

# MATERNAL SMOKING AND SOCIO-DEMOGRAPHIC CHARACTERISTICS IN CORRELATION WITH LOW BIRTH WEIGHT: A TURIN (PIEDMONT) STUDY

## KAJENJE MATERE IN SOCIALNO-DEMOGRAFSKE ZNAČILNOSTI V POVEZAVI Z NIZKO PORODNO TEŽO: TORINSKA (PIEMONTE) ŠTUDIJA

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### ABSTRACT

#### Key words:

low birth weight,  
maternal smoking,  
newborn, pregnancy,  
risk factors

**Introduction.** 15 to 25% of women smoke during pregnancy. Scientific evidence suggests that exposure to smoking causes decreased birth weight. The aim of this study was to assess the correlation between smoking during pregnancy, maternal sociodemographic characteristics, and low birth weight.

**Methods.** Data were derived from 1572 questionnaires administered to each woman that gave birth at the Gynecology Teaching Hospital "S. Anna" in Turin (Italy) during the period from 2008 to 2010. Multiple logistic analysis was used to evaluate the association between socio-demographic characteristics and birth weight; the stepwise approach with a "backward elimination" procedure was followed, and the goodness of fit of the model was estimated using the Hosmer-Lemeshow test.

**Results.** The univariate analysis revealed that smoking cigarettes (17%), having a lower educational level (13%), and female sex of the infant (13%) seem to be risk factors, as they increase the risk of having a low birth weight child. Logistic regression analysis showed that gestational age and maternal smoking are the statistically associated variables.

**Conclusions.** The results confirmed that birth weight increases proportionally with the length of the gestational age and that maternal smoking and the child's sex (female) increase the risk of having a lower birth weight. Logistic regression demonstrated that the association between maternal smoking and low birth weight shows an increased risk for the whole population (OR=2.85), for male (OR=3.45) and for female newborns (OR=2.44).

### IZVLEČEK

#### Ključne besede:

nizka porodna teža,  
kajenje mater,  
novorojenček,  
nosečnost,  
dejavniki tveganja

**Uvod.** Med nosečnostjo kadi 15 % do 25 % žensk. Znanstveni dokazi kažejo, da izpostavljenost kajenju povzroča nižjo porodno težo. Cilj te študije je oceniti povezavo med kajenjem med nosečnostjo, socialno-demografskimi značilnostmi matere in nizko porodno težo.

**Metode.** Podatki so bili pridobljeni iz 1572 vprašalnikov, ki so jih izpolnile vse ženske, ki so v obdobju od leta 2008 do leta 2010 rodile v učni bolnišnici za ginekologijo »S. Anna« v Torinu (Italija). Za oceno povezave med socialno-demografskimi značilnostmi in porodno težo je bila uporabljena multipla logistična analiza; sledil je postopni pristop z »vzratnim izločanjem« in ocena ustreznosti modela s pomočjo Hosmer-Lemeshowega testa.

**Rezultati.** Univariatna analiza je razkrila, da kajenje cigaret (17 %), nižja stopnja izobrazbe (13 %) in ženski spol dojenčka (13 %) predstavljajo dejavnik tveganja, saj povečujejo tveganje, da bo imel otrok nizko porodno težo. Analiza z logistično regresijo je pokazala, da sta gestacijska starost in kajenje matere statistično povezani spremenljivki.

**Zaključki.** Rezultati potrjujejo, da se porodna teža povečuje sorazmerno z gestacijsko starostjo ter da kajenje matere in spol otroka (ženski) povečujeta tveganje za nižjo porodno težo ob rojstvu. Logistična regresija dokazuje, da povezava med kajenjem matere in nizko porodno težo pomeni povečano tveganje za celotno populacijo (RO = 2,85), tako za novorojenčke moškega (RO = 3,45) kot tudi ženskega spola (RO = 2,44).

## 1 INTRODUCTION

Despite current knowledge about the negative effects of smoking during pregnancy, it has been estimated that 15 to 25% of women worldwide smoke during pregnancy, and although a minority stop smoking for part of their pregnancy, most of them start again after delivery (1, 2).

In 1957, Simpson first recognized that maternal smoking causes lower birth weight (LBW) (3). This term identifies newborns weighing 2500 g or less at birth, independent of their gestational age. More specifically, these newborns can be classified as “very low birth weight - VLBW” (1000-1499 g) and “extremely low birth weight - ELBW” (500-999 g). This condition is related to an increase in perinatal morbidity and mortality: in fact, LBW is the second greatest cause of perinatal death after premature birth (4).

Several current scientific studies showed that smoking and secondhand smoke exposure cause a decreased birth weight (5-7).

Many of the constituents of tobacco smoke are able to pass through the feto-placental barrier. The most harmful components that affect fetal development are nicotine and carbon monoxide (CO), which reduce placental perfusion. CO binds fetal hemoglobin (HbF), thereby forming carboxyhemoglobin (HbCO), which has a reduced affinity for oxygen and inhibits the release of oxygen into fetal tissues (8).

Nicotine causes vasoconstriction of uterine arteries with a reduction of blood flow.

As a result, the reduced area of placental exchange results in chronic hypoxia and fetal ischemia, these causing the low birth weight (9, 10).

A very recent study revealed a high level of cotinine and cadmium in the cord blood in newborns exposed to smoke (11); these tobacco metabolites have a negative correlation with birth weight as a result of their toxic effects, confirming the easy permeability to the fetal compartment.

Scientific literature has shown that maternal cigarette smoking is associated with a dose dependent reduction in birth weight of 175-200 g (12).

According to the CDC, maternal smoking during pregnancy appears to be strongly correlated to young age, unmarried status, and low socio-demographic condition (13). Approximately 13% of women reported smoking during the last 3 months of pregnancy, but the prevalence is more than 20% in women with less than 12 years of education (14).

Newborns of women who smoke during pregnancy are estimated to have twice the risk of low birth weight compared with those of non-smokers (15).

Kramer estimated a birth weight decrement of 5% per pack of cigarettes smoked per day during pregnancy (16).

In addition, age and race seem to modify the effects of tobacco smoke exposure (15).

A large prospective study confirmed the increased risks of low birth weight (LBW) and small for gestational age (SGA) due to heavier maternal smoking (>10 cigarettes/day), especially for newborns of older mothers (≥30 years);

high environmental tobacco smoke exposure (≥7 hours/day in non-smokers) was also moderately associated with low birth weight (adjusted OR = 1.8, 95% CI = 0.82-4.1) (15).

A recent review and meta-analysis of the effects of secondhand smoke on birth outcomes reported associations of exposure with reduced birth weight (by 37-40 g) and 20% increased risk of LBW (<2500 g) (17).

The aim of this study is to assess the relationship between low birth weight of newborns in Italy in relation to maternal socio-demographic factors, including smoking habits.

## 2 METHODS

A cross-sectional study was carried out according to the STROBE checklist (18, 19).

A questionnaire was administrated to each woman who gave birth at the Gynecology Teaching Hospital “S. Anna” in Turin (Italy) during the period from 2008 to 2010.

Data were gathered from 2008 to 2010.

Information regarding socio-demographic characteristics were collected (shown in Table 1): nationality (Italian/not Italian), educational level (high school or graduated/lower educational level), working status (employed/not employed), mother's age at time of birth (in years), height of the mother (in centimeters), lifestyle habits such as maternal smoking (yes/no) and alcohol consumption (yes/no) and also some information about the newborns (sex, gestational age in weeks, presence/absence of malformation, weight of previous birth in grams).

**Table 1.** Description of the sample.

*Preglednica 1. Opis vzorca.*

Variables/Spremenljivke		Frequency/ Pogostost	%
Work/ Zaposlitev	yes/da	1098	69.8
	no/ne	474	30.2
Educational level/ Stopnja izobrazbe	high (high school or graduated)/ visoka (srednja šola ali fakulteta)	695	44.2
	low/nizka	877	55.8
Nationality/ Državljanstvo	Italian/italijansko	1229	78.4
	other/drugo	343	21.6
Maternal Smoking/ Kajenje matere	yes/da	136	8.7
	no/ne	1436	91.3
Alcohol/ Alkohol	yes/da	468	29.8
	no/ne	1104	70.2
Children gender/ Spol otroka	M/M	781	49.7
	F/Ž	791	50.3

Mother age (median) (= 31.5 years (range 17-46); SD = 5.08 /  
Starost matere (mediana) (= 31.5 let (razpon 17-46); SD/SO = 5.08

Celoten vzorec = 1572

Percentages and frequencies were used to describe the qualitative variables, while mean and standard deviation (SD) were used to describe the quantitative ones.

Previously, a univariate analysis was carried out using the Chi-square test for qualitative variables to investigate the association between the dependent and independent variables (low birth weight vs. socio-demographic); a t-student test and Mann-Whitney test were used to compare the quantitative ones. To check the normality of the sample, a Kolmogorov-Smirnov goodness of fit test was used; a t-student test was used for normal distributions, otherwise a Mann-Whitney test was applied.

Multiple logistic regression analysis was conducted to assess the influence on the outcome (having a low birth weight Yes/No). Only covariates, including potential confounders, with values of  $p < 0.25$  based on the univariate analysis were selected according to the procedure described by Hosmer and Lemeshow.

The stepwise approach with a “backward elimination” procedure was followed. The goodness of fit of the model was estimated using the Hosmer-Lemeshow test. Results were presented as odds ratios (OR) and 95% confidence intervals (95% CI). If an individual questionnaire had missing values, it was excluded from the univariate analysis.

The level of statistical significance was set at  $p < 0.05$ .

All statistical analyses were performed by using the Statistical Package for the Social Sciences, Version 19 for Windows (SPSS Inc, Chicago, IL, USA).

3 RESULTS

The sample population consisted of 1572 women (Table 1) aged between 17 and 46 years old (median age: 31.5 years, SD = 5.08).

Of the 1572 interviewed women, 78% were Italians, 70% were employed, and 44% had a high educational level (high school or graduated); 136 of the 1572 women were smokers (9%), and 468 of them admitted to having consumed alcohol (30%). 781 of the newborns born were males (50%) and 791 females (50%).

The univariate analysis (Table 2) revealed significant differences. Smoking cigarettes (17%) and having a lower educational level (13%) increase the risk of having a low birth weight child; female sex of the infant (13%) also seems to be a risk factor.

Table 2. Univariate analysis.  
*Preglednica 2. Univariatna analiza.*

Variables/ <i>Spremenljivke</i>		Low birthweight/ <i>Nizka porodna teža</i>		
		No (N %)/ <i>Ne (N %)</i>	Yes (N %)/ <i>Da (N %)</i>	P/ <i>P</i>
Work/ <i>Zaposlitev</i>	no/ <i>ne</i>	413 (87.1)	61 (12.9)	0.246 <sup>^</sup>
	yes/ <i>da</i>	979 (89.2)	119 (10.8)	
Educational level/ <i>Stopnja izobrazbe</i>	low/ <i>nizka</i>	762 (86.9)	115 (13.1)	0.020 <sup>^</sup>
	high (high school or graduated)/ <i>visoka (srednja šola ali fakulteta)</i>	630 (90.6)	65 (9.4)	
Nationality/ <i>Državljanstvo</i>	other/ <i>drugo</i>	307 (89.5)	36 (10.5)	0.530 <sup>^</sup>
	Italian/ <i>italijansko</i>	1085 (88.3)	144 (11.7)	
Maternal Smoking/ <i>Kajenje matere</i>	no/ <i>ne</i>	1066 (89.2)	129 (10.8)	0.034 <sup>^</sup>
	yes/ <i>da</i>	113 (83.1)	23 (16.9)	
Alcohol/ <i>Alkohol</i>	no/ <i>ne</i>	716 (88.6)	92 (11.4)	0.965 <sup>^</sup>
	yes/ <i>da</i>	413 (88.2)	55 (11.8)	
Children gender/ <i>Spol otroka</i>	M/ <i>M</i>	705 (90.3)	76 (9.7)	0.033 <sup>^</sup>
	F/ <i>Ž</i>	687 (86.9)	104 (13.1)	
Mean (SD)/ <i>Povprečna vrednost (standardni odklon)</i>				
Mother age (years)/ <i>Starost matere (v letih)</i>		32.97 (5.080)		0.437 <sup>*</sup>
Gestational age (weeks)/ <i>Gestacijska starost (v tednih)</i>		38.9 (18.10)		<0.001

<sup>^</sup> p-value of  $\chi^2$ /vrednost  $p$  pri  $\chi^2$   
<sup>\*</sup> t-student test/*Studentov t-test*

Using multiple logistic regression models (Table 3), the relationship between the same socio-demographic variables and the outcome (low birth weight) was examined.

Three logistic regression models were performed: one concerning the whole sample and two more analyses that stratified the sample by sex (male and female newborns).

The first logistic regression analysis (Hosmer-Lemeshow test = 0.10) concerning the whole sample showed that gestational age operates as a protective factor [OR = 0.85 (CI 95% = 0.83-0.87)], since for every additional week of gestational age the risk of having a low birth weight child decreases; maternal smoking nearly triples the risk [OR = 2.85 (CI 95% = 1.41-5.76)], and female newborns appear to be more prone to having a low birth weight [OR = 2.04 (CI 95% = 1.21-3.43)].

The second analysis included only female newborns; the results of the analysis pointed out that gestational age

[OR = 0.86 (CI 95% = 0.83-0.88)] seems to influence the birth weight, acting as a protective factor; in addition, maternal smoking more than doubles the risk [OR = 2.44 (CI 95% = 1.00-5.98)]. The Hosmer-Lemeshow test of the model was 0.44.

Finally, the third logistic regression analysis regarding only male newborns (Hosmer-Lemeshow test = 0.05) indicated that gestational age is a protective factor [OR = 0.83 (CI 95% = 0.79-0.86)] and maternal smoking [OR = 3.45 (CI 95% = 1.11-10.75)] is a risk factor (more than triples the risk).

**Table 3.** Logistic regression model for low birth weight (< 2.500 grams/> 2.500 grams).

**Preglednica 3.** Model logistične regresije za nizko porodno težo (< 2.500 gramov/> 2.500 gramov).

	Total/Skupaj		Female/Ženske		Male/Moški	
	Birthweight (gr)/ Porodna teža (g)		Birthweight (gr)/ Porodna teža (g)		Birthweight (gr)/ Porodna teža (g)	
<b>Covariates/Kovariate</b>	<b>OR/RO</b>	<b>95% CI/IZ</b>	<b>OR/RO</b>	<b>95% CI/IZ</b>	<b>OR/RO</b>	<b>95% CI/IZ</b>
Residence in Turin/ Prebivališče v Torinu	0.77	0.46-1.30	0.69	0.36-1.34	0.92	0.39-2.15
Working status/Delovni status	0.85	0.46-1.55	0.75	0.37-1.50	0.95	0.34-2.63
Educational level/Stopnja izobrazbe	0.84	0.49-1.44	0.82	0.41-1.62	0.90	0.36-2.23
Italian nationality/ Italijansko državljanstvo	1.24	0.63-2.44	0.88	0.35-2.19	2.30	0.73-7.26
Gestational age (weeks)/ Gestacijska starost (v tednih)	0.85	<b>0.83-0.87</b>	0.86	<b>0.83-0.88</b>	0.83	<b>0.79-0.86</b>
Maternal Smoking/Kajenje matere	2.85	<b>1.41-5.76</b>	2.44	<b>1.00-5.98</b>	3.45	<b>1.11-10.75</b>
Mother age (years)/ Starost matere (v letih)	0.98	0.93-1.03	1.02	0.95-1.10	0.93	0.86-1.01
Sex F/Spol Ž	2.04	<b>1.21-3.43</b>	--	---	--	---
Hosmer-Lemeshow test/ Hosmer-Lemeshowov test	0.10		0.44		0.05	

#### 4 DISCUSSION

The present study highlights the relationship between low birth weight of newborns in the city of Turin related to maternal socio-demographic factors, including smoking habits during pregnancy.

The harmful effect of tobacco smoke exposure in children during and after pregnancy is one of the most important topics in public health policies (5, 14, 20-23).

A case-control study performed by Spinillo et al. demonstrated that several factors (such as male fetus, nulliparity, maternal age of 20 years or less, a history of first trimester hemorrhage and low pre-pregnancy weight) can affect the risk of fetal growth retardation associated with maternal smoking (21).

Lazzaroni et al. carried out a prospective study, investigating the effect of passive smoking during pregnancy on a set of perinatal parameters: it showed a mean reduction of 16 g in birth weight and a decrease in birth length of 0.05 cm

for each hour of antenatal passive smoke exposure but no or slight effects were reported for the other perinatal parameters considered (22).

A recent case-control study presented by Fantuzzi et al. assessed the relationship between preterm/early preterm delivery and active smoking as well as environmental tobacco smoke (ETS) exposure in a sample of pregnant Italian women: a dose-response relationship was found for the number of cigarettes smoked daily (23).

For the present study, a logistic regression was performed that showed consistent outcomes.

As a matter of fact, the regression confirmed, as we expected, the evidence from scientific literature (4, 16) about the relationship between gestational age and birth weight: newborns' weight increases proportionally with the length of the gestational age. Furthermore, infant sex plays a role in the reduction of birth weight: female newborns have an increased risk for low birth weight; maternal smoking also influences the outcome.

The variables “gestational age”, “maternal smoking”, and “child’s sex” have statistically significant values.

The association between maternal smoking and low birth weight displays an increased risk (OR=2.85) with a statistically significant Confidence Interval (CI=1.41-5.76) in the analysis regarding the whole population.

In addition, male newborns whose mothers smoked during pregnancy have a three and a half times greater risk of low birth weight (OR=3.45; CI=1.11-10.75); this was also true for female newborns (OR=2.44; CI=1.00-5.98).

These findings should be considered in light of the following limitations. It was not possible to assess the amount of underreporting of cigarette smoking or ETS exposure and cotinine levels in pregnant women, which would have facilitated an assessment of exposure and provided insight into possible misclassifications.

Moreover, no information about environmental exposure to ETS is given. This factor could affect the intensity of exposure.

In addition, the length of exposure remains unknown, since the cumulative effect could be age dependent, with older women affected differently than younger women.

Finally, even though our sample population consisted of more than 1500 women, it was limited to the city of Turin, and this sample could not fully represent the Italian situation.

## 5 CONCLUSION

Our study highlights the fact that the socio-demographic characteristics of women have a great influence on the fetus and, in particular, on birth weight.

Women’s behavior changes considerably during and after pregnancy, and promoting a healthy lifestyle during this particular period of life for women and their cohabitants should represent one of the main goals of Public Health strategies. In recent years, much attention has been paid to the effect of tobacco smoking during pregnancy and ETS exposure on pregnancy outcomes, and it appears that policies are needed to limit the harmful effect of the principal preventable risk factors.

## COMPETING INTERESTS

None declared.

## FOUNDING

None.

## ETHICAL APPROVAL

Not required.

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