Continued smoking and continued alcohol consumption during mid-pregnancy distinctively associated with personality

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Abstract

Aim: pregnancy is a unique period to quit smoking and alcohol consumption and although motivated, not all women succeed at this. We investigated the associations of personality with continued smoking and continued alcohol consumption during mid-pregnancy. In addition, we studied whether antenatal anxiety and depressive symptoms during pregnancy can explain these associations.

Method: two antenatal measurements from the population-based Pregnancy Anxiety and Depression cohort study were used. Pregnant women in their first trimester were recruited via midwifery practices and hospitals. We analyzed a sample of women who continued (n=101) or quit smoking (n=254), and a sample of women who continued (n=110) or quit alcohol consumption (n=1230). Measures included questions about smoking, alcohol consumption, the NEO-Five Factor Inventory (personality), the State Trait Anxiety Inventory, and the Edinburgh Postnatal Depression Scale.

Findings: we found associations between continued alcohol consumption and higher levels of openness to experience, and lower levels of conscientiousness (p<0.05). The association between conscientiousness and continued alcohol consumption was partly explained by both anxiety and depressive symptoms. No associations between personality and continued smoking emerged.

Conclusions: this study contributes to the limited literature on personality differences between women who continue and quit smoking and alcohol consumption during mid-pregnancy. General population studies have not confirmed the association between openness to experience and alcohol consumption which implies that pregnancy is indeed a unique period. Increased insight in how personality influences continued smoking and alcohol consumption during pregnancy can help health professionals to improve lifestyle interventions targeted at pregnant women.
Introduction

Smoking and alcohol consumption during pregnancy hold several risks for both mother and child. Smoking during pregnancy increases the risk of adverse pregnancy outcomes such as reduced birth weight, lower Apgar scores, preterm delivery \([1]\), placental abruption \([2]\), changes in brain development \([3]\) and a 150% increase in overall perinatal mortality \([4]\). Prenatal alcohol consumption has been associated with reduced birth weight \([5]\), preterm delivery \([6]\), spontaneous abortion \([7]\) and the fetal alcohol syndrome \([8]\). However, studies investigating the effects of small to moderate amounts of alcohol show a lack in consensus regarding the negative effects \([9]\). Nevertheless, pregnant women are typically advised to abstain completely from alcohol consumption throughout their pregnancy \([10]\).

Pregnancy is considered a unique window of opportunity to quit smoking and alcohol consumption. Indeed, women appear to be both intrinsically and extrinsically motivated to change their health behavior \([11\text{-}13]\). Notwithstanding these motivations, many women do not try or do not succeed in quitting smoking or alcohol consumption when pregnant. In western countries it is estimated that between 5% and 21% of all women smoke during pregnancy \([14,15]\). The prevalence rate of alcohol consumption shows a wider range and is estimated to vary between 6% and 50% in western countries \([10,16\text{-}20]\). Quitting rates during pregnancy are between 23% and 47% for smoking \([21]\) and vary between 27% and 80% for alcohol consumption \([22\text{-}24]\).

Risk factors associated with smoking and alcohol consumption during pregnancy include the level of education, being multiparae, being single, and experiencing anxiety or depressive symptoms \([21,25,26]\). General population studies have shown that personality traits predict both health behavior and risky health behavior (e.g. excessive drug and alcohol consumption) \([27,28]\). In pregnancy, continued smoking and alcohol consumption can be considered as a form of risky health behavior and therefore personality traits are likely predictors of these behaviors. The well-known Five Factor Model explains personality as consisting of five domains or traits, each accompanied by six facets, that describe individual differences between people (table 1) \([29]\). Neuroticism is characterized by a tendency to experience negative affects. Extraversion is characterized by being social, energetic, and adventurous. Openness to experience relates to curiosity, intellect and creativity. Conscientiousness is related to responsibility, carefulness, and conforming to societal norms. Agreeableness refers to avoiding conflict, being sensitive to social cues, and being considerate \([29]\).
As far as we know, personality has been related to continued smoking and alcohol consumption during pregnancy in only two studies. Maxson and colleagues found an association between lower levels of agreeableness and continued smoking, compared to smoking cessation, using the NEO-Five Factor Inventory [29,30]. Another study, using the Big Five Inventory [31], did not find an association between personality and continued smoking, but found that higher levels of extraversion and lower levels of conscientiousness increased the risk for continued alcohol consumption [32]. However, the latter study included non-smokers and non-drinkers as reference groups which provide little information if one is particularly interested in how continued users differ from quitters during pregnancy. To our knowledge, no study has investigated personality associated with continued alcohol consumption compared to discontinued consumption during pregnancy. Furthermore, the association of personality with the amount of smoking and alcohol consumption among continued users during pregnancy has not been investigated to date.

Smoking and alcohol consumption are, particularly in women, considered to be a strategy to regulate or cope with feelings of negative affect [33-35]. Therefore, we propose that anxiety and depressive symptoms may explain part of the association of personality with continued smoking and alcohol consumption during pregnancy.

The present study investigated the relationships of personality traits with continued smoking and continued alcohol consumption during mid-pregnancy. Based on the characteristics of the traits and previous research, we expected to find an association of continued smoking and alcohol consumption with higher levels of neuroticism and extraversion and with lower levels of conscientiousness, agreeableness, and openness to experience. Furthermore, we assumed that some proportion of the associations would be explained by anxiety or depressive symptoms.
symptoms. Finally, we explored the associations between personality and the amount of smoking and alcohol consumption among continued users.

**Methods**

*Setting and Participants*

Data from the ongoing ‘Pregnancy, Anxiety and Depression’ (PAD) study were used. This population-based prospective cohort study investigates psychological, medical and social factors during pregnancy and the postnatal period. Participants in the PAD study are enrolled at primary midwifery practices (n= 102) and obstetric and gynecology departments of hospitals (n=9) throughout The Netherlands. Women who provide written informed consent enter the study before 16 weeks of gestation and complete online questionnaires during and after pregnancy. For the present study we used data from the first two assessments at 14 and 19 weeks of gestation, collected between December 2011 and April 2013. Out of the 3,102 women who agreed to participate, 2,033 (66%) completed the online questionnaires. The PAD study was approved by the medical ethical review board of the University Medical Center Groningen.

*Smoking status*

Smoking status was recorded at the second assessment in three categories; “not smoking before pregnancy”, “quit smoking during pregnancy”, and “continued smoking during pregnancy”. “Continued smoking” was defined as a positive response to the question ‘Are you currently smoking cigarettes?’ (yes/no) and ‘Did you smoke before finding out about your current pregnancy?’. “Quit smoking” was defined as a positive response to ‘Did you smoke before finding out about your current pregnancy?’ (yes/no) and a negative response to ‘Are you currently smoking cigarettes?’. “Not smoking before pregnancy” was defined as a negative response to ‘Did you smoke before finding out about your current pregnancy?’ (yes/no). The mean amount of cigarettes smoked per day by continued smokers was assessed in five different categories: 1-5, 6-10, 11-15, 16-20, and 21 or more.

*Alcohol consumption status*

Alcohol consumption status was recorded at the second assessment in three categories; “not drinking alcohol before pregnancy”, “quit alcohol consumption during pregnancy”, and “continued alcohol consumption during pregnancy”. “Continued alcohol consumption” was defined as a response larger than zero to; ‘How often do you drink during the week?’ and a positive response to ‘Did you drink alcohol before finding out about your current pregnancy?’.
pregnancy?" (yes/no). “Quit alcohol consumption” was defined as a positive response to ‘Did you drink alcohol before finding out about your current pregnancy?’ (yes/no) and zero-response to ‘How often do you drink during the week?’. “Not drinking before pregnancy” was defined as a negative response to ‘Did you drink alcohol before finding out about your current pregnancy?’ (yes/no). Frequency of alcohol consumption among continued users was assessed in the following seven categories: less than once a month, once a month, 2 to 3 times a month, and 1, 2, 3, 4 or more day(s) per week. The typical amount of alcohol consumption was assessed using five categories: 1-2, 3-5, 6-10, 11-15, and over 15 glasses each time. Frequency of alcohol consumption was multiplied by the amount to provide a single estimate of the mean total amount of weekly alcohol consumption.

**Personality traits**
Personality traits were measured at the first assessment using the Dutch validated version of the NEO-Five Factor Inventory [29,36]. Questions in this 60-item self-report questionnaire are based on a 5-point Likert scale with a range from 1 (strongly disagree) to 5 (strongly agree). In the present study Cronbach’s alpha reliabilities were good: 0.89 for neuroticism, 0.81 for extraversion, 0.73 for openness to experience, 0.80 for conscientiousness, and 0.71 for agreeableness.

**Anxiety and depressive symptoms**
Anxiety and depressive symptoms were recorded at the first assessment. Anxiety symptoms were measured using the Dutch version of the validated 6-item State Trait Anxiety Inventory (STAI) [37]. The Dutch version of the 10-item Edinburgh Postnatal Depression Scale (EPDS) was used to measure depressive symptoms [38], and has also been validated for measuring depressive symptoms during pregnancy [39].

**Other variables**
Socio-demographic variables were measured at both assessments. They included level of education (assessed as elementary education, lower tracts of secondary education, higher tracts of secondary education, higher vocational education, and university education), age, parity (primiparae or multiparae), and relationship status (in a relationship or not in a relationship). These variables were analyzed for descriptive purposes only. They were not considered confounders based on existing knowledge. However, we examined whether the associations were stronger in a lower education group as it has been shown that educational level and personality traits may interact with regard to health outcomes, including smoking
Lower education was defined as elementary education, lower tracts of secondary education, and higher tracts of secondary education.

**Multiple imputation of missing data**

To avoid the risk of bias and loss of statistical power in complete case analyses, missing data in the total sample were imputed. This was performed using multiple imputation by chained equations under the assumption that the missing data mechanism is missing at random or missing completely at random. As suggested by Graham [42], 20 datasets were imputed and combined according to Rubin’s rules [43]. The percentage missing data was approximately 25% for the variables of interest. The imputation model included the following variables: smoking status, alcohol consumption status, amount of smoking and alcohol consumption, anxiety and depressive symptoms, level of education, age, parity, and relationship status. The missing data mechanism of each variable was studied by predicting missingness (yes/no) of each of these variables from the other variables in the imputation model using a multivariable logistic regression analysis. These analyses showed explained variances ranging from 4.0% to 35.3% (Nagelkerke’s R²), implying that data were missing at random at least to some extent. Consequently, multiple imputation may have minimized bias in the present study. Nevertheless, data being missing not at random can never be excluded, and therefore we included complete case analyses as a sensitivity analysis.

**Data analysis**

The analyses focused on the comparison of continued and quit use. Therefore, two samples were identified: those participants who either continued or quit smoking, and those who either continued or quit alcohol consumption. The sample of participants who continued both smoking and alcohol consumption was too small to study (n=4). However, this latter group may be a distinct group; therefore we conducted an additional, exploratory analysis excluding this group. Subsequent changes in the odds ratios of 10% or more were considered noteworthy changes.

Groups were compared using t-tests, Mann-Whitney tests, and Pearson Chi-Square tests where appropriate. Logistic univariable regression analyses were used to investigate the independent associations of continued smoking and alcohol consumption (dependent variables) with the personality traits (independent variables). Odds ratios from these analyses were calculated as quantitative association measures and were accompanied by 95% confidence intervals. Before exploring the explanation of the associations by anxiety or depressive symptoms, we first investigated whether these symptoms were associated with the dependent and independent
variables. If so, anxiety- and depressive symptoms were added separately (model 1 and 2) to those models that showed statistical significance. Any resulting changes in the beta-coefficient of the personality traits were considered as measures of explanation of the associations of personality traits and continued smoking and alcohol consumption. In a supplementary analysis we stratified the analyses according to the level of education (low versus high), and differences between subgroups were statistically tested by including education*personality trait interaction terms. Values of the personality traits, anxiety and depressive symptoms were converted into z-scores prior to the analyses to ensure comparability of the magnitude of the associations. Associations between personality traits and the amount of smoking and alcohol consumed by continued users were tested using Spearman’s rank correlation. The level of statistical significance was set at 0.05, two-sided. Imputation and all analyses were performed using IBM SPSS Statistics version 20.0.

Results

Descriptives
Characteristics of the study participants after imputation of missing data are presented in table 2. Women who continued smoking reported a lower educational level compared to women who quit smoking (p<0.001). Women who continued alcohol consumption differed from those who quit regarding the personality traits openness to experience and conscientiousness (p=0.012 and p=0.038, respectively). Furthermore, women who continued alcohol consumption had somewhat higher levels of anxiety and depressive symptoms (p=0.048 and p=0.056, respectively), compared to those who quit.
Table 2: Characteristics of the study participants (pooled) according to smoking status (continued versus quit) and alcohol consumption status (continued versus quit).

<table>
<thead>
<tr>
<th></th>
<th>Continued smoking (n = 101)</th>
<th>Quit smoking (n = 254)</th>
<th>P-value</th>
<th>Continued alcohol cons. (n = 110)</th>
<th>Quit alcohol cons. (n = 1230)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean yrs (SD)</td>
<td>29.7 (4.8)</td>
<td>29.8 (4.9)</td>
<td>0.836</td>
<td>31.85 (4.5)</td>
<td>30.97 (4.4)</td>
<td>0.096</td>
</tr>
<tr>
<td>Education, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary education</td>
<td>3 (3.0)</td>
<td>3 (1.2)</td>
<td>P&lt;0.001</td>
<td>0 (0)</td>
<td>5 (0.4)</td>
<td>0.123</td>
</tr>
<tr>
<td>Lower tracts of secondary education</td>
<td>20 (19.8)</td>
<td>43 (16.9)</td>
<td></td>
<td>8 (7.3)</td>
<td>96 (7.8)</td>
<td></td>
</tr>
<tr>
<td>Higher tracts of secondary education</td>
<td>58 (57.4)</td>
<td>93 (36.6)</td>
<td></td>
<td>19 (17.3)</td>
<td>319 (25.9)</td>
<td></td>
</tr>
<tr>
<td>Higher vocational education</td>
<td>17 (16.8)</td>
<td>85 (33.5)</td>
<td></td>
<td>44 (40.0)</td>
<td>499 (40.6)</td>
<td></td>
</tr>
<tr>
<td>University education</td>
<td>3 (3.0)</td>
<td>30 (11.8)</td>
<td></td>
<td>39 (35.5)</td>
<td>311 (25.3)</td>
<td></td>
</tr>
<tr>
<td>Personality traits, mean (SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neuroticism</td>
<td>30.9 (8.8)</td>
<td>29.5 (7.5)</td>
<td>0.316</td>
<td>29.4 (8.1)</td>
<td>28.5 (7.0)</td>
<td>0.318</td>
</tr>
<tr>
<td>Extraversion</td>
<td>41.0 (6.2)</td>
<td>41.7 (5.6)</td>
<td>0.495</td>
<td>42.1 (6.2)</td>
<td>42.3 (5.5)</td>
<td>0.863</td>
</tr>
<tr>
<td>Openness to experience</td>
<td>36.5 (5.5)</td>
<td>36.9 (5.7)</td>
<td>0.671</td>
<td>38.9 (5.9)</td>
<td>37.1 (5.5)</td>
<td>0.012</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>45.4 (5.6)</td>
<td>45.5 (4.9)</td>
<td>0.876</td>
<td>44.7 (6.1)</td>
<td>46.1 (4.8)</td>
<td>0.038</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>44.2 (4.7)</td>
<td>45.3 (4.6)</td>
<td>0.133</td>
<td>46.3 (4.7)</td>
<td>46.3 (4.3)</td>
<td>0.973</td>
</tr>
<tr>
<td>Multiparous, n (%)</td>
<td>56 (53.4)</td>
<td>139 (54.7)</td>
<td>0.337</td>
<td>66 (60.0)</td>
<td>676 (55.0)</td>
<td>0.182</td>
</tr>
<tr>
<td>In a relationship, n (%)</td>
<td>96 (95.0)</td>
<td>246 (96.8)</td>
<td>0.274</td>
<td>108 (98.2)</td>
<td>1217 (99.0)</td>
<td>0.471</td>
</tr>
<tr>
<td>Anxiety score, median (IQR)</td>
<td>36.3 (14.7)</td>
<td>33.3 (10.3)</td>
<td>0.080</td>
<td>33.5 (13.5)</td>
<td>33.3 (10.0)</td>
<td>0.048</td>
</tr>
<tr>
<td>Depression score, median (IQR)</td>
<td>5.1 (5.8)</td>
<td>4.6 (4.8)</td>
<td>0.164</td>
<td>4.6 (5.5)</td>
<td>4.0 (4.0)</td>
<td>0.056</td>
</tr>
</tbody>
</table>

Note: for some variables the numbers do not add up to the total due to rounding of imputed values.
Personality traits and continued smoking

None of the associations between the personality traits and continued smoking were statistically significant (table 3). Subgroup analyses did not show substantial differences in the associations between a low and high educational level. Results of the complete case analyses were not notably different from the results of imputed data. When excluding women who continued both smoking and alcohol consumption, the odds ratios changes less than 10%.

<table>
<thead>
<tr>
<th>Personality trait</th>
<th>Unadjusted OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
<td>1.19 (0.85;1.66)</td>
</tr>
<tr>
<td>Extraversion</td>
<td>0.89 (0.63;1.25)</td>
</tr>
<tr>
<td>Openness to experience</td>
<td>0.93 (0.68;1.29)</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>0.98 (0.69;1.39)</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>0.80 (0.60;1.07)</td>
</tr>
</tbody>
</table>

Table 3: Odds ratios (OR) with 95% confidence intervals (95% CI) for continued smoking.

Note: each personality trait was entered in a univariable regression model. Values for personality traits were included as z-scores.

Personality traits and continued alcohol consumption

Unadjusted odds ratios for the personality traits associated with continued alcohol consumption are presented in table 4. Each unit increase in openness to experience z-score increased the odds of continued alcohol consumption by 38%. Higher scores of conscientiousness decreased the odds of continued alcohol consumption by 23% per unit z-score. The association with continued alcohol consumption was stronger in the lower education group compared to the higher education group for the traits neuroticism and conscientiousness (lower education group: OR 1.56, CI 1.02;2.38 and OR 0.60, CI 0.40;0.90, and higher education group: OR 1.02, CI 0.79;1.33 and OR 0.80, CI 0.61;1.04, respectively). However, the interaction terms for these traits were not statistically significant (p= 0.110 and p=0.259, respectively). Results of the complete case analyses were not notably different from the results of imputed data. When excluding women who continued both smoking and alcohol consumption, the odds ratios changes less than 10%, although the association with conscientiousness showed a confidence interval including 1.00.
Smoking and alcohol consumption during pregnancy

Explanation by anxiety and depressive symptoms
Although depressive symptoms were associated with continued alcohol consumption only borderline statistically significantly (table 2), we did explore explanation by these symptoms. After adding anxiety and depressive symptoms to the statistical significant association between conscientiousness and continued alcohol consumption, the beta decreased by 32.3% and 27.0%, respectively (table 4). Openness to experience appeared unrelated to both anxiety and depressive symptoms ($r_s=0.02$ and $r_s=0.05$, respectively), therefore we refrained from exploring explanation by these symptoms.

The amount of cigarettes and alcohol consumption during pregnancy
Spearman's correlation coefficients ranged between -0.01 and 0.11 for the correlations of the personality traits with the amount of smoking and alcohol consumption. None of the correlations were statistically significant.

Table 4: Odds ratios (OR) with 95% confidence intervals (95% CI) for continued alcohol consumption.

<table>
<thead>
<tr>
<th>Personality Trait</th>
<th>Unadjusted OR (95% CI)</th>
<th>Model 1 OR (95% CI)</th>
<th>Model 2 OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroticism</td>
<td>1.13 (0.91;1.39)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraversion</td>
<td>0.98 (0.77;1.25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Openness to experience</td>
<td>1.38 (1.07;1.77)*</td>
<td>0.84 (0.66;1.06)</td>
<td>0.83 (0.65;1.06)</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>0.77 (0.62;0.95)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agreeableness</td>
<td>1.00 (0.76;1.30)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: each personality trait was entered in a univariable regression model. Values for personality traits, anxiety and depressive symptoms were included as z-scores. Model 1: anxiety symptoms added to unadjusted model Model 2: depressive symptoms added to unadjusted model * P<0.05

Discussion

This study investigated the associations of personality traits with continued smoking and alcohol consumption during mid-pregnancy. Our results showed that continued alcohol consumption is associated with higher levels of openness to experience and lower levels of conscientiousness, compared to women who quit. Moreover, the association between conscientiousness and continued alcohol consumption was partly explained by both anxiety and depressive symptoms. Conversely, continued smoking was not associated with the personality traits. No associations emerged between the personality traits and the amount of...
smoking, and alcohol consumption among continued users. Surprisingly, we did not find an association between higher levels of neuroticism and extraversion, and continued smoking and alcohol consumption. General population studies did find higher levels of neuroticism and extraversion to be associated with smoking and alcohol consumption [44-47]. This discrepancy suggests that pregnancy may be a unique period accompanied by different motivations to quit smoking and alcohol consumption, and associated personality traits [12]. On the other hand, more information could have been gained if personality traits had been assessed using a fine-grained approach (i.e. measuring personality at the facet level using for example the 240-item NEO-Personality Inventory) [29].

Continued alcohol consumption

The association between lower levels of conscientiousness and alcohol consumption has been found in the general population as well [45]. Conscientiousness has been identified as a relevant health-related trait [48], and high scores of conscientiousness are consistently associated with health promoting behavior [28]. Individuals scoring high on conscientiousness also tend to follow societal norms and rules [29,31]. This may be an important motivating factor for them especially during pregnancy, as in this time period smoking and alcohol consumption is often actively discouraged by health professionals and the social environment.

In contrast to our finding in a pregnant sample, alcohol consumption seems unrelated to openness to experience in the general population [45,49-51], which further emphasizes that pregnancy may indeed be a unique period. As openness to experience is associated with intellectual curiosity [29], this may imply that women scoring high on this trait are familiar with information about the risks of alcohol consumption during pregnancy. Current literature is inconclusive about the negative effects of small to moderate amounts of alcohol consumption [9], and studies also reported the absence of negative effects on the development of young children [52,53] or on birth outcomes [54]. The lack of consistent evidence regarding negative effects may explain why women scoring high on openness to experience choose to continue alcohol consumption during pregnancy.

Continued smoking

It is difficult to establish whether our findings of non-significant associations with continued smoking is due to the nature of our study population, i.e. consisting of relatively well educated women, or due to a lack of statistical power. Maxson and colleagues studied 482 predominantly low income, non-Hispanic black pregnant women in the United States and found an association between lower levels of agreeableness and continued smoking [30].
However, as low income is related to smoking during pregnancy [21], including a sample of predominantly low income women may hamper generalizability to the total pregnant population. Moreover, our findings on continued smoking suggest that the role of personality is limited compared to continued alcohol consumption. Possibly other factors such as a low socioeconomic status, having a partner who smokes, and great nicotine dependence are more important determinants of continued smoking during pregnancy [21,55,56]. Future studies should address the topic of personality and continued smoking during pregnancy in a large representative sample as we cannot exclude the possibility of a small effect.

Anxiety and depressive symptoms
The association between lower levels of conscientiousness and continued alcohol consumption was partly explained by anxiety and depressive symptoms. These findings suggest that continued alcohol consumption may indeed be a strategy to cope with feelings of negative affect during pregnancy.

Strengths and limitations
To our knowledge, this is the first study that investigated the associations between personality traits and continued versus quit alcohol consumption during mid-pregnancy. Also the relationships of the personality traits with the amount of smoking and alcohol consumption during pregnancy have not been explored before. As the present study investigated both smoking and alcohol consumption behavior, we were able to perform an additional, exploratory analysis in which we excluded women who continued both risky behaviors. Results from this analysis suggested that this latter group may be a distinct group to a small extent only as we observed changes in the odds ratios of less than 10%, compared to our primary analyses. Due to a small number, our study was not able to properly investigate the association between personality traits and continuation of both risky behaviors. Future studies including a larger sample may further investigate this association. Consequently, the results from the present study can be generalized to Dutch women who smoked and/or consumed alcohol before pregnancy. Some limitations should be considered. First, questions about smoking and alcohol consumption may have been subject to social desirable reporting which in turn may be related to personality. Second, we did not assess the exact time point in which women quit smoking or alcohol consumption. However, as personality is seen as a relatively stable factor [57], it is not likely that this influenced the associations under study, perhaps with the exception of the associations of anxiety and depressive symptoms. These symptoms could have been the result rather than the cause of quitting smoking and alcohol consumption. Third, regarding the amount of smoking and alcohol consumption among continued users,
studies performed among the general population did show associations with personality [58].
In our study the amount of smoking and alcohol consumption was measured categorically
which has inevitably caused some loss of detail in outcome assessment and consequent
dilution of associations. Fourth, we were not able to assess the level of dependence, which is
considered an important factor with respect to smoking and alcohol consumption during
pregnancy [21,25]. Finally, we did not measure personality traits at the facet level and it may
well be that there are associations at the facet level.

Conclusion
This study demonstrated that two personality traits, openness to experience and
conscientiousness, are related to continued alcohol consumption during mid-pregnancy, but
none of the traits to continued smoking. Increased insight in how personality influences
continued smoking and alcohol consumption during pregnancy can help health professionals,
such as midwives, gynecologists, and general practitioners, to improve lifestyle interventions
targeted at pregnant women.
Reference list


