Geographic and Maternal Characteristics Associated with Alcohol Use in Pregnancy

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Background: To date, no studies have used population-level data to investigate whether maternal location of residence (metropolitan vs. regional/remote populations) is associated with alcohol use in pregnancy. This information has important implications for appropriate service provision.

Methods: Information on all live births in New South Wales Australia was linked to records of alcohol-related admissions for mothers of these births over a 6-year period (2000 to 2006). Cases were women who had at least 1 alcohol-related hospital admission during pregnancy or at birth. Controls were women who had at least 1 live birth over that same time period but no alcohol-related hospital admissions during that time. Admissions were considered to be alcohol-related based on the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification (ICD-10-AM) code. Demographic, obstetric, and neonatal variables were compared.

Results: A total of 417,464 singleton birth records were analyzed, 488 of which were coded positive for at least 1 alcohol-related ICD-10-AM diagnosis. Characteristics associated with alcohol-related admissions in pregnancy were residence in a remote/very remote area, being Australian-born, having had a previous pregnancy, smoking in the current pregnancy, and presenting late to antenatal care. Alcohol-exposed pregnancies were associated with a range of poor obstetric and neonatal outcomes, with no geographic differences noted. However, women in regional/remote areas were less likely to attend specialist obstetric hospitals.

Conclusions: This study shows the need for standardized screening programs for alcohol use in pregnancy and where problematic use is detected, for clear clinical guidelines on management and referral.

Key Words: Pregnancy, Alcohol Use.

APPROXIMATELY 50 TO 60% OF women in Australia report having consumed alcohol at some stage in their pregnancy (Colvin et al., 2007; O'Callaghan et al., 2003), typically at low or reduced levels (< 1 standard drink per day) (Australian Institute of Health and Welfare, 2005; Colvin et al., 2007; Hotham et al., 2008; O'Callaghan et al., 2003). As alcohol use during pregnancy has been associated with a range of adverse outcomes including miscarriage, premature birth, stillbirth, low birthweight, small for gestational age, and fetal alcohol spectrum disorder (FASD), this is cause for concern (Burns et al., 2006; Chudley et al., 2005; Henderson et al., 2007; Jones et al., 1973; Stratton et al., 1996). This is particularly so given safe levels of consumption in pregnancy are unknown and only 10 to 50% of pregnant women who drink at problematic levels access treatment services (Hankin et al., 2000). Clearly, increasing our understanding of who is most at risk and establishing opportunities for prevention and intervention is crucial for appropriate service provision.

FASD is a broad term used for a range of outcomes observed among individuals with prenatal alcohol exposure. Fetal alcohol syndrome was first described in the French medical literature by Lemoine and colleagues (1968). The outcomes of FASD range from physical malformations and major developmental delay, to less-specific outcomes such as hyperactivity and poor learning (Bertrand et al., 2004). Identified factors for FASD include age of the pregnant woman (Bobo et al., 2006; Caetano et al., 2006; Haynes et al., 2003; Kost et al., 1998; Leonardson and Loudenburg, 2003; Leonardson et al., 2007; Stewart and Streiner, 1994); parity (Hotham et al., 2008; Kost et al., 1998; Leonardson et al., 2007; Strandberg-Larsen et al., 2008); patterns of previous alcohol use (e.g., Bobo et al., 2006; Chang et al., 2006; Hayes et al., 2002; McNamara et al., 2006; Strandberg-Larsen et al., 2008); mental health (Anderson et al., 2002; Haynes et al., 2003; Leonardson and Loudenburg, 2003; Leonardson et al., 2007; Strandberg-Larsen et al., 2008); and smoking in

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pregnancy (Anderson et al., 2002; Bobo et al., 2006; Jesse et al., 2006; Leonardson and Loudenburg, 2003; Leonardson et al., 2007; Pirie et al., 2000; Strandberg-Larsen et al., 2008).

Geographic area of residence and socioeconomic status (SES) has also been the focus of investigation, although results are not conclusive. For example, some studies indicate that women of lower SES are more likely to consume alcohol in pregnancy (Leonardson and Loudenburg, 2003; Leonardson et al., 2007; Raatikainen et al., 2006; Stewart and Streiner, 1994; Strandberg-Larsen et al., 2008), while others have found the opposite (Centers for Disease Control and Prevention [CDC] (1995); Chang et al., 2006; Pevalin et al., 2001). May and colleagues (2000) found higher rates of FASD in rural rather than urban South Africa; a nation where there is extreme variation in social class with associated variation in drinking patterns and social class variables of the mothers (e.g., body mass, nutrition, and antenatal care). May and colleagues (2000) suggest this may reflect greater socioeconomic resources in urban areas, or that urban areas provide respite from the heavy drinking patterns in the rural wine producing area studied. However, these authors also noted that urban dwelling was not related to the prevalence of FASD among children in a province of Italy (May et al., 2005, 2006, 2008). This is attributed to the fact that most of the Italian sample was truly middle class and there was little variation in SES, childbearing, and child-rearing practices across the school district. This finding may also be partially accounted for by the study methods where parental consent was required, resulting in a response rate of only 50%. However, no information exists as to whether there is an association between alcohol in pregnancy and maternal area of residence. In a study of all live births in South Australia (1998 to 2002) using administrative data, it was found that women residing in rural areas were less likely to report any substance use during pregnancy (figures for alcohol alone not given), with the authors suggesting this may be related to availability (presumably of illicit drugs rather than alcohol) or socioeconomic factors (Kennare et al., 2005). An earlier Australian study of births in a rural hospital in New South Wales (NSW), Australia's most populous state, found an incidence of 7 per 1,000 births being drug affected. However, women who only used cannabis and/or alcohol were excluded, and hence, information about alcohol use in pregnancy is limited (Richardson et al., 2001).

The question of whether there is a geographic difference in where alcohol use in pregnancy most commonly occurs has not yet been resolved. Previous work by the first author used record linkage to examine the factors associated with alcohol use in pregnancy (Burns et al., 2006). The present study extends that work by using record (or data) linkage to examine whether maternal area of residence is predictive of alcohol consumption in pregnancy. Record linkage is a relatively new technique employed to investigate public health issues and involves bringing together records from different sources that relate to the same individual (Holman et al., 1999). Where data are routinely collected, such as in the case of many large health department data collections, record linkage provides a highly cost-effective method of allowing population-level information to be analyzed; results are consequently generalizable, and it may also provide an opportunity to obtain information about sensitive, taboo, and rare issues that may be difficult to assess through relying on self-report. It should be noted, however, that a limitation of using this method to examine substance use in hospital records is that identified cases represent only those individuals whose substance use has been severe enough to require hospitalization or where the attending clinician has identified substance use as a problem. The results of this study should be reviewed in this light. The current study explored whether alcohol-related pregnancies and associated neonatal outcomes were more common in major metropolitan or regional/remote areas of residence.

MATERIALS AND METHODS

Data Sources

This study examined linked midwives (the Midwives Data Collection [MDC]) and hospital data (the Admitted Patients Data Collection [APDC]) for the period 2000 to 2006. The MDC collects information about pregnancy care, services, and pregnancy outcomes for all births in NSW of at least 400 grams birthweight or at least 20 weeks gestation. Data collected cover demographics, maternal medical and obstetric information on the labor, delivery, and condition of the infant. The APDC collects information on all admitted patients services in NSW provided by public and private hospitals. The information collected includes patient demographics, source of referral, where referred to on separation, and clinical information (diagnoses, procedures, external causes, activities when injured, places of occurrence, and morphologies). Data were de-identified before they were received by the investigators. Clinical information in both data sets was coded following the International Classification of Diseases, 10th revision, Australian modification (ICD-10-AM). Coding involves the allocation of a code for each relevant diagnosis/condition/disorder/health status and a code for each relevant procedure and treatment that a patient encounters during an in-patient hospital stay. Prior to 1998, 20 ICD-9 codes were allowed for each admission, and from 1998 onward 40 ICD-10-AM codes were allowed.

Grouping Variable

Alcohol-Exposed Pregnancies (Cases). Cases were defined as live births between 2000 and 2006 where the mother had also attended hospital during that pregnancy and received a primary or additional ICD-10-AM alcohol-related diagnosis at that time (F10.0-F10.9; T51.0-T51.3; T51.8; T51.9; X45; X65; Y15; O35.4). Women were considered to have been pregnant at the time of hospital admission based on the estimated gestational age at birth in the MDC; a date of conception was calculated from this variable and babies born to women who had alcohol-related admissions between conception and birth were considered to have been alcohol-exposed prenatally.

Nonalcohol Exposed Pregnancies (Controls). This group included births to mothers who did not have an alcohol-related admission at any time between 2000 and 2006.

Measures

Maternal Demographic Characteristics. Maternal age in years (< 20; 20 to 29; 30 to 39; 40 or more), country of birth (Australian born vs. others), Statistical Local Area of residence (SLA) (see remoteness area below) at baby's birth, previous pregnancy of at least

20 weeks gestation (yes/no), smoking in the second half of pregnancy (yes/no), more than 20 weeks pregnant at first antenatal visit (yes/no), and transfer to a different hospital (yes/no).

Obstetric and Neonatal Characteristics. Booked admission (yes/no), prematurity (< 37 weeks gestation), small for gestational age (< 10th centile), delivery type (vaginal/other), birth weight (grams), Apgar score at 5 minutes (1 to 10), transfer to neonatal intensive care unit (NICU) (yes/no), transfer to special care nursery (SCN) (yes/no), transfer to a different hospital, and hospital obstetric level (1 to 7).

Remoteness Area. Cases and controls were split into 2 groups according to maternal area of residence at delivery (major metropolitan vs. regional/remote). In Australia, each geographic area has an SLA code, which can be categorized in terms of its remoteness by using the Accessibility/Remoteness Index of Australia Plus (ARIA+). The relevant SLA codes and their corresponding ARIA+ codes for 2001 and 2006 were applied to each year's data as appropriate. The ARIA+ is an index of remoteness incorporating measures of road distance from populated localities and service centres, used to classify geographic remoteness in Australia (see http://www.gisca.adelaide.edu.au). These values can then be categorized according to the Australian Bureau of Statistics (ABS)' Australian Standard Geographical Classification (ASGC) of Remoteness Area into the following remoteness areas: major metropolitan, inner and outer regional, and remote and very remote (Australian Bureau of Statistics, 2006); this study collapsed the remote and very remote categories because of small numbers. Comparisons were also made between all regional/remote categories and major metropolitan centres.

Analysis

Data were analyzed using SAS for Windows software, version 9.1.2 (SAS Institute, Inc., Cary, NC). Statistical comparisons were made between births where the mother had had an alcohol-related hospital admission during pregnancy (cases) and births where the mother had not had such an admission (controls). In this study, the unit of analysis was the birth, and a mother may therefore have more than 1 birth over the 5-year period. In the case of multiple births (e.g., twins), the first birth was used. Statistical tests between groups using dichotomous variables used chi-square tests. Student's *t*-tests were used to compare means of normally distributed variables. Logistic regression with backward elimination was used to examine the relationship between neonatal outcomes and prenatal alcohol-related hospital admission after adjusting for covariates.

Ethics

Ethics approval was sought and obtained from the New South Wales Population and Health Services and UNSW Research ethics committees.

RESULTS

Predictors of Alcohol Use in Pregnancy

A total of 417,464 singleton births were analyzed from the linked data files. This consisted of 488 alcohol-exposed infants born to 483 women ("cases") and 416,976 nonexposed infants born to 316,926 women ("controls"). This represents a rate of 0.8 alcohol-related births per 1,000 live births in major metropolitan areas and 1.8 alcohol-related births per 1,000 live births in regional and remote areas. As shown in Table 1, cases were significantly associated with: residing in remote/very remote areas ($p < 0.001$); being Australian-born ($p < 0.001$); having had a previous pregnancy ($p < 0.001$), smoking during the current pregnancy ($p < 0.001$), and

Table 1. Variables Associated with Alcohol-Related Hospital Admissions During Pregnancy (2000 to 2006)

	Maternal status				
	Controls *N* = 416,976		Cases *N* = 488		
Variables	%	*n*	%	*n*	*p*-Value
Maternal					
Age at delivery (years)					
<20	4.1	17,078	6.2	30	<0.05
20 to 29	43.2	180,132	45.5	222	
30 to 39	49.3	205,644	43.2	211	
40 to 49	3.4	13,967	5.1	25	
Area of residence at birth					
Major metropolitan	58.3	235,280	38.7	189	<0.001
Inner regional	31.6	127,450	37.7	184	
Outer regional	9.0	36,406	17.6	86	
Remote/very remote	1.2	4,528	6.0	29	
Australian born	72.3	301,494	91.6	447	<0.001
Previous pregnancy of >20 weeks	58.1	242,246	73.6	359	<0.001
Smoking in current pregnancy	15.2	63,168	76.8	375	<0.001
>20 weeks gestation at first antenatal visit	10.2	42,668	29.7	145	<0.001
Maternal transfer to different hospital	3.5	14,744	6.4	31	<0.001
Labor, delivery, neonatal					
Not booked at delivery	2.5	10,321	15.8	77	<0.001
Normal vaginal delivery	63.6	265,338	71.1	347	<0.001
Gestational age <37 weeks	5.7	23,662	17.6	86	<0.001
Small for gestational age <10 centile	9.8	40,711	34.9	170	<0.001
Apgar 5 minutes <7	1.9	8,074	6.2	30	<0.001
Baby transferred to neonatal intensive care	2.2	9,203	7.8	38	<0.001
Baby transferred to special care nursery	13.5	55,146	33.6	164	<0.001
Baby transferred to different hospital	5.0	20,656	10.3	50	<0.001

more than 20 weeks gestation at the first antenatal visit ($p < 0.001$). After controlling for age, being Australian born and smoking during the second half of pregnancy, women residing in rural/remote areas were 1.4 (95% confidence interval: 1.2, 1.7) times more likely to be cases than women in metropolitan areas. There was, however, no difference in the mean number of alcohol-related hospital admissions per pregnancy by region: 273 admissions in major metropolitan areas (mean 1.4 admissions per pregnancy, SD = 0.975, range 1 to 8) and 417 in regional/remote areas (mean 1.4 admissions per pregnancy, SD 1.302, range 1 to 15).

Frequency and Type of Alcohol Admissions During Pregnancy

To be defined as a case a pregnancy must have included at least 1 hospital admission where an alcohol-related diagnosis was made, either as the principal (main) reason for stay or as a secondary diagnosis (at each admission in addition to the principal reason for stay, up to 39 additional or secondary diagnosis could be recorded). In this study, alcohol-related diagnoses were the principal diagnosis in just 22% of cases and/or as an additional diagnosis in the remainder (78%). The most common principal diagnoses for cases (where an alcohol-related diagnosis was a secondary diagnosis) were for problems with pregnancy, childbirth, and the puerperium (59%), followed by mental health problems (24%) and injuries/poisonings (11%).

With respect to geographic differences, the most common alcohol-related diagnoses recorded during pregnancy among women in major metropolitan areas were alcohol dependence (46% of admissions), harmful alcohol use (32%), and acute alcohol intoxication (26%). Among the regionally and remotely based women, these figures were 37% alcohol dependence, 39% harmful alcohol use, and 21% acute alcohol intoxication.

Approximately one-fifth of alcohol-exposed pregnancies involved multiple alcohol-related admissions to hospitals during that pregnancy (rather than a single admission), accounting for 23% of prenatally alcohol-exposed births to mothers residing in metropolitan areas and 20% of those to mothers who lived in regional/remote areas. Further, one-fifth to one-quarter of prenatally alcohol-exposed births were to women whose first alcohol-related hospital admission during that pregnancy was on their day of delivery (25%, $n = 47$ major metropolitan; 21%, $n = 63$ regional/remote).

Frequency of Alcohol Admissions in the 12 Months Prior to and Following Pregnancy

Where 12 months of hospital data were available prior to pregnancy for cases ($n = 82$), 17% of these births involved 1 or more alcohol admissions in the year preceding pregnancy (20% of cases in major metropolitan areas and 15% in regional/rural regions). Where 12 months of hospital data were available for cases following delivery ($n = 60$), 12% of all children were born to women who had 1 or more alcohol-related admissions in this time period (15% in major metropolitan regions and 11% in regional/rural areas).

Regional Differences in Maternal and Neonatal Outcomes

Among cases, there was a significant association between maternal area of residence (major metropolitan vs. regional/remote areas) and a number of variables, with regionally/remotely based women being younger ($p < 0.001$), more likely to be Australian-born ($p < 0.001$) and to attend antenatal care earlier in pregnancy ($p < 0.001$) (Table 2). There were no significant differences in neonatal outcomes by maternal area of residence, although infants in remote areas were more likely to be transferred to SCN or a different hospital. While case births in major metropolitan areas most commonly occurred in specialist obstetric hospitals (obstetric level 6), births among cases living in regional and remote areas were across hospitals with a range of obstetric levels and capabilities (Table 3).

There were differences in both cases and controls by geographic location. Both cases and controls in rural/regional areas were older, more likely to be smokers, Australian born and less likely to access antenatal care late (Table 4). There were also noted differences in transfer rates of both mothers and babies; both mothers and babies in rural/regional areas were more likely to be transferred to a different hospital.

DISCUSSION

Main Findings

A number of key findings emerged from this study. First, approximately 0.1% of births recorded in NSW between 2000 and 2006 were to women who had had an alcohol-related admission during pregnancy, the majority of whom resided in regional and remote areas, often great distances away from specialist services, which are typically located in metropolitan areas. Given that these deliveries were associated with a range of poor obstetric and neonatal outcomes, including being small for gestational age, low Apgar scores, and higher rates of transfer to NICU and SCN, this raises some cause for concern. Ensuring that services in regional and remote (particularly very remote) areas are equipped to assist women who may be drinking in pregnancy and subsequently care for them and their babies appears particularly warranted. As we found that infants in these rural and remote area are less often transferred to special care units within the hospital and more likely to be transferred elsewhere, research is required to follow them up to determine their outcomes in the longer term.

In particular, our findings provided validation of previous work that showed women who have alcohol-exposed pregnancies are less likely to access antenatal services (16% were not booked in on their delivery day compared to only 3% of controls in the current study) (Burns et al., 2006). In the Australian general population, area of residence is predictive of

Table 2. Maternal and Neonatal Variables for Cases by Maternal Area of Residence (2000 to 2006)

	Maternal area of residence				
	Major metropolitan areas $N = 189$		Regional/remote areas $N = 299$		
Variables	%	*n*	%	*n*	*p*-Value
Maternal					
Age at delivery (years)					
<20	6.9	13	5.7	17	<0.001
20 to 29	34.4	65	52.5	157	
30 to 39	51.3	97	38.1	114	
40 to 49	7.4	14	3.7	11	
Australian born	83.1	157	97.0	290	<0.001
Previous pregnancy >20 weeks gestation	70.9	134	75.3	225	>0.05
Smoking in current pregnancy	72.5	137	79.6	238	>0.05
>20 weeks gestation at first antenatal visit	39.7	75	23.4	70	<0.001
Mother transferred to different hospital	1.6	3	9.4	28	<0.001
Labor, delivery, neonatal					
Not booked	12.7	24	17.7	53	>0.05
Normal vaginal delivery	70.4	133	71.6	214	>0.05
Gestational age <37 weeks	15.9	30	18.7	56	>0.05
Small for gestational age	37.1	70	33.6	100	>0.05
Apgar 5 minutes <7	6.9	13	5.8	17	>0.05
Baby transferred to neonatal intensive care	10.1	19	6.4	19	>0.05
Baby transferred to special care nursery	36.0	68	32.1	96	<0.05
Baby transferred to different hospital	4.8	9	13.7	41	<0.05

Table 3. Obstetric Level of Hospital for Birth by Geographic Area (Metropolitan vs. Regional/Remote) for Cases (2000 to 2006)

	Major metropolitan areas $N = 189$		Regional/remote areas $N = 299$	
Hospital obstetric level[a]	%	*n*	%	*n*
1. Local hospitals (no births), postnatal only	0	0	0.7	2
2. Small isolated hospitals, low-risk births only	0	0	6.4	19
3. Country district and smaller metropolitan hospitals, care for mothers and infants at low-moderate risk	1.6	3	24.8	74
4. Country base-metropolitan district hospitals. Delivery and care for mothers and/or babies with moderate risk factors	15.3	29	22.7	68
5. Country base-metropolitan district hospitals, care for mothers and infants known to be at high risk	13.8	26	29.8	89
6. (tertiary)—specialist obstetric hospitals (supra-regional)—low, moderate and high risk births	65.1	123	15.1	45
P Private hospitals	4.2	8	0.7	2

[a]Centre for Epidemiology and Research—NSW Department of Health, 2007.

alcohol consumption: people residing in regional and remote areas have been found to consume alcohol in quantities that place them at short-term risk of harm (e.g., through accidents) (Australian Institute of Health and Welfare, 2008). While this may reflect the incidence of these harms, it may also be related to the distribution of treatment agencies for substance-related harm. Information about the use of drug and alcohol treatment agencies in Australia reported that in 2007, 60% of agencies were located in major metropolitan areas; 32% in inner regional; and 8% in outer regional areas. There were no dedicated agencies in rural and remote areas (Australian Institute of Health and Welfare, 2008).

In addition, 30% presented to antenatal care at a later stage of pregnancy compared to 10% of controls. Together with results that showed one-third of women who consumed alcohol during pregnancy presented to hospital with an alcohol-related admission on their day of delivery, these findings suggest that there is a need for ensuring that maternity staff are adequately trained and supported to address such issues. Furthermore, identifying ways of overcoming the barriers to service delivery experienced by women at risk of alcohol-exposed pregnancies is of considerable importance.

Second, a high proportion of women with an alcohol-related diagnosis received a diagnosis of alcohol dependence. In developing strategies to overcome barriers to service delivery, particular attention needs to be paid to those women who might be alcohol dependent. Our findings suggest that these women are likely to represent a proportion of women who may be alcohol dependent and who, in addition to their child, may require extra and ongoing support: (i) the high proportion of admissions where dependence and withdrawal were recorded; (ii) the significant proportions (15 to 20%) of women who had previously presented to hospital with alcohol-related admission prior to pregnancy; (iii) similarly, the notable proportions (11 to 15%) who presented with alcohol-related admissions in the year following birth; and (iv) also that one-fifth of these women present to hospital multiple times during pregnancy.

Table 4. Variables Associated with Alcohol-Related Hospital Admissions During Pregnancy by Maternal Area of Residence (2000 to 2006)

	Metropolitan					Regional/rural				
	Controls N = 235,280		Cases N = 189			Controls N = 168,384		Cases N = 299		
Variables	%	*n*	%	*n*	*p*-Value	%	*n*	%	*n*	*p*-Value
Maternal										
Age at delivery (years)										
<20	3.0	7,127	6.9	13	<0.001	5.7	9,574	5.7	17	>0.05
20 to 29	40.9	96,154	34.4	65		47.1	79,208	52.5	157	
30 to 39	52.4	123,198	51.3	97		44.5	74,902	38.1	114	
40 to 49	3.7	8,746	7.4	14		2.7	4,618	3.7	11	
Australian born	60.1	141,374	83.1	157	<0.001	89.6	150,828	97.0	290	<0.001
Previous pregnancy of >20 weeks	55.8	131,305	70.9	134	<0.001	61.9	104,272	75.3	225	<0.001
Smoking in current pregnancy	10.6	24,940	72.5	137	<0.001	21.7	36,454	79.6	238	<0.001
>20 weeks gestation at first antenatal visit	12.4	29,073	39.7	75	<0.001	7.4	12,459	23.4	70	<0.001
Maternal transfer to different hospital	0.8	1,860	1.6	3	<0.001	7.6	12,715	9.4	28	<0.001
Labor, delivery, neonatal										
Not booked at delivery	2.1	5,013	12.7	24	<0.001	3.0	4,974	17.7	53	<0.001
Normal vaginal delivery	62.9	148,019	70.4	133	<0.001	64.9	109,195	71.6	214	<0.001
Gestational age <37 weeks	5.4	12,792	15.9	30	<0.001	6.0	10,144	18.7	56	<0.001
Small for gestational age <10 centile	10.3	24,216	37.0	70	<0.001	9.1	15,252	33.6	100	<0.001
Apgar 5 minutes <7	1.9	4,479	6.9	13	<0.001	2.0	3,327	5.8	17	<0.001
Baby transferred to neonatal intensive care	2.5	5,789	10.1	19	<0.001	1.9	3,131	6.4	19	<0.001
Baby transferred to special care nursery	13.0	30,556	36.0	68	<0.001	14.3	23,997	32.1	96	<0.001
Baby transferred to different hospital	1.9	4,393	4.8	9	<0.001	9.5	15,971	13.7	41	<0.001

Women may be reluctant to disclose alcohol use for many reasons, including stigma and fear of having the child removed (Roberts & Nanson, 2000), so sensitivity and care around screening for identification of alcohol problems among pregnant women remains crucial. The present study indicates that a proportion of women who drink in pregnancy are accessing health services during the pregnancy period, when they may have poor or nonexistent contact with antenatal health care services; many of these women were presenting late to antenatal care and were unbooked at delivery, suggesting low rates of access. Hospital admissions where alcohol use is detected provide an opportunity for the screening for alcohol problems and subsequent referral and support. However, given that not all women who consume alcohol during pregnancy will attend hospital with an alcohol-related issue (and that not all alcohol-related problems may be identified/recorded), this represents only 1 potential opportunity for intervention.

Third, smoking tobacco during pregnancy is associated with a higher likelihood of alcohol use in pregnancy (Bobo et al., 2006; Jesse et al., 2006; Leonardson and Loudenburg, 2003; Leonardson et al., 2007; Strandberg-Larsen et al., 2008); being a nonsmoker has also been found to predict quitting alcohol in pregnancy (Pirie et al., 2000). The present study presents further evidence of this association; support provided to women who smoke in pregnancy to quit or cut down their tobacco use may also usefully provide simultaneous screening and treatment of alcohol-related problems. Other risk factors identified that may flag problematic alcohol use among pregnant women include abuse and violence (Flynn et al., 2007; Haynes et al., 2003; Leonardson and Loudenburg, 2003; Leonardson et al., 2007); poor physical health (Haynes et al., 2003); psychiatric distress (Strandberg-Larsen et al., 2008), including depressive symptoms (Leonardson and Loudenburg, 2003; Leonardson et al., 2007); and previous inpatient treatment for mental health problems and/or illicit drug use (Anderson et al., 2002; Haynes et al., 2003; Leonardson and Loudenburg, 2003; Leonardson et al., 2007). With regard to the licit substances alcohol, tobacco, and caffeine, use of these has been found to cluster within individuals, with users of multiple substances less likely to quit each substance than users of single substances (Pirie et al., 2000). These authors found that among the multiple substance users who had quit 1 substance, having quit a second substance was more, rather than less, common (Pirie et al., 2000). Clearly, when targeting and treating/supporting women who drink in pregnancy, consideration of the broader context in which they live and other issues that they may face is of utmost importance.

Finally, prior alcohol use (including binge drinking, years of alcohol use, abuse, and dependence) has been well established as a risk factor for alcohol use in pregnancy (e.g., Hayes et al., 2002; McNamara et al., 2006; Strandberg-Larsen et al., 2008), with some studies identifying recent drinking as a stronger risk factor than prior patterns of binge drinking and "problem" drinking (Bobo et al., 2006; Chang

et al., 2006). While it was not possible to gauge the extent of alcohol use among pregnant women in the present study, evidence of recent problematic alcohol use among some was identified prior to becoming pregnant. Screening and referral for alcohol problems in the hospital context may not always be possible depending on the circumstances surrounding the admission (e.g., other matters may be more pressing; the woman may be too intoxicated at the time to screen), but opportunities should be identified and taken where possible. Accurately screening these women prior to pregnancy (and following pregnancy, to reduce the chances of another pregnancy that is alcohol-exposed) appears warranted. Ideally, screening should be followed by appropriate provision of advice on the risks of alcohol use, including during pregnancy, contraception (where it is requested), and alcohol treatment.

Limitations

While the analysis of linked data is a powerful tool in examining alcohol use in pregnancy, there are limitations. First, the data sets used in this study were not designed for the purposes of examining the impact of alcohol use in pregnancy. For example, while being Australian born is a significant factor associated with alcohol use in pregnancy, this is a broad category and further research is required to examine particular subgroups that may be most at risk. The definition of a "case" through coding of an alcohol-related ICD-10-AM diagnosis will depend on the thoroughness of the medical history taking and the disclosure of alcohol use by the women themselves. It is clear a case will be identified more often when there are clear signs of intoxication or alcohol-related poor health or if the clinician was aware of the woman's history. Hence, the population described in this study would be likely to be at the extreme end of harmful and hazardous alcohol consumption during pregnancy. Alternatively, lack of a diagnostic code does not mean women are not drinking, but rather that their consumption levels are not unsafe or are assessed as being nonproblematic. Finally, there will be a proportion of linkages that are false or missed between the 2 data files (Churches and Lim, 2001).

CONCLUSION

In conclusion, the present study has shown that alcohol-related hospital admissions in pregnancy are more likely to occur in regional and remote rather than metropolitan areas, often those least equipped to deal with these issues. Research is required to determine the levels of service provision to these mother/infant dyads and their outcomes in the longer term.

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