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Head circumference at birth and exposure to tobacco, alcohol and illegal drugs during early pregnancy

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Abstract

Aims—We aimed to assess the effects of exposure to tobacco smoke, alcohol and illegal drugs during early pregnancy on the head circumference (HC) at birth of otherwise healthy neonates.

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Methods—A follow-up study from the first trimester of pregnancy to birth was carried out in 419 neonates. An environmental reproductive health form was used to record data of substance exposure obtained during the first obstetric visit at the end of the first trimester. A multiple linear regression model was created for this purpose.

Results—Alcohol intake during pregnancy and medical ionizing radiation exposure were the most significant predictors of HC. The mothers' alcohol consumption increased with the mothers' and fathers' education level, net family income and fathers' alcohol consumption. In contrast, maternal smoking decreased with increasing mothers' and fathers' education level and net family income. About 13% of the surveyed embryos were exposed to illegal drugs.

Conclusions—Mild to moderate alcohol consumption diminishes the at-birth HC of theoretically healthy newborns in a linear form. There was no threshold dose. We perceived a need for increasing the awareness, and for training, of health care professionals and parents, in regard to risks of alcohol consumption and for recommending abstinence of these substances in both parents during pregnancy. It should also be remembered that medical ionizing radiation should be performed only during the first half of the cycle in fertile women. We think that our study has an important social impact as it affords data for implementing policies for promoting “healthy pregnancies”.

Keywords

Pregnancy; Ethanol; Smoking; Illegal drugs; Anthropometry; Neonate; Healthy pregnancies

Introduction

Head circumference (HC) assessment at birth is a widely used somatic measurement that is easily obtained. Decrease in HC has been used as a biomarker of the effect to neurotoxicants and constitutes diagnostic criteria in fetal alcohol syndrome (FAS) that has been correlated with performance IQ [1]. Decreases in HC associated with tobacco smoke exposure and alcohol intake have afforded discordant results in the current literature [2–20]. Our aim was to analyze the effect of exposure to tobacco smoke, alcohol and other illegal drugs on the at-birth HC of healthy newborns.

Methods

Study population

Newborns and their parents, belonging to Health Area 1 of the Region of Murcia, Spain, constitute the study population. The Hospital's Ethics Committee and the Institutional Review Board approved the survey. Future parents were identified during their first visit to the Obstetrics Department performed at the end of the first trimester of pregnancy and invited to participate in the study. The study was carried out during the period comprised between December 2009 and July 2010. Exclusion criteria included twin pregnancies, miscarriages or stillbirths, preterm newborns (<37 weeks) or neonates admitted to the Neonatal Unit during the first 72 h after delivery. A total of 419 healthy neonates were thus included in this study.

Exposure data: Green Page (GP)

Green Page (GP) on reproductive environmental health constitutes the standard clinical record of pregnant women and includes a series of concise and basic questions through which the health care professional identifies environmental exposures during gestation [21]. Data about smoking were collected—a smoker is someone who smokes any tobacco product, either daily or occasionally (smoking at least one cigarette every week along any critical development period). We recorded the consumption of tobacco during the critical development periods with the transgenerational and environmental tobacco exposure that includes: 1. Active and passive exposure during the period of maturation of spermatogenesis (72 days before conception) and 2. Active and passive smoking (at work, and/or domestic exposure and/or in recreational activities) of the mother during pregnancy. Exposure during the intrauterine period can be directly from the mother (second hand smoke) or due to environmental exposure from the father, the workplace, home, etc. (third hand exposure). The exposure to ethanol was explored from the periconceptional stage to the moment of interview. The data were obtained through a questionnaire (Table 1) and was administered again once the mother reported a change of consumption. This table allowed the conversion of alcohol consumption to grams per day during critical periods (periconceptionally, weeks 3–5, weeks 6–7, and weeks 8–10 of embryonic development). We assumed that the alcohol content for each type of drink (wine or beer) was equivalent to 10 g of alcohol. The exposure to illegal drugs was first explored by asking if the mother or father could have been exposed to any of these substances. If the answer was “yes”, then the couple was asked for the type of drug as well as its consumption and type of exposure. The GP also includes information on gestational age, socioeconomic status (net family income), parents’ educational level and other environmental factors. The completion of the GP questionnaire lasted approximately 15 min. The interview was conducted personally with both parents being present at the first pregnancy visit (mean 10.3 weeks of fetal development). An informed consent was obtained from all future parents. An especially trained nurse, with expertise on environmental reproductive health and risk communication, conducted all the interviews.

The information on HC (cm), birth weight (g), and duration of gestation (weeks) were obtained at birth or at admission from the hospital’s informatics program SELENE that contains all the records at the time of discharge from the maternity unit. The *z*-scores adjusted for age and gender were calculated for HC at birth using a World Health Organization tool [22]. The following confounding variables were considered: socioeconomic status (net family income), parents’ educational level, children’s birth weight, mother’s age and exposure to medical ionizing radiation during pregnancy.

Statistical methods

SPSS version 15.0 (SPSS Inc., Chicago, IL, USA) was used for statistical evaluation. Statistical methods included descriptive studies, univariate analysis through Anova, partial and total Pearson correlation adjusted for weeks of gestation, birth weight and sex for the quantitative continuous variables, as well as Spearman correlation for ordinal variables. A multiple linear regression model was created using variables with a significant difference in the univariate analysis. The results were considered statistically significant for a *p* value <0.05.

Results

Sociodemographic and exposure data are shown in Tables 2 and 3. The mean HC measurement was 34.3 cm (95% CI 34.2–34.2). Sixty-two percent of the embryos were exposed to environmental tobacco smoke. More than 70% of the mothers consumed some alcohol during the periconceptional period. There were no significant differences between mothers' alcohol consumption by the number of previous spontaneous abortions, the wish of becoming pregnant or pregnancy obtained through a fertilization treatment. The mothers' alcohol consumption during the periconceptional period or during early pregnancy increased with the mother's and father's education level, net family income, and father's alcohol consumption (Spearman's correlation 0.14, $p<0.01$; 0.10, $p<0.05$; 0.16, $p<0.01$; 0.40, $p<0.01$; respectively). In contrast, maternal smoking diminished with increasing mother's and father's educational level and net family income (Spearman's correlation -0.23 , $p<0.01$; -0.19 , $p<0.01$; -0.15 , $p<0.01$; respectively). The Spanish native mothers consumed more alcohol and tobacco than mothers of different origins ($p<0.01$). About 13% of the embryos were exposed to illegal drugs, half of them through mothers' active consumption. Five percent of pregnant women had been exposed to medical ionizing radiation. Table 4 shows the predictor variables that correlated significantly with each clinical end point. Alcohol intake during pregnancy and medical ionizing radiation exposure were the most significant predictor of a change in HC measurements. Figure 1 shows the decrease in HC in relation with the mothers' alcohol intake.

Discussion

Our study suggests that exposure to ionizing radiation and ethanol decreases the HC of the neonates. The effect of ethanol exposure on the HC is observed from the beginning of week 8 of embryonic development. Alcohol has fetotoxic, teratogenic and carcinogenic effects and, in addition, it may be associated with other noxious effects. The most vulnerable period is from weeks 4 to 10 of gestation, but alcohol-related damage may occur at any period of pregnancy [23]. Ionizing radiation during gestation, especially during organogenesis period, is associated with a reduction in HC [24].

When using a questionnaire, the prevalence of pregnant women who admit alcohol intake during gestation has been reported from 12% to 45% [25, 26]. Our study shows that the prevalence of mothers consuming alcohol during the periconceptional stage reaches 72% with a gradual reduction to 25% by the end of the first trimester. The Spanish National Survey on Drug abuse reported that 54% of women with ages comprised from 25 to 44 years admit some alcohol intake during the last month [27]. A study performed in Barcelona in a low socioeconomic status population, by determining fatty acids ethyl esters in meconium, found that 45% of mothers consumed alcohol during pregnancy [28]. In our study, 13% of pregnant women were exposed to cannabis and more than 5% were active consumers. These results are similar to previous studies reported in Spain by using these biomarkers in meconium [29].

Most studies on the effects of maternal alcohol consumption on offspring growth have focused on their effects at birth. Several of these studies have documented a decrease in the

children's HC [6–15]. In contrast, a number of works found no deleterious effects on head size measurements [16, 20]. The contradictory findings between these studies reflect a variable number of factors such as duration and amount of alcohol use among different samples; findings for moderate levels of alcohol intake are more inconsistent. Other factors include failure to control variables that may potentially confound the association between alcohol use and pregnancy outcomes (smoking, socioeconomic status, including heavy drinkers,...) [13, 15, 20]. According to our inclusion criteria, our study analyzed the effects of mild and moderate alcohol-drinking mothers on “healthy newborns at birth (only five women drank between ten to 25 g/day of alcohol). In the present work, mothers with higher education levels and net family income consumed more alcohol and smoked less. This paradoxical effect can be explained by the scarce or null alcohol risk's perception by the surveyed families in our region. Alcohol industries constitute an important pressure lobby in many Mediterranean countries. In addition, regular alcohol consumption is part of their culture. Finally, alcohol consumption during pregnancy already constitutes a real taboo for health professionals.

It is also important to consider the correlation between paternal and maternal alcohol intake. If the father does not drink alcohol, not only does the semen quality increase but it also helps the mother to keep away from drinking during pregnancy. In regard to alcohol intake, we need to take a comprehensive and family approach.

We would like to discuss the limitations of the study. A recall bias is always present when the questionnaires are used to obtain exposure data. Also a priori, underreporting of alcohol, tobacco and other illegal drug consumption during pregnancy does seem to take place. In order to reduce these effects, a trained professional in reproductive environmental health carried out the interview face-to-face during the first trimester of pregnancy. Another limitation of the study was the absence of biomarkers of fetal exposure. Nonetheless, the data of exposure obtained in this study are similar to those obtained in other works from Spain that used exposure biomarkers [29]. In addition, the lack of data on exposure during the second and third trimesters does not allow for the differentiation of a critical timing to lead to the decrease in the HC. It seems that the effect begins to be appreciated from the eighth week of embryonic development. To control variables that may potentially confound the association between alcohol use and HC, we have included cigarette smoking, sociodemographic status, and ionizing radiation exposure. The effect of tobacco is diluted by that of alcohol and ionizing radiation at the beginning of pregnancy. This is in agreement with previous studies, in which third trimester nicotine use was a stronger predictor of decreased weight and HC at birth than was the data corresponding to the first trimester [19].

Conclusions

Mild to moderate alcohol consumption diminishes the at-birth HC of theoretically healthy newborns in a linear form. There was no level of alcohol consumption without effect. In Murcia, around 70% of women consumed alcohol during the periconceptional period. Including a carefully obtained GP questionnaire in pregnancy programs will help to detect, and prevent, the exposures to neurotoxic substances such as tobacco, alcohol and other illegal drugs. An increase in awareness and training of health care professional is needed, as

well as alcohol risk perception by the parents. Total alcohol abstinence during pregnancy of both parents is highly recommendable. At the same time, it should be remembered that medical ionizing radiation should be done only during the first half of the cycle in fertile women. All untoward effects of these substances may thus become easily preventable.

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Fig. 1.

Partial regression plots. Head circumference (cm and z-score) in relation with the mothers' alcohol intake. Scatter plot of head circumference (cm and z-score) vs. mothers' alcohol intake (g/day) (partial correlation $r=0.01$, $p<0.01$ and $r=0.02$, $p<0.01$; respectively) after controlling for newborn weight, medical ionizing radiation exposure, mother's alcohol intake, mother and father smoker during pregnancy, mother's age, and gestational age, sex. The line is plotted by linear regression with the IC 95%

Table 1

Questionnaire quantification of alcohol intake

	Never <1 month	1–3 per month	1 per week	2–4 per week	5–6 per week	1 per day	2–3 per day	4–5 per day	6+ per day
1. Red wine (1 glass, 4 oz.) (10 g/alcohol)	①	②	③	④	⑤	⑥	⑦	⑧	⑨
2. White or pink wine (1 glass, 4 oz.) (10 g/alcohol)	①	②	③	④	⑤	⑥	⑦	⑧	⑨
3. Sherry, dried wines, vermouth (glass, 2 oz.) (12 g/alcohol)	①	②	③	④	⑤	⑥	⑦	⑧	⑨
4. Beer (1 can or 1/5 bottle, 8 oz.) (10 g/alcohol)	①	②	③	④	⑤	⑥	⑦	⑧	⑨
5. Liquor (20–30°C): fruit (apple), whisky cream (1 glass, 2 oz.) (15 g/alcohol)	①	②	③	④	⑤	⑥	⑦	⑧	⑨
6. Alcohol (>30°C): brandy, gin, rum, whisky, vodka (1 glass, 2 oz.) (20 g/alcohol)	①	②	③	④	⑤	⑥	⑦	⑧	⑨

Table 2

Sociodemographic variables

	Number (%)	Mean (IC 95%)
Newborn's gender		
Male	201 (48.9%)	
Female	210 (51.1%)	
Gestational age		39.0 (38.9–39.1)
Newborn weight		3.291 (3.247–3.335) ^a
Head circumference (HC)		34.3 (34.2–34.5)
z-Score HC		0.18 (0.06–0.29)
Mother's age at pregnancy		33.1 (32.6–33.6) ^a
Father's age at pregnancy		35.3 (34.7–35.9)
Mother's race/ethnicity		
White	371 (88.5)	
Gipsy	7 (1.7)	
Latin American	22 (5.3)	
Magrebi/Arab	16 (3.8)	
Black	3 (0.7)	
Mother's educational level		
None	33 (8.0)	
Primary school	139 (33.9)	
Complete secondary	94 (22.9)	
Complete college	144 (34.4)	
Father's educational level		
None	58 (14.3)	
Primary school	146 (36.0)	
Complete secondary	103 (25.4)	
Complete college	98 (24.2)	
Family net income/month (€)		
<800	48 (12.0)	
800–1,500	90 (22.5)	
1,500–2,500	142 (35.5)	
>2,500	120 (30.0)	
Type of pregnancy		
Fertility treatment	47 (11.5)	
Spontaneous	363 (88.5)	
Pregnancy proactive search		
Yes	304 (71.1)	
Non	112 (26.9)	

^aThere were significant differences for HC in these variables.

Table 3**Exposures during pregnancy**

		Number (%)	Mean (IC 95%)	Anova		Total correlation	
				HC	z-Score	HC	z-Score
Periconceptional	Father's alcohol consumption	344 (83.7)	20.2 (18.0–22.3) g/day	ns	ns	ns	ns
	Mother's alcohol consumption						
	Periconceptional stage	303 (72.3)	9.4 (8.1–10.8) g/day	ns	ns	ns	ns
	Tobacco						
	Mother smoker	162 (38.7)	4.7 (3.9–5.6) cg/day	0.05	0.02	–0.16 (0.02)	–0.14 (0.03)
	Father smoker	183 (44.2)	16.4 (14.8–17.9) cg/day	ns	ns	ns	–0.15 (0.03)
	Cannabis						
	Mother smoker	21 (5.1)		ns	ns		
	Father smoker	36 (8.7)		ns	ns		
	Cocaine						
Pregnancy	Mother's exposure	8 (1.9%)		ns	ns		
	Mother's alcohol consumption (g/d)						
	Up to 3–5 weeks of development	220 (52.5)	8.7 (7.0–10.4) g/day	ns	ns	ns	ns
	Up to 6–7 weeks of development	110 (26.3)	3.6 (1.8–5.5) g/day	0.05	ns	ns	ns
	Up to 8–10 weeks of development	97 (23.2)	1.2 (1.4–2.9) g/day	ns	ns	–0.14 (<0.01) ^a	–0.16 (<0.01) ^a
	Tobacco						
	Mother smoker	72 (17.3)	7.1 (5.6–8.6) cg/day	ns	ns	ns	ns
	Father smoker	171 (41.2)	15.7 (14.0–17.3) cig/day	ns	ns	ns	ns
	Intrauterine tobacco smoker ^b	256 (62)		ns	ns		
	Cannabis						
	Mother smoker	21 (5.1)		ns	ns		
	Father smoker	4 (1%)		ns	ns		
	Intrauterine exposure	36 (8.7)		ns	ns		
	Cocaine (intrauterine exposure)	54 (13)		ns	ns		
	Medical transplacental X-ray	13 (5)		0.01	<0.01		

^aCorrelation adjusted for gestational age, Newborn weight and sex of infant. *ns* not significant differences^bIntrauterine tobacco smoker—any fetal tobacco smoke exposure, including second hand smoke exposure

Table 4

Stepwise linear regression of clinical end point with predictor variables

	HC (cm)			z-Scores HC		
	Regression coefficient	IC 95%	p Value	Regression coefficient	IC 95%	p Value
Newborn weight	0.002	0.001 to 0.002	<0.01	0.001	0.001 to 0.001	<0.01
Medical ionizing radiation	0.93	0.30 to 1.55	<0.01	0.88	0.39 to 1.37	<0.01
Mother's alcohol intake up to 8–10 weeks of development	−0.05	−0.11 to −0.01	<0.05	−0.05	−0.10 to −0.01	<0.01

The following predictor variables were included: Newborn weight, medical ionizing radiation exposure, mother's alcohol intake, mother and father smoker during pregnancy, mother's age, and gestational age, sex. To obtain predictor variables the comparisons of all variables were made using the unpaired Student's *t* test, ANOVA test and Spearman's rho correlation

HC head circumference