

Characteristics of Women Who Consume Alcohol Before and After Pregnancy Recognition in a Canadian Sample: A Prospective Cohort Study

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Background: High levels of alcohol consumption during pregnancy are teratogenic to fetal development, yet less is known about the effects of low levels of consumption. Only a few studies have reported on the predictors and maternal characteristics associated with different alcohol consumption patterns prior to and following pregnancy recognition.

Methods: The All Our Babies longitudinal study in Alberta, Canada was used to analyze the association of maternal characteristics with binge drinking prior to pregnancy recognition and low to moderate levels after pregnancy recognition among 2,246 women who consumed alcohol 1 year prior to pregnancy. Bivariate and multivariable analyses were conducted.

Results: Thirteen percent of women reported binge drinking prior to pregnancy recognition. Forty-six percent reported drinking after pregnancy recognition, almost all at low to moderate levels. Significant, independent predictors (odds ratio, 95% confidence interval) of binge drinking in early pregnancy included high school or less education (3.61, 1.81 to 7.19), some or completed university/college (2.23, 1.16 to 4.27), nulliparity (1.62, 1.19, 2.20), not trying to get pregnant (1.92, 1.37 to 2.69), smoked in the year prior to pregnancy (1.98, 1.43 to 2.73), binge drinking in the year prior to pregnancy (10.83, 6.71 to 17.46), and low dispositional optimism (1.73, 1.23 to 2.42). Independent predictors of low to moderate average levels of consumption after pregnancy recognition included not trying to get pregnant (1.91, 1.45 to 2.52), prepregnancy body mass index <25.0 kg/m² (1.41, 1.61 to 1.72), smoking in the year before pregnancy (1.90, 1.43 to 2.53), and binge drinking in the year before pregnancy (2.62, 2.16 to 3.18).

Conclusions: Common risk factors for different alcohol consumption patterns are unintended pregnancy and substance use behaviors prior to pregnancy. Other risk factors were specific to the different patterns. Targeted strategies that address the needs of alcohol or nicotine using women and that can reduce the risk of unintended pregnancy may be beneficial.

Key Words: Alcohol Consumption, Binge Drinking, Pregnancy, Pregnancy Recognition.

HIGH LEVELS OF alcohol consumption during pregnancy are teratogenic to fetal brain structure, function, and development (Abel, 1998; Behnke and Smith, 2013; Cudd, 2005; Jones and Smith, 1973). Prenatal alcohol exposure increases the risk for birth defects, early onset psychopathology, and neurodevelopmental disorders (Kelly et al., 2000; Kodituwakku, 2009; O'Connor et al., 2002; O'Leary, 2012; Rasmussen et al., 2008, 2013). Individual fetal effects are a result of a complex interaction between maternal and

fetal genetic susceptibility and metabolic factors, maternal lifestyle factors such as nutrition and physical health (Abel and Hannigan, 1995), and timing, dose, and pattern of alcohol consumption (Matthews, 2002; O'Leary et al., 2010). Consequently, the relationship between prenatal alcohol exposure and fetal development has been debated in the literature, in particular, identification of a level below which there is no harm to the fetus (O'Leary and Bower, 2012). In Canada, recent Clinical Practice Guidelines by the Society of Gynecologists and Obstetricians highlight that there is *insufficient* evidence to define any safe threshold for low-level drinking in pregnancy, thus recommending abstinence (Carson et al., 2010).

Approximately 80% of women of childbearing age consume alcohol (Tough et al., 2006). Prevalences of drinking during pregnancy differ across studies and countries, ranging from 6% in Sweden to 71% in Denmark (Hutchinson et al., 2013). Population-based studies in Canada, the United States, and New Zealand have reported prevalences of alcohol consumption prior to pregnancy recognition of up to 50% (Floyd et al., 1999; Parackal et al., 2013; Tough et al., 2006), even among women with planned pregnancies (Tough

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Received for publication May 14, 2014; accepted September 13, 2014.

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DOI: 10.1111/acer.12579

et al., 2006). A majority of women abstain from alcohol on pregnancy recognition, yet postrecognition prevalences of between 12% and 26% were reported in studies in the United States (12%; Denny et al., 2009), New Zealand (13%; Parackal et al., 2013), Japan (23%; Yamamoto et al., 2008), and Taiwan (26%; Yen et al., 2012).

Only a few studies have reported on the patterns and predictors of alcohol consumption among women in early pregnancy prior to pregnancy recognition (Parackal et al., 2013); however, this information is critical for developing strategies to reduce the risk of alcohol-exposed pregnancies. A systematic review of predictors of “any” drinking during pregnancy identified 2 consistent predictors: previous exposure to abuse or violence, and prepregnancy alcohol consumption (Skagerstrom et al., 2011). The majority of studies on low to moderate alcohol consumption in pregnancy have focused on child development outcomes, such as cognitive and behavioral problems. As such, there is a knowledge gap regarding the maternal preconception characteristics and life circumstances associated with this specific pattern of consumption. The objectives of this study were to examine the maternal characteristics associated with 2 separate patterns of drinking in pregnancy: (i) any binge drinking in early pregnancy, prior to pregnancy recognition; and (ii) low to moderate average levels of alcohol consumption after pregnancy recognition, using prospective data drawn from a community pregnancy cohort study in Alberta, Canada.

MATERIALS AND METHODS

The All Our Babies (AOB) pregnancy cohort in Calgary, Alberta, Canada has enrolled and followed over 3,000 mother infant dyads since 2008. Study design, recruitment, and other methodological details are reported elsewhere (Gracie et al., 2010; McDonald et al., 2013). In brief, participants were recruited early in pregnancy and completed questionnaires at <25 weeks, 34 to 36 weeks, and 4 months postpartum. Recruitment strategies included primary healthcare offices, community posters and word of mouth, and collaboration with a citywide single provider public health laboratory service (Calgary Laboratory Services). Women were eligible if they were ≤ 24 weeks and 6 days gestation age at the time of recruitment, at least 18 years of age, receiving prenatal care in Calgary, and able to complete the questionnaires in English. Longitudinal data collection of child outcomes at 12, 24, and 36 months postbirth followed perinatal data collection, with <5% attrition at each follow-up time point. The questionnaires included standardized scales and investigator derived questions about sociodemographics, lifestyle, healthcare utilization, maternal mental health, birth outcomes, breastfeeding, and child development. Participants were also asked to provide consent for the research team to access their electronic obstetrical and birth records. This study was approved by the Conjoint Health Research Ethics Board of the University of Calgary.

Study Variables

Information on alcohol consumption patterns in the year before pregnancy and the periods prior to and subsequent to pregnancy recognition were collected during pregnancy through mailed, self-report questionnaires. The questions on preconception patterns

were asked at <25 weeks gestation, and the questions on consumption during pregnancy were administered between 34 and 36 weeks gestation. Single item questions on frequency (days per week) and amount (drinks per occasion) were asked for each period. Average levels of alcohol consumption were categorized according to combinations of frequency and amount as per Canadian guidelines for low and risky drinking patterns in pregnancy (Carson et al., 2010), in consultation with FASD content experts, and in consideration of drinking patterns. Final categories comprised low levels (<1 drink per occasion at ≤ 7 days per week), moderate levels (1 drink per occasion at ≤ 7 days per week or 2 drinks per occasion at ≤ 3 days per week), and high levels (2 drinks per occasion at 4 to 7 days per week or ≥ 3 drinks per occasion at any time). Binge drinking for each period was assessed using a separate question and was defined as consuming 5 or more drinks per occasion.

Maternal characteristics and predictors of alcohol consumption included sociodemographics, previous mental health problems, history of abuse, prepregnancy lifestyle (body mass index [BMI], smoking and drinking behavior), pregnancy intention, parity, prenatal depression, anxiety, social support, and maternal optimism. Prenatal psychosocial health and optimism were assessed using standardized measures with adequate psychometric properties. At <25 weeks, the Edinburgh Postnatal Depression Scale (Cox et al., 1987), the Spielberger State-Trait Anxiety Scale (Meades and Ayers, 2011; Spielberger et al., 1970), and the Medical Outcomes Study Social Support Scale (Sherbourne and Stewart, 1991) were used to assess symptoms of prenatal depression, anxiety, and perceived social support, respectively. The Life-Orientation Test-Revised (Scheier et al., 1994) was used to measure maternal dispositional optimism at 34 to 36 weeks. Low maternal optimism was defined as scoring below the 20th percentile of the distribution. Poor prenatal psychosocial health was operationalized as scoring in the excessive symptom range (high or low depending on the construct) as per each scale's established cutoff. All other variables were assessed using single item question(s) that were developed by the research team or drawn from other cohort studies. Prepregnancy BMI was defined as prepregnancy weight (kg) per height (m^2) and was categorized according to World Health Organization guidelines: underweight (<18.5 kg/ m^2); normal weight (18.5 to 24.9 kg/ m^2); overweight (25 to 29.9 kg/ m^2); and obese (≥ 30 kg/ m^2). Underweight and normal weight categories were collapsed as were overweight and obese prior to analysis and defined as BMI <25 kg/ m^2 versus BMI ≥ 25 kg/ m^2 . History of abuse was defined as having ever experienced neglect, or any physical, sexual, emotional, or financial abuse.

Statistical Analysis

Descriptive statistics were generated using frequencies and proportions. Bivariate analysis was conducted to examine associations between maternal characteristics and any binge drinking prior to pregnancy recognition and low to moderate average levels of drinking after pregnancy recognition using chi-square tests. Unadjusted and adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were generated in crude and multivariable logistic regression models. Statistical significance was set at $p < 0.05$. Variables were considered eligible for inclusion in the multivariable analysis at $p < 0.1$. Final, parsimonious regression models are presented. On average, never-drinkers have been found to have lower socioeconomic status and poorer physical and mental health than drinkers (Ng Fat and Shelton, 2012; Ng Fat et al., 2014; Power et al., 1998). Use of never-drinkers as the reference group in studies on the effects of alcohol consumption is not recommended due to the potential for residual confounding as covariates are less likely to be balanced between comparison groups (Ng Fat et al., 2014). The final analytic sample comprised those who reported drinking in the year prior to pregnancy and who filled out all 3 questionnaires across the

perinatal period ($n = 2,246$). The reference group included pre-pregnancy drinkers who abstained during pregnancy.

RESULTS

Sample Characteristics

Participant demographics, obstetrical, and lifestyle characteristics are presented in Table 1. Psychosocial characteristics are shown in Table 2. The majority of participants were less than 35 years of age at delivery (77%), Caucasian (87%), and Canadian born (85%). Almost all were living with a partner as married or in a common-law relationship (95%). Approximately 90% had completed at least some postsecondary education, and 76% had household incomes of at least \$80,000. Almost half were nulliparous (49%), and 18% indicated that they were not trying to get pregnant. In the

Table 1. Demographics, Obstetrical, and Lifestyle Characteristics of the All Our Babies Study Sample ($n = 2,246$)^a

Characteristic	n (%) ^b
Maternal age	
≤ 24	127 (5.7)
25 to 34	1,607 (71.5)
≥ 35	512 (22.8)
Household income	
$\leq \$79,999$	554 (24.2)
$\geq \$80,000$	1,702 (75.8)
Education	
\leq High school	212 (9.4)
Some or complete university/college	1,671 (74.4)
Some or complete grad school	363 (16.2)
Marital status	
Married/common-law	2,132 (94.9)
Other	114 (5.1)
Ethnic origin	
Other	296 (13.2)
White/Caucasian	1,950 (86.8)
Born in Canada	
Yes	1,913 (85.2)
No	333 (14.8)
Parity	
No previous birth	1,145 (51.0)
Previous birth	1,101 (49.0)
Pregnancy intention	
Trying	1,854 (82.5)
Not trying	392 (17.5)
History of abuse (physical, emotional, sexual, financial)	
No	1,617 (72.0)
Yes	629 (28.0)
Previous mental health problems	
No	2,062 (91.8)
Yes	184 (8.2)
Prepregnancy BMI	
$< 25 \text{ kg/m}^2$	1,459 (65.0)
$\geq 25 \text{ kg/m}^2$	787 (35.0)
Smoking 12 months prior to pregnancy	
No	1,852 (82.5)
Yes	394 (17.5)
Binge drinking 12 months prior to pregnancy	
No	1,086 (48.4)
Yes	1,094 (48.7)

^aNondrinkers in the year before pregnancy removed.

^bDenominators may differ slightly due to variable specific missing data.

Table 2. Psychosocial Characteristics of the All Our Babies Study Sample ($n = 2,246$)^a

Characteristic	n (%) ^b
Prenatal depression	
No	2,103 (93.6)
Yes	139 (6.2)
Prenatal anxiety	
No	1,860 (82.8)
Yes	338 (15.0)
Prenatal social support	
Adequate	2,000 (89.0)
Inadequate	234 (10.4)
Dispositional optimism	
Medium to high	1,703 (75.8)
Low	378 (16.8)

^aNondrinkers in the year before pregnancy removed.

^bDenominators may differ slightly due to variable specific missing data.

year prior to pregnancy, 18% smoked and 49% reported at least 1 episode of binge drinking. Twenty-eight percent had experienced abuse. Women in the AOB cohort reported prevalences of prenatal depression and anxiety of 6% and 15%, respectively. The majority of women reported adequate prenatal social support (89%) and medium to high levels of optimism (76%).

Patterns of Consumption

Almost half (49%) of the women reported drinking some alcohol in pregnancy, including before they realized they were pregnant. Three percent stopped consuming alcohol at pregnancy recognition, with 46% of all women continuing to drink, almost all at low to moderate levels. Among women who reported drinking some alcohol in pregnancy, average drinking levels prior to pregnancy recognition were high (11%), moderate (64%), and low (25%). Postpregnancy recognition, average drinking levels were high (1%), moderate (6%), and low (93%). Approximately 13% of women reported at least 1 binge episode prior to recognizing they were pregnant. None of the women reported an episode of drinking after recognizing they were pregnant.

Bivariate Analysis

Tables 3 and 4 present bivariate results. Women who reported binge drinking in early pregnancy were more likely to be younger, have lower income and education levels, living without a partner, and born in Canada ($p < 0.05$). In addition, women who were nulliparous, not trying to get pregnant, had a history of abuse, smoked 1 year prior to pregnancy, and had at least 1 binge episode in the year before pregnancy were more likely to report binge drinking in early pregnancy ($p < 0.05$). Finally, binge drinking was associated with prenatal depression, prenatal anxiety, and low dispositional optimism ($p < 0.05$) (Table 3).

For low to moderate levels of consumption after pregnancy recognition, the 1% of women who reported

Table 3. Maternal Characteristics Associated with Binge Drinking in Early Pregnancy

Characteristic	Binge in pregnancy n (%)	Did not binge/Did not drink in pregnancy n (%)	Unadjusted OR (95% CI)	p-Value*
Maternal age				
≤24	35 (29.4)	84 (70.6)	4.28 (2.58, 7.09)	<0.001
25 to 34	188 (12.4)	1,324 (87.6)	1.46 (1.03, 2.07)	
≥35	42 (8.9)	431 (91.1)	1.00	
Household income				
≤\$79,999	81 (15.7)	436 (84.3)	1.42 (1.07, 1.88)	0.015
≥\$80,000	184 (11.6)	1,403 (88.4)	1.00	
Education				
≤High school	108 (23.0)	362 (77.0)	7.19 (2.79, 13.63)	<0.001
Some or complete university/college	146 (10.8)	1,212 (89.2)	2.90 (1.55, 5.43)	
Some or complete grad school	11 (4.0)	265 (96.0)	1.00	
Marital status				
Married/common-law	231 (11.5)	1,771 (88.5)	1.00	<0.001
Other	34 (33.3)	68 (66.7)	3.83 (2.48, 5.92)	
Ethnic origin				
Other	30 (10.9)	244 (89.1)	1.00	0.379
White/Caucasian	235 (12.8)	1,595 (87.2)	1.20 (0.80, 1.79)	
Born in Canada				
Yes	239 (13.4)	1,548 (86.6)	1.73 (1.13, 2.64)	0.011
No	26 (8.2)	291 (91.8)	1.00	
Parity				
No previous birth	89 (8.5)	956 (91.5)	2.14 (1.63, 2.81)	<0.001
Previous birth	176 (16.6)	883 (83.4)	1.00	
Pregnancy intention				
Trying	179 (10.2)	1,572 (89.8)	1.00	<0.001
Not trying	86 (24.4)	267 (75.6)	2.83 (2.12, 3.77)	
History of abuse (physical, emotional, sexual, financial)				
No	167 (10.8)	1,384 (89.2)	1.00	<0.001
Yes	98 (17.7)	455 (82.3)	1.79 (1.36, 2.34)	
Previous mental health problems				
No	242 (12.5)	1,700 (87.5)	1.00	0.522
Yes	23 (14.2)	139 (85.8)	1.16 (0.73, 1.84)	
Prepregnancy BMI				
<25 kg/m ²	174 (12.8)	1,187 (87.2)	1.05 (0.80, 1.38)	0.723
≥25 kg/m ²	91 (12.2)	652 (87.8)	1.00	
Smoking 12 months prior to pregnancy				
No	154 (8.8)	1,590 (91.2)	1.00	<0.001
Yes	111 (30.8)	249 (69.2)	4.60 (3.49, 6.08)	
Binge drinking 12 months prior to pregnancy				
No	20 (2.0)	991 (98.0)	1.00	<0.001
Yes	240 (23.6)	778 (76.4)	15.29 (9.59, 24.35)	
Prenatal depression				
No	237 (12.0)	1,730 (88.0)	1.00	0.011
Yes	26 (19.5)	107 (80.5)	1.77 (1.13, 2.78)	
Prenatal anxiety				
No	200 (11.4)	1,554 (88.6)	1.00	<0.001
Yes	62 (19.7)	252 (80.3)	1.91 (1.40, 2.62)	
Prenatal social support				
Adequate	231 (12.3)	1,646 (87.7)	1.00	0.376
Inadequate	31 (14.4)	184 (85.6)	1.20 (0.80, 1.80)	
Dispositional optimism				
Medium to high	188 (11.0)	1,523 (89.0)	1.00	<0.001
Low	76 (20.0)	304 (80.0)	2.03 (1.51, 2.72)	

*Omnibus *p*-value from chi-square analysis.

drinking high average levels of drinking after pregnancy recognition was removed. Women who were younger, had lower education, not living with a partner, born in Canada, and Caucasian were more likely to report drinking low to moderate levels of alcohol after pregnancy recognition ($p < 0.05$). Nulliparity, not trying to get pregnant, smoking and binge drinking history, and prepregnancy BMI <25.0 kg/m² were also associated with low to moderate levels of drinking

in pregnancy ($p < 0.05$). Finally, women with prenatal depression and anxiety were more likely to consume alcohol at low to moderate levels in pregnancy ($p < 0.05$) (Table 4).

Multivariable Analysis

Table 5 presents parsimonious models derived from multivariable analysis. Manual backward stepwise deletion was

Table 4. Maternal Characteristics Associated with Low to Moderate Level Alcohol Consumption After Pregnancy Recognition

Characteristic	Low-moderate level drinking in pregnancy <i>n</i> (%)	Did not drink in pregnancy <i>n</i> (%)	Unadjusted OR (95% CI)	<i>p</i> -Value*
Maternal age				
≤24	79 (68.1)	37 (31.9)	1.48 (0.96, 2.28)	0.037
25 to 34	820 (56.4)	635 (43.6)	0.89 (0.72, 1.11)	
≥35	269 (59.1)	186 (40.9)	1.00	
Household income				
≤\$79,999	286 (57.9)	208 (42.1)	1.01 (0.83, 1.24)	0.899
≥\$80,000	882 (57.6)	650 (42.4)	1.00	
Education				
≤High school	286 (63.3)	166 (36.7)	1.28 (0.94, 1.75)	0.021
Some or complete university/college	730 (55.8)	579 (44.2)	0.94 (0.72, 1.22)	
Some or complete grad school	152 (57.4)	113 (42.6)	1.00	
Marital status				
Married/common-law	1,090 (56.6)	835 (43.4)	1.00	<0.001
Other	78 (77.2)	23 (22.8)	2.60 (1.62, 4.17)	
Ethnic origin				
Other	129 (48.5)	137 (51.5)	1.00	0.001
White/Caucasian	1,039 (59.0)	721 (41.0)	1.53 (1.18, 1.98)	
Born in Canada				
Yes	1,019 (59.1)	704 (40.9)	1.50 (1.17, 1.91)	0.001
No	149 (49.2)	154 (50.8)	1.00	
Parity				
No previous birth	618 (60.6)	401 (39.4)	1.28 (1.07, 1.53)	0.006
Previous birth	550 (54.6)	457 (45.4)	1.00	
Pregnancy intention				
Trying	921 (54.7)	763 (45.3)	1.00	<0.001
Not trying	247 (72.2)	95 (27.8)	2.15 (1.67, 2.78)	
History of abuse (physical, emotional, sexual, financial)				
No	845 (56.6)	649 (43.4)	1.00	0.096
Yes	323 (60.7)	209 (39.3)	1.19 (0.97, 1.45)	
Previous mental health problems				
No	1,072 (57.4)	797 (42.6)	1.00	0.356
Yes	96 (61.1)	61 (38.9)	1.17 (0.84, 1.63)	
Prepregnancy BMI				
<25 kg/m ²	784 (59.7)	529 (40.3)	1.27 (1.06, 1.53)	0.011
≥25 kg/m ²	384 (53.9)	329 (46.1)	1.00	
Smoking 12 months prior to pregnancy				
No	901 (53.7)	776 (46.3)	1.00	<0.001
Yes	267 (76.5)	82 (23.5)	2.80 (2.15, 3.66)	
Binge drinking 12 months prior to pregnancy				
No	446 (46.1)	521 (53.9)	1.00	<0.001
Yes	706 (71.4)	283 (28.6)	2.91 (2.42, 3.51)	
Prenatal depression				
No	1,079 (57.0)	815 (43.0)	1.00	0.037
Yes	85 (66.4)	43 (33.6)	1.49 (1.02, 2.18)	
Prenatal anxiety				
No	959 (56.7)	733 (43.3)	1.00	0.048
Yes	189 (62.8)	112 (37.2)	1.29 (1.00, 1.66)	
Prenatal social support				
Adequate	1,041 (57.6)	767 (42.4)	1.00	0.853
Inadequate	120 (58.3)	86 (41.7)	1.03 (0.77, 1.38)	
Dispositional optimism				
Medium to high	952 (57.5)	703 (42.5)	1.00	0.623
Low	211 (58.9)	147 (41.1)	1.06 (0.84, 1.34)	

*Omnibus *p*-value from chi-square analysis.

used to derive final models. All excluded variables were added 1 at a time to ensure robustness of the final models (likelihood ratio tests). Factors that remained significant, independent predictors of binge drinking in early pregnancy included high school or less education (odds ratio [OR] 3.61, 95% confidence interval [CI]: 1.81, 7.19), some or completed university/college (OR 2.23, 95% CI: 1.16, 4.27), nulliparity (OR 1.62, 95% CI: 1.19, 2.20), not trying

to get pregnant (OR 1.92, 95% CI: 1.37, 2.69), smoked in the year prior to pregnancy (OR 1.98, 95% CI: 1.43, 2.73), binge drinking in the year prior to pregnancy (OR 10.83, 95% CI: 6.71, 17.46), and low dispositional optimism (OR 1.73, 95% CI: 1.23, 2.42). Significant independent predictors of low to moderate average levels of consumption after pregnancy recognition included not trying to get pregnant (OR 1.91, 95% CI: 1.45, 2.52), prepregnancy

Table 5. Final Multivariable Logistic Regression Models^a

Independent variable	Binge drinking prior to pregnancy recognition OR (95% CI)	Low to moderate consumption levels after pregnancy recognition OR (95% CI)
Education		
High school or less education	3.61 (1.81, 7.19)	–
Some or completed university/college	2.23 (1.16, 4.27)	–
Some or completed graduate studies	1.00	
Parity		
Nulliparous	1.62 (1.19, 2.20)	–
Primi/multiparous	1.00	
Pregnancy intention		
Not trying to get pregnant	1.92 (1.37, 2.69)	1.91 (1.45, 2.52)
Trying to get pregnant	1.00	1.00
Prepregnancy BMI		
<25.0 kg/m ²	–	1.41 (1.61, 1.72)
≥25.0 kg/m ²		1.00
Smoking 12 months prior to pregnancy		
Yes	1.98 (1.43, 2.73)	1.90 (1.43, 2.53)
No	1.00	1.00
Binge drinking 12 months prior to pregnancy		
Yes	10.83 (6.71, 17.46)	2.62 (2.16, 3.18)
No	1.00	1.00
Dispositional optimism		
Low	1.73 (1.23, 2.42)	–
Medium to high	1.00	

^aVariables considered for inclusion that were common to both models included: maternal age, education, marital status, born in Canada, parity, pregnancy intention, history of abuse, smoking 12 months prior to pregnancy, binge drinking 12 months prior to pregnancy, prenatal depression, and prenatal anxiety. For *binge drinking prior to pregnancy recognition*, household income and dispositional optimism were also considered for inclusion. For *low to moderate consumption levels after pregnancy recognition*, ethnicity and pregnancy BMI were also considered for inclusion.

BMI < 25.0 kg/m² (OR 1.41, 95% CI: 1.61, 1.72), smoking in the year before pregnancy (OR 1.90, 95% CI: 1.43, 2.53), and binge drinking in the year before pregnancy (OR 2.62, 95% CI: 2.16, 3.18).

DISCUSSION

Main Findings

The present study found that 46% of women who consume alcohol in the year before pregnancy do not abstain from alcohol after pregnancy recognition, although for the majority, levels of consumption are low. Thirteen percent of all women reported at least 1 binge episode in pregnancy that occurred prior to pregnancy recognition.

In this study, the 13% of women who were binge drinking in early pregnancy was lower than the 20% reported by the Danish National Birth Cohort (Strandberg-Larsen et al., 2008). This latter study found that binge drinking prior to pregnancy recognition was more common among women who were nulliparous, aged 25 to 29 years, and were well educated and skilled workers. Although the multivariable

results showed a different set of predictors, nulliparity was common to both and discrepancies may be due to differences in potential variables examined. The finding that prepregnancy binge drinking was an independent predictor of binge drinking in early pregnancy aligns with a recent nationwide cross-sectional study in New Zealand (Parackal et al., 2013). A systematic review on predictors of drinking during pregnancy found that consistent predictors of alcohol consumption in pregnancy were exposure to violence or abuse and prepregnancy drinking patterns (Skagerstrom et al., 2011). Although not significant in the final multivariable model, history of abuse was significantly associated with binge drinking in bivariate analysis. Studies stemming from the Adverse Childhood Experiences study have documented associations between child maltreatment and neglect and poor health outcomes in adult life, including risky lifestyle behaviors such as substance use and abuse (Anda et al., 2002; Dube et al., 2002). Previous binge drinking could be a mediator of the association between a history of abuse and binge drinking in early pregnancy, and therefore could be 1 potential explanation as to why the effect of a history of abuse was no longer an independent predictor in the multivariable analysis.

The finding that unintended pregnancy was associated with binge drinking in early pregnancy was not surprising and aligns with previous research (Backhausen et al., 2014; Ethen et al., 2009; Strandberg-Larsen et al., 2008). Of note, low maternal dispositional optimism remained a significant independent predictor of binge drinking in pregnancy prior to pregnancy recognition. This novel finding aligns with other recent work suggesting that an ego-dystonic pregnancy (one that is psychologically uncomfortable) predicts prenatal consumption of alcohol (O'Brien, 2012) and that a self-medication hypothesis and “drinking to cope” may apply to prenatal drinking. Further research is clearly warranted as the ability to cope and propensity to self-medicate may be indicators of underlying issues that may benefit from targeted intervention and screening.

Previous research indicates that a majority of women cease drinking or reduce their levels of consumption on pregnancy recognition (Bakker et al., 2010; Ethen et al., 2009; Ho and Jacquemard, 2009). Postrecognition alcohol consumption levels were lower than prerecognition levels in the present study. Continuing to consume alcohol at low levels aligns with a Canadian study based on the Maternity Experience Survey that found that over 95% of the 10% of pregnant women who consumed alcohol once they knew they were pregnant did so at low to moderate levels (Walker et al., 2011). The low postrecognition alcohol abstinence rates found in the present study is surprising compared to previous reports. Indeed, a recent study conducted in New Zealand found strikingly different rates, with almost 50% stopping on pregnancy recognition and 13% drinking otherwise in pregnancy (Parackal et al., 2013). The low stopping rate and the high rate of continuing to consume <1 drink per week found in the present study could be due to question wording,

as the questions were posed in a nonleading way, possibly decreasing social desirability response bias and thus better reflective of “true” rates.

Examination of sociodemographic and prepregnancy characteristics in the multivariable analysis found that a pattern of low to moderate average level of alcohol consumption after pregnancy recognition was associated with unintended pregnancy, <25 kg/m² BMI, and smoking and binge drinking in the year prior to pregnancy. A recent population-based study in Australia also found that prepregnancy drinking behavior was an important predictor of drinking in pregnancy (Anderson et al., 2013). Further, studies in the United States have also found that the risk of alcohol exposure during pregnancy is elevated among women who binge drink before becoming pregnant (Ethen et al., 2009; Naimi et al., 2003).

A number of studies have reported that comorbid substance use during pregnancy is associated with drinking in pregnancy. In particular, prenatal tobacco use is a consistent correlate of prenatal alcohol use (Hutchinson et al., 2013). Although smoking in pregnancy was not examined as a *predictor* in the present study, additional analyses showed that both alcohol outcomes were correlated with prenatal smoking, and smoking in the previous 12 months was a strong predictor of smoking in pregnancy (data not shown). Findings from a number of studies in developed nations support a broad cultural trend that women who consume low to moderate levels of alcohol are likely to be older, more affluent, and in good health (Hutchinson et al., 2013; Jeffery et al., 1991). In the present study, <25 kg/m² BMI could be a proxy for a healthy lifestyle and the finding that women in this weight category were more likely to consume low levels of alcohol in pregnancy fit this trend. However, older age and “affluence,” defined as higher education and income in the present study did not emerge as significant predictors in bivariate and multivariable analyses for low to moderate alcohol consumption after pregnancy recognition. Although, in general, the study sample reflects a relatively affluent sample, demographically similar to the pregnancy population in a Canadian urban center (McDonald et al., 2013), the exclusion of nondrinkers prior to pregnancy likely decreased the extent of variability in these sociodemographic characteristics between the comparison groups.

Strengths and Weaknesses

Strengths of this study include its prospective design, large sample size, high retention rate, and data collection of a wide range of maternal characteristics and information about alcohol use before and after pregnancy recognition and in the year prior to pregnancy. A potential limitation of this study may be that all information collected was based on maternal self-report. In addition, data on alcohol consumption in the year prior to pregnancy and during pregnancy were retrospectively collected in the third trimester, at 34 to 36 weeks, and a definition of a standard drink was not given.

Although recall bias and misclassification of drinking may underestimate the true prevalence of alcohol consumption, there is no reason to suspect that *associations* are misrepresented. Furthermore, self-report information has been found to be more reliable than other data collection methods for assessing alcohol consumption in pregnancy (McNamara et al., 2005). Further, we were unable to assess the impact of previous or current illicit drug abuse in this study due to extremely low numbers reporting this behavior. Finally, we acknowledge that our exclusion of women who abstained from alcohol in the year prior to pregnancy is not equivalent to exclusion of lifetime abstainers. As such, we may have excluded women who abstained from alcohol while trying to become pregnant and took longer than 12 months to conceive. This could potentially overestimate the prevalence of drinking during pregnancy and underestimate the prevalence of women who stopped drinking due to a planned pregnancy. Although women who were nondrinkers in the year prior to pregnancy were not significantly different than the present study's reference group in terms of pregnancy intention (results not shown), the potential for residual confounding remains.

CONCLUSION

The challenge to women of childbearing age who consume alcohol is to stop drinking prior to conception, and public health strategies that support women to abstain from alcohol if they are able to conceive are needed. The results of this study align with others and highlight the important influence of prepregnancy behaviors on alcohol consumption at different time points during pregnancy. Targeted strategies that can reduce the risk of unintended pregnancy and that address the needs of alcohol using women may be beneficial (Tough et al., 2005, 2006). Some examples include the provision of opportunities for safe discussions about substance use for young women and supporting healthcare providers as key educators regarding appropriate alcohol use for women in the preconception period and during pregnancy (Tough et al., 2004). Further, it is necessary to go beyond education and recommendations for individual action and consider approaches based on a population-based and lifecourse perspective (Mills et al., 2009; Tough, 2010). Strategies that invest in early identification of risk for substance use are recommended for primary prevention to reduce the risk of substance abuse and dependence in general, and alcohol-exposed pregnancies in particular.

ACKNOWLEDGMENTS

We are extremely grateful to all the families who took part in this study and the whole All Our Babies team. We acknowledge and express our gratitude to the investigators, coordinators, research staff, and managers. Initial funding for this cohort was provided by Three Cheers for the Early

Years, the Alberta Children's Hospital Foundation and through PreHOT by Alberta Innovates Health Solutions Interdisciplinary Team Grant #200700595.

REFERENCES

- Abel E (1998) Fetal Alcohol Abuse Syndrome. Plenum Press, New York, NY.
- Abel EL, Hannigan JH (1995) Maternal risk factors in fetal alcohol syndrome: provocative and permissive influences. *Neurotoxicol Teratol* 17:445–462.
- Anda RF, Whitfield CL, Felitti VJ, Chapman D, Edwards VJ, Dube SR, Williamson DF (2002) Adverse childhood experiences, alcoholic parents, and later risk of alcoholism and depression. *Psychiatr Serv* 53:1001–1009.
- Anderson AE, Hure AJ, Forder P, Powers JR, Kay-Lambkin FJ, Loxton DJ (2013) Predictors of antenatal alcohol use among Australian women: a prospective cohort study. *BJOG* 120:1366–1374.
- Backhausen MG, Ekstrand M, Tydén T, Magnussen BK, Shawe J, Stern J, Hegaard HK (2014) Pregnancy planning and lifestyle prior to conception and during early pregnancy among Danish women. *Eur J Contracept Reprod Health Care* 19:57–65.
- Bakker R, Pluimgraaff LE, Steegers EA, Raat H, Tiemeier H, Hofman A, Jaddoe VW (2010) Associations of light and moderate maternal alcohol consumption with fetal growth characteristics in different periods of pregnancy: the Generation R Study. *Int J Epidemiol* 39:777–789.
- Behnke M, Smith VC (2013) Prenatal substance abuse: short- and long-term effects on the exposed fetus. *Pediatrics* 131:e1009–e1024.
- Carson G, Cox LV, Crane J, Croteau P, Graves L, Kluka S, Koren G, Martel MJ, Midmer D, Nulman I, Poole N, Senikas V, Wood R, Society of Obstetricians and Gynaecologists of Canada (2010) Alcohol use and pregnancy consensus clinical guidelines. *J Obstet Gynaecol Can* 32(8 Suppl 3):S1–S31.
- Cox JL, Holden JM, Sagovsky R (1987) Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *Br J Psychiatry* 150:782–786.
- Cudd TA (2005) Animal model systems for the study of alcohol teratology. *Exp Biol Med* (Maywood) 230:389–393.
- Denny CH, Tsai J, Floyd RL, Green PP (2009) Alcohol use among pregnancy and non-pregnant women of childbearing age United States, 1991–2005. *MMRW Morb Mortal Wkly Rep* 58:529–532.
- Dube SR, Anda RF, Felitti VJ, Edwards VJ, Croft JB (2002) Adverse childhood experiences and personal alcohol abuse as an adult. *Addict Behav* 27:713–725.
- Ethen MK, Ramadhani TA, Scheuerle AE, Canfield MA, Wyszynski DF, Druschel CM, Romitti PA (2009) Alcohol consumption by women before and during pregnancy. *Matern Child Health J* 13:274–285.
- Floyd RL, Decoufle P, Hungerford DW (1999) Alcohol use prior to pregnancy recognition. *Am J Prev Med* 17:101–107.
- Gracie SK, Lyon AW, Kehler HL, Pennell CE, Dolan SM, McNeil DA, Siever JE, McDonald SW, Bocking AD, Lye SJ, Hegadoren KM, Olson DM, Tough SC (2010) All Our Babies Cohort Study: recruitment of a cohort to predict women at risk of preterm birth through the examination of gene expression profiles and the environment. *BMC Pregnancy Childbirth* 10:87.
- Ho R, Jacquemard R (2009) Maternal alcohol use before and during pregnancy among women in Taranaki, New Zealand. *N Z Med J* 122:20–32.
- Hutchinson D, Moore EA, Breen C, Burns L, Mattick RP (2013) Alcohol use in pregnancy: prevalence and predictors in the Longitudinal Study of Australian Children. *Drug Alcohol Rev* 32:475–482.
- Jeffery RW, French SA, Forster JL, Spry VM (1991) Socioeconomic status differences in health behaviors related to obesity: the Healthy Worker Project. *Int J Obes* 15:689–696.
- Jones KL, Smith DW (1973) Recognition of the fetal alcohol syndrome in early infancy. *Lancet* 302:999–1001.
- Kelly SJ, Day N, Streissguth AP (2000) Effects of prenatal alcohol exposure on social behavior in humans and other species. *Neurotoxicol Teratol* 22:143–149.
- Koditwakkhu PW (2009) Neurocognitive profile in children with fetal alcohol spectrum disorders. *Dev Disabil Res Rev* 15:218–224.
- Matthews SG (2002) Early programming of the hypothalamo-pituitary-adrenal axis. *Trends Endocrinol Metab* 13:373–380.
- McDonald SW, Lyon AW, Benzies KM, McNeil DA, Lye SJ, Dolan SM, Pennell CE, Bocking AD, Tough SC (2013) The All Our Babies pregnancy cohort: design, methods, and participant characteristics. *BMC Pregnancy Childbirth* 13(Suppl 1):S2.
- McNamara TK, Orav EJ, Wilkins-Haug L, Chang G (2005) Risk during pregnancy—self-report versus medical record. *Am J Obstet Gynecol* 193:1981–1985.
- Meades R, Ayers S (2011) Anxiety measures validated in perinatal populations: a systematic review. *J Affect Disord* 133:1–15.
- Mills RM, Siever JE, Hicks M, Badry D, Tough SC, Benzies K (2009) Child guardianship in a Canadian home visitation program for women who use substances in the perinatal period. *Can J Clin Pharmacol* 16:e126–e139.
- Naimi TS, Lipscomb LE, Brewer RD, Gilbert BC (2003) Binge drinking in the preconception period and the risk of unintended pregnancy: implications for women and their children. *Pediatrics* 111(5 Pt 2):1136–1141.
- Ng Fat L, Cable N, Marmot M, Shelton N (2014) Persistent long-standing illness and non-drinking over time, implications for the use of lifetime abstainers as a control group. *J Epidemiol Community Health* 68:71–77.
- Ng Fat L, Shelton N (2012) Associations between self-reported illness and non-drinking in young adults. *Addiction* 107:1612–1620.
- O'Brien PL (2012) Ego-dystonic pregnancy and prenatal consumption of alcohol among first-time mothers. *Matern Child Health J* 16:1431–1439.
- O'Connor MJ, Shah B, Whaley S, Cronin P, Gunderson B, Graham J (2002) Psychiatric illness in a clinical sample of children with prenatal alcohol exposure. *Am J Drug Alcohol Abuse* 28:743–754.
- O'Leary CM (2012) The association between prenatal alcohol exposure, fetal growth and preterm birth: evidence from a systematic review and meta-analyses. *Evid Based Nurs* 15:77–78.
- O'Leary CM, Bower C (2012) Guidelines for pregnancy: what's an acceptable risk, and how is the evidence (finally) shaping up? *Drug Alcohol Rev* 31:170–183.
- O'Leary CM, Nassar N, Zubrick SR, Kurinczuk JJ, Stanley F, Bower C (2010) Evidence of a complex association between dose, pattern and timing of prenatal alcohol exposure and child behaviour problems. *Addiction* 105:74–86.
- Parackal SM, Parackal MK, Harraway JA (2013) Prevalence and correlates of drinking in early pregnancy among women who stopped drinking on pregnancy recognition. *Matern Child Health J* 17:520–529.
- Power C, Rodgers B, Hope S (1998) U-shaped relation for alcohol consumption and health in early adulthood and implications for mortality. *Lancet* 352:877.
- Rasmussen C, Andrew G, Zwaigenbaum L, Tough S (2008) Neurobehavioural outcomes of children with fetal alcohol spectrum disorders: a Canadian perspective. *Paediatr Child Health* 13:185–191.
- Rasmussen C, Tamana S, Baugh L, Andrew G, Tough S, Zwaigenbaum L (2013) Neuropsychological impairments on the NEPSY-II among children with FASD. *Child Neuropsychol* 19:337–349.
- Scheier MF, Carver CS, Bridges MW (1994) Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): a reevaluation of the Life Orientation Test. *J Pers Soc Psychol* 67:1063–1078.
- Sherbourne CD, Stewart AL (1991) The MOS social support survey. *Soc Sci Med* 32:705–714.
- Skagerstrom J, Chang G, Nilsen P (2011) Predictors of drinking during pregnancy: a systematic review. *J Womens Health (Larchmt)* 20:901–913.
- Spielberger C, Gorsuch R, Lushene R (1970) Test Manual for the State-Trait Anxiety Inventory. Consulting Psychologist's Press, Palo Alto, CA.
- Strandberg-Larsen K, Rod Nielsen N, Nybo Andersen AM, Olsen J, Gronbaek M (2008) Characteristics of women who binge drink before and after they become aware of their pregnancy. *Eur J Epidemiol* 23:565–572.

- Tough SC (2010) Dispelling myths and developing a framework for reducing the risk of alcohol-exposed pregnancies. *Forum Publ Pol Online*. Available at: <http://forumonpublicpolicy.com/spring2010.vol2010/spring2010archive/tough.pdf>. Accessed March 12, 2014.
- Tough SC, Clarke M, Clarren S (2005) Preventing fetal alcohol spectrum disorders. Preconception counseling and diagnosis help. *Can Fam Physician* 51:1199–1201.
- Tough SC, Clarke M, Hicks M, Clarren S (2004) Clinical practice characteristics and preconception counseling strategies of health care providers who recommend alcohol abstinence during pregnancy. *Alcohol Clin Exp Res* 28:1724–1731.
- Tough S, Tofflemire K, Clarke M, Newburn-Cook C (2006) Do women change their drinking behaviors while trying to conceive? An opportunity for preconception counseling. *Clin Med Res* 4:97–105.
- Walker MJ, Al-Sahab B, Islam F, Tamim H (2011) The epidemiology of alcohol utilization during pregnancy: an analysis of the Canadian Maternity Experiences Survey (MES). *BMC Pregnancy Childbirth* 11:52.
- Yamamoto Y, Kaneita Y, Yokoyama E, Sone T, Takemura S, Suzuki K, Ohida T (2008) Alcohol consumption and abstinence among pregnant Japanese women. *J Epidemiol* 18:173–182.
- Yen CF, Yang MS, Lai CY, Chen CC, Yeh YC, Wang PW (2012) Alcohol consumption after the recognition of pregnancy and correlated factors among indigenous pregnant women in Taiwan. *Matern Child Health J* 16:528–538.