incidence rate over time, doubling in time period 2 (IRR 2.35, 95% CI 1.47–3.74), before a dramatic increase in time period 3 (IRR 10.70, 95% CI 6.52–17.56). The sensitivity analysis of number of drinks consumed on a single typical drinking occasion

**Table 1.** Adolescent drinking and binge drinking rates and percentages at each measurement wave<sup>a</sup>

	Annual assessment wave and school grade			
	Wave 1, school grade 7 ( <i>n</i> = 1911) <sup>b</sup>	Wave 2, school grade 8 ( <i>n</i> = 1837) <sup>b</sup>	Wave 3, school grade 9 ( <i>n</i> = 1786) <sup>b</sup>	Wave 4, school grade 10 ( <i>n</i> = 1706) <sup>b</sup>
Past 12-month drinking				
Whole (standard) drink(s) consumption, <i>n</i> <sup>c</sup> (%)	111 (5.8)	150 (8.2)	267 (15.0)	498 (29.2)
Binge drinking ( $\geq 4$ standard drinks on an occasion), <i>n</i> <sup>c</sup> (%)	26 (1.4)	101 (5.5)	169 (9.5)	323 (19.2)

<sup>a</sup> Students were a mean age of 12.9 years at wave 1.

<sup>b</sup> Number of respondents with valid data.

<sup>c</sup> Number of participants reporting the behaviour at each measurement wave.

(online Supplementary Table S7) supports the results of the model of binge drinking. Adolescents supplied alcohol by parents drank lower numbers of drinks on a typical occasion (IRR 0.89; 95% CI 0.79–0.99) than those adolescents supplied only by other sources (i.e. other supply). The sensitivity analyses of the dose–response relationship found that this relationship was maintained in complete case analysis. When more extreme assumptions were made, either assuming missing outcome data were all non-drinkers or all drinkers, the significant association with parental supply remained, although the pattern of ORs was less consistent with a dose–response relationship (online Supplementary Tables S8–S10). Two additional *post-hoc* sensitivity analyses were also conducted. First, to separate out the influence of sources of ‘other supply’ on drinking behaviour, we conducted *post-hoc* analyses of the two primary outcomes with each source of ‘other supply’ entered separately (i.e. other adults, siblings, peers, religious service, and self-supply). The only significant ‘other supply’ sources predictive of drinking and/or bingeing were self-supply (OR 2.62, 95% CI 1.71–4.03 and OR 3.16, 95% CI 2.11–4.74, respectively) and peer-supply (OR 3.91, 95% CI 2.16–7.08 and OR 2.64, 95% CI 1.56–4.49). Second, to eliminate the possibility that results were influenced by less common living arrangements, we re-conducted the primary analysis limiting the sample to adolescents who reported living in a two-parent mixed-sex (mother/father) household. A breakdown of adolescent-rearing environment for each wave is presented in online Supplementary Tables S11 and S12. The sensitivity analysis showed no substantive differences to the primary analysis.

### Moderating variables

Analysis of potential moderating effects showed two significant interactions (of child externalizing and

peer substance use) with parental supply on the two outcomes. For both outcomes, the effect of parental supply was stronger with lower externalizing scores, with the effect declining as externalizing score increased (online Supplementary Fig. S1). That is, if a child is higher on externalizing, parental supply is less important to that child’s drinking – externalizers seem more likely to seek out alcohol whether their parents supply or not. On the other hand, the interaction of parental supply and peer substance use showed a reversal in the direction of effect, with parental supply increasing the odds of drinking when low peer substance use was observed, but decreasing the odds when peer substance use was higher (online Supplementary Fig. S2). Family history of alcohol problems, and peer disapproval did not show any significant interaction effect.

### Discussion

This first longitudinal study of associations between parental supply and other supply of alcohol and adolescent drinking, conducted over 4 years in a large representative cohort with excellent retention, comprehensively adjusted for known covariates (Kaynak *et al.* 2014). Before adjustment, parental supply of alcohol was associated with five-fold increased unadjusted odds of consuming whole drinks, consistent with earlier studies (Jackson *et al.* 1999; Komro *et al.* 2007; Shortt *et al.* 2007; Livingston *et al.* 2010; Van Der Vorst *et al.* 2010; Danielsson *et al.* 2011; McMorris *et al.* 2011). Also, there were increased unadjusted odds of bingeing among adolescents supplied alcohol by parents. In adjusted longitudinal mixed-model analyses which: (a) controlled for familial/adolescent/peer characteristics in each wave being interrelated; (b) assessed parental supply controlling for growth in drinking rates over time; and (c) included variables with significant unadjusted associations, parental supply was still

**Table 2.** Source(s) of supply of alcohol and rates of adolescent drinking whole standard drinks and binge drinking by wave<sup>a</sup>

Source(s) of supply of alcohol (sips or whole standard drinks)		Percentage of adolescents reporting no supply of alcohol and those receiving alcohol from parental supply, other supply, or from both sources ( <i>n</i> of participants at each wave)			
		Wave 1 ( <i>n</i> = 1911)	Wave 2 ( <i>n</i> = 1837)	Wave 3 ( <i>n</i> = 1786)	Wave 4 ( <i>n</i> = 1706)
No alcohol was reported as being supplied from any source		81.5	67.5	62.0	51.6
Parental supply only was reported (and no other supply source)		9.3	13.1	11.9	10.5
Other supply only was reported (and no parental supply source)		3.3	6.9	10.8	14.2
Both parental supply and other supply were reported		6.0	12.6	15.3	23.7
		Drinking of whole standard drinks and bingeing behaviours among those who were supplied alcohol ( <i>n</i> of participants consuming whole standard drinks at each wave)			
		Wave 1 ( <i>n</i> = 111)	Wave 2 ( <i>n</i> = 150)	Wave 3 ( <i>n</i> = 267)	Wave 4 ( <i>n</i> = 498)
Any parental supply occurred in the wave <sup>b</sup>	Mean (s.d.) no. of standard drinks consumed p.a.	52.7 (98.3)	157.9 (461.8)	139.2 (425.8)	139.0 (508.7)
	No. of drinkers/no. of drinkers who binged	67 drank/15 drinkers binged	86 drank/62 drinkers binged	156 drank/92 drinkers binged	315 drank/208 drinkers binged
Any other supply occurred in the wave <sup>b</sup>	Mean (s.d.) no. of standard drinks consumed p.a.	51.8 (96.3)	165.2 (438.6)	132.9 (366.0)	126.0 (445.1)
	No. of drinkers/no. who of drinkers binged	70 drank/22 drinkers binged	131 drank/92 drinkers binged	229 drank/158 drinkers binged	435 drank/304 drinkers binged

s.d., Standard deviation; p.a., per annum.

<sup>a</sup> Bingeing is defined as >4 standard drinks on an occasion.

<sup>b</sup> The categories of 'parental supply' and 'other supply' are not mutually exclusive; adolescents could derive supply from more than one of these two sources – the analyses of the impacts of parental supply controlled for other supply (and the other covariates) when estimating odds ratios/associations and vice versa, so that the impact of each type of supply can be estimated independent of and controlling for each type of supply and each covariate.

**Table 3.** ORs and 95% CIs for associations of source of supply at current wave, and subsequent wave drinking of whole beverages and binge drinking

Variables	Odds of drinking whole drinks <sup>a</sup>				Odds of binge drinking <sup>a</sup>				
	Unadjusted		Adjusted <sup>b</sup>		Unadjusted		Adjusted <sup>b</sup>		
	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	
Current wave parental supply	No	1.00		1.00		1.00		1.00	
	Yes	5.71 (4.41–7.39)	<0.001	1.80 (1.33–2.45)	<0.001	4.66 (3.48–6.24)	<0.001	1.12 (0.80–1.55)	0.518
Current wave other supply <sup>c</sup>	No	1.00		1.00		1.00		1.00	
	Yes	12.73 (10.01–16.19)	<0.001	2.53 (1.86–3.45)	<0.001	15.39 (11.66–20.32)	<0.001	3.51 (2.53–4.87)	<0.001

OR, Odds ratio; CI, confidence interval; s.d., standard deviation; YSR, Youth Self Report.

<sup>a</sup> Results of random intercept mixed-effects logistic regression models. Data included as paired waves, with covariates from one wave and outcome from subsequent wave. Significant random effects were observed for the multivariate logistic mixed model of drinking whole drinks (school intercept s.d. = 0.37, individual intercept s.d. = 1.54,  $p < 0.001$ ) and binge drinking (school intercept s.d. = 0.38, individual intercept s.d. = 1.45,  $p < 0.001$ ).

<sup>b</sup> Models controlled for other covariates (see online Supplementary Tables S3 and S4): parental average alcohol use; home access to and availability of alcohol; parental alcohol specific rules; parental monitoring; authoritative parenting: demandingness; authoritative parenting: responsiveness; parenting consistency; parental religiosity at baseline; parent born in Australia; two-parent household; family conflict; family positive relations; relative socio-economic disadvantage of area of residence; household income; child has money to buy alcohol; smoking; YSR: externalizing; YSR: anxious/depressed; YSR: withdrawn/depressed; YSR: social problems; age; sex; peer use of alcohol and/or tobacco; peer disapproval of alcohol and/or tobacco use.

<sup>c</sup> Included here was alcohol supply from: a family friend or relative or adult; a brother/sister; friends; or alcohol received as part of religious service; or alcohol where 'I got it myself'.



associated with a doubling of the odds of drinking, but no longer associated with bingeing. Our results are consistent with the results of studies that consistently find increased drinking, but not necessarily increased heavy episodic drinking (Kaynak *et al.* 2014). We also found adolescents supplied alcohol by parents drank less on a typical drinking occasion than adolescents supplied alcohol from other sources (and not from their parents), as some others also report (Foley *et al.* 2004; Bellis *et al.* 2007; Dietze & Livingston, 2010), possibly due to the supervisory nature where there is parental presence. In this last regard, it is likely that the drinking context matters, as do child perceptions of parental permissiveness, issues which we are pursuing in this cohort. There was no evidence of over-adjustment or collinearity affecting these results.

As expected from other research (Alati *et al.* 2005; Fisher *et al.* 2007; Donovan & Molina, 2011; Kuperman *et al.* 2013), we also detected some variables associated with lower odds of drinking, specifically: parental monitoring; responsive and consistent parenting; religiosity; child social problems; and peer disapproval of substance use (online Supplementary Table S3). Increased odds of drinking were observed for: peer substance use and child externalizing. Turning to bingeing, odds were decreased by: alcohol-specific rules; responsive and consistent parenting; religiosity; and peer disapproval of substance use. Externalizing was associated with increased odds of bingeing, as reported elsewhere (Swendsen *et al.* 2012; Kuperman *et al.* 2013).

Our results also showed a dose-response relationship: adolescents supplied alcohol by parents in the one, two, or in all three initial years were increasingly more likely to drink whole beverages in year 4. Sensitivity analyses showed that this relationship was robust when only complete cases were analysed, and also when missing responses were classified as non-drinkers. Interestingly, being supplied alcohol from other sources increased the odds of both drinking and bingeing. It thus seems that while both parental supply and other supply were equally related to drinking, only other supply – but not parental supply – was more likely to be associated with bingeing. Findings from these mixed-effect regressions were replicated in fixed-effect logistic regression analyses, indicating robust results, confirming relationships reported in cross-sectional studies (Foley *et al.* 2004; Bellis *et al.* 2007; Dietze & Livingston, 2010). Notably, given no other cohort studies control for other supply, associations of parental supply with drinking in those studies may be inflated. This is an important point, as causality is often inferred via associations.

Our study has limitations. First, IRB approval allowed information about the study to be available through classrooms, but families had to opt in, so the

self-selected sample restricts generalizations to the population, and reporting biases may underestimate population rates of alcohol consumption (Stockwell *et al.* 2004). However, our child and parent drinking rates were very similar to those in population surveys (Australian Institute of Health and Welfare, 2011; White & Bariola, 2012; Wadolowski *et al.* 2015), and the sample closely matches the Australian population in sex, age, household composition and socio-economic status. Additionally with regard to bias, we aimed to assess associations between exposures and outcomes, where population representativeness is less crucial. These observations suggest selective responding and reporting may not have substantially affected the alcohol estimates and associations herein. Second, the legal age to purchase alcohol in Australia is 18 years (parents may legally provide alcohol to children), so generalizations to other cultures should be considered carefully, although there is evidence of some cross-country similarities (McMorris *et al.* 2011). Third, the cohort is too young to show development of alcohol-use disorders (Hingson *et al.* 2006), so we cannot assess long-term harms (Gore *et al.* 2011; Patton *et al.* 2012). Fourth, we have not explored associations between either amounts (sips *v.* drinks) or settings (supervised *v.* unsupervised) of parental supply and adolescent consumption. Such analyses between drinking and the amounts/frequency and settings of parental supply, or indeed the specific sources of other supply (Samek *et al.* 2015), are beyond our scope here, but need to be undertaken. Fifth, we do not address population trends over time (Keyes *et al.* 2012), advertising or environmental/regulatory factors (Moreno *et al.* 2011; Tanski *et al.* 2015).

While we report associations, the findings do strongly suggest the potential for parental supply to accelerate adolescent alcohol consumption, compared with no supply, consistent with conclusions by others (Kaynak *et al.* 2014). This possibility is concerning, given adolescent vulnerabilities to the effects of alcohol (Brown *et al.* 2008), and associations with adverse adult outcomes (Patton *et al.* 2012). However, while adolescents supplied alcohol by parents were more likely to drink than those not supplied, parental supply was not associated with increased bingeing. This finding was supported by less alcohol being consumed on a typical drinking occasion by adolescents who have been supplied by parents, compared with those accessing alcohol from other sources (controlling for each source in the analyses). Also, in contrast, and somewhat surprisingly, other supply was associated with increased odds of bingeing after adjustment.

There are several possible explanations for the pattern of findings. Given that parental supply increases the odds of drinking, but not of bingeing, parental

supply may have a protective effect, possibly due to the supervised nature of the supply. However, our view is that such a conclusion is premature at this time. These results should not be taken to suggest that parental supply is somehow protective of bingeing in the longer term. In fact, parents may be accelerating children into drinking alcohol, and laying down the potential for later harms (Shaffer *et al.* 2000; Hingson *et al.* 2006; Jackson *et al.* 2012; Patton *et al.* 2012). It is possible that parents supplying alcohol to their children are setting up a pattern of drinking; higher frequency but lower volume than those supplied by others. Parental supply of alcohol may ultimately signify permissiveness to children, and while only other supply was associated with bingeing in this study, the patterns of use may alter as these children grow older. Further investigation of the patterns of use in adolescence and in early adulthood is needed. The significant interaction effect of child externalizing behaviour further adds to the complexity of the findings; depending on the children themselves, the impact of parental supply of alcohol is likely to be different. While these parents may be supplying alcohol as an attempt to moderate their child's drinking, or because they believe their child will receive alcohol from their peers anyway, as we have found in this cohort (Wadolowski *et al.* 2016), it seems that children high on externalizing are less influenced by parental supply and seem likely to obtain alcohol whether their parents supply or not.

This is clearly a highly complex area and one that has significant relevance to public and mental health professionals and policymakers, and parents, as understanding these relationships can alter professional opinion, and parental and child behaviour. The results have international relevance as alcohol use increases with the growth in wealth of developing economies whose populations embrace Western habits (Jiang *et al.* 2015). Given that the findings here are limited to drinking between early and mid-teen years, further study of the cohort is essential to understand the longer-term relationships between parental supply and early adult alcohol use and bingeing.

The questions are clear. Does parental supply protect in the short-term and set up patterns of moderate (non-binge) drinking into adulthood, or lead to heavier drinking when adolescents are of a legal age to drink? This is the issue that is central to our work – does parental supply harm or help? A precautionary principle remains appropriate for parents to ensure that early drinking does not compromise child well-being (Furtner & Rivara, 2011). Follow-up of this cohort into adulthood will help clarify impacts of early drinking on more mature consumption patterns.

## Supplementary material

The supplementary material for this article can be found at <http://dx.doi.org/10.1017/S0033291716002373>

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R.P.M., J.N., K.K., T.S. and D.H. conceptualized the study and, with M.W., A.A., R.B. and N.M., designed the data collection methods. M.W., A.A. and R.P.M. acquired the data. P.J.C. and R.P.M. conducted the data analyses, and R.P.M. and P.J.C. drafted the manuscript. All authors provided substantial contributions to the interpretation of the results, and all critically revised the manuscript for important intellectual content, and approved the final manuscript as submitted. All authors have agreed to be accountable for all aspects of the work.

## Declaration of Interest

None.

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