



Tobacco, alcohol and cannabis use during pregnancy: Clustering of risks



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ABSTRACT

Background: Antenatal substance use poses significant risks to the unborn child. We examined use of tobacco, alcohol and cannabis among pregnant Aboriginal and Torres Strait Islander women; and compared characteristics of women by the number of substances reported.

Methods: A cross-sectional survey with 257 pregnant Indigenous women attending antenatal services in two states of Australia. Women self-reported tobacco, alcohol and cannabis use (current use, ever use, changes during pregnancy); age of initiation of each substance; demographic and obstetric characteristics. **Results:** Nearly half the women (120; 47% (95%CI:40%, 53%)) reported no current substance use; 119 reported current tobacco (46%; 95%CI:40%, 53%), 53 (21%; 95%CI:16%, 26%) current alcohol and 38 (15%; 95%CI:11%, 20%) current cannabis use. Among 148 women smoking tobacco at the beginning of pregnancy, 29 (20%; 95%CI:14%, 27%) reported quitting; with 80 of 133 (60%; 95%CI:51%, 69%) women quitting alcohol and 25 of 63 (40%; 95%CI:28%, 53%) women quitting cannabis. Among 137 women reporting current substance use, 77 (56%; 95%CI:47%, 65%) reported one and 60 (44%; 95%CI:35%, 53%) reported two or three. Women using any one substance were significantly more likely to also use others. Factors independently associated with current use of multiple substances were years of schooling and age of initiating tobacco. **Conclusions:** While many women discontinue substance use when becoming pregnant, there is clustering of risk among a small group of disadvantaged women. Programmes should address risks holistically within the social realities of women's lives rather than focusing on individual tobacco smoking. Preventing uptake of substance use is critical.

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1. Introduction

Antenatal substance use is associated with significant risks to the unborn child. Smoking tobacco increases the risk of low birth weight (LBW), pre-term birth, intra-uterine growth retardation (IUGR) and perinatal death (British Medical Association, 2004). Alcohol is teratogenic and use during pregnancy may result in foetal alcohol syndrome as well as LBW, preterm birth and perinatal death (NHMRC, 2009). While less well established, smoking cannabis is associated with adverse outcomes including LBW, preterm birth, IUGR and admission to the neonatal intensive care unit (Hayatbakhsh et al., 2012). Antenatal exposure to any of these

substances is also related to adverse child behavioural and cognitive outcomes including Attention Deficit Hyperactivity Disorder, increased externalising behaviour and decreased cognitive function (Huizink and Mulder, 2006).

In Australia, pregnant Aboriginal and Torres Strait Islander (hereafter referred to as Indigenous) women are more likely to smoke tobacco than non-Indigenous pregnant women, with 50% of Indigenous women reporting smoking antenatally (Li et al., 2011). Smoking rates are also elevated among pregnant Indigenous women in Canada, New Zealand and the United States (Dixon et al., 2009; National Center for Health Statistics, 2012; The First Nations Information Governance Centre and First Nations Regional Health Survey (RHS), 2012). National data on antenatal alcohol and cannabis use is not available, however nearly one third of Indigenous Australian women aged 15–45 years report alcohol consumption at risky levels, and one in ten used cannabis in the last 12 months (Australian Institute of Health and Welfare, 2011a). Studies among pregnant Indigenous Australian women have identified rates of alcohol consumption between nine and 38% (Panaretto et al., 2005; Rumbold et al., 2011; Stewart and Li, 2005; Zubrick et al., 2004) and cannabis use between nine and 12% (Panaretto

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et al., 2005; Zubrick et al., 2004). High rates of substance use among Indigenous peoples have been attributed to social and historical factors including socio-economic disadvantage, marginalisation, impacts of colonisation and grief and loss (Gray et al., 2004; Saggers and Gray, 1998; Thomas et al., 2008).

Associations between use of these substances are well recognised. Alcohol consumption is associated with higher rates of tobacco and cannabis smoking and lower rates of smoking cessation (Australian Institute of Health and Welfare, 2011a; Hendricks et al., 2011). Similarly, the prevalence of tobacco smoking is higher among cannabis smokers, (Agrawal et al., 2012; Australian Institute of Health and Welfare, 2011a) including among Indigenous Australians (Clough, 2005).

Studies among pregnant women have examined relationships between use of tobacco and illicit drugs or alcohol, but few have specifically explored concurrent use of tobacco, alcohol and cannabis. Dutch women using cannabis in early pregnancy were more likely to use alcohol and tobacco during early pregnancy and continue to smoke tobacco (El Marroun et al., 2008). Among pregnant Danish women, alcohol intake was associated with tobacco smoking, but too few women used cannabis to allow statistical testing (Kesmodel et al., 2003). English and Spanish studies have also found associations between antenatal use of cannabis, alcohol and tobacco (Fergusson et al., 2002; Friguts et al., 2012).

We identified only two studies exploring concurrent use of alcohol, tobacco and cannabis among pregnant Indigenous women. The Western Australian Aboriginal Child Health Survey interviewed mothers of children aged 0–17 years about substance use during their pregnancy, and reported high rates of use (tobacco 49%, alcohol 23% and cannabis 9%) with women using one substance also more likely to use others (Zubrick et al., 2004). A study among Canadian Inuit women reports high rates of use of each substance and strong associations between alcohol consumption and use of tobacco and cannabis (Muckle et al., 2011).

Given the significant harm associated with antenatal use of these substances and the high rates of use among non-pregnant Indigenous Australian women, better understanding of use during pregnancy is important in developing appropriate programmes to reduce the associated harms and improve birth outcomes.

This paper examines self-reported and concurrent use of tobacco, alcohol and cannabis among pregnant Indigenous women and compares characteristics of women by the number of current substances reported.

2. Methods

Cross-sectional surveys with pregnant Indigenous women were undertaken in the Northern Territory (NT) and New South Wales (NSW). The project was guided by a community reference group (CRG) of Aboriginal women and service providers from rural NSW to enhance cultural security.

2.1. Recruitment

2.1.1. Settings. 22 of 28 Aboriginal Maternal and Infant Health Strategy (AMIHS) teams, providing antenatal care in community settings agreed to participate. From July to December, 2009, eligible women receiving antenatal care at these sites were invited to participate by the midwife or Aboriginal Health Worker. Aboriginal Health Workers are health professionals who work in a range of roles within the health system to facilitate engagement between Indigenous Australians and the health system. Each site was asked to recruit five to 20 consecutive women, proportional to the number who received antenatal care in the previous year. A female Aboriginal research assistant recruited eligible women from the antenatal clinic of a major hospital from July to September 2010 and April to June 2011.

2.1.2. Client sample. Women were eligible if pregnant and if they or their partner were Indigenous. They were excluded if they were aged less than 16; being treated for mental illness; or unable to provide informed consent. The staff explained the study and provided eligible women with information sheets. Written consent was obtained. Recruitment staff offered assistance to complete the questionnaire if required. Staff completed a recruitment log to track participation rates but did not collect data on non-participants.

2.2. Questionnaire development and contents

Questionnaire development is described in detail elsewhere (Passey et al., 2012). In brief, it involved initial review of published literature on substance use during pregnancy and/or among Aboriginal peoples to develop the draft questionnaire. This was critically reviewed by the CRG and colleagues experienced in Aboriginal health research, tobacco control and questionnaire design, to assess face and content validity, reduce redundancy and refine the wording to ensure cultural appropriateness. Minor revisions included removal of some redundant questions and addition of others. The revised questionnaire was pilot-tested with 15 pregnant Aboriginal women in NSW and Western Australia. The CRG discussed feedback from these women, with further minor changes.

The final questionnaire had a grade 6 Flesch-Kincaid reading level and took 15–20 min to complete. The items relevant to this paper covered: (1) *Demographic and obstetric characteristics*: age, education, if the pregnancy was planned, gestation, parity, and number of antenatal visits; (2) *Tobacco smoking status and changes during pregnancy*: smoking status – current daily smoker, current occasional smoker, ex-smoker or never smoked. Current and ex-smokers were asked the age they started smoking, and changes to their smoking status since becoming pregnant; (3) *Cannabis smoking status and changes during pregnancy*: the same questions as for tobacco; (4) *Alcohol consumption and changes during pregnancy*: any alcohol in the previous month (never, only once, 2–4 times in the month, 2–3 times a week, or ≥ 4 times a week). Current and ex-drinkers were asked the age they started drinking and changes to drinking status in pregnancy.

2.3. Statistical analysis

Summary statistics of respondent characteristics were obtained. Age, years of school, parity and gestation were categorised, and the number and percentage in each category reported. The numbers of antenatal visits are presented as medians due to non-normal distributions.

For each substance (tobacco, alcohol, cannabis), women were classified as: current users; having quit during pregnancy; having quit prior to pregnancy; or never having used the substance, based on self-report. Women were also categorised as currently using zero, one, or two to three substances. Proportions in each category are presented with 95% confidence intervals. The age at which they reported initiating use of each substance was categorised into <15 years, ≥ 15 years or never.

Two-way tables were generated for each combination of substances. Odds ratios and exact 95% confidence intervals were generated to assess associations between use of one substance and use of each of the others, as well as between quitting one substance during pregnancy, and quitting each of the others.

Univariate associations of demographic and obstetric variables with number of substances currently used (0, 1, ≥ 2) were examined using Pearson's chi-square test for categorical explanatory variables and the non-parametric Kruskal-Wallis test for continuous variables. Multinomial logistic regression was used to determine associations between explanatory variables and the number of substances used, adjusting for clustering by site. Initially, all variables with a p -value < 0.25 in the univariate analyses were included in the model. Wald tests, adjusted for clustering of women within sites, were used to test the significance of each parameter estimate, with stepwise removal of variables with a p -value ≥ 0.1 . Jurisdiction (state/territory) was retained regardless of statistical significance as the differences in social context between jurisdictions were considered important.

We aimed to recruit 400 women but only recruited 264 within the study period. This sample allowed estimation of the prevalence of current substance use with 95% confidence intervals within $\pm 6\%$ of the point estimate. Assuming that approximately a third of women would be in each of the three substance use categories (0, 1, ≥ 2), and with a design effect of 1.2, the study would be able to detect differences between groups of slightly more than 20%.

2.4. Ethical approval

The study was approved by the Human Research Ethics Committees of the University of Newcastle; Hunter New England Health; the Aboriginal Health & Medical Research Council; NT Department of Human Services and Menzies School of Health Research.

3. Results

At the hospital, 137 women were invited and 107 (78%) consented. At community sites, 157 women consented. Of these, 128 were from the 15 sites which returned participation records documenting the number of women approached and consenting. These sites had invited 146 women, giving a response rate of 88%. The remaining seven sites returned 29 questionnaires but no participation records; thus the consent rate is unknown for these sites. Of the 264 questionnaires returned, 257 had data on current use of all three substances and are used in this analysis.

The women had a median age of 23 years. Only 45 (18%) had completed year 12 at school (the final year of secondary school in Australia), with 75 (30%) not completing year 10. The majority (189, 77%) were greater than 20 weeks gestation, with 8% in their first trimester, 35% in their second trimester and the remaining 56% in their third trimester, although gestational age was missing for 11 women. Eighty two (32%) were primiparous and 73 (29%) reported that the pregnancy was planned.

3.1. Self-reported use of tobacco, alcohol and cannabis

3.1.1. Current use. Almost half the women (120 or 47%; 95%CI:40%, 53%) reported no substance use at the time of the survey. Tobacco was the most commonly reported substance currently used, with 119 (46%; 95%CI:40%, 53%) women smoking tobacco, 53 (21%; 95%CI:16%, 26%) drinking alcohol and 38 (15%; 95%CI:11%, 20%) smoking cannabis. Women currently smoking tobacco reported a mean of 10 cigarettes per day, while those currently smoking cannabis reported a mean of seven cones or joints per day.

3.1.2. Ever use. Tobacco was the most commonly reported substance ever used, with 162 (63%; 95%CI:57%, 69%) women having smoked tobacco, 141 (55%; 95%CI:49%, 61%) having drunk alcohol, and 84 (33%; 95%CI:27%, 39%) having smoked cannabis at some time.

3.1.3. Quitting during pregnancy. Among 148 women smoking tobacco at the beginning of their pregnancy, 29 (20%; 95%CI:14%, 27%) reported quitting prior to the survey; with corresponding figures being 80 of 133 (60%; 95%CI:51%, 69%) women quitting alcohol and 25 of 63 (40%; 95%CI:28%, 53%) women quitting cannabis.

3.2. Concurrent substance use

Of 137 women who reported currently using any tobacco, alcohol or cannabis, 77 (56%) used only one substance, while 60 (44%) used more than one. Fig. 1 shows the number of women reporting current use of each substance. Seven distinct groups were identified.

3.2.1. No substances. 120 women (47%) reported no current substances. Among these women, 64 (53%) had used one or more substances previously, with 24 (20%) quitting tobacco, 44 (37%) quitting alcohol and 12 (10%) quitting cannabis since becoming pregnant; 20 (17%), 11 (9%) and 10 (8%) had quit tobacco, alcohol and cannabis respectively, prior to becoming pregnant. Thirteen of these women reported being in their first trimester.

3.2.2. Tobacco only. 60 women (23%) reported current tobacco use only, with 26 (43%) of these having quit alcohol and seven (12%) having quit cannabis since becoming pregnant. Two of these women were in their first trimester.

3.2.3. Alcohol only. 13 women (5%) reported currently consuming alcohol only. One woman was in her first trimester

3.2.4. Cannabis only. Five women (2%) reported only smoking cannabis. None of these women were in their first trimester.

3.2.5. Tobacco and alcohol only. 26 women (10%) reported current tobacco and alcohol use but not cannabis use. Two of these women were in their first trimester.

3.2.6. Tobacco and cannabis only. 20 women (8%) reported smoking both tobacco and cannabis but not consuming alcohol. None of these women were in their first trimester.

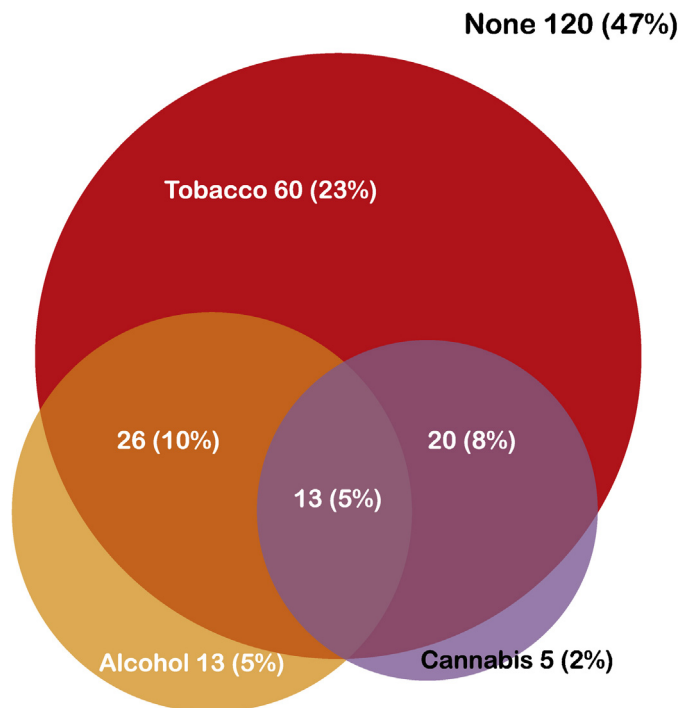


Fig. 1. Self-reported current substance use. (NB Cells with fewer than 5 participants have been combined consistent with ethical requirement to not present results, which may allow identification of individuals.)

3.2.7. Tobacco, alcohol and cannabis. 13 women (5%) reported current use of all three substances. Two of these women were in their first trimester.

Only 18 (13%) women who did not currently smoke tobacco reported use of any other substance, compared to 59 (50%) women who smoked tobacco. Current tobacco smokers had higher odds of reporting current alcohol consumption (OR: 4.32; 95%CI:2.12, 9.13) and cannabis use (OR: 10.21; 95%CI:3.73, 34.52) than women who didn't report current tobacco smoking. Women who reported alcohol consumption also had higher odds of reporting cannabis use than those who did not currently consume alcohol (OR: 2.69; 95%CI:1.17, 5.97).

Women who reported quitting tobacco since becoming pregnant had higher odds of also having quit alcohol (OR:5.32; 95%CI:1.52, 23.36) and cannabis (OR:12.69; 95%CI:1.19, 617.8) than women who had not quit tobacco. Similarly, women who quit alcohol had higher odds of also reporting quitting cannabis (OR:3.7; 95%CI:0.93, 15.8) than women who had not quit drinking ($\chi^2 = 4.51$, $p = 0.034$).

3.3. Characteristics of women by current number of substances reported

One hundred and twenty women (47%; 95%CI:40%, 53%) reported no current substances, while 77 (30%; 95%CI:24%, 36%) reported one and 60 (23%; 95%CI:18%, 29%) reported two or three. Characteristics of women by number of substances currently used are shown in Table 1. Jurisdiction of residence, years of schooling, post-secondary education (vocational training and/or university), and number of antenatal visits with a doctor were all significantly associated with number of substances. Starting to use tobacco, alcohol or cannabis when younger than age 15 were each significantly associated with number of substances currently used.

Table 1Characteristics of respondents by level of reported current substance use ($n = 257$).

	No substances $n = 120$ n (%)		1 substance $n = 77$ n (%)		2–3 substances $n = 60$ n (%)		p -Value ^b
Jurisdiction							
NSW	64	(53%)	46	(60%)	46	(77%)	0.010
Northern Territory	56	(47%)	31	(40%)	14	(23%)	
Age							
<20	30	(25%)	12	(16%)	13	(22%)	0.497
20–29	62	(52%)	47	(61%)	36	(60%)	
≥30	28	(23%)	18	(23%)	11	(18%)	
Highest year at school ^a							
<10	25	(22%)	19	(25%)	31	(53%)	<0.001
10–11	62	(53%)	43	(57%)	25	(42%)	
12	29	(25%)	13	(17%)	3	(5.1%)	
Post-secondary education	58	(48%)	33	(43%)	15	(25%)	0.011
Planned pregnancy ^a	37	(32%)	23	(32%)	13	(22%)	0.372
Gestation: ≤20 weeks ^a	24	(21%)	17	(23%)	16	(28%)	0.630
Primiparous	47	(39%)	21	(27%)	14	(23%)	0.058
Age started smoking tobacco ^a							
<15	13	(11)	15	(20)	37	(65)	<0.001
≥15	27	(24)	51	(68)	19	(33)	
Never	75	(65)	9	(12)	1	(1.8)	
Age started drinking alcohol ^a							
<15	8	(6.7)	9	(12)	21	(36)	<0.001
≥15	45	(38)	34	(44)	24	(41)	
Never	67	(56)	34	(44)	13	(22)	
Age started smoking cannabis ^a							
<15	9	(7.6)	5	(6.5)	19	(32)	<0.001
≥15	12	(10)	15	(20)	24	(41)	
Never	98	(82)	57	(74)	16	(27)	
	Median	(Q1, Q3)	Median	(Q1, Q3)	Median	(Q1, Q3)	
Antenatal doctor visits ^a	4	(2, 6)	4	(2, 6)	3	(1, 5)	0.007
Antenatal midwife visits ^a	4	(2, 6)	3	(2, 6)	3	(2, 5)	0.089

^a Missing data – school years = 7; planned pregnancy = 8; gestation = 9; antenatal doctor visits = 17; antenatal midwife visits = 22; age started smoking tobacco = 10; age started drinking alcohol = 2; age started smoking cannabis = 2.

^b p -Value for Pearson's chi-squared test for categorical variables; non-parametric Kruskal–Wallis test for continuous explanatory variables in which the median is presented.

3.4. Factors associated with the number of substances currently used

Multinomial logistic regression was used to identify factors independently associated with the number of different substances currently used by women, with 'No substances' as the reference group (Table 2). Never having started smoking tobacco was the only variable significantly associated with current use of one substance relative to use of none.

For current use of two or more substances, number of years of schooling and age of initiating tobacco use were significant. Among women who had 10 or 11 years of high school education, the odds of using two or more substances was one third that for women who had less than 10 years schooling, and for women who had

completed year 12, the odds were 0.12, relative to those with less than 10 years. Women who started smoking tobacco at age 15 or more had odds of reporting two or more substances approximately one third that of women who started smoking before turning 15. Women who had never smoked tobacco had extremely low odds ($OR = 0.01$, 95%CI:0.001, 0.053) of currently using two or more substances.

4. Discussion

This paper is the first we are aware of to explore concurrent use of tobacco, alcohol and cannabis during pregnancy among Indigenous Australian women. Nearly half the women reported currently not using any of these substances and many had quit at

Table 2Multinomial model of associations with number of current substances reported, with no substances as the reference group ($n = 240$).^a

	1 substance		p -Value ^c	2–3 substances		p -Value ^c
	OR	95% CI		OR	95% CI	
Jurisdiction						
Northern Territory ^b						
NSW	0.88	0.398, 1.932	0.745	1.42	0.510, 3.941	0.503
Highest year at school						
<10 ^b						
10–11	0.93	0.395, 2.182	0.865	0.33	0.116, 0.933	0.037
12	0.76	0.342, 1.697	0.505	0.12	0.018, 0.772	0.026
Age started smoking tobacco						
<15 ^b						
≥15	1.56	0.663, 3.646	0.310	0.30	0.124, 0.710	0.006
Never	0.11	0.032, 0.361	<0.001	0.01	0.001, 0.053	<0.001

^a 17 women had data missing on at least one of the included variables.

^b Reference category.

^c Variables with p -value < 0.05 from the Wald test are shown in bold.

least one substance since becoming pregnant. However, over half reported current use of at least one substance, with tobacco the most common (46%) followed by alcohol (21%) and cannabis (15%). A small proportion of these women were in their first trimester and may subsequently have ceased use of these substances. The rates reported here are consistent with other studies (Li et al., 2011; Panaretto et al., 2005; Stewart and Li, 2005; Zubrick et al., 2004). We identified significant concurrent use, such that women currently using any one substance were significantly more likely to also be using others. Many women reported quitting these substances since becoming pregnant, with both a greater number (80) and a greater proportion (60%) of those using alcohol at the beginning of their pregnancy reporting quitting, than those smoking tobacco (29 women; 20%) or cannabis (25 women; 40%) at the beginning. There was a strong association between quitting one substance and quitting others. Finally, while the majority of women currently used either no substances or only one, those reporting multiple substances were characterised by other risks including low educational achievement, early initiation of substance use and fewer antenatal visits.

Our findings highlight several fundamental issues for policy and clinical practice: clustering of risks among a disadvantaged sub-set of women, and the need to address risks holistically within the social realities of women's lives; concurrent use of substances and the need to address these substances together; and the importance of prevention and addressing the social determinants of health.

4.1. Clustering of risks and the need to address them holistically

Traditionally policy and service delivery have targeted individual risks such as tobacco, while neglecting consideration of clustering of risks and interactions between risks. This failure to address risk modification holistically limits our ability to address the complexity of risk behaviour within the context of people's lives and may contribute to disparities in risk behaviour and health outcomes. This is exemplified by the case of antenatal tobacco smoking, where guidelines recommend a 5As approach to advising women to quit smoking, (Fiore et al., 2008; NSW Department of Health, 2006) focusing on the individual woman, with little consideration of other substance use, or the social realities of many disadvantaged women's lives.

A strong socio-economic gradient in smoking during pregnancy is well documented, (Graham et al., 2010; Mohsin et al., 2011; Page et al., 2012) including among Indigenous Australians (Thrift et al., 2011), and there is evidence that this gradient is related to psycho-social stressors (Graham et al., 2010; Hauge et al., 2012; Pickett et al., 2009). Several studies have demonstrated clustering of psycho-social and behavioural risks among disadvantaged pregnant women (El-Mohandes et al., 2011; Erickson and Arbour, 2012; Page et al., 2012; Pickett et al., 2009). Thus, women who continue to smoke during pregnancy are likely to also experience other risks including other substance use, financial stress, domestic violence and depression, suggesting that a holistic approach to risk modification is required. In our study, women currently using multiple substances had less education and had initiated substance use at earlier ages, than women not currently using any substance. Although we did not measure other socio-economic or psycho-social risks, it is likely that poorly educated women will experience other disadvantages including unemployment, family poverty and housing stress, all of which are more common among Indigenous than non-Indigenous Australians (Australian Institute of Health and Welfare, 2011b). Among Indigenous Australians, stress is repeatedly cited as a major barrier to cessation (Johnston and Thomas, 2008; Lindorff, 2002; Passey et al., 2011), including among

pregnant women (Gilligan et al., 2009; Passey et al., 2012; Wood et al., 2008).

Factors contributing to the high prevalence of smoking among Indigenous Australians are similar to those for other disadvantaged groups—in addition to socio-economic disadvantage, poor housing, high unemployment, and associated social problems (Australian Institute of Health and Welfare, 2011b), many people are surrounded by other smokers, increasing cigarette availability, providing frequent smoking cues and 'normalising' smoking (Johnston and Thomas, 2008; Lindorff, 2002). For Indigenous Australians, other factors include experiences of racism, a history of grief and loss associated with colonisation and its aftermath, and the importance of smoking in maintaining relationships within community social networks (Johnston and Thomas, 2008; Passey et al., 2011; Wood et al., 2008). Among pregnant Indigenous women, poor knowledge of risks of antenatal smoking, high levels of stress and partner smoking are associated with continued smoking (Gilligan et al., 2009; Passey et al., 2012; Wood et al., 2008). Failure to acknowledge these environmental contributors to antenatal smoking has resulted in programmes focusing on the individual woman, while providing little support to address household or community smoking, nor providing individuals with resources and skills to deal with these problems.

4.2. Concurrent substance use

In our study, the most commonly reported drug was tobacco, with 46% of women currently smoking. Among these women, 50% reported current use of cannabis and/or alcohol, compared to only 13% of women who did not smoke tobacco. Continued tobacco smoking is, therefore, a potentially useful indicator of possible other drug use. Recent Canadian research also identified heavy smoking as a marker for other lifestyle risk factors including substance use (Erickson and Arbour, 2012). Thus, assessment of smoking status helps identify women (tobacco smokers) for whom more careful assessment of alcohol and cannabis use should be undertaken, and who may need additional support to address these and other risks.

4.3. Prevention

Women who were not currently using any substance were better educated, and many had never initiated any substance use, while those who had, had tended to start later. By contrast, those using multiple substances were less educated and had initiated substance use at younger ages. This suggests that preventing uptake of substance use, through measures which focus on the early years is required. Supporting girls to stay in school, and providing opportunities for positive engagement with society through improved educational, sporting and employment prospects is likely to yield considerable benefits.

4.4. Limitations

The results from this study need to be considered in light of its limitations. Due to the small sample size there is adequate power to detect only large differences between groups. Secondly, the study relies on self-report. It is likely that some women under-reported substance use due to social desirability bias and concerns about the consequences of admitting substance use, particularly cannabis, as it is illegal. However, previous studies have confirmed reasonable validity of self-report for tobacco use among pregnant Indigenous Australian women (Gilligan et al., 2010). Nonetheless, some under-reporting is likely. Finally, we did not collect data on many socio-economic or psycho-social factors. Further research to identify characteristics of women most likely to use multiple

substances and to experience other psycho-social risks is required. Longitudinal designs and larger sample size would enable better exploration of the relationships between these factors.

4.5. Implications

4.5.1. For research. While there is a substantial body of evidence demonstrating a correlation between socio-economic disadvantage, psycho-social stress, substance use and poor birth outcomes, only a small number of interventions specifically addressing multiple risks among disadvantaged pregnant women have been trialled (Bryce et al., 2009; El-Mohandes et al., 2011), and, to date, this issue has been largely neglected in health policy and practice. It is critical that interventions addressing multiple risks, including tobacco and other substances, be developed and tested in rigorously designed trials. These should be developed specifically for disadvantaged pregnant women, including Indigenous women, and include strategies to address social risks as well as substance use.

4.5.2. For service delivery. Antenatal services providing care for Indigenous women, or other disadvantaged groups, need to be aware of the complexity of tobacco smoking within the context of other psycho-social and behavioural risks, and the realities of women's lives. In addition to assessing tobacco status, clinicians should explore use of other substances, particularly among tobacco smokers, and support women to quit multiple substances if appropriate. This should happen as early as possible in the pregnancy to maximise benefits to the foetus. It may be possible within the antenatal setting, but may require partnerships with, or referral to, specialised drug and alcohol services. Antenatal providers should also identify other problems women face, and address these themselves or through referral, as these problems may impede women's ability to address their substance use and may themselves pose a risk. In particular, smoking cessation should not just focus on the individual, but also on the woman's partner, family and social environment, using a holistic approach consistent with Indigenous models of health and wellbeing (National Aboriginal Health Strategy Working Party, 1989).

4.5.3. Preventing the problem. Greater focus on prevention through addressing the social determinants of poor health is required to reduce the number of women using substances at the beginning of their pregnancies. Community level interventions may also help shift attitudes to tobacco use and increase knowledge of risk (Secker-Walker et al., 2008), thus shifting community norms related to tobacco use, and in the longer term reducing uptake. Current government initiatives to reduce Indigenous smoking through the health promotion roles of the Regional Tackling Smoking Teams (Australian Government Department of Health and Ageing, 2013) may help in this regard.

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Contributors

MEP and RSF developed the initial concept for the study. MEP designed the study and data collection tools and coordinated data collection, with advice from RSF and JMS. MEP conducted the data analysis with advice from RSF and CDE. All authors contributed to

interpretation and MEP wrote the first draft of the manuscript. All authors contributed to and approved the final manuscript.

Conflicts of interest

Dr Passey receives research grant funding from Pfizer Australia, through an Australian Research Council Linkage Grant and a National Health and Medical Research Council Partnership Grant, for unrelated work. The authors declare no conflicts of interest.

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