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The effect of maternal smoking and alcohol consumption on lip morphology

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Abstract

Objective: To determine whether maternal smoking and/or alcohol consumption has an influence on lip morphology. Maternal smoking is a known risk factor for orofacial clefts; however, its influence on normal lip variation is unknown. Recent research regarding normal lip morphology has been contradictory.

Design: Retrospective cohort study.

Setting and participants: A total of 4747 children from the Avon Longitudinal Study of Parents and Children (ALSPAC) who each had 3D facial scans carried out at 15 years of age were included in the study.

Methods: Each of the participants was automatically categorised regarding predetermined lip morphological traits. Questionnaires completed by their mothers identified smoking and alcohol habits during pregnancy. Logistic regression analyses were applied to determine the effect of maternal smoking and alcohol consumption on lip morphology.

Results: Maternal smoking has significant effects on upper and lower lip contours, Cupid's bow, lower lip-chin shape and lower lip tone (all $P < 0.05$). There was also an indication of a potential epigenetic effect of smoking pre-pregnancy on upper lip contour ($P = 0.0573$). Alcohol consumption is significantly associated with philtrum shape, particularly when >6 units of alcohol are consumed per week ($P = 0.0149$, 32 weeks). Overall results suggest a deeply grooved philtrum is more likely if alcohol is consumed. Investigating the combined effect of smoking and alcohol consumption, lower lip contour ($P = 0.00923$) and lower lip-chin shape ($P = 0.0171$) are statistically significant, with lower lip contour more likely to be narrow in the midline, and lower lip-chin shape more likely to be an angular concavity.

Conclusion: Maternal smoking influences a number of lip traits, including a possible epigenetic effect on upper lip contour. Maternal alcohol consumption, particularly at a high level, influences philtrum shape. Maternal smoking and alcohol consumption have a combined effect on lower lip contour and lower lip-chin shape.

Keywords

lip shape, lip morphology, facial shape, facial morphology, ALSPAC, 3D imaging, imaging and cephalometry, maternal smoking, maternal alcohol

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Introduction

There is overwhelming evidence to support maternal smoking as a risk factor for non-syndromic cleft lip/palate (CLP) (Chung et al., 2000; Hackshaw et al., 2011; Little et al., 2004; Shi et al., 2007). Saito et al. (2005) have suggested that the deleterious effects of tobacco may be due to N-nitrosonornicotine (NNN), while Shaw et al. (1996) and

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Romitti et al. (1999) suggest a genetic variant of TGF-alpha. Possible genes involved include ANK3 (Haaland et al., 2019), GRID2 and ELAVL2 (Beaty et al., 2013). Despite the link between smoking and CLP, however, there is an apparent lack of evidence for the effect of smoking on lip morphology in non-cleft patients.

The role of maternal alcohol consumption in the formation of orofacial clefts is uncertain. A number of studies suggest a link (Chevrier et al., 2005; Dixon et al., 2011; Romitti et al., 1999), with Chevrier et al. (2005) suggesting polymorphism of the ADH1C gene, whereas others have either failed to find an association (Meyer et al., 2003) or concluded there may only be an effect if alcohol is consumed in high levels (Shaw and Lammer, 1999). The relationship between maternal alcohol consumption and other birth defects has been more widely reported, such as holoprosencephaly (Oullette et al., 1977) and fetal alcohol syndrome (FAS) (Abel, 1995; Ahlgren et al., 2002; Astley and Clarren, 1996; Jones and Smith, 1973). FAS is a continuum of birth defects with an incidence of 1 in 1000 (Abel, 1995) that presents with characteristic facial features such as a smooth philtrum, thin upper lip vermilion and short palpebral fissure length, as well as learning disabilities or behavioural problems (Hoyme et al., 2005). Identifying a link between maternal alcohol consumption and facial morphology may aid with the diagnosis of FAS, as this has been reported to be challenging (Astley, 2004; Morleo, et al., 2011; Wilson-Nagrani, 2016).

Two recent studies investigating the effects of maternal alcohol consumption on facial shape have been contradictory. A prospective cohort study by Muggli et al. (2017) found 'a consistent association between alcohol and craniofacial shape', including a suggestion that binge drinking may affect the lower lip. By contrast, a systematic review and meta-analysis by Mamluk et al. (2017) found no evidence of any detrimental effects, although there was only one study in the review addressing craniofacial morphology in non-cleft individuals. A more recent study by Howe et al. (2019) stratified subjects according to maternal alcohol intake and reported a possible dose-response relationship but no strong association. While the evidence is inconclusive, current advice in the UK is that it should be avoided completely during pregnancy (Chief Medical Officer, 2015).

The aim of this observational cohort study was to determine whether maternal smoking and/or alcohol consumption during pregnancy influences the lip morphology of the offspring, using an automated lip classification system (Abbas, 2017; Abbas et al., 2015, 2018, 2019).

Materials and methods

The sample comprised individuals from the Avon Longitudinal Study of Parents and Children (ALSPAC), a birth cohort study that recruited pregnant women living in the Bristol area during 1990–1992. Details about the study cohort have been reported by Fraser et al. (2013) and Boyd et al. (2013) and are discussed in a Davies et al., (In press). Questionnaires were completed by the pregnant mothers at 8, 18 and 32 weeks of gestation, seeking to determine the frequency and number of cigarettes smoked and/or amount of alcohol consumed before and during pregnancy. During 2006–2007, at age 15 years, 4747 of the individuals had 3D facial scans obtained for analysis. Of the scans, 4730 underwent automated lip trait categorisation by means of Kmeans++, a method discussed Davies et al., (In press). Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees. This includes all questionnaire content, analysis of the pre-existing dataset and acquisition of the facial scans (reference: 06/Q2006/53 Avon Longitudinal Study of Parents and Children [ALSPAC], Hands on Assessments: Teen Focus 3 [Focus 15+] [7 August 2006; confirmed 15 September 2006]). Informed consent for the use of data collected via questionnaires and clinics was obtained from participants following the recommendations of the ALSPAC Ethics and Law Committee at the time.

Data were analysed using the statistical software RStudio (R Core Team, 2018; RStudio Team, 2016) and descriptive statistics were first run to assess trends in the data. Due to the heavy right-skewed distribution of the continuous data for alcohol consumption and high proportion of zeros, the following variables were categorised into a binomial variable of 'yes' and 'no' for alcohol: 'units' consumed per week at eight weeks; frequency of alcohol consumption in the first three months; and 'units' consumed per week at 32 weeks. The sample contained a large number of pregnant mothers who consumed alcohol in low concentrations, and assuming a binomial approach, these individuals would be classed as a 'yes' for consuming alcohol. To this end, and in line with Howe et al. (2019), the sample was also stratified into ≤6 'units' and >6 'units' of alcohol at 8 and 32 weeks of pregnancy, such that the effect of heavy versus light alcohol consumption could be investigated. Data about smoking habits were already presented binomially pre-pregnancy, during the first three months, and at 16–18 weeks. In order to evaluate a potential epigenetic effect of maternal smoking, an analysis was also carried out using only mothers who smoked before pregnancy but not during pregnancy. Logistic regression models were used to assess if the lip shape traits of the children could be used to predict smoking and drinking patterns of the mothers at various stages in the pregnancy.

In order to test whether smoking habits and the consumption of alcohol were independent, a *t*-test was carried out to compare the drinking patterns between smokers and non-smokers. Following this, in order to look at the combined effect of smoking and alcohol, a 'profile' of four categories (no drinking and no smoking, drinking but no

Table 1. Changes to smoking and alcohol habits during pregnancy.

No. of cigarettes smoked per day pre-pregnancy, during the first 3 months and at 16–18 weeks asked at 18 weeks of gestation			
Number smoked	Pre-pregnancy	First 3 months	16–18 weeks
0	3378 (77.0)	3714 (84.3)	3878 (88.0)
1–4	156 (3.6)	196 (4.4)	152 (3.5)
5–9	180 (4.1)	175 (4.0)	128 (2.9)
10–14	195 (4.4)	151 (3.4)	117 (2.7)
15–19	208 (4.7)	91 (2.1)	70 (1.6)
20–24	190 (4.3)	55 (1.2)	46 (1.0)
25–29	51 (1.2)	20 (0.5)	10 (0.2)
30+	29 (0.7)	<5 (<0.2)	<5 (<0.2)
(Not answered)	(343)	(324)	(325)
Alcohol consumption pre-pregnancy, during the first 3 months, and since the baby first moved asked at 18 weeks of gestation			
Alcohol consumption	Pre-pregnancy	First 3 months	Baby first moved
Never	258 (5.9)	1899 (43.1)	2042 (47.2)
Less than 1 glass per week	1664 (37.7)	1825 (41.4)	1596 (36.9)
At least 1 glass per week	1949 (44.2)	607 (13.8)	632 (14.6)
1-2 glasses every day	476 (10.8)	64 (1.5)	51 (1.2)
3-9 glasses every day	61 (1.4)	8 (0.2)	<5 (<0.2)
At least 10 glasses every day	<5 (<0.2)	<5 (<0.2)	<5 (<0.2)
(Not answered)	(320)	(326)	(406)

Values are given as n (%).

smoking, smoking but no drinking, and drinking and smoking) was created at three months – the only timepoint for which comparable data were available. A multinomial logistic regression was carried out to investigate if this profile could be predicted by individual lip traits, thus suggesting a combined effect of smoking and alcohol consumption on lip shape.

Results

Prevalence of maternal smoking and alcohol consumption

Table 1 shows the smoking and alcohol habits of pregnant mothers in the sample at various timepoints. The prevalence of smoking in the sample was 23.0% before pregnancy but fell to 15.7% during the first three months of pregnancy, and further to 12.0% at 16–18 weeks of pregnancy. The prevalence of alcohol consumption in the sample was 94.1% before pregnancy but fell to 56.9% during the first three months of pregnancy, and slightly further to 52.8% when the mothers first felt the baby move. Before pregnancy, only 5.9% reported never consuming alcohol, and the majority of mothers reported consuming alcohol less than daily (81.9%). Of mothers, less than 0.2% consumed more than 10 glasses per day at any of the timepoints.

Stratifying the sample at 6 'units' per week to account for heavy versus light drinking, the following spread of data was observed (Table 2). The vast majority of pregnant mothers consumed $\leqslant$6 'units' of alcohol per week at both 8 weeks and 32 weeks of pregnancy (3694, 92.8% and 2361, 92.1% respectively). The proportion of mothers who drank heavily (>6 'units' of alcohol per week) changed very little between the timepoints (7.2% to 7.9%).

The effect of maternal smoking

Analysing the variable for smoking during the first three months of pregnancy, there were statistically significant associations between smoking and upper lip contour (LRT

Table 2. Stratified alcohol consumption by 'units' consumed per week.

	8 weeks of pregnancy	32 weeks of pregnancy
⩽6 'units' of alcohol per week	3694 (92.8)	2361 (92.1)
>6 'units' of alcohol per week	286 (7.2)	203 (7.9)
Incomplete data	750	2166

Values are given as n (%).

= 8.446, df = 3, P = 0.0377), lower lip contour (LRT = 12.318, df = 3, P = 0.00637), lower lip-chin shape (LRT = 12.776, df = 4, P = 0.0124) and lower lip tone (LRT = 12.696, df = 4, P = 0.0129). Predicted probabilities were assessed (Figure 1), and while confidence intervals for the predicted probabilities overlap for most of the lip traits, the odds ratios (ORs) are significant for many of the comparisons, and hence they are good predictors of whether the mothers smoked. Descriptors for the different types of each lip trait are outlined in Davies et al., (In press). ORs for upper lip contour Types 1 and 3 (concave and pseudo-convex) were significantly larger than Types 2 and 4 (straight and convex). For lower lip contour, the OR for Type 2 (curved) was significantly lower than the other types. For lower lip-chin shape, the ORs for Types 2 and 4 (both angular concavities) were significantly larger than Types 3 and 5 (convex and flat). For lower lip tone, the ORs for Types 2 and 3 (both with central concavities) were significantly larger than Type 4 (wide concavity). At 16–18 weeks of pregnancy, there were again statistically significant associations between smoking and upper lip contour (LRT = 8.933, df = 3, P = 0.0302) and lower lip tone (LRT = 15.465, df = 4, P = 0.00383), with an additional association identified between smoking and Cupid's bow (LRT = 6.847, df = 2, P = 0.0326).

An analysis was carried out for smoking pre-pregnancy, for mothers who stopped smoking during pregnancy only (307 mothers). This model reveals a possible effect on the upper lip contour, with marginal non-significance (LRT = 7.511, df = 3, P = 0.0573). ORs for the potential epigenetic effect of smoking pre-pregnancy on the upper lip contour (Table 3) indicate a higher probability of smoking pre-pregnancy than never smoking, with upper lip contour Type 1 (concave) than Type 4 (convex). No other comparisons were significant.

The effect of maternal alcohol consumption

For alcohol consumption during the first three months of pregnancy, a significant association was identified for philtrum shape (LRT = 16.126, df = 6, P = 0.0131). There were marginal non-significant associations for Cupid's bow (LRT = 5.114, df = 2, P = 0.0776) and lower lip contour (LRT = 6.304, df = 3, P = 0.0977). Following stepwise deletion, philtrum shape remained significant (LRT = 14.940, df = 6, P = 0.0207) and Cupid's bow also remained near significant (P = 0.0601). The ORs for philtrum shape are displayed in Table 4. The results suggest that while philtrum shape appears to be influenced by maternal alcohol consumption, the highest probability for alcohol consumption when pregnant was seen with philtrum shape Type 4 (deep groove). At 32 weeks of pregnancy, the result for philtrum shape also approached statistical significance (LRT = 11.083, df = 6, P = 0.0858). There were otherwise no other statistically significant associations between maternal alcohol consumption and lip morphology, with all other P values ⩾ 0.104.

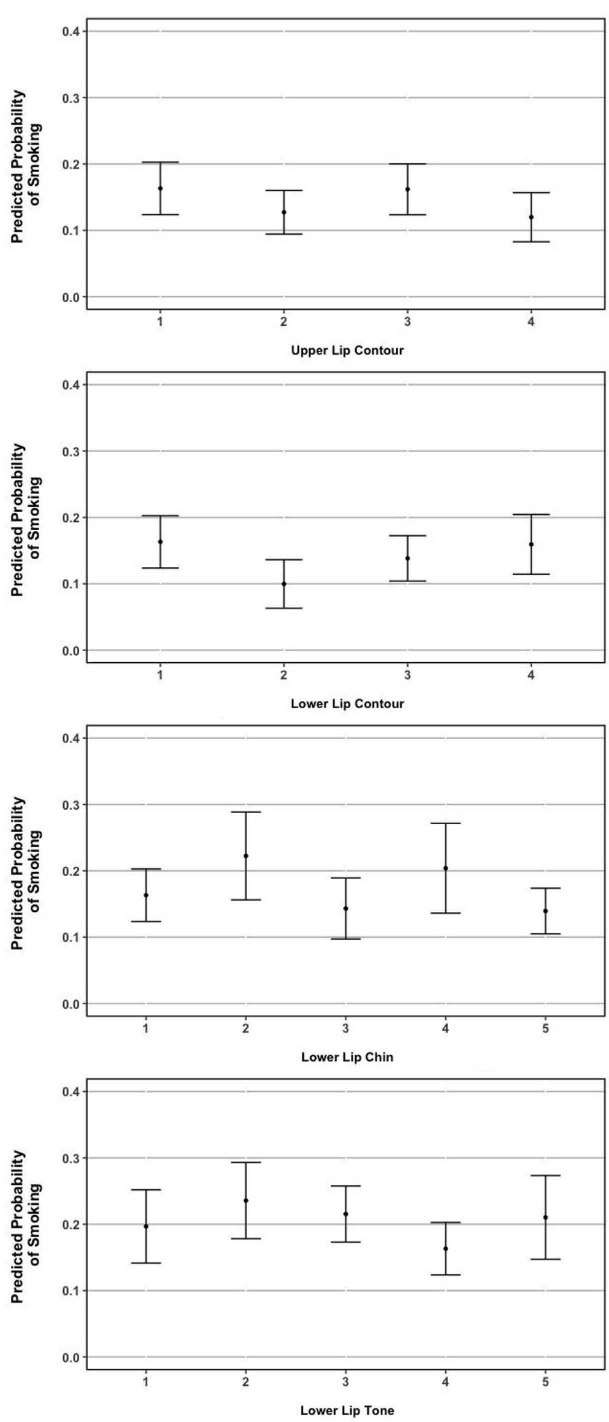
The effect of 'heavy drinking'

Data were stratified at ⩽6 'units' and >6 'units' per week at 8 weeks and 32 weeks of pregnancy. At 32 weeks, there was a statistically significant association between heavy drinking and philtrum shape (LRT = 15.790, df = 6, P = 0.0149), and a potentially significant association between heavy drinking and upper lip border (LRT = 5.371, df = 2, P = 0.0682). As with the binomial data for the effect of alcohol consumption on philtrum shape, ORs were investigated to determine which philtrum shape types are more common among the 'heavy drinking' group. For this set of data, the model parameters exhibited a poor fit, and the confidence intervals were too large to be able to make any reliable conclusions. Of note is the fact that the distribution across the different classes of philtrum shape is poor. For philtrum shape Type 5 – smooth and wide – there are only 73 individuals in the class, and all their mothers consumed alcohol while pregnant.

The combined effect of smoking and alcohol

Table 5 demonstrates that large numbers of pregnant mothers either did not smoke or drink at all (n=1649, 37.58%) or consumed alcohol but did not smoke (n=2050, 46.72%). A *t*-test was carried out to investigate the difference in drinking patterns between smokers and non-smokers. On average, mothers who smoked before pregnancy consumed significantly more alcohol at eight weeks of pregnancy, 2.28±0.17 'units', than those who did not smoke,

Figure 1. Predicted probabilities of smoking for upper lip contour, lower lip contour, lower lip-chin shape and lower lip tone during the first three months of pregnancy.



1.31 ± 0.05 'units' (t = 5.4774, df = 1067.4, $P < 0.0001$). Multinomial logistic regression analyses were applied to test the variable 'profile' for each of the lip morphological traits to investigate the combined effect of smoking and alcohol. The reference category was set as 'no smoking or alcohol' such that ORs could be investigated for smoking only, alcohol consumption only and the combined effect of both in relation to the reference category. Statistically significant results were obtained for combined smoking and alcohol consumption for lower lip contour (LRT = 21.890, df = 9, P = 0.00923) and lower lip-chin shape (LRT = 24.534, df = 12, P = 0.0171). ORs for each of the lower lip contour and lower lip-chin shape types are outlined in Table 6. The results suggest a higher probability of combined maternal smoking and alcohol consumption for lower lip contour Type 1 (narrow in the midline) than Types 2 or 3, and for lower lip-chin shape Type 4 (an angular concavity) than Type 5 (flat).

Discussion

National data published in 2019 reported that 10.4% of pregnant mothers in England are self-reported smokers at the time of delivery (NHS Digital, 2019), compared to 12.0% at 16–18 weeks of pregnancy in this sample. Regarding alcohol consumption, 94.1% consumed alcohol before pregnancy in this sample, slightly higher than reported by Popova et al. (2017). These differences reflect changing attitudes to smoking and alcohol consumption from the early 1990s to the present day. Overall, more women gave up smoking completely than gave up alcohol completely.

This study addresses the apparent lack of evidence into the effect of maternal smoking on lip morphology in non-cleft individuals and adds to existing evidence into the effect of maternal alcohol consumption. The results suggest that maternal smoking influences upper lip contour, lower lip contour, lower lip tone, lower lip-chin shape and Cupid's bow. A statistically significant result was obtained for upper lip contour and lower lip tone at all of the timepoints assessed, but only at one timepoint for the other traits. Despite little variation, predicted probabilities reveal a tendency for lower lip contour Type 2 (curved) and lower lip tone Type 4 (wide concavity) to be associated with a lower probability of smoking, and lower lip-chin shape Types 2 and 4 (both angular concavities) to be associated with a greater probability of smoking. As the confidence intervals overlap for each of the lip trait types, the predicted probabilities serve as an indication of how smoking might affect lip morphology while suggesting that the effects are not likely to be very strong. ORs suggest that should there be a true epigenetic effect, smoking before pregnancy would more likely result in a concave upper lip contour (Type 1) than convex (Type 4). While epigenetic effects of smoking and alcohol have been reported in the literature (Cantacorps et al., 2019; Kaur et al., 2019), the extent of which environmental influences on lip morphology are epigenetic is unclear.

Table 3. Odds ratios for upper lip contour, smoking pre-pregnancy.

Upper lip contour type	OR	95% CI
1	1.000	1.000
2	0.750	0.552–1.016
3	0.852	0.647–1.179
4	0.622	**0.420–0.902**
LRT = 7.511, df = 3, P = 0.0573		

CI, confidence interval; OR, odds ratio.
Bold values are where the 95% CI does not include 1, therefore a statistically significant result.

Table 4. ORs for philtrum shape, alcohol consumption during the first 3 months of pregnancy.

Philtrum shape type	OR	95% CI
1	0.776	**0.624–0.965**
2	0.727	**0.551–0.958**
3	0.670	**0.493–0.909**
4	1.000	
5	0.699	0.382–1.291
6	0.882	0.689–1.130
7	0.599	**0.462–0.776**
LRT = 16.126, df = 6, P = 0.0131		

CI, confidence interval; OR, odds ratio.
Bold values are where the 95% CI does not include 1, therefore a statistically significant result.

While assessing data binomially does not facilitate investigation of the relevance of number of cigarettes smoked, there is evidence to suggest that approximately 70% of women who smoke during pregnancy smoke every day rather than occasionally (Lange et al., 2018). It has also been suggested that smoking is harmful even at low levels (Schane et al., 2010).

Stratifying alcohol data to above or below 6 'units' per week seemed to provide convincing evidence for the influence of alcohol on philtrum shape. The majority of mothers who drank heavily initially continued to do so, whereas a higher number of mothers who consumed alcohol at lighter levels gave up completely.

Initial interpretation of these results raised the question why at eight weeks of pregnancy there was no apparent effect of maternal alcohol consumption, considering that the early stages of pregnancy are critical for craniofacial development, and that lip development and fusion takes place in the weeks leading up to, and including, eight weeks in utero

Table 5. Smoking and alcohol consumption during the first 3 months profile.

No smoking or alcohol	1649
Smoked only	246
Consumed alcohol only	2050
Smoked and consumed alcohol	443
Incomplete data	342

(Yoon et al., 2000). It is of importance, however, to note that the data at timepoints 8 weeks, 3 months and 32 weeks are not independent of each other. It could be argued that a more reliable result would have been obtained if the timepoints were not investigated separately, and non-drinkers were compared with those who consumed alcohol all the way through pregnancy. The ORs suggest that the most likely philtrum shape type to present for mothers who consumed alcohol is Type 4 – a deep groove. This does not correlate with extensive research into FAS, which reports that individuals with FAS often present with a wide, smooth philtrum (Abel, 1995; Ahlgren et al., 2002; Astley and Clarren, 1996; Jones and Smith, 1973), and that FAS is associated with reduced philtrum depth (Blanck-Lubarsch et al., 2019). It is important to note, however, that it was not possible to analyse ORs for heavy drinking – which is associated with a diagnosis of FAS – and that this cohort of patients were a normal population, not known FAS individuals.

The combined effect of smoking and alcohol seems to be on the lower lip contour and lower lip-chin shape, with statistical significance being achieved for both lip traits. The results suggest that the effect may be an increased likelihood of a lower lip contour that is narrow in the central region (Type 1), and a lower lip-chin shape that has an angular concavity (Type 4).

In agreement with Muggli et al. (2017) but in contrast to Mamluk et al. (2017), the results of the present study suggest that maternal alcohol consumption may influence facial shape, specifically the lip region, although the results are not as conclusive as the Muggli et al. (2017) study. Howe et al. (2019) failed to find a strong association between maternal alcohol and facial shape, despite using the same large sample as used in the present study; however, the study by Howe et al. (2019) used facial landmarks for analysis, whereas surface contours are used in the present study.

By using the ALSPAC dataset that was obtained for the present study, there was no opportunity to influence or manipulate the means by which the data were recorded. The questions relating to maternal smoking and alcohol consumption completed at 8, 18 and 32 weeks were inconsistent, in that some asked for number of 'units' consumed (continuous), some asked for frequency (ordinal) and some smoking questions required 'yes/no' answers (binomial).

Table 6. ORs for lower lip contour and lower lip-chin shape, combined smoking and alcohol consumption during the first 3 months of pregnancy.

Lower lip contour			
Lower lip contour type	OR (95% CI)		
	Smoking only	Alcohol only	Combined
1	1.000	1.000	1.000
2	**0.365 (0.205–0.652)**	**0.728 (0.556–0.940)**	**0.547 (0.344–0.868)**
3	0.860 (0.392–1.887)	0.813 (0.552–1.198)	**0.485 (0.270–0.871)**
4	1.10 (0.666–1.823)	0.962 (0.753–1.230)	0.893 (0.610–1.308)
LRT = 21.890, df = 9, P = 0.00923			
Lower lip-chin shape			
Lower lip-chin shape type	OR (95% CI)		
	Smoking only	Alcohol only	Combined
1	0.800 (0.448–1.431)	0.922 (0.688–1.235)	0.710 (0.454–1.109)
2	**2.218 (1.041–4.724)**	1.340 (0.910–1.974)	0.991 (0.528–1.860)
3	0.562 (0.279–1.134)	0.906 (0.641–1.280)	0.683 (0.403–1.159)
4	1.000	1.000	1.000
5	0.754 (0.391–1.454)	1.001 (0.720–1.392)	**0.581 (0.346–0.976)**
LRT = 24.534, df = 12, P = 0.0171			

CI, confidence interval; OR, odds ratio.
Bold values are where the 95% CI does not include 1, therefore a statistically significant result.

One 'unit' of alcohol as described by ALSPAC was not entirely consistent with the standard UK unit (10 mL or 8 g of ethanol). Timepoints were not comparable for smoking and alcohol consumption, which inevitably made data analysis challenging. All information about maternal smoking and alcohol consumption in this study was self-reported by means of questionnaire, which may result in an underestimation of the number of cigarettes smoked or amount of alcohol consumed due to societal pressures, although Swamy et al. (2011) suggest that most pregnant women do, in fact, disclose their true smoking status. A number of potential confounders also need to be taken into consideration, for example those associated with maternal deprivation, age, and socioeconomic status (Alati et al., 2013).

Future studies designed explicitly to investigate the effect of maternal smoking and alcohol consumption on offspring lip morphology may wish to pay attention to the following points. Consideration could be given to other methods of reporting and recording smoking and alcohol consumption, including the urine sample method described by Dhalwani et al. (2015), and exhaled carbon monoxide measurement, which is both non-invasive and reliable (Coultas et al., 1988). Alternative statistical analyses could be considered to answer the research question. The study could be designed such that statistical analysis can include continuous data rather than binomial data alone, in order to better predict the effect of heavy smoking and alcohol consumption. There was no power calculation carried out before the present study, as it was felt that the sample size of 4730 participants would be sufficient to identify an association between smoking and alcohol consumption and lip morphology, should there be one; however, there were very few pregnant mothers who consumed a large amount of alcohol. As such, it may be more appropriate to carry out a cohort-type study to investigate the effects of maternal smoking and alcohol consumption.

Conclusion

Following the descriptive analysis of the data collected for this project, it is possible to conclude that self-reported smoking and alcohol consumption during pregnancy were relatively high at the time of data collection. The proportion of women who smoked and consumed alcohol fell on discovering that they were pregnant and continued to fall during pregnancy. Maternal smoking influences upper and lower lip contours, Cupid's bow, lower lip-chin shape and lower lip tone, with a possible epigenetic effect on the upper lip contour. Maternal alcohol consumption (particularly at a high level) influences philtrum shape, and the combined effects of smoking and alcohol consumption during pregnancy are on lower lip contour and lower lip-chin shape.

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