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ORIGINAL RESEARCH

Adverse effects of maternal age, weight and smoking during pregnancy in Pleven, Bulgaria

Mariela Stefanova Kamburova[1], Petkana Angelova Hristova[1], Stela Ludmilova Georgieva[1], Azhar Khan[1]

[1] Department of Public Health Sciences, Faculty of Public Health, Medical University, Pleven, Bulgaria.

Corresponding author: Dr. Mariela Kamburova, Medical University, Pleven;
Address: 1, St. Kliment Ohridski, Str, Pleven, 5800, Bulgaria
Telephone: +359887636599; Email: mariela_kamburova@yahoo.com

Abstract

Aim: This paper aims to study the relationship between mothers' age, body mass index (BMI), gestational weight gain (GWG) and smoking and the risk for premature birth in Pleven, Bulgaria.

Methods: A case-control study was conducted in Pleven in 2007. The study was comprehensive for all premature children (N=58) and representative for full-term infants (N=192, or 10.4% of all of the 1827 full-term children) born in 2007 at the University Hospital of Pleven and resident in the city of Pleven. Retrospective data on determinants under study were collected from all the mothers included in this study (N=250).

Results: Mothers of premature children were more likely to be above 35 years old (27.6%), with a BMI ≥25 kg/m² (23.1%), GWG below the recommended value (38.5%) and to smoke during pregnancy (37.9%). The odds of being a smoker during pregnancy were five times higher among mothers with low birth weight (LBW) newborns compared with their counterparts with normal birth weight newborns (OR=5.1, 95%CI=2.4-10.6). There was a positive association between BMI and LBW in infants whose mothers were overweight (OR=2.1, 95%CI=1.0-4.0). The risk of LBW increased when GWG was less than recommended (OR=1.8, 95%CI=1.0-3.1).

Conclusion: Our results indicate that pre-pregnancy BMI ≥25 kg/m², less than recommended GWG and smoking during pregnancy are risk factors for premature birth in Pleven region. Findings from this study suggest the need for active health and educational actions by health professionals in order to avoid premature births in Bulgaria.

Keywords: Bulgaria, lifestyle, Pleven, premature birth, risk factors.

Conflicts of interest: None.

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Introduction

Premature birth (PB) is a major public health problem worldwide (1). Furthermore, PB is rated as one of the most important single causes of the global burden of diseases in neonatal period (2). It is associated with increased infant mortality, short and long-term negative effects on health and additional costly care needs (3).

The interest of researchers in personal characteristics and lifestyle factors of the mothers is due to the fact that they are modifiable and they affect the incidence of premature birth. The challenge is to accurately measure the impact of these factors because of their complexity (4).

Several studies have shown young maternal age as a significant risk factor for premature birth (5,6). It has not been established with certainty yet, whether this risk is associated primarily with the biological immaturity of young mothers, or an increased incidence of certain risk factors associated with socioeconomic status such as age-appropriate educational level, parity, smoking status, prenatal care utilization and poverty status (7,8). Women over the age of 35 years are also at increased risk of pre-term birth. Astolfi and Zonta (2002) found a 64% increase in the probability of giving premature birth for women over 35 years after controlling for educational status, birth order, and sex of the newborns (9).

Low or high pre-pregnancy body mass index (BMI) and inadequate or excess gestational weight gain (GWG) are linked to an increased risk of adverse neonatal outcomes (10,11). The weight of a woman before the pregnancy is related to her diet, quantity and quality of food (4). Studies have shown that low weight of women before pregnancy is associated with an increased risk of preterm birth (12). Campbell et al. (2012) found a link between low pre-pregnancy BMI and the birth of a premature baby, with a relative risk of >2.5 (6). A study conducted in 2010 in Bulgaria on the role of some risk factors for preterm birth failed to establish a statistically significant difference in the weight of women bearing preterm children and those with to term births (13).

Smoking is defined as one of the most common and preventable causes of adverse outcomes of pregnancy (14,15). Many chemicals in maternal smoking pass from the pregnant woman to the fetus through the placenta (16). Smoking is associated with placental abruption and inadequate weight gain during pregnancy, but this relationship with the birth of a premature baby is not conclusive and is not proven in all studies. The probable reason for this is that the impact of smoking depends on its duration and intensity, and decreases in women who stop smoking at the beginning of pregnancy (17). Some studies have found a strong causal association between smoking and PB of a child (18). A large number of studies have found a moderate influence of smoking in relation to PB of a baby (14,16,17).

Bulgaria is a country that is characterized by one of the highest indicators of age-specific fertility rate (above 40 per 1000) in Europe in the age-group 15-20 years, which is a risk factor for giving birth to a premature baby (19). According to Manolova (2004), 42.3% of women in Bulgaria smoked during pregnancy (20). However, prematurity as a public health issue has not been subject to scientific inquiry in Bulgaria in the past two decades. Yet, there are a small number of scientific publications in terms of risk factors for PB in Bulgarian children (21).

In this context, there is a need to determine the lifestyle characteristics of mothers as important factors for PB in Bulgaria. This paper aims at studying the relationship between mothers' age, BMI, GWG and smoking during pregnancy and the risk for PB in the city of Pleven, Bulgaria. We hypothesized a positive association between PB and younger or older age and smoking habits of the mothers. Furthermore, we assumed a positive link between low BMI and low weight gain during pregnancy and PB.

Methods

Study design

A case-control study was carried out in 2007 in the city of Pleven, Bulgaria. Pleven is a typical township, located in Central North Bulgaria. At the beginning of the study (in 2007) the size of the population of the city was 139,573 people. In the same year, the birth rate was 8.96‰. Maternal care was carried out only by the University Hospital. There were 2004 children born at the University Hospital, of whom, 1981 were live births. The proportion of preterm infants among all live births was 7.7%.

Study population

The anticipated sample size for inclusion in this study consisted of 250 newborns. The study was comprehensive for all premature children (N=58) and representative for full-term infants (192, or 10.4% of all 1827 full-term children) born in 2007 at the University Hospital of Pleven and resident in the city of Pleven.

Cases: 58 premature infants weighing 2500 g or less at birth. Their gestational age was 37 weeks or less, and they resided in Pleven.

Controls: 192 term infants who were matched to premature infants by date of birth. They were selected randomly among preterm children born on the same date. They weighed more than 2500 g. Their gestational age was more than 37 weeks and they also resided in Pleven.

Data collection

Document analysis: The information on birth weight, gestational age and home addresses of newborns was derived from medical records in a neonatal clinic at the University Hospital-Pleven.

Interview: The information for mother's age, weight of women before the pregnancy, weight gain during pregnancy and smoking habits was gathered retrospectively by interviewing mothers during home visits. Such information was not available in the records of mothers in the obstetrics ward, and not all women retained documents from antenatal visits.

Special questionnaires were designed for the purpose of the study. They were part of a larger study on risk factors for premature birth in the region of Pleven, Bulgaria. The questionnaire used for the documents' analysis contained 39 questions, four of which were related to demographic and socio-economic status of the mother. The questionnaire for the interview comprised 92 questions, nine of which were about the lifestyle factors of the mother. For the validation of the questionnaires, a pilot study was conducted. Before and after the pilot study questionnaires were discussed and approved by experts, pediatricians, obstetricians and public health professionals.

All included mothers answered the questionnaire in the process of an interview. All data in this study were based on women's reports during the survey interviews.

Ethical considerations

The study was conducted under the supervision of the Chair of the IRB (Institutional Review Board). The right of privacy of the studied subjects was guaranteed. Only the leading investigator had access to the identifying information. Mothers expressed their free will for participation and signed an informed consent before the interview.

Outcomes

We studied two outcomes: preterm birth (PB<37 weeks completed gestation and birth weight <2500 g) and low birth weight (LBW: birth weight <2500 g).

Determinants

Age of the mothers was determined as: ≤24 years, 25-29 years, 30-34 years and ≥35 years.

Pre-pregnancy BMI was categorized according to the World Health Organization (WHO) as either being underweight (BMI<18.5kg/m²), normal weight (18.5≤ BMI≤ 24.9), overweight (25≤BMI≤29.9), or obese (BMI≥30).

We utilized the 2009 Institute of Medicine guidelines on GWG to categorize women's weight gain for their BMI as below, within, or above the recommended value (22).

Smoking during pregnancy was determined based on the question *"Did you smoke during pregnancy?"*. Women who responded *"yes"* or *"rarely"* were categorized as "regular smokers" and "occasional smokers".

Statistical analysis

The survey data was processed with the statistical software packages SPSS (Statistical Package for Social Sciences), version 11.5, STATGRAPHICS and EXCEL for Windows.

The results were described using tables. Percentages were used to report the observed distribution of age of the mothers, BMI, GWG, smoking during pregnancy and other maternal characteristics.

Parametric tests for hypotheses testing at normal and near to normal distribution of cases: T-test, ANOVA with post hoc tests (LSD, Tukey, Scheffe, Bonferroni, Newman-Keuls, Duncan) and nonparametric tests in other than normal distribution of cases Pearson χ^2-test, Mann-Whitney, Kruskal-Wallis H-test were applied. Regression models for modeling and predicting of correlations and multiple logistic regression analyses controlled for covariates estimated the odds ratios with 95% confidence intervals of PB and LBW were used.

Using multivariable linear regression we assessed the relationships of studied determinants with outcomes (PB, LBW). Odds ratios (OR) were calculated to determine the effect of the age, weight and smoking during pregnancy, as factors for preterm birth.

In all cases, a value of P≤0.05 was considered as statistically significant.

Results

Table 1 presents the distribution of basic characteristics of the participants by PB status. The distribution of maternal characteristics varied across mothers with PB and term birth.

Overall, 17.2% of women were above 35 years old. The share of older mothers was two times higher among those with PB compared to women with term-birth. Overall, 23.3% of women were underweight and 12.5% were either overweight or obese. The proportion of overweight was more than two times higher among mothers with PB (19.2%) compared to mothers with term-birth (9.6%). Around half (48.8%) of women gained above than the recommended weight for their BMI and a quarter (24.6%) gained less than the recommended weight. About 39% of women with PB compared to 21% of mothers with term-birth gained less than the recommended weight. Smoking was reported by 38% of women: 16% of them were regular smokers and 22% occasional smokers. The proportion of mothers with PB who smoked (38%) was about four times higher compared to smoking women with term-birth (10%).

Compared to mothers with term-born infants, mothers of premature children were more likely to be above 35 years (27.6%), have a BMI≥25 (23,1%), have a GWG below the recommended value (38.5%), smoke during pregnancy (37.9%) and deliver PB children after the third delivery (17.2%). Significant differences among mothers with PB were identified for maternal age, pre-pregnancy BMI, GWG, maternal smoking during pregnancy and birth order. Conversely, there was no significant difference between groups with regard to their income level.

Table 1. Distribution of maternal characteristics

Characteristics	All women (N=250)	Mothers with premature birth (N=58)	Mothers with term birth (N=192)	P
Maternal age				
≤24 years	25.8	10.4	30.5	0.001
25-29 years	27.4	37.9	24.2	0.049
30-34 years	29.1	24.1	30.5	NS
≥35 years	17.2	27.6	14.8	0.047
Pre-pregnancy BMI				
<18.5 kg/m^2	23.3	15.4	25.5	NS
18.5-24.9 kg/m^2	64.2	61.5	64.9	NS
25.0-29.9 kg/m^2	11.7	19.2	9.6	NS
≥30 kg/m^2	0.8	3.9	-	-
Gestational weight gain				
<recommended	24.6	38.5	20.7	0.010
= recommended	26.7	26.9	26.6	NS
> recommended	48.8	34.6	52.7	0.020
Smoking during pregnancy				
Regularly	16.1	37.9	9.5	0.001
Occasionally	21.8	10.3	25.3	0.002
No	62.1	51.8	65.2	NS
Per capita income				
Lowest (0-125 Euro)	36.0	41.4	34.4	NS
Middle (126-250 Euro)	46.4	41.4	47.9	NS
Highest (>250 Euro)	17.6	17.2	17.7	NS
Birth order				
1	52.4	41.4	55.8	0.050
2-3	41.2	41.4	41.1	NS
≥4	6.4	17.2	3.1	0.005

Table 2. Maternal characteristics correlated with normal birth-weight and low birth-weight (g)

Characteristics	Linear regression						Logistic regression	
	All (n=250)		Low birth weight (N=58)		Normal birth weight (N=192)		Low birth weight	P
	Mean±SE	P	Mean±SE	P	Mean±SE	P	OR (95%CI)	
Maternal age								
25-29	3120±85	-	2297±45	-	3491±46	-	Reference	-
≤24	3219±69	NS	2256±47	NS	3318±62	NS	0.22 (0.08-0.58)	0.001
30-34	3168±71	NS	2361±43	NS	3318±53	NS	0.50 (0.23-0.99)	0.048
≥35	2790±127	0.007	1876±88	0.001	3312±71	0.005	1.19 (0.54-2,65)	0.600
Pre-pregnancy BMI								
18.5-24.9	3185±59	-	2149±90	-	3427±41	-	Reference	-
<18.5	3124±72	NS	2163±72	NS	3284±56	NS	0.64 (0.27-1.48)	0.280
25.0-29.9	2844±101	0.040	2296±45	NS	3148±96	0.001	2.12 (1.02-4.03)	0.049
≥30*	2400±0	0.010	2400±0	NS	-	-	-	-
Gestational weight gain								
= recommended	3158±84	-	2300±44	-	3347±64	-	Reference	-
<recommended	2955±74	0.020	2307±40	NS	3287±61	NS	1.83 (1.04-3.08)	0.048
> recommended	3191±66	NS	1971±146	0.002	3402±46	NS	0.65 (0.30-1.41)	0.270
Smoking during pregnancy								
No	3192±60	-	2065±92	-	3437±40	-	Reference	-
Regularly	2666±72	0.001	2328±29	0.030	3080±86	0.001	5.05 (2.41-10.58)	0.001
Occasionally	3162±66	NS	2333±58	NS	3265±58	0.001	0.52 (0.20–1.32)	0.160

* Only two children weighing 2400 g were born from mothers with BMI≥30.

Table 2 shows that maternal age at delivery, GWG and smoking during pregnancy were significantly associated with LBW.

Mothers who smoked regularly had a significant fivefold increase in LBW risk compared with nonsmoking mothers (OR=5.05, 95%CI=2.41-10.58, P=0.001). The association between BMI and LBW was evident among infants whose mothers' were overweight (OR=2.12, 95%CI=1.02=4.03, P=0.049). We did not assess obesity as a risk factor for LBW, because there were no mothers of children with normal birth weight who had a BMI≥30. The risk of LBW increased when GWG was less than the recommended value (OR=1.83, 95%CI=1.04-3.08, P=0.048).

Age of the mothers upon delivery less than 24 years (OR=0.22, 95%CI=0.08- 0.58, P=0.001) and between 30-34 years (OR=0.50, 95%CI=0.23-0.99, P=0.048) was found as a protective factor for LBW.

Table 3 shows the results of fitting a multiple linear regression model to describe the relationship between prematurity and three independent variables: pre-pregnancy BMI, GWG and maternal age. The model explains 93% of the variability in PB.

The equation of the fitted model was as follows:

PB = 87.6117*BMI + 41.0981*GWG + 9.6293*Maternal age

Table 3. Multiple regression analysis: Pre-pregnancy BMI, GWG and maternal age correlated with premature birth

Dependent variable: premature birth					
Parameter	**Estimate**	**Standard Error**	**T Statistic**		**P**
Pre-pregnancy BMI	87.6117	12.4486	7.03787		0.001
Gestational weight gain	41.0981	7.13523	5.75988		0.001
Maternal age	19.6293	8.4454	2.32426		0.021
Analysis of Variance					
Source	**Sum of Squares**	**Df**	**Mean Square**	**F-Ratio**	**P-Value**
Model	2.30485E9	3	7.68283E8	1059.53	0.001
Residual	1.70403E8	235	725119.0		
Total	*2.47525E9*	*238*			

R-squared = 93.1157 %; R-squared (adjusted for d.f.) = 93.0571 %; Standard Error of Est. = 851.539; Mean absolute error = 646.141; Durbin-Watson statistic = 1.04712.

Discussion

This study provides useful evidence about PB and LBW in the region of Pleven, Bulgaria. Our results indicate that pre-pregnancy BMI, GWG related with personal BMI and smoking during pregnancy are important characteristics for PB in this population.

The age of the mother is essential for normal pregnancy and delivery with a favorable outcome. From a biological point of view, the best age for childbirth is 20-29 years (8). The average age of women in our study was 26.3±5.8 years which was non-significantly lower than the average age for childbirth established in Bulgaria (27.9 years of age) (23) and also lower than that established by Yankova and Dimitrov (2010) who stated an average age of 28 years at birth (24). The results for more than a twofold increased risk of premature birth to mothers aged under 20 years were reported by Branum and Schoendorf in 2005 (25). The association between the risk of a preterm labor and mother's age is reported to be inverse (21,26), but we did not establish this. We found the age of the mothers at delivery less than 34 years as a protective factor for LBW.

We did not find a significant difference between the mean weight of mothers of premature (55 kg) and to term infants (54 kg) before pregnancy. We found a more than two times higher risk for LBW among mothers with pre-pregnancy BMI 25.0-29.9 kg/m², but there was no effect found of pre-pregnancy BMI<18.5 kg/m². The results of our study are compatible with the findings of a recent meta-analysis on the existence of a weak association or lack of association between low BMI before pregnancy and the birth of a premature baby (27).

According to our results, the probability of giving birth to a premature baby in women who have had GWG less than recommended is around two times higher compared with mothers with recommended GWG. The insufficient weight gain during pregnancy increases the risk of having a premature baby, especially amongst women with low BMI before pregnancy: RR=1.5-2.5 (27). Our results are similar to those of Schieve LA et al. (2000), who found out a three times higher risk of giving birth to a premature baby in women with a normal BMI, but not enough weight gain during pregnancy compared with women of normal weight and with adequate weight gain during pregnancy (28).

Our results concerning smoking during pregnancy (around 40% of all mothers) are close to a previous study from Bulgaria conducted by Manolova (2004), which reported that about 42% of all women smoked during the whole pregnancy (20). Yet, the proportion of smoking mothers in our study was higher than a previous study conducted in Bulgaria in 2007, which reported a prevalence of 33% (23).

Smoking is regarded as one of the most common and preventable causes of poor pregnancy outcomes (17). There is variability in the reported results for the relationship between smoking and PB, but a large number of studies establish an RR=1.2-1.5 when daily consumption of cigarettes is 10-20, and an RR=1.5-2.0 when more than 20 cigarettes are smoked per day. The same results were obtained by Andriani and Kuo for smoking mothers who lived in urban areas (17). Our survey revealed a greater than fivefold increase in the risk of LBW among mothers who smoked during pregnancy, a finding which is in line with previous reports about the influence of smoking on the PB risk (14,17).

Study limitations

This study may have several limitations. Firstly, reports of the characteristics of mothers were retrospective after the child was born. Additionally, self-reported data on BMI, GWG and smoking are highly correlated with PB and LBW, but they tend to underestimate these measures. Women who smoked were categorized into three groups based on qualitative variables, and not according to the number of cigarettes smoked per day. The dissemination of information on adverse outcomes of smoking may have discouraged some mothers from disclosing it.

Secondly, because the place of study was an urban area we did not find enough mothers less than 19 years old. The result was that we did not establish the association between young maternal age and PB.

Thirdly, we utilized the Institute of Medicine guidelines to categorize women's weight gain as below, within, or above recommended value (22), which maybe is not appropriate for Bulgaria, but there are no other recommendations to be used.

Finally, we excluded from the analysis some women with either missing information on the principal determinants of interest (age, BMI, GWG, smoking), or missing information on gestational age and birth weight (needed for outcome variables), but the number of missing values was small.

Obviously, there is a need for prospective studies from the registration of the pregnancy, in Pleven and in other regions of Bulgaria, in which such data should be collected in a standardized manner and the number of mothers and their children should be higher.

Conclusion

Our results confirm our research hypothesis that pre-pregnancy BMI>25 kg/m², less than recommended GWG related with their personal BMI and smoking during pregnancy are risk factors for PB. Age of the mothers at delivery <34 years was a protective factor for LBW.
This analysis was part of a study on the risk factors for PB and their impact on development and health status of children <3 years in Bulgaria. Our findings highlight the public health importance of promoting a healthy lifestyle of mothers in order to reduce the level of PB in Bulgaria.

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