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Risk factors associated to tobacco and alcohol use in a large French cohort of pregnant women

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Abstract

Tobacco and/or alcohol use during pregnancy is a major public health concern. The aim of our study was to identify risk factors associated to maternal alcohol and tobacco use assessed by maternal self-reports combined with biological measurements in meconium samples of cotinine and ethylglucuronide which reflect fetal exposure to tobacco and alcohol, respectively, during the 3rd trimester of pregnancy. We conducted a prospective study in three maternity hospitals in a large urban area during consecutive weeks (2010 and 2011). Maternal sociodemographic and clinical characteristics were assessed after delivery, using the French version of the Addiction Severity Index. Cotinine and ethylglucuronide were measured in meconium samples. Seven hundred and twenty-four women were included, and 645 meconium samples collected. Using multivariate analyses, we found that not being married or having a smoking partner predicts maternal tobacco use. In contrast, a decreased risk was associated with higher education level and wanted pregnancy. The risk for alcohol use increased when the mother had been in conflict with any relative or her partner for a long time throughout her life, as well as in case of previous treatment for any mental or emotional disorder. Using multivariate analyses and cotinine presence in meconium samples, the risks were similar except for marital status, which was not associated to cotinine presence. Community education and prevention programs should urgently be improved for all women of childbearing age with a special focus on those with past histories of mental or emotional disorders and addictive disorders. Smoking cessation should be recommended to both parents.

Keywords Pregnancy · Tobacco · Alcohol · Addiction severity index · Cotinine · Ethylglucuronide

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Introduction

The increasing use of tobacco and, mostly, alcoholic beverages, during pregnancy affects both mother and child in a negative way and has lifelong neurodevelopmental, as well as behavioral, consequences (Lamy and Thibaut 2010; Wendell 2013; Konijnenberg 2015). Almost 16% of women in Europe consumed alcohol during pregnancy with large cross-country variations (Mårdby et al. 2017). In a German study, 21.2% of women admitted low-to-moderate alcohol consumption during pregnancy (Goecke et al. 2014). In the USA, Oh et al. (2017) have described that, in the past month, 8.7 and 14.9% of pregnant women have reported alcohol and tobacco use, respectively. The prevalence observed in a French population of pregnant women in 2008 was 22 and 20% for tobacco and alcohol use, respectively (Chassevent-Pajot et al. 2011). According to a review conducted by Skagerström et al. (2011), the most consistent predictors of alcohol use during pregnancy were pre-pregnancy alcohol consumption and past history of sexual abuse or exposure to violence. Unemployment, marital status, and education level were less consistent predictive factors. In a review conducted by Schneider et al. (2010), more than half of all smoking women do not manage to quit smoking completely during pregnancy. Pregnant women with low social status, smoking partners, high degree of addiction, and multiple former pregnancies find it particularly difficult to quit smoking. However, few studies evaluating the risk factors associated to maternal alcohol and/or tobacco use during pregnancy have simultaneously included all pregnant women in a given area and used simultaneously biological measurements of alcohol and tobacco fetal exposure in large samples. In two studies conducted on small samples, no profile of socioeconomic or psychological characteristics of women positively tested via meconium (using ethylglucuronide (EtG)) could be established (Goecke et al. 2014 (557 women; 17% were EtG positive); Abernethy et al. 2017 (235 meconium samples; 15% were EtG positive)). The aim of our study was to identify factors associated to maternal alcohol and/or tobacco use assessed by maternal self-reports combined with biological measurements in meconium samples of cotinine and ethylglucuronide which reflect fetal exposure to tobacco and alcohol, respectively, during the 3rd trimester of pregnancy.

Materials and methods

This epidemiological study was conducted in all maternity hospitals of a single large urban area (half a million residents, located in Normandy, North West of France), namely Rouen University Hospital (public hospital, about 2700 deliveries per year), Mathilde Clinic (private clinic, about 3100 deliveries per year), and Le Belvédère Hospital (public hospital, 3600 deliveries per year). Any pregnant woman aged 18 years or over and living in our catchment area who delivered a child in one of these maternity hospitals was included. The study has been conducted during three consecutive weeks in August 2010 and two consecutive weeks in August 2011. Within 72 h after delivery, sociodemographic and clinical characteristics were assessed in mothers using a semi-structured interview conducted by trained midwifery students with the French version of the 5th Edition of the Addiction Severity Index (ASI) (McLellan et al. 1992; Martin et al. 1996). The ASI provided an overview of recent (past 30 days) and lifetime problems. Additional sociodemographic and clinical data were also collected from clinical charts. Severity scores were not used. Meconium samples were collected quickly after birth (within 48 h after the birth) from neonates.

Detection of cotinine and EtG in meconium samples

Biological measurements were conducted blindly to clinical evaluations. Cotinine (nicotine metabolite) and EtG (alcohol metabolite) presence were assessed in meconium samples, as described previously in Lamy et al. (2017). Briefly, cotinine was detected using a highly specific and sensitive liquid chromatography-tandem mass spectrometry (LC-MS/MS) method with a limit of detection (LOD), used as the cutoff for interpretation, of 10 ng/g. EtG was first detected using a commercial immunoanalysis assay (DRI EtG assay from Microgenics) with a limit of detection of 60 ng/g, and, subsequently, all positive or near the detection threshold samples were checked and quantified using a gas chromatography-mass spectrometry (GC-MS/MS) method with a limit of quantification (LOQ) of 40 ng/g.

Statistical analysis

Women were classified as users (at least one cigarette or one standard alcoholic drink during the entire pregnancy) or non-users (1) before current pregnancy, (2) during current pregnancy, or (3) during the 3rd trimester of the current pregnancy, based on self-reports and/or the presence of cotinine or EtG in meconium samples.

The associations of demographic, obstetric, or clinical variables with maternal self-reports of tobacco or alcohol use and/or cotinine- or EtG-positive meconium samples were examined using univariate analyses. A Pearson's chi-square test or a Fisher exact test was used as appropriate for categorical variables and a Student's t test or a Mann and Whitney test was used as appropriate for continuous variables. Odds ratio and corresponding 95% confidence interval (CI) were estimated using unconditional logistic regression. Variables associated with tobacco or alcohol use during pregnancy or the presence of cotinine in meconium with p value less than 0.20 in the univariate analysis and with at most 15% missing data were

retained for the multivariate analysis. A backward step-by-step unconditional logistic regression was then performed to identify factors independently associated with tobacco or alcohol use during pregnancy or the presence of cotinine in meconium. The goodness-of-fit for the final model was tested using the Hosmer and Lemeshow goodness-of-fit test, and the area under the ROC curve was used as an assessment of model discrimination. Univariate and multivariate analyses were not conducted to differentiate the presence or "non-presence" of EtG in meconium due to the small sample size.

Statistical significance was defined as $p < 0.05$. Analyses were performed using SAS 9.2 software (SAS Institute, Cary, NC, USA).

Results

Characteristics of pregnant women

In total, 724 among 993 deliveries fulfilled the inclusion criteria (93.8% of women agreed to participate); 645 and 642 meconium samples were analyzed for cotinine and EtG presence/absence, respectively. In total, 269 deliveries were not included: 61 mothers refused to participate; 48 did not speak and/or understand French language; 6 were aged less than 18 years; 145 were living outside of our catchment area; 12 left the maternity hospital before inclusion; 2 had a critical illness at inclusion; in 6 cases, stillbirths were observed; and one mother delivered anonymously. Twenty-five mothers reported concurrent alcohol and tobacco use; three reported concurrent cannabis and tobacco use; and three reported polyconsumption of alcohol, tobacco, and cannabis. The respective prevalence of tobacco, alcohol, and cannabis use declared before and during the 3rd trimester of the current pregnancy in the entire population of pregnant women and presence of cotinine and/or EtG in meconium samples are described in Table 1. Tobacco use was reported by 21.1% of women [95% CI 18.2–24.2] during pregnancy, and 129/645 meconium samples (20%) [95% CI 16.91–23.09] were cotinine positive. Among women who reported the amount of tobacco use during the current pregnancy, 74.8% (101/135) reduced, 2.9% (4/135) increased, and 22.2% (30/135) did not change their consumption, respectively. During the 1st, 2nd, and 3rd trimesters, the mean number of cigarettes per day was 7.1, 6.1, and 6.1, respectively. Maternal alcohol use (any use) was reported in 15.4% [95% CI 12.8–18.1] and 3.7% [95% CI 2.3–5.0] during the current pregnancy and during the 3rd trimester of pregnancy, respectively. Of note, only 2.9% [95% CI 1.6–4.3] of meconium samples were EtG-positive.

Sociodemographic and clinical characteristics of the population of pregnant women ($n = 724$) are reported in Table 1.

Factors associated with tobacco use as indicated by maternal self-report and cotinine presence in meconium

Maternal self-reports

The risk for tobacco use was increased if the mother was smoking tobacco (but not alcohol) before the current pregnancy; if she was using caffeine (but not alcohol) during the current pregnancy; if she was single/divorced/widowed rather than married; if she was previously hospitalized for medical disorders; if she has spent free time alone rather than with her family or friends; if she had no regular monitoring of pregnancy, with the number of previous children; if the father was a current tobacco smoker or was using alcohol regularly; and, finally, if the mother reported, at least once in her life, past history of depressive disorders, any treatment (including psychotropic drug use) for emotional or depressive disorders, suicidal ideations, or any previous suicide attempt (Table 2).

In contrast, the risk for tobacco use was decreased with the increase of father's age and if parental education level or socioeconomic status was high, if the mother was employed during pregnancy, if the mother was satisfied with her marital status, and if pregnancy was wanted (Table 2).

Cotinine presence in meconium

Using cotinine detection in meconium samples, the associations were quite similar to those observed with maternal self-reports, except for paternal age, satisfaction of the mother with her marital status, spending free time alone or not, previous hospitalizations for medical disorders, past history of psychotropic drug use, and, mostly, maternal past history of depressive disorders, which were not associated to cotinine presence in meconium samples (Table 2).

Interestingly, past history of sexual, physical, or emotional abuse was associated to positive cotinine detection, but not with maternal self-reports of tobacco use (Table 2).

Factors associated with alcohol use as indicated by maternal self-report

The risk for alcohol use during pregnancy increased with maternal age and if the mother was using alcohol (but not tobacco) before pregnancy; if she was using caffeine during current pregnancy; if she had been in conflict with her current partner or a relative for a long time; if she had a past history of abuse (sexual, physical, or emotional), a history of family psychiatric disorders, a personal psychiatric care for anxiety, depressive disorders or emotional disorders, suicidal ideations or suicide attempts, or psychotropic treatment use at any time in the past; and, finally, if her partner was Caucasian, had high

Table 1 Sociodemographic and clinical characteristics of our population

	Number (%) or Mean ± SD
Mother Caucasian (yes) $n = 724$	626 (86.5)
Maternal age (years) $n = 724$ (mean ± SD)	30.1 ± 5.0
Mother's education level	
Elementary school and high school graduation	328 (45.4)
University	395 (54.6)
Mother's economic status	
Manual or unskilled	448 (69.8)
Managerial	194 (30.2)
Employed mother during pregnancy (yes) $n = 719$	546 (75.9)
Father Caucasian (yes) $n = 716$	602 (84.1)
Paternal age (years) $n = 709$ (mean ± SD)	32.4 ± 5.8
Father's education level	
Elementary school and high school graduation	391 (55.8)
University	310 (44.2)
Father's economic status	
Manual or unskilled	483 (69.9)
Managerial	208 (30.1)
Employed father (yes) $n = 724$	631 (87.2)
Marital status	
Married	319 (44.7)
Divorced, widowed, or single	395 (55.3)
Happy with these conditions of life (marital status) (yes) $n = 720$	659 (91.5)
Lifestyle	
With children and partner	672 (92.9)
No partner	51 (7.1)
Happy with these conditions of life (lifestyle) (yes) $n = 716$	680 (95.0)
The mother had been in conflict with any relative for a long time (yes) $n = 717$	21 (2.9)
The mother had been in conflict with her partner (yes) $n = 712$	20 (2.8)
Spend free time	
With family or friends	690 (97.6)
Alone	17 (2.4)
Sexual, physical or emotional abuse past history (yes) $n = 713$	63 (8.8)
Past treatment for mental or emotional disorders (yes) $n = 716$	32 (4.4)
Depressive disorders lifetime yes) $n = 720$	105 (14.6)
Anxiety disorders lifetime (yes) $n = 717$	138 (19.2)
Suicidal ideation lifetime (yes) $n = 717$	40 (5.6)
Suicide attempt lifetime (yes) $n = 716$	21 (2.9)
Any psychotropic drug use lifetime (yes) $n = 717$	69 (9.7)
Family history of psychiatric disorders (yes) $n = 712$	81 (11.4)
Alcohol use in the family $n = 714$	158 (22.1)
Alcohol (any use) use during current pregnancy (using maternal self-reports) $n = 717$	111 (15.4)
Tobacco (any use) use during current pregnancy (using maternal self-reports) $n = 721$	153 (21.2)
Cannabis (any use) use during current pregnancy (using maternal self-reports) $n = 719$	7 (1.0)
Cola (any use) use during current pregnancy (using maternal self-reports) $n = 720$	398 (55.3)
Coffee (any use) use during current pregnancy (using maternal self-reports) $n = 722$	340 (47.1)
Tea (any use) use during current pregnancy (using maternal self-reports) $n = 720$	284 (39.4)
Alcohol (any use) use during the 3rd trimester of current pregnancy (using maternal self-reports) $n = 712$	26 (3.7)
Binge drinking	0
Tobacco (any use) use during the 3rd trimester of current pregnancy (using maternal self-reports) $n = 715$	123 (17.2)

Table 1 (continued)

	Number (%) or Mean ± SD
Cannabis (any use) use during the 3rd trimester of current pregnancy (using maternal self-reports) $n = 719$	6 (0.8)
Cola (any use) use during the 3rd trimester of current pregnancy (using maternal self-reports) $n = 724$	358 (49.5)
Coffee (any use) use during the 3rd trimester of current pregnancy (using maternal self-reports) $n = 724$	303 (41.9)
Tea (any use) use during the 3rd trimester of current pregnancy (using maternal self-reports)	251 (34.7)
Alcohol (any use) use before the current pregnancy $n = 722$	414 (57.3)
Binge drinking before pregnancy $n = 710$	25 (3.5)
Tobacco (any use) use before the current pregnancy $n = 721$	215 (29.9)
Partner alcohol use during pregnancy (from mother's interview) (yes) $n = 719$ (only 8/719 (1.1) use alcohol regularly > 3–5 times/week)	544 (75.7)
Partner tobacco use during pregnancy (from mother's interview) (yes) $n = 716$	308 (43.0)
Pregnancy wanted $n = 709$	619 (87.3)
Discovery of pregnancy (< 3 months) $n = 723$	696 (96.3)
Parity (newborn alive) $n = 717$ (mean ± SD)	1.8 ± 1.0
At least one previous miscarriage $n = 724$	85 (11.7)
Maternal body mass index before pregnancy $n = 711$ (mean ± SD)	23.7 ± 4.9
Number of previous hospitalizations for medical disorders $n = 719$	1.7 ± 4.3
Regular monitoring during pregnancy (yes) $n = 723$	632 (87.4)
Cotinine positive in meconium $n = 645$	129 (20.0)
EtG positive in meconium $n = 642$	19 (2.9)

socioeconomic status, and if he was using alcohol regularly (Table 3).

Maternal clinical and demographic factors observed in women for whom EtG was positive in meconium samples from their neonates

In these 19 cases (all were Caucasians), we have observed the following interesting maternal factors: 16 (84.2%) women were using alcohol regularly before pregnancy (including previous pregnancies), 10 (52.6%) declared alcohol use during the 1st trimester of the current pregnancy, whereas only one reported alcohol use during the 3rd trimester. In contrast, 5 (26.3%) reported tobacco use during the 3rd trimester (cotinine was positive in 7/19 cases) (Table 3).

In only 2 cases (10.5%), partners were using alcohol regularly (> 3 times per week) and in 7 out of those 19 mothers (36.8%), partners were current smokers.

Six mothers (31.5%) had past history of depressive disorders. These 19 mothers had been more often exposed to conflicts with relatives or partners and were less often employed. Maternal and paternal ages were slightly higher, as well as maternal body mass index. The prevalence of previous hospitalizations for medical disorders was 100%.

Pregnancies were not the first one in 12 cases (63.2%); they were mostly wanted, with regular monitoring. Interestingly, 4 (21.0%) mothers had previous miscarriages.

Best predictors of tobacco and alcohol use during pregnancy

Tobacco

When the mother reported that her partner was a current smoker or when the mother reported being divorced/widowed/single rather than married, increased odds of tobacco use during pregnancy were observed (OR 5.3 [95% CI 3.4–8.4]; $p < 0.0001$; OR 2.0 [95% CI 1.2–3.1]; $p = 0.004$, respectively). In contrast, a maternal high education level and a wanted pregnancy were associated with decreased odds of tobacco use during pregnancy (OR 0.4 [95% CI 0.3–0.7]; $p < 0.0001$; OR 0.5 [95% CI 0.3–0.9]; $p = 0.04$, respectively).

Using cotinine measurements, as compared to previous results obtained using the ASI and maternal self-reports, the risks were similar (OR 4.2 [95% CI 2.6–6.6]; $p < 0.001$; OR 0.4 [95% CI 0.2–0.6]; $p < 0.001$; OR 0.5 [95% CI 0.3–0.8]; $p = 0.001$, respectively) except for marital status, which was not associated to cotinine presence in meconium samples.

Alcohol

When the mother had been in conflict with her partner, with any relative (for a long time) or when the mother reported a past history of treatment for any mental or emotional disorder, increased odds of alcohol use during pregnancy were observed (OR 3.0 [95% CI 1.1–8.3]; $p = 0.03$; OR 3.3 [95% CI

Table 2 Sociodemographic and clinical characteristics associated with tobacco use during pregnancy using maternal self-reports and cotinine measurements in meconium

	No tobacco use (n = 568) n (%) or mean ± SD	Tobacco use (n = 153) n (%) or mean ± SD	p value	OR (95%CI)	Negative cotinine (n = 516) n (%) or mean ± SD	Positive cotinine (n = 129) n (%) or mean ± SD	p value	OR (95% CI)
Mother Caucasian (yes)	491/563 (87.2)	132/149 (88.6)	0.6508	1.1 (0.6–2.0)	446/512 (87.1)	113/125 (90.4)	0.3143	1.3 (0.7–2.7)
Maternal age (years) (mean ± SD)	n = 568 30.3 ± 4.9	n = 153 29.5 ± 5.3	0.0852	/	n = 516 30.2 ± 4.9	n = 129 29.4 ± 5.2	0.1374	
Mother's education level								
Elementary school and high school graduation	224 (39.5)	103 (67.3)	<0.0001*	1	208 (40.4)	90 (69.8)	<0.0001*	1
University	343 (60.5)	50 (32.7)		0.3 (0.2–0.4)	307 (59.6)	39 (30.2)		0.3 (0.2–0.5)
Mother's economic status								
Manual or unskilled	338 (66.0)	108 (85.0)	<0.0001*	1	312 (67.1)	86 (81.1)	0.0045*	1
Managerial	174 (34.0)	19 (15.0)		0.3 (0.2–0.6)	153 (32.9)	20 (18.9)		0.5 (0.3–0.8)
Employed mother (yes)	453/565 (80.2)	106/151 (70.2)	0.0085*	0.6 (0.4–0.9)	413/512 (80.7)	86/128 (67.2)	0.0010*	0.5 (0.3–0.7)
Father Caucasian (yes)	473/561 (84.3)	126/152 (82.9)	0.6720	0.9 (0.6–1.5)	431/509 (84.7)	105/128 (82.0)	0.4640	0.8 (0.5–1.4)
Paternal age (years) (mean ± SD)	n = 560 32.6 ± 5.6	n = 146 31.6 ± 6.6	0.0130*	/	n = 506 32.4 ± 5.5	n = 125 31.7 ± 6.8	0.0764	/
Father's education level								
Elementary school and high school graduation	279 (50.5)	112 (76.6)	<0.0001*	1	261 (52.1)	95 (77.2)	<0.0001*	1
University	274 (49.5)	34 (23.4)		0.3 (0.2–0.5)	240 (47.9)	28 (22.8)		0.3 (0.2–0.5)
Father's economic status								
Manual or unskilled	370 (67.5)	111 (79.3)	0.0067*	1	338 (68.6)	93 (77.5)	0.0546	1
Managerial	178 (32.5)	29 (20.7)		0.5 (0.4–0.9)	155 (31.4)	27 (22.5)		0.6 (0.4–1.0)
Employed father (yes)	511/561 (91.1)	128/149 (85.9)	0.0609	0.6 (0.3–1.0)	459/508 (90.4)	112/126 (88.9)	0.6226	0.8 (0.5–1.6)
Marital Status								
Married	279 (49.8)	39 (25.8)	<0.0001*	1	249 (48.9)	42 (32.8)	0.001*	1
Divorced, widowed or single	281 (50.2)	112 (74.2)		2.9 (1.9–4.2)	260 (51.1)	86 (67.2)		1.9 (1.3–2.9)
Happy with these conditions of life (marital status) (yes)	525/565 (92.9)	133/153 (86.9)	0.0175*	0.5 (0.3–0.9)	474/512 (92.6)	115/129 (89.1)	0.2305	0.7 (0.4–1.3)
Lifestyle								
With children and partner	532 (93.8)	137 (89.5)	0.0668	1	479 (93.0)	117 (90.7)	0.3713	1
No partner	35 (6.2)	16 (10.5)		1.8 (1–3.3)	36 (7.0)	12 (9.3)		1.4 (0.7–2.7)
Happy with these conditions of life (lifestyle) (yes)	540/564 (95.7)	138/150 (92.0)	0.0625	0.5 (0.3–1.1)	488/511 (95.5)	118/127 (92.9)	0.2322	0.6 (0.3–1.4)
The mother had been in conflict with any relative for a long time (yes)	15/563 (2.7)	6/152 (3.9)	0.4178	1.5 (0.6–3.9)	14/510 (2.7)	6/128 (4.7)	0.2600	1.7 (0.7–4.6)
The mother had been in conflict with her partner (yes)	12/558 (2.2)	8/152 (5.3)	0.0516	2.5 (1.0–6.3)	13/507 (2.6)	6/127 (4.7)	0.2400	1.9 (0.7–5.1)
Spend free time								
With family or friends	542 (97.7)	146 (97.3)	<0.0001*	/	492 (97.6)	124 (97.6)	0.3223	/
Alone	13 (2.3)	4 (2.7)			12 (2.4)	3 (2.4)		
Sexual, physical or emotional abuse past history (yes)	43/561 (7.7)	19/152 (12.5)	0.0606	1.7 (1.0–3.0)	37/511 (7.2)	17/127 (13.4)	0.0260*	2.0 (1.1–3.7)
Past treatment for mental or emotional disorders (yes)	19/564 (3.4)	14/152 (9.2)	0.0041*	2.9 (1.4–5.9)	18/512 (3.5)	13/128 (10.2)	0.0017*	3.1 (1.5–6.5)
Depressive disorders lifetime (yes)	70/565 (12.4)	34/153 (22.2)	0.0022*	2.0 (1.3–3.2)	67/513 (13.1)	24/128 (18.8)	0.0990	1.5 (0.9–2.6)
Anxiety disorders lifetime (yes)	102/562 (18.1)	36/153 (23.5)	0.1349	1.4 (0.9–2.1)	94/511 (18.4)	27/128 (21.1)	0.4800	1.2 (0.7–1.9)

Table 2 (continued)

	No tobacco use (n = 568) n (%) or mean ± SD	Tobacco use (n = 153) n (%) or mean ± SD	p value	OR (95%CI)	Negative cotinine (n = 516) n (%) or mean ± SD	Positive cotinine (n = 129) n (%) or mean ± SD	p value	OR (95% CI)
Suicidal ideation lifetime (yes)	23/552 (4.1)	16/153 (10.5)	0.0021	2.7 (1.4–5.3)	23/511 (4.5)	13/128 (10.2)	0.0131	2.4 (1.2–4.9)
Suicide attempt lifetime (yes)	8/561 (1.4)	13/153 (8.5)	<0.0001*	6.4 (2.6–15.8)	8/510 (1.6)	10/128 (7.8)	<0.0001*	5.3 (2.0–13.8)
Any psychotropic drug use (yes) lifetime	47/562 (8.4)	21/153 (13.7)	0.0450*	1.7 (1.0–3.0)	44/511 (8.6)	14/128 (10.9)	0.4125	1.3 (0.7–2.5)
Family history of psychiatric disorders (yes)	59/562 (10.5)	22/150 (14.7)	0.1532	1.5 (0.9–2.5)	59/507 (11.6)	16/127 (12.6)	0.7642	1.1 (0.6–2.0)
Alcohol use in the family (yes)	116/559 (20.8)	42/151 (27.8)	0.2332	1.5 (1–2.2)	107/507 (21.1)	35/128 (27.3)	0.1301	1.4 (0.9–2.2)
Alcohol (any use) use during current pregnancy (using maternal self-reports)	86/565 (15.2)	25/152 (16.4)	0.8171	1.0 (0.7–1.7)	77/511 (15.1)	20/129 (15.5)	0.9019	1.0 (0.6–1.8)
Cannabis (any use) use during current pregnancy (using maternal self-reports)	1/568 (0.2)	6/149 (4.0)	/	/	0/513 (0)	6/127 (4.7)	/	/
Cola (any use) use during current pregnancy (using maternal self-reports)	299/566 (52.8)	98/153 (64.1)	0.0132*	1.6 (1.1–2.3)	270/512 (52.7)	81/129 (62.8)	0.0403*	1.5 (1.0–2.2)
Coffee (any use) use during current pregnancy (using maternal self-reports)	249/568 (43.8)	91/153 (59.5)	0.0006*	1.9 (1.3–2.7)	221/514 (43.0)	79/129 (61.2)	0.0002*	2.1 (1.4–3.1)
Tea (any use) use during current pregnancy (using maternal self-reports)	237/566 (41.9)	47/153 (30.7)	0.0123*	0.6 (0.4–0.9)	206/512 (40.2)	46/129 (35.7)	0.3417	0.8 (0.6–1.2)
Alcohol use (any use) use before the current pregnancy	323/568 (56.9)	88/151 (58.3)	0.7553	1.1 (0.7–1.5)	296/515 (57.5)	73/128 (57.0)	0.9275	0.9 (0.7–1.5)
Tobacco use (any use) before the current pregnancy	69/568 (12.1)	146/151 (96.7)	<0.0001*	/	78/512 (15.2)	117/128 (91.4)	<0.0001*	/
Partner tobacco use during pregnancy (from mother's interview)	193/560 (34.5)	114/149 (76.5)	<0.0001*	6.2 (4.1–9.4)	185/506 (36.6)	93/126 (73.9)	<0.0001*	4.9 (3.2–7.6)
Lives with a partner who uses alcohol regularly	3/565 (0.5)	5/153 (3.3)	–	–	2/153 (0.4)	4/128 (3.1)	–	–
Pregnancy wanted	502/552 (90.9)	115/145 (79.3)	<0.0001*	0.4 (0.2–0.6)	456/501 (91.0)	97/123 (78.9)	0.0001*	0.4 (0.2–0.6)
Discovery of pregnancy (<3 months)	550/568 (96.8)	143/152 (94.1)	0.1127	1.9 (0.9–4.4)	501/516 (97.1)	120/128 (93.8)	0.1043	2.2 (0.9–5.4)
Parity (newborn alive) (mean ± SD)	n = 568; 1.8 ± 1.0	n = 153; 2.0 ± 1.2	0.0852	/	n = 516; 1.8 ± 1.0	n = 129; 2.0 ± 1.2	0.1678	/
At least one previous miscarriage (yes)	86/568 (15.1)	21/153 (13.7)	0.6620	0.9 (0.5–1.5)	79/516 (15.3)	18/129 (13.9)	0.6998	0.9 (0.5–1.6)
Maternal body mass index before pregnancy (mean ± SD)	n = 558; 23.7±4.7	n = 150; 23.8 ± 5.4	0.6226	/	n = 507; 23.8 ± 4.8	n = 126; 23.6 ± 5.8	0.1798	/
Number of previous hospitalizations for medical disorders (mean ± SD)	n = 463; 1.6+4.5	n = 153; 2.1+3.6	0.0190*	/	n = 513; 1.7 ± 4.7	n = 129; 2.0 ± 3.8	0.3712	/
Regular monitoring of pregnancy (yes)	507/562 (90.2)	122/150 (81.3)	0.0026*	0.5 (0.3–0.8)	458/511 (89.6)	104/128 (81.3)	0.0092*	0.5 (0.3–0.8)
EtG positive in meconium (yes)	13/503 (2.6)	6/136 (4.4)	0.2611	/	12/514 (2.3)	7/128 (5.5)	0.0774	/

For some variables, odds ratio were not calculated due to the small number of available data

OR (95% CI) Odds ratio (confidence interval 95%), SD standard deviation

*p < 0.05. p value based on Pearson chi-square test or Fisher's exact test (when appropriate) for qualitative variables or Mann and Whitney's test for quantitative variables

Table 3 Sociodemographic and clinical characteristics of pregnant women who used alcohol during pregnancy and factors associated with alcohol use as indicated by maternal self-report

	No alcohol use (n = 608) N (%) Mean ± SD	Alcohol use (n = 111) N (%) Mean ± SD	p value	OR (95% CI)	EtG (n = 19) N (%) Mean ± SD
Mother Caucasian (yes)	519/599 (86.6)	100/109 (91.7)	0.1397	1.7 (0.8–3.5)	19/19 (100)
Maternal age (years) (mean ± SD)	n = 606	n = 111		/	n = 19
	30.0 ± 5.0	31.0 ± 5.0	0.0261*		31.4 ± 4.5
Mother's education level					
Elementary school and high school graduation	282 (46.6)	45 (40.5)	0.2979	1	6 (31.5)
University	323 (53.4)	66 (59.5)		1.3 (0.8–1.9)	9 (47.4)
Mother's economic status					
Manual or unskilled	377 (70.9)	67 (65.0)	0.2388	1	11 (68.8)
Managerial	155 (29.1)	36 (35.0)		1.3 (0.8–2.0)	5 (31.2)
Employed mother during pregnancy (yes)	465/601 (77.4)	90/111 (81.1)	0.3864	1.3 (0.8–2.1)	9/19 (47.4)
Father Caucasian (yes)	488/599 (81.5)	107/110 (97.3)	< 0.0001*	8.1 (2.5–26.0)	16/19 (84.2)
Paternal age (years) (mean ± SD)	n = 592	n = 110		/	n = 18
	32.3 ± 5.8	33.1 ± 6.2	0.14		33.9 ± 6.3
Father's education level					
Elementary school and high school graduation	333 (56.9)	57 (52.3)	0.3711	1	8 (57.1)
University	252 (43.1)	52 (47.7)		1.2 (0.8–1.8)	6 (42.9)
Father's economic status					
Manual or unskilled	413 (71.7)	67 (62.0)	0.0440*	1	13 (68.4)
Managerial	163 (28.3)	41 (38.0)		1.5 (1.0–2.4)	6 (31.6)
Employed Father (yes)	539/595 (90.6)	97/111 (87.4)	0.3003	0.7 (0.4–1.3)	16/18 (88.9)
Marital Status					
Married	276 (46.2)	40 (36.7)	0.0678	1	8 (42.1)
Divorced, widowed or single	322 (53.8)	69 (63.3)		1.5 (0.9–2.3)	11 (57.9)
Happy with these conditions of life (marital status) (yes)	554/603 (91.9)	100/111 (90.1)	0.5336	0.8 (0.4–1.6)	18/19 (4.7)
Lifestyle					
With children and partner	563 (93.1)	102 (91.9)	0.6606	1	18 (94.7)
No partner	42 (6.9)	9 (8.1)		1.2 (0.6–2.5)	1 (5.3)
Happy with these conditions of life (lifestyle) (yes)	573/601 (95.3)	101/109 (92.7)	0.2406	0.6 (0.3–1.4)	18/19 (94.7)
The mother had been in conflict with any relative for a long time (yes)	12/600 (2.0)	9/111 (8.1)	0.0023*	4.3 (1.8–10.5)	2/19 (10.5)
The mother had been in conflict with her partner (yes)	13/596 (2.2)	7/110 (6.4)	0.0247*	3.0 (1.2–7.9)	1/19 (5.3)
Spend free time					
With family or friends	581 (97.6)	103 (97.2)	0.7685	/	19 (100)
Alone	14 (2.4)	3 (2.8)			0
Sexual, physical or emotional abuse past history (yes)	44/599 (7.3)	17/110 (15.5)	0.0053*	2.3 (1.3–4.2)	2/19 (10.5)
Past treatment for mental or emotional disorders (yes)	21/602 (3.5)	12/110 (10.9)	0.0007*	3.4 (1.6–7.1)	1/19 (5.3)
Depressive disorders lifetime (yes)	76/603 (12.6)	27/111 (24.3)	0.0012*	2.2 (1.4–3.7)	6/19 (31.6)
Anxiety disorders lifetime (yes)	106/601 (17.6)	31/110 (28.2)	0.0099*	1.8 (1.1–2.9)	3/19 (15.8)
Suicidal ideation lifetime (yes)	24/601 (4.0)	15/110 (13.6)	< 0.0001*	3.8 (1.9–7.5)	3/19 (15.8)
Suicide attempt lifetime (yes)	12/600 (2.0)	9/110 8.2)	0.0022*	4.4 (1.8–10.6)	2/19 (10.5)
Any psychotropic drug use lifetime (yes)	46/601 (7.7)	21/110 (19.1)	0.0002*	2.8 (1.6–5)	3/19 (15.8)
Family history of psychiatric disorders (yes)	59/597 (9.9)	21/111 (18.9)	0.0058*	2.1 (1.2–3.7)	0/19 (0)
Alcohol use in the family (yes)	129/599 (21.5)	28/111 (25.2)	0.6492	1.2 (0.8–2.0)	5/19 (26.3)

Table 3 (continued)

	No alcohol use (n = 608) N (%) Mean ± SD	Alcohol use (n = 111) N (%) Mean ± SD	p value	OR (95% CI)	EtG (n = 19) N (%) Mean ± SD
Tobacco (any use) use during current pregnancy (using maternal self-reports)	127/606 (21.0)	25/111 (22.5)	0.7107	1.1 (0.7–1.8)	6/19 (31.6)
Cannabis (any use) use during current pregnancy (using maternal self-reports)	4/604 (0.7)	3/111 (2.7)	/	/	2/19 (10.5)
Cola (any use) use during current pregnancy (using maternal self-reports)	324/605 (53.6)	71/100 (71.0)	0.0330*	1.6 (1.0–2.4)	8/19 (42.1)
Coffee (any use) use during current pregnancy (using maternal self-reports)	273/606 (45.0)	64/111 (57.7)	0.0144*	1.7 (1.1–2.5)	9/19 (47.4)
Tea (any use) use during current pregnancy (using maternal self-reports)	229/605 (37.9)	53/110 (48.2)	0.0414*	1.5 (1.0–2.3)	11/19 (57.9)
Alcohol (any use) use before the current pregnancy	302/605 (49.9)	107/110 (97.3)	< 0.0001*	/	16/18 (88.9)
Tobacco (any use) use before the current pregnancy	175/605 (28.9)	38/110 (34.5)	0.2358	1.3 (0.8–2.0)	6/18 (33.3)
Partner alcohol use during pregnancy (from mother's interview) (yes)	435/585 (74.4)	104/111 (93.7)	< 0.0001*	5.1 (2.3–11.3)	16/18 (88.9)
Partner who uses alcohol regularly (> 3–5 times/week)	6/603 (1.0)	2/111 (1.8)	–	–	2/19 (0.5)
Partner tobacco use during pregnancy (from mother's interview) (yes)	261/606 (43.0)	45/111 (40.5)	0.62	1.1 (0.7–1.7)	7/18 (36.8%)
Pregnancy wanted	518/583 (88.9)	95/110 (86.4)	0.4540	0.8 (0.4–1.4)	16/19 (84.2)
Discovery of pregnancy (< 3 months)	583/605 (96.4)	106/111 (95.5)	0.5930	1.3 (0.5–3.4)	19/19 (100)
Parity (newborn alive)	n = 606	n = 111		/	n = 19
(mean ± SD)	1.8 ± 1.1	1.8 ± 0.9	0.9554		2.1 ± 1.1
At least one previous miscarriage	92/606 (15.2)	15/111 (13.5)	0.6502	0.9 (0.5–1.6)	4/19 (21.1)
Maternal body mass index before pregnancy	n = 596	n = 108	0.2522	/	n = 18
(mean ± SD)	23.8 ± 4.9	23.4 ± 5.0			25.1 ± 5.6
Number of previous hospitalizations for medical disorders	n = 602	n = 110		/	n = 19
(mean ± SD)	1.7 ± 4.6	1.7 ± 2.5	0.6332		2.4 ± 4.5
Regular monitoring pregnancy (yes)	526/598 (88.0)	99/110 (90.0)	0.5410	1.2 (0.6–2.4)	16/19 (84.2)
Cotinine positive in meconium (yes)	109/543 (20.0)	20/97 (20.6)	0.9019	/	7/19 (36.8)

No statistical analyses were conducted concerning EtG due to the small number of positive meconium samples. For some variables, odds ratio were not calculated due to the small number of available data

OR (95% CI) odds ratio (confidence interval 95%), *SD* standard deviation

*$p < 0.05$. *p* value based on Pearson chi-square test or Fisher's exact test (according to the sample size) for qualitative variables or Mann and Whitney's test for quantitative variables

1.3–8.5]; $p = 0.01$; OR 2.7 [95% CI 1.5–5.0]; $p = 0.001$, respectively).

Discussion

Our population was composed of all pregnant women who gave birth to a living child in a large urban area of 350,000 inhabitants during a limited period of time. In this population, the prevalence of alcohol and tobacco use reported before pregnancy was close to the one observed in the general population in France (Beck et al. 2014). The prevalence observed in our population was also similar to the prevalence reported in previous studies conducted in pregnant women in France (Chassevent-Pajot et al. 2011; Dumas et al. 2014).

In our population, using the ASI, maternal self-reports, and multivariate analyses, we have found that having a higher education level, as well as a wanted pregnancy, reduced the risk for tobacco use during pregnancy, which suggests that pregnancy is a good opportunity to stop smoking to the extent that most women having wanted pregnancies may have a higher motivation (Miyazaki et al. 2015; Thibaut et al. 2018). In contrast, the risk for tobacco smoking increased when the partner was a current smoker, which means that tobacco withdrawal should be recommended to both parents. This risk was also increased when women was single rather

than married. These results were also reported in a recent meta-analysis conducted by Riaz et al. in 2018.

In previous studies, similar and other clinical or demographic factors such as young age, ethnicity, income, parity, current depressive disorder, past family history of psychiatric disorders, or past history of criminal records were considered as additional risk factors for tobacco use during pregnancy (Wakschlag et al. 2002; Smedberg et al. 2014; Cui et al. 2014; Dumas et al. 2014; Goodwin et al. 2017; Oh et al. 2017; Riaz et al. 2018). However, in many previous studies, some recruitment biases were observed. The strength of our cohort is the low risk of selection bias in the recruitment and the multivariate analysis. In fact, every pregnant woman who delivered a child in one of all three maternity hospitals of a large geographic area was included. In total, 73% of all pregnant women fulfilled our eligibility criteria.

In our study, using maternal self-reports, we have found positive associations between tobacco use during the current pregnancy and tobacco use before pregnancy or caffeine (coffee, tea, or cola) use during the current pregnancy. However, no association was observed between tobacco and alcohol use (before or during the current pregnancy). Alcohol use was probably under-reported due to stigma. An association between tobacco and alcohol use during current pregnancy was previously reported by Hamułka et al. (2018), Gomez-Roig et al. (2018), and in the meta-analysis of Riaz et al. (2018). A correlation between pre-pregnancy and pregnancy tobacco use was also reported in developing, as well as in European countries (Schneider and Schütz 2008; Smedberg et al. 2014). An association between smoking and caffeine consumption was previously reported in two European cohorts (Treur et al. 2016). Risk factors associated to tobacco use during pregnancy were quite similar when maternal self-reports or cotinine presence in meconium samples was used (except for marital status), which suggests that maternal self-reports of tobacco use are reliable indicators of fetal exposure.

In our population, the risk for alcohol use was increased in women with previous treatment for any mental or emotional disorder, suggesting once more that screening for and care of mental disorders should be systematic during pregnancy. Interestingly, in our study, we have focused on maternal clinical characteristics in cases of EtG-positive meconium samples. Women with unfavorable employment status, past history of regular alcohol use, or depressive disorders were at higher risk of alcohol use during pregnancy. Tobacco use during pregnancy was also more frequent. Fathers were also using alcohol and tobacco and should be involved in prevention campaigns. Most surprisingly, almost all pregnancies were wanted and regularly monitored; therefore, detection of alcohol use should be conducted in all women at all prenatal visits and by all caregivers until delivery. Moreover, all women of childbearing age should be advised to quit alcohol and tobacco before becoming pregnant. Finally, past history of miscarriages should draw attention to alcohol use during previous pregnancies.

Study limitations

This study has some limitations that need to be considered when interpreting the results.

We have used maternal self-reports of tobacco and alcohol use before and during current pregnancy, which is a source of uncertainty. Indeed, the responses may have been influenced by social desirability, a bias that tends to be important when the questions deal with socially desirable (or undesirable) behaviors and, specifically, when alcohol is considered. To decrease the risk of social desirability bias, anonymity of participants was ensured and cotinine and EtG presence were assessed in meconium samples from neonates. However, in 79 cases, meconium was not available. In those cases of early or late meconium release or intensive neonatal care, we may have under-estimated some risk factors associated to tobacco and/or alcohol use.

Alcohol use was probably under-reported; however, the size of the sample of pregnant women with EtG-positive meconium samples was rather small.

Finally, another limitation was the use of a retrospective questionnaire (ASI) answered after delivery. Women often did not precisely remember the amounts of tobacco and/or alcohol used during each trimester of pregnancy.

Conclusion

The present study emphasizes the urgent need for community education and implementation of prevention strategies focused on risks associated to tobacco and alcohol use during pregnancy. Regular obstetrical monitoring is a crucial time for information and education of women, especially in population socially disadvantaged and in women with past history of psychiatric or emotional, as well as addictive disorders. Importantly, planned/wanted pregnancies are associated to a reduced risk of tobacco use during pregnancy, which means that tobacco use should be checked in every women of childbearing age in order to help them to plan pregnancies and to stop tobacco use before becoming pregnant. Finally, tobacco withdrawal should be recommended to both parents.

Compliance with ethical standards

The ethical committee gave approval for this study (EudraCT: 2010-A00035-34). A written informed consent was obtained from all mothers

Conflict of interest F Thibaut is Editor-in-Chief of Dialogues in Clinical Neurosciences (the journal receives a grant from Servier).

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