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Smoking during Pregnancy: A Risk Factor for Stunting and Anemia in Infancy

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Abstract

Background: The co-occurrence of smoking, stunting, anaemia and poverty represent multiple biological and psychosocial risks that increase unjust and unfair inequalities since early infancy. Smoking during pregnancy not only increases risk of intrauterine growth retardation (IUGR) and preterm birth, also impacts negatively on growth and child development.

Study design and subjects: Study population came from a cross-sectional, national, representative survey conducted in Uruguay (2011) involving 2,994 infants <24 months to study stunting and overweight and a sample of 756 infants 6-24 months to investigate anaemia. Birth weight, birth length and gestational age were taken from health records. Measurements of current weight, length and head circumference were collected by appropriately trained nutritionists following WHO anthropometry recommendations. Binary logistic regression was carried out to estimate the probability of stunting and anaemia in offspring of mother who continuing smoking during pregnancy controlled for intrauterine growth retardation (IUGR) and for maternal and social variables.

Major findings: Smoking remains prevalent in younger and less educated women in Uruguay; 23.2% of women smoke and 12.6% smoke while pregnant. Stunting prevalence was almost double (16.8% vs 10.4% P<0.001) and anaemia prevalence was higher: 47.1% compared 29.7% among non-smokers (P=0.002). The results indicate that intrauterine smoke exposure increased chance of intrauterine growth retardation OR:3.0(1.7-5.2); stunting OR: 1.5(1.1-2.1) and anaemia OR:1.9(1.1-3.0).

Conclusions: Our results highlight the association between smoking exposure in utero with stunting and anaemia particularly in infants living in a poverty co006Etext. Consequently efforts to prevent smoking should be a cornerstone in promoting healthy child growth and development.

Keywords: Smoking; Stunting; Anaemia

Introduction

Every major advance in public health has involved the reduction or elimination of risk factors. Tobacco is emerging as a key risk for healthy growth and psychosocial development especially in children from transitional countries where 12–15% of all women continue to smoke during pregnancy [1,2].

Smoking during pregnancy has profound and negative effects on mothers and their children. Each cigarette smoking during pregnancy reduces flow from the uterus to the placenta compromising the delivery of oxygen and nutrients to the foetus. Tobacco not only increases risk of intrauterine growth retardation (IUGR) and preterm birth [3-8], also impacts negatively on growth and child development [2,4,12-17].

Smoking during pregnancy increases risk of stunting in infancy and affects children's performance producing hyperactivity, depression, hyper-aggressive, antisocial and oppositional behaviour [7,9-10]. These effects are exacerbated by iron deficiency and it has been demonstrated that maternal smoking increases anaemia in both pregnant women and their offspring [2,7,11,18]. The co-occurrence of smoking, stunting, anaemia and poverty represent multiple biological and psychosocial risks that increase unjust and unfair inequalities since early infancy [19].

Uruguay, as well as most countries has adopted anti-smoking measures and, although tobacco use is decreasing, it is remains elevated among young, poorer and less educated women. For the present study, we hypothesized that active maternal smoking during pregnancy is a risk factor for stunting and anaemia in offspring less than 24 months.

Subjects and Methods

Data are drawn from a cross-sectional, national, representative survey conducted in Uruguay in 2011 by Ministry of Public Health, Ministry of Social Development, RUANDI and UNICEF. The sample size was determined considering four clusters: Montevideo, Interior,

Public and Private Services. Sample design was polyetapic and stratified by age of child and proportional to each cluster. To investigate stunting and overweight, we selected a sample of 2,994 infants <24 months. We study anaemia in a sample of 756 infants aged from 6 to 24 months also representative of the four clusters. Survey result has been published by UNICEF(20).

Birth weight, birth length and gestational age were taken from health records. We considered low birth weight birthweight (LBW) <2500 g; preterm <37 weeks of gestation and Intrauterine growth retardation (IUGR) when a new-born was born ≥ 37 weeks and had a birth weight <2500 g. Measurements of current weight, length and head circumference were collected by appropriately trained nutritionists following World Health Organization (WHO) recommendations. Children weights were measured with scales with a precision of 0.1 kg. Horizontal length was measured with infantometer with accuracy to 0.1 cm. Head circumferences were measured with plastic inextensible tapes to the nearest 0.1cm. We computed Z-scores: height-for-age by sex (HAZ), Z-scores weight-for-age by sex (WAZ) and body mass index-for-age by sex (BAZ) using MGRS Child Growth Standards (21). Measurements were excluded from the analyses as outliers if HAZ <-6 or >6, WAZ <-6 or > 5 and BAZ <-5 or >5 z-scores; 1.2 % of all measurements were considered outliers and thus were excluded from the analysis. Infants were defined as stunted if their HAZ were more than two standard deviation (SD) units below the median of WHO international reference population.

To assess anaemia, blood haemoglobin levels were measured using the portable Hemo Cue system. The system uses a drop of blood from a finger prick, which is inserted into a portable instrument to obtain a digital reading on haemoglobin concentration. According haemoglobin level and cut point proposed by WHO, were considered non-anaemic (≥ 11.0 g/dl), mildly anaemic (10.0–10.9 g/dl), moderately anaemic (7.0–9.9 g/dl) and severely anaemic (<7.0 g/dl).

The survey also collected detailed information about household and maternal characteristics. Maternal height and weight were measured while the mother stood without shoes and without heavy clothing. Body mass index (BMI) was calculated (kg/m^2). We considered underweight as BMI<18.5 and obesity BMI>30. Weight gain during pregnancy was assessed considering self-reported weight. We considered first decile ≤ 6 kg as low weight gained during pregnancy.

We asked the mother whether she smoked during her pregnancy, the number of cigarettes daily she smoked and if she remembered episodes of illness during pregnancy.

Since the effect of smoking during pregnancy on stunting and anaemia in infancy may be mediated by intrauterine growth retardation (IUGR) and confounded by other a priori established variables, we controlled such factors.

Statistical Method

Descriptive statistics [mean, standard deviation (SD) were calculated for each independent numeric variable. We applied Kolmogorov-Smirnov test to assess normality. Differences between means were tested using Student´s t test. We applied Chi square test to analyse the association between categorical variables. Minimum statistical significance level was P<0.05. Binary logistic regression was carried out to estimate the probability of being stunted or anaemia in offspring of mother who continuing smoking during pregnancy controlling for IUGR and other relevant factors. The association of each explanatory variable was expressed as adjusted odds ratios (OR) with upper and lower 95% confidence. Data processing and statistical analysis were conducted using SPSS version 15.0.

Ethical Consideration

The survey was approved by the ethics committee of the Public Health Ministry. Informed consent was obtained from mothers before the survey was conducted. We obtained length, weight, and blood haemoglobin measurements in the children and informed mothers on test results. Anaemic children were treated based on current paediatric practices in Uruguay.

Results

Smoking during pregnancy was reported by 12.6% of the total; smokers were younger, had lower household income, 2 years less education as well as more children than non-smoking women. Women´s weight and BMI were lower, but stature was similar in both groups (Table 1).

Mean ± SD	Yes (N=376)	No (N=2605)	P
Mothers			
Age (years)	26.1 ± 6.4	27.2 ± 6.7	0.004
Education (years)	7.7 ± 2.3	9.5 ± 3.3	<0.001
Number children	2.8 ± 5.3	2.2 ± 4.9	0.05
Household income	$6,000	$10,000	-
Stature (meters)	1.60 ± 0.07	1.60 ± 0.07	0.136
Weight (kg)	59.2 ± 11.4	64.6 ± 13.3	<0.001
Body Mass Index (kg/m2)	22.9 ± 3.9	24.9 ± 4.8	<0.001
Infants			
Pregnancy duration (weeks)	38.6 ± 3.6	38.5 ± 2.5	0.806
Weights birth (grams)	3059 ± 548	3239 ± 558	<0.001
Length at birth (cm)	47.9 ± 2.8	48.6 ± 2.9	<0.001
Age (months)	9.1 ± 6.6	9.6 ± 6,5	0.124
Length (cm)	67.4 ± 10.4	68.9 ± 10.2	<0.001
Length-for-age (Z-score)	-0.78 ± 1.27	-0.50 ± 1.3	<0.001
Weight (Kg)	8.6 ± 2.6	9.1 ± 2.6	0.006
Head circumference (cm)	46.9 ± 5.1	47.0 ± 3.8	0.902
Head circumference (Z-score)	0.44 ± 1.0	0.69 ± 1.1	0.04
Haemoglobin (g/dl)	10.9 ± 1.1	11.4 ± 1.0	0.004

Table 1: Characteristic of mothers and infants according smoking habit during pregnancy

Duration of gestation was 38.5 ± 2.7 weeks and did not differ by smoking habit. However birth weight of newborns exposed in utero to smoke, was ~200 g less and length was ~1 cm shorter; ponderal index was also lower (Table 1). Prevalence of low birth weight (14.7% 7.9%, P<0.001) and percentage of intrauterine growth retardation was

almost double (7.4% vs 3.0% respectively, P<0.001) (Table 2). Newborns whose mothers smoked tripled their chance of having intrauterine growth retardation after adjusting for maternal short stature, episodes of illness and low weight gained during pregnancy (Table 3).

	Yes	No	P
Mothers			
Underweight *f*	25(10.3%)	74 (4.1%)	<0.001
Obesity ʕ	13 (5.3%)	267 (14.7%)	<0.001
Infants			
LBW ף	46 (14.6%)	211 (7.9%)	<0.001
IUGR §	28 (7.4%)	79 (3.0%)	<0.001
Stunting ɒ	52 (16.8%)	271(10.4%)	<0.001
Mild anaemia Θ	34 (34,3%)	140 (21,6%)	0.003
Moderate anaemia ∫	14 (13,7%)	46 (7,0%)	0.003
Severe anaemia ⌂	-	-	

Table 2: Underweight and Obesity of the mothers and low birth weight, intrauterine growth retardation, stunting, anaemia and overweight among offspring according maternal smoking during pregnancy; *f* Mother`s underweight BMI <18.5; ʕ Obesity BMI >30; Low birth weight < 2500 g; § Intrauterine growth retardation: born small (<2500 g) at term (≥ 37 weeks of gestation); ɒ Stunting Height-for-age Z-score <-2SD (WHO Child Growth Standards); Θ Mild anaemia Haemoglobin <10.0-10.9 g/dl; ∫ Moderate anaemia Haemoglobin 7.0-9.9 g/dl; ⌂ Severe anaemia Haemoglobin <7.0 g/dl; ɋ Overweight Body mass index-for-age Z-score > 2SD (WHO Child Growth Standards).

Offspring's age of both groups was similar but length was 1.5 cm shorter (P<0.001). Length-for-age Z-score (P<0.001) and head circumference-for-age Z-score (P= 0.04) were also lower (Table 1). Stunting prevalence was almost double (16.8% vs 10.4% P<0.001) and we could observe after controlling by intrauterine growth retardation and maternal variables that smoking exposure in utero infants increased probabilities of stunting OR:1.5 (1.1-2.1) (Table 3).

Haemoglobin level (10.9 ± 1.1 g/dl) was significantly lower among infants from 6 to 24 months of age exposure smoking in utero (non-exposed 11.4 ± 1.0 g/dl, P=0.004). Anaemia prevalence was higher: 47.1% compared 29.7% among non-smokers (P=0.002). Use of tobacco during pregnancy doubled the likelihood of anaemia in the offspring OR: 1.9 (1.1-3.0).

Household poverty represented a risk factor of both anaemia OR: 1.9 (1.3-2.8) and stunting OR: 1.5(1.1-2.0).

IUGR 107 (3.6%)*	n %	B**	S.E.**	Sig.	OR (95% C.I.)**
Maternal Smoking in pregnancy §	28 (7.4%)	1.1	0.28	<0.001	3.0 (1.7-5.2)
Short stature (<1.52 m) ¶	20 (7.9%)	0.9	0.28	<0.001	2.6 (1.5-4.4)
Episodes of illness during pregnancy	51 (4.5%)	0.5	0.24	<0.001	1.7 (1.1-2.7)
Low weight gained in pregnancy ʕ	28 (8.0%)	1.02	0.27	<0.001	2.8 (1.6-4.7)
Stunting 348 (11.9%) ɒ	n %	B	S.E.	Sig.	OR (95% C.I.)**
Maternal Smoking in pregnancy §	64 (17.3%)	0.39	0.17	0.02	1.5 (1.1-2.1)
4 children or more	38 (18.3%)	0.45	0.22	0.04	1.6 (1.1-2.4)
Poverty ף	262 (12.8%)	0.38	0.16	0.02	1.5(1.1-2.0)
Low weight gained in pregnancy ʕ	63 (18.1%)	0.4	0.17	0.02	1.5(1.1-2.1)
IUGR ıı	42 (39.3%)	1.49	0.24	<0.001	4.4 (2.8-7.1)
Anaemia 237 (31.7%) Θ	n %	B	S.E.	Sig.	OR (95% C.I.)**
Maternal Smoking in pregnancy §	41 (47.6%)	0.62	0,25	0,01	1.9 (1.1-3.0)
Poverty ף	166 (37.6%)	0.65	0.19	<0.001	1.9 (1.3-2.8)

Table 3: Risk factors of low intrauterine growth retardation, stunting, and anaemia control by maternal variables and intrauterine growth; **B is the regression logistic coefficients. SE: Standard Error of B. All odds ratios were obtained from logistic regression models adjusted; Odds Ratios = labelled EXP (B), 95% Confidence Interval for EXP (B); ת Intrauterine growth retardation: born small (<2500 g) at term (> 37 week of gestation); § Mother answered she continued smoking during her pregnancy; ¶ First decile of maternal stature (≤1.52 cm); ɋ Prematurity <37 weeks gestational-age; ʕ First decile of weight gained during pregnancy ≤ 6 kg; ɒ Stunting Height-for-age Z-score <-2SD (WHO Child Growth Standards); Θ Anaemic Infant Haemoglobin <11.0 g/dl; Household income below the lowest income quintile of Uruguayan population.

Discussion

There are several weaknesses in our study. Data are from a cross-sectional survey so our study provides evidence for associations but cannot serve to establish causal relationships. We assessed smoking by questionnaire so misclassification might have occurred and the percentage of mothers who smoked may have been higher than what we documented. We only have children haemoglobin concentration values so we study anaemia prevalence but not Iron-deficiency. Despite limitations, our study has value due to its large sample size and the fact that it is a national representative sample.

Our study confirmed that despite Uruguay, has adopted anti-smoking measures and tobacco use is decreasing, smoking during pregnancy remains prevalent, particularly in younger and less educated women. Similar to other studies we identified 12% of women who continued smoking: 20% among the less educated and dropping to only 1% among the most educated women [1,2,7].

We did not observe lower weight gain during pregnancy as reported by others [22], but women who smoked were 6 kg lighter despite no difference in height. In our study we observed three times minus obesity prevalence among smoker women (5.3% compared to14.7% in non-smoker women).

In agreement with previous studies newborns infants were 200 grams lighter and almost 1 cm shorter in length [3]. Smoking during pregnancy was close associated with foetal growth, tripling IUGR risk [2,4].

Our results also highlight the association between smoking exposure in utero with stunting and anaemia particularly in infants living in a poverty context [11,13]. Anaemia continues being the most common nutritional disorder in Uruguay affecting approximately 28% to 34% of infant from 6 to 23 months [20]. Smoking exposure in utero infants duplicated the chance of anaemia as well as stunting. Anaemia is associated with diminished mental, motor, and behavioural disturbances and stunting also affects cognitive, education and work capacity [23]. Nicotine augments this effect because it impacts on brain development compromising even further psico-social development [2,6,24-25]. Nicotine is the major psychoactive chemical identified and due to its low molecular weight and high lipid solubility, nicotine rapidly peruses through the human placenta resulting in 15% higher nicotine concentration in the foetal circulation than in the maternal circulation [34].

In light of the evidence we consider it is necessary to act before pregnancy and focus prevention and cessation programs targeting adolescence, a period of heightened susceptibility to nicotine addiction [26,27]. However, when it is not possible to stop smoking during pregnancy, we must consider the need to balance risks from not breastfeeding versus the risk of maternal smoking during breastfeeding [28]. Breastfeeding is the best feeding practice to ameliorate the impact of intrauterine tobacco exposure [12,16,29,30,31]. Smoking women constitute a group at risk of abandoning breastfeeding [32,33] so we should develop specific policies to promote, protect and support breastfeeding in women with a high rate of tobacco use [30].

Conclusion

Risk of foetal growth retardation, stunting and anaemia are significantly related to smoking during pregnancy. Consequently efforts to prevent smoking should be a cornerstone in promoting healthy child growth and development.

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