



Original Research - Quantitative

## Consumption of alcohol during pregnancy—A multinational European study

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## ABSTRACT

**Background:** Although single-country studies indicate alcohol consumption among some pregnant European women, it is difficult to interpret European differences. Few multinational studies exist using the same methodology.

**Aim:** To estimate the proportion of women consuming alcohol during pregnancy in Europe, and to analyze whether between country variations could be explained by sociodemography and smoking.

**Methods:** An anonymous online questionnaire was accessible for pregnant women and new mothers in 11 European countries during two months between October 2011 and February 2012 in each country. The questionnaire covered alcohol consumption, sociodemographic factors, and smoking habits during pregnancy. Descriptive analyses and logistic regression models were conducted.

**Findings:** The study population consisted of 7905 women, 53.1% pregnant and 46.9% new mothers. On average, 15.8% reported alcohol consumption during pregnancy. The highest proportion of alcohol consumption during pregnancy was found in the UK (28.5%), Russia (26.5%), and Switzerland (20.9%) and the lowest in Norway (4.1%), Sweden (7.2%), and Poland (9.7%). When reporting alcohol consumption during pregnancy, 39% consumed at least one unit per month. In Italy, Switzerland, and the UK, over half consumed at least one alcohol unit per month. Higher education and smoking before pregnancy were predictors of alcohol consumption during pregnancy.

**Conclusions:** Almost 16% of women resident in Europe consumed alcohol during pregnancy with large cross-country variations. Education and smoking prior to pregnancy could not fully explain the differences between the European countries. A united European strategy to prevent alcohol consumption during pregnancy is needed with focus on countries with the highest consumption.

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## Statement of significance

## Problem or issue

To enable European policy changes, studies with comparable data collecting methods are needed. National studies examining alcohol consumption during pregnancy have often used various methods to collect data. Existing multinational studies do not have a European perspective.

## What is already known

Some women consume alcohol in pregnancy despite its associated risk of negative health outcomes to the child.

## What this paper adds

Almost 16% of the European women consumed alcohol during pregnancy and 39% of these at least one unit per month, with large differences between the countries. Education and smoking before pregnancy could not fully explain these differences.

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## 1. Introduction

The prevention of alcohol consumption during pregnancy is a priority in the European Union.<sup>1</sup> To enable policy decisions, cross-country studies need to ensure a comparable data collection process.<sup>2</sup> No such European study of consumption during pregnancy is available. One recent prospective multicenter study included Ireland and the United Kingdom (UK).<sup>3</sup> The Nordic or Mediterranean countries were not included. The multicenter study found that 82% of the pregnant Irish women reported alcohol consumption during pregnancy and 75% of the pregnant British women.<sup>3</sup> Published national studies indicate a variation of alcohol consumption during pregnancy across countries (Supplementary Table S1).<sup>4–12</sup> The range are from 6% in a Swedish cross-sectional study with women registered at maternal health service centers to 52% among pregnant Russian women visiting women's public clinics in the Moscow surroundings, a socioeconomically deprived area.<sup>7,9</sup> Some of the variation seen in these studies<sup>4–12</sup> could, however, be due to the different measures of alcohol consumption.<sup>2</sup>

A high prenatal exposure to alcohol is known to have negative health outcomes for the child in all stages during pregnancy, from fetal alcohol spectrum disorder and fetal alcohol syndrome, to lower educational results and behavior problems among children.<sup>1,6,13,14</sup> No strong scientific evidence has, however, been found between low prenatal alcohol exposure and negative health outcomes for the child.<sup>14</sup> So far, it has not been possible to establish the amount of alcohol which is absolutely safe.<sup>14</sup>

From prior studies it is also difficult to compare the amount of alcohol consumed in different European countries.<sup>6,10–12,15–17</sup> Swedish women reported at least one drink each time they consumed alcohol.<sup>15</sup> The average amount of alcohol consumption was 0.84 drinks per week among pregnant Russian women.<sup>16</sup> At least one binge drinking episode during pregnancy was reported by 2.2% of Swiss women and 15.5% of British women.<sup>6,10</sup> In France at least one episode of binge drinking during pregnancy was reported retrospectively by 3.2% of the included women after they gave birth.<sup>12</sup> Almost one in ten pregnant Ukrainian women reported at least three drinks at the same occasion during the previous month.<sup>11</sup> In a British study 22.2% of the pregnant women reported a drinking pattern which could risk the health of the fetus during the first trimester.<sup>17</sup> Among the women in this British study, 2.4% also reported heavy episodic drinking on a weekly or monthly basis ( $\geq 6$  units each occasion).

It is possible that sociodemographic factors could explain any cross-country variations in the prevalence of alcohol consumption during pregnancy. Factors such as higher age, socioeconomic status, ethnicity, previous children, and smoking have been recognized as important. Women of a higher age from the Nordic countries, Ireland, France, and the USA<sup>18</sup> have been found to consume alcohol to a higher extent than younger women.<sup>3,5,12,15</sup> An exception was a Spanish study, where women with a higher age were less likely to drink alcohol during pregnancy.<sup>19</sup> Early age of drinking initiation also predict alcohol consumption during pregnancy.<sup>11</sup> High income, smoking, at least one previous child, as well as high and low education have also been recognized to predict alcohol consumption during pregnancy.<sup>3,11,12,15,20</sup> Women of immigrant status have been seen to be less likely to consume alcohol during pregnancy.<sup>3,12,17</sup> Among women from Ireland and Australia, Ireland, New Zealand<sup>3</sup> and the UK,<sup>3,17</sup> non-Caucasian ethnicity has been seen to protect against alcohol consumption during pregnancy. Similar results have also been observed among women who had migrated to France compared with native-born French women.<sup>12</sup>

The aim of this study was to estimate the proportion of women consuming alcohol and the amount consumed during pregnancy,

and to analyze whether between country variations could be explained by sociodemography and smoking.

## 2. Methods

This cross-sectional study is a part of the 'Multinational Medication Use in Pregnancy Study' project. National coordinators were recruited from the European Network of Teratology Information Services and European institutions conducting public health research. Details on the project, participating countries, the full version of the questionnaire, pregnancy websites posting participation invitations, country specific sociodemographic comparisons between study sample and general birthing population, and internet penetration rates are described elsewhere.<sup>21</sup>

### 2.1. Participants

Pregnant women at any gestational week and mothers with children less than one year old were invited through banners available on country specific websites and/or social networks commonly visited by pregnant women and new mothers.<sup>21</sup> In each country, the national coordinator chose the most appropriate websites according to their relevance and number of daily users. Women who did not remember ( $n=69$ ) or did not give answers ( $n=7$ ) to 'Did you drink any alcohol after finding out that you were pregnant?' were excluded. Countries with low number of participants ( $n < 200$ ) were excluded. In Fig. 1, the data selection procedure to achieve the final study sample is shown ( $n=7905$ ).

### 2.2. Ethical consideration

The study was performed in compliance with the Declaration of Helsinki of 1975 and later amendments. The Regional Ethics Committee, Region South-East in Norway, approved this project. National approval was sought according to legislations in each participating country. Prior to participating, information regarding aim, that the study was voluntary, and that participants could withdraw at any time during the data collection was given on the website. The women did not receive specific information from the researchers regarding the risks of alcohol consumption during pregnancy before, during or after participating in the study. They did receive contact information to the study coordinator, who could be contacted with any questions. The participants gave their informed consent to participate in the study before accessing the questionnaire. The data were handled and stored anonymously and then analyzed on group level.

### 2.3. Setting and data collection

The settings were Croatia, Finland, France, Italy, Norway, Poland, Russia, Serbia, Sweden, Switzerland, and the UK. Data was collected through an online and anonymous questionnaire administered through QuestBack (<http://www.questback.com>) during two months between October 2011 and February 2012 in each country. The questionnaire covered week of pregnancy or age (weeks) of new born child, sociodemographic factors, and lifestyle factors during pregnancy.<sup>21</sup> It was developed in Norwegian and English based on experiences from a previous national study on patterns and predictors of medication use in pregnancy in Norway.<sup>22</sup> The questionnaire was then translated into relevant languages.<sup>21</sup> A pilot study carried out in Norway, Sweden, Finland, and Italy ( $n=47$ ) elicited no major changes. No duplicate responses were identified.

The outcome variable was alcohol consumption during pregnancy. This was measured with 'Did you drink any alcohol after finding out that you were pregnant?' and answered with 'Yes'

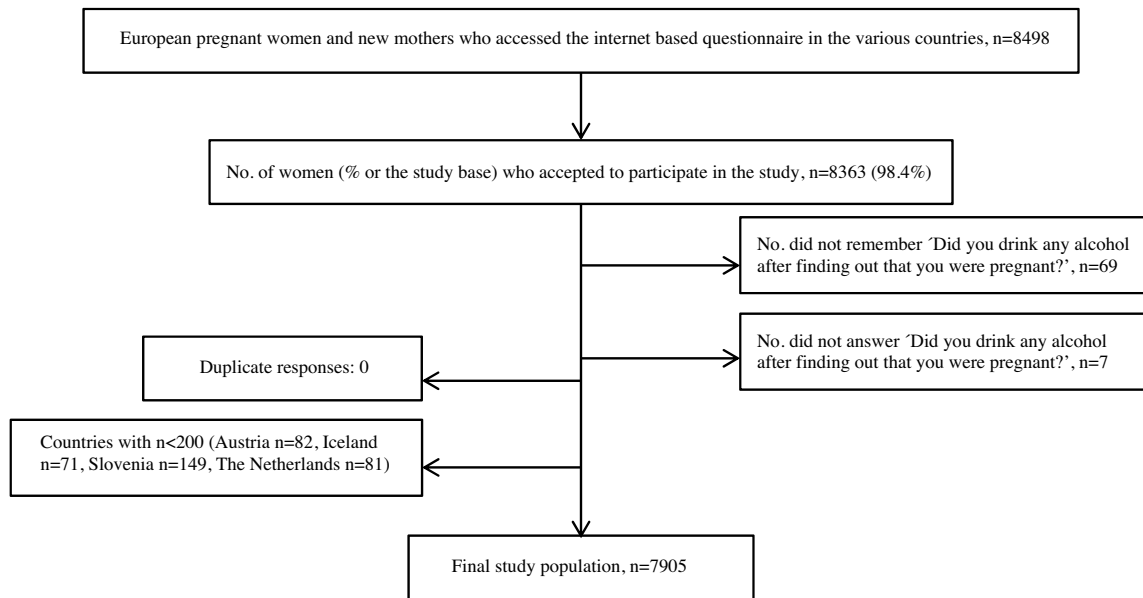


Fig. 1. Participant flow chart to achieve the study sample.

or 'No'. Those with 'Yes' received 'How much did you drink (in units) during your pregnancy?'. This was answered with '>1–2 units per week', '1–2 units per week', '1–4 units per month', '1–2 units during the pregnancy', or 'Cannot remember'. Since the definition of one unit is different across countries<sup>23</sup> this study included a description of one unit in each country (Supplementary, Table S2).

The explanatory variable was country of residence (Croatia, Finland, France, Italy, Norway, Poland, Russia, Serbia, Sweden, Switzerland, and the UK). Age, education, occupational status, civil status (married/cohabiting, divorced/single/others) mother tongue, previous children, unplanned pregnancy and smoking before pregnancy were treated as confounders. These were categorized as shown in Table 1.

#### 2.4. Statistical analyses

IBM Statistics (SPSS) version 22 was used for statistical analyses. Missing values were not included in the analyses. Descriptive statistics were utilized using Pearson's  $\chi^2$ , with a *p*-value < 0.05 as statistically significant. Univariate and multivariate logistic regression analyses were performed; data were presented as crude and adjusted odds ratios (OR) with 95% confident intervals (CI). Crude analyses with the outcome and the explanatory or confounding variables were estimated in separate models. Then variables with a *p*-value < 0.10 were included in a multivariate model. Backstep analyses were performed where the least significant variable was excluded manually, and the model was re-run until remaining variables had a *p*-value < 0.05. Sensitivity analyses were made excluding pregnant women in the first trimester ( $\leq$  week 12).

### 3. Results

The study population consisted of 7905 women, 4194 (53.1%) were pregnant and 3711 (46.9%) new mothers (Fig. 1). Among the pregnant women 856 (20.4%) were in the first trimester ( $\leq$  week 12), 1915 (45.7%) in the second trimester (week 13–28), and 1423 (33.9%) in the third trimester ( $\geq$  week 29). Among the new mothers, 1111 (29.9%) stated that their baby was  $\leq$  16 weeks, 818

(22.0%) 17–28 weeks, and 1782 (48.0%)  $\geq$  29 weeks. Stratified analyses of the pregnant women and the new mothers revealed only small differences in terms of parity, age, and country of origin (not shown in any table). Therefore, the women were analyzed as one group. Women who reported alcohol consumption during pregnancy were more likely to be older, more highly educated, employed, and smoking before pregnancy than women who did not report this consumption (Table 1).

The overall prevalence of alcohol consumption during pregnancy was 15.8% (Table 2). The countries with the highest proportion of women consuming alcohol were the UK (28.5%), Russia (26.5%) and Switzerland (20.9%). The lowest prevalence was reported from women resident in Norway (4.1%), Sweden (7.2%), and Poland (9.7%).

In Europe, 38.9% of the women who consumed alcohol during pregnancy reported a consumption of at least one alcohol unit per month (Table 2). The highest proportion of women who consumed this amount was found in Italy (56.6%), Switzerland (54.7%) and the UK (52.2%) (Table 2). Concerning the lowest amount of alcohol consumption (1–2 units during the pregnancy), the highest proportion was found in Norway and Sweden (>80%) and France, Poland, and Russia (>70%).

The logistic regression models confirmed the different proportions consuming alcohol in the included European countries (Table 3). With Norway as reference (lowest proportion), the highest crude odds ratios were found for the UK (OR = 9.25, CI 6.83–12.54), Russia (OR = 8.35, CI 6.13–11.38), Switzerland (OR = 6.15, CI 4.39–8.61), and Italy (OR = 5.15, CI 3.73–7.11). Age, education, occupational status, and smoking before pregnancy were significantly associated with alcohol consumption during pregnancy in the univariate analysis, and hence treated as potential confounding factors. In the final multivariate model, higher odds than Norway for alcohol consumption during pregnancy were found in all participating countries. Education (<high school: OR = 0.59, CI 0.41–0.85; high school: OR = 0.68, CI 0.58–0.80–0.85; other: OR = 0.78, CI 0.64–0.96), and smoking before pregnancy (OR = 1.42, CI 1.24–1.62) had confounding effects on country differences. The OR for the countries with the highest likelihood to consume alcohol during pregnancy compared with Norway were strengthened for the UK (OR = 9.36, CI 6.90–12.70),

**Table 1**  
Maternal sociodemographic and lifestyle characteristics of the study sample (n = 7905).

	Alcohol consumption after awareness of pregnancy					
	Yes, %	(n)	No, %	(n)	Total, %	(n)
Age (years) (n = 7905)*						
≤20	1.7	(21)	3.2	(210)	2.9	(231)
21–30	48.2	(601)	56.7	(3772)	55.3	(4373)
31–40	47.9	(597)	38.3	(2549)	39.8	(3146)
≥40	2.2	(28)	1.9	(127)	2.0	(155)
Education (n = 7905)*						
<High school	3.0	(37)	4.3	(288)	4.1	(325)
High school	22.4	(279)	29.2	(1945)	28.1	(2224)
>High school	62.6	(780)	54.6	(3635)	55.9	(4415)
Other	12.1	(151)	11.9	(790)	11.9	(941)
Occupational status (n = 7895)**						
Employed	76.1	(948)	73.4	(4884)	73.9	(5832)
Student	6.5	(81)	9.1	(604)	8.7	(685)
Housewife	9.5	(118)	7.7	(512)	8.0	(630)
Unemployed	3.2	(40)	4.7	(314)	4.5	(354)
Other	4.7	(58)	5.1	(336)	5.0	(394)
Civil status (n = 7890)						
Married or cohabiting	94.9	(1184)	94.9	(6318)	94.9	(7502)
Divorced, single or others	5.1	(63)	5.1	(340)	5.1	(403)
Mother tongue (n = 7890)						
Same as in country of residence	94.9	(1180)	94.2	(6263)	94.3	(7443)
Other than in country of residence	5.1	(63)	5.8	(384)	5.7	(447)
Previous children (n = 7905)						
Yes	48.4	(603)	49.0	(3261)	48.9	(3864)
No	51.6	(644)	51.0	(3397)	51.1	(4041)
Pregnancy completely unplanned (n = 7882)						
Yes	8.8	(110)	8.4	(556)	8.4	(666)
No	91.2	(1134)	91.6	(6082)	91.6	(7216)
Smoking before pregnancy (n = 7892)*						
No	59.80	(744)	65.5	(4352)	64.6	(5096)
Yes	40.20	(501)	34.5	(2295)	35.4	(2796)

Pearson's Chi2.

\* p-Value < 0.001.

\*\* p-Value < 0.05.

**Table 2**  
Proportion of alcohol consumption during pregnancy according to European country.

	Alcohol consumption after awareness of pregnancy			Amount of alcohol consumption during pregnancy					
	Total, n	Yes, %	No, %	Total, n	≥1–2 units per week, %	1–2 units per week, %	1–4 units per month, %	1–2 units during pregnancy, %	Cannot remember, %
United Kingdom	1112	28.5	71.5	317	2.8	10.9	38.5	47.0	1.6
Russia	990	26.5	73.5	262	0.4	3.8	23.7	70.6	1.5
Switzerland	611	20.9	79.1	128	0.0	7.0	47.7	43.0	2.3
Serbia	214	15.4	84.6	33	0.0	9.1	30.3	54.5	6.1
Italy	914	18.2	81.8	166	7.8	18.1	30.7	40.4	3.0
Finland	572	14.0	86.0	79	1.3	1.3	19.0	78.5	0.0
Croatia	281	12.8	87.2	36	0.0	11.1	30.6	58.3	0.0
France	374	11.5	88.5	43	0.0	4.7	14.0	72.1	9.3
Poland	668	9.7	90.3	65	1.5	4.6	20.0	70.8	3.1
Sweden	886	7.2	92.8	64	0.0	1.6	14.1	81.3	3.1
Norway	1283	4.1	95.9	50	0.0	4.0	4.0	88.0	4.0
Total	7905	15.8	84.2	1243	2.0	7.8	29.1	58.7	2.3

1 unit = 1 bottle/can (33 cl) of beer or cider, 1 glass (12 cl) of wine, or 1 shot glass (4 cl) of spirit or liqueur; missing values not included.

**Table 3**

Logistic regression models of the association between alcohol consumption during pregnancy, and country, maternal sociodemographic and lifestyle factors.

	Logistic regression			
	Univariate model		Multivariate model (n = 7892)	
	Odds ratio	95% CI	Odds ratio	95% CI
Country	(n = 7905)			
Norway	Reference			
Croatia	<b>3.41</b>	(2.19–5.32)	<b>3.12</b>	(1.99–4.88)
Finland	<b>3.77</b>	(2.63–5.42)	<b>3.77</b>	(2.62–5.43)
France	<b>3.01</b>	(1.98–4.59)	<b>2.85</b>	(1.87–4.34)
Italy	<b>5.15</b>	(3.73–7.11)	<b>5.38</b>	(3.88–7.45)
Poland	<b>2.50</b>	(1.72–3.64)	<b>2.25</b>	(1.54–3.29)
Russia	<b>8.35</b>	(6.13–11.38)	<b>7.32</b>	(5.36–9.99)
Serbia	<b>4.23</b>	(2.67–6.71)	<b>3.89</b>	(2.45–6.20)
Sweden	<b>1.81</b>	(1.24–2.63)	<b>1.82</b>	(1.25–2.65)
Switzerland	<b>6.15</b>	(4.39–8.61)	<b>6.36</b>	(4.53–8.93)
United Kingdom	<b>9.25</b>	(6.83–12.54)	<b>9.36</b>	(6.90–12.70)
Age (years)	(n = 7905)			
≥40	Reference			
31–40	1.06	(0.70–1.61)		
21–30	0.72	(0.48–1.10)		
≤20	<b>0.45</b>	(0.25–0.83)		
Education	(n = 7895)			
>High school	Reference			
High school	<b>0.67</b>	(0.58–0.77)	<b>0.68</b>	(0.58–0.80)
<High school	<b>0.60</b>	(0.42–0.85)	<b>0.59</b>	(0.41–0.85)
Other	0.89	(0.74–1.08)	<b>0.78</b>	(0.64–0.96)
Occupational status	(n = 7905)			
Employed	Reference			
Student	<b>0.69</b>	(0.54–0.88)		
Housewife	1.19	(0.96–1.47)		
Unemployed	<b>0.66</b>	(0.47–0.92)		
Other	0.89	(0.67–1.19)		
Civil status	(n = 7890)			
Married or cohabiting	1.01	(0.77–1.33)		
Divorced, single or others	Reference			
Mother tongue	(n = 7905)			
Same as in country of residence	1.15	(0.87–1.51)		
Other than in country of residence	Reference			
Previous children	(n = 7905)			
Yes	Reference			
No	1.03	(0.91–1.16)		
Pregnancy unplanned	(n = 7882)			
Yes	Reference			
No	0.94	(0.76–1.17)		
Smoking before pregnancy	(n = 7892)			
No	Reference			
Yes	<b>1.28</b>	(1.13–1.45)	<b>1.42</b>	(1.24–1.62)

Logistic regression: outcome 1 = Consumed alcohol during pregnancy; univariate model: **Bold** = p-value < 0.10; the multivariate model with predictors (p-value < 0.05 from Crude models), last model shown where back step analyses done with including variables p-value < 0.05 (**Bold**).

Switzerland (OR=6.36, CI 4.53–8.93) and Italy (OR=5.38, CI 3.88–7.45), but weakened for Russia (OR=7.32, CI 5.36–9.99). Sensitivity analyses did not result in any other pattern (not shown in any table).

## 4. Discussion

### 4.1. Result discussion

To our knowledge, this is the first study comparing alcohol consumption during pregnancy across eleven of the European countries using the same method for collecting data and taking maternal sociodemographic and smoking before pregnancy into account. We found that almost 16% of the European women consumed alcohol during pregnancy after recognized pregnancy and of these 39% consumed at least one unit per month. There were, however, large variations between the countries. Some of these differences can be explained by level of education and smoking before pregnancy. However, a large part of the differences remained unexplained.

The association between education and alcohol consumption was the strongest of the sociodemographic factors in our study. The women with more than high school education were more likely to consume alcohol during pregnancy compared with women with lesser education. A similar result was found in a recent French study.<sup>12</sup> High levels of education on individual and country level are associated with increased alcohol consumption in the general population.<sup>24</sup> In a Ukrainian study, however, a low level of education predicted alcohol consumption during pregnancy.<sup>11</sup> As argued by Grittner et al.<sup>24</sup> alcohol consumption among women may be regarded as a symbol of gender equality. This could possibly be present even among women in our study with a higher education and despite their awareness of the pregnancy. When interpreting our cross-country differences it is also likely that education influenced alcohol consumption during pregnancy in different ways in the included countries, as also noticed in a review by Skagerström et al.<sup>20</sup> Compared to the other European countries, the effect estimate for alcohol consumption in pregnancy among women from Finland and Sweden did not change when education was added to the model. One explanation to this may be based on

the results from a study by Bloomfield et al.<sup>25</sup> This study found that fewer social inequalities affected alcohol consumption for Nordic women in general compared with women from other European countries.

Our study found that smoking before pregnancy was associated with consumption of alcohol during pregnancy. This confirms results found in other studies.<sup>3,11,12,15</sup> Smoking was also associated with alcohol consumption during pregnancy among Ukrainian women in the second trimester and French mothers.<sup>11,12,15</sup> A Swedish study found that smoking before pregnancy was a strong predictor for alcohol consumption during pregnancy among women at least 18 weeks pregnant.<sup>15</sup> In a study among women in Ireland and the UK, smoking was a stronger predictor of alcohol consumption during pregnancy compared with factors such as age, socioeconomic, and BMI.<sup>3</sup> Taken together, all these results substantiate an important link between smoking and alcohol consumption during pregnancy, with the subsequent need of tailored interventions to increase maternal-fetal health.

One reason for the difference in alcohol consumption and the amount consumed during pregnancy found between the European countries in our study could originate from whether advice at all is given by healthcare professionals to pregnant women in countries across Europe. A recent study has found that preconception guidance was found in countries like Belgium, Denmark, Italy, the Netherlands, Sweden, and the UK.<sup>26</sup> These guidelines differ concerning the time (e.g. preconception, pregnancy, and/or breast feeding), which they refer to, and the recommended amount of alcohol. Two Danish studies have shown that giving alcohol advice to pregnant women has increased among midwives and general practitioners during the 21st century.<sup>27,28</sup> To further increase the advice in maternal care, a Swedish national intervention containing education regarding motivational interviews and the risks with alcohol during pregnancy has been tested with positive results.<sup>29</sup> As another way, an evaluation of the Scottish antenatal care routines has suggested person-centered communication interventions for personnel in antenatal care.<sup>30</sup> This could enable an increase of discussions about the risks of alcohol consumption during pregnancy in the beginning of the antenatal care.<sup>30</sup> An important aspect is that women ought to be given the best knowledge available to make informed decisions about the health of their child.

Our findings are important for policy makers as well as for clinical practice. Firstly, alcohol consumption during pregnancy is still common throughout Europe. If our results are extrapolated to the birthing population ( $n=4\,598\,040$ ) in the 11 European countries included in this study,<sup>21</sup> over 700 000 infants could have been exposed to alcohol in their fetal life each year. However, it is also important to not impose guilt upon pregnant women who consumed alcohol before their pregnancy was recognized.<sup>14</sup> Nonetheless, it is of importance to underline that alcohol consumption during pregnancy is a potential risk for the fetus that can be avoided. Pregnant women have voiced the need for the latest scientific information concerning the risk levels of alcohol consumption during pregnancy as early on in the pregnancy as possible.<sup>31</sup> This calls for improved and unified preventative actions from central European, national health authorities, and healthcare professionals alike, with focus on countries where alcohol consumption is most common. Future studies are needed with the aim to address interventions aiming for a reduction in alcohol consumption during pregnancy.

#### 4.2. Method discussion

An important strength is that data collection was performed uniformly across all participating countries. This permits comparison between countries concerning the consumption of alcohol

during pregnancy. We specifically asked about alcohol consumption after awareness of pregnancy. This was an advantage over prior studies with no distinction between consumption before and after the woman knew she was pregnant. The anonymous web-based approach has also facilitated the reach of a large proportion of the birthing population in European countries. Since women have been shown to use the internet in a very high extent during pregnancy to seek for pregnancy-related information,<sup>32</sup> this population is probably a suitable target group in e-epidemiology.

Limitations to the study include the risk of social bias concerning the self-reported consumption of alcohol. The consequence could be underreporting of the consumption during pregnancy. The use of an anonymous online questionnaire may have promoted more truthful answers to sensitive questions,<sup>33</sup> such as alcohol consumption. Also our study included retrospectively reporting of alcohol consumption among new mothers; hence, the risk of recall bias cannot be ruled out. Furthermore, we only used two questions to characterize alcohol consumption due to the length of the questionnaire. There are several validated screening tools available to assess alcohol consumption during pregnancy, like the TWEAK (Tolerance, Worried, Eye-opener, Amnesia, Kut down), T-ACE (Take (number of drinks), Annoyed, Cut down, Eye-opener) or AUDIT-C (Alcohol Use Disorder Identification Test-consumption) that have been developed to identify high-risk in women.<sup>34</sup> These were considered too lengthy to be included. Moreover, our study did not include alcohol habits prior to pregnancy, which has been observed to be of importance.<sup>20</sup> Specifically, a high frequency of alcohol consumption prior to pregnancy has been found to be more important than weekend consumption.<sup>20</sup> Also, inclusion of pregnant women at any gestational week might have reduced the proportion of alcohol consumption. Women at an early stage of pregnancy might not have consumed alcohol at the moment of completing the questionnaire, but might have done so later in their pregnancy. The sensitivity analyses where women in the first trimester were excluded did, however, not change the pattern of cross country differences or the significant associations.

As the questionnaire was only available through internet websites, a conventional response rate cannot be calculated. This study design implied no probability sampling of the target population which means that selection bias cannot be excluded. To reduce this risk and reach the widest possible segment of the target population, the invitation to participate in the study was posted on 2–3 websites per country and/or social networks. These were selected according to the number of daily users and widespread use in the pregnant population at the time of the data collection. However, epidemiological studies indicate sound validity of web-based recruitment methods.<sup>33</sup> In addition, the penetration rate of internet in households or at work was relatively high among individuals aged 25–34 years, regardless of gender. In Europe, the penetration rates ranged from approximately 50% in Russia and Serbia to 100% in Norway and Sweden.<sup>21</sup> The study participants from each participating country were similar to their fertile population concerning age, parity distribution, and level of smoking, but had somewhat higher educational levels than the general birthing populations. The responders in Croatia were somewhat older than the general birthing population. Hence, our results could have been overestimated as women that are more educated consume alcohol to a larger extent than women with a lower education do. Our results should be interpreted with these strengths and limitations in mind.

#### 5. Conclusion

Almost one out of six European women reported consumption of alcohol during pregnancy after they received knowledge of their

pregnancy. The highest proportion of women consuming alcohol came from the UK, Russia, and Switzerland while the lowest came from Norway, Sweden, and Poland. The cross-country differences could not be fully explained by sociodemographic factors or smoking before pregnancy. United European interventions are needed on different societal levels with the ultimate goal of increasing awareness among healthcare professionals about the importance of maternal factors, i.e., education level and smoking before pregnancy, on alcohol consumption during pregnancy. These interventions may be especially relevant in countries with the highest prevalence of alcohol consumption during pregnancy.

### Contribution of authors

A-CM, AL, GH, and HN all contributed to the study question and the design of the study. A-CM prepared, analyzed, and interpreted the data, and drafted the manuscript. GH interpreted the data and drafted the manuscript. AL and HN interpreted the data and critically revised the manuscript for important intellectual content. All authors have approved the final version of the manuscript.

### Disclosure

The authors have no financial or other relationships to declare which might lead to a conflict of interest.

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### Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.wombi.2017.01.003>.

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