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Risk factors for small-for-gestational-age neonates: A retrospective study in Northern Greece

Panagiota Kripouri, Nerisa Tona, Apostolos Mamopoulos, Themistoklis Dagklis, Ioannis Tsakiridis

Third Department of Obstetrics and Gynaecology, School of Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece

Correspondence
Ioannis Tsakiridis, Konstantinoupoleos 49, 54642, Thessaloniki Tel: +30 2313312120 and Fax: +30 2310 992950
e-mail: iotsakir@gmail.com

Abstract

Introduction: Small-for-gestational-age (SGA) neonates are defined as those born below the 10th percentile for their gestational age. SGA neonates are a major concern in obstetrics due to their association with adverse neonatal outcomes. The objective of this study was to investigate the risk factors for SGA neonates.

Material and methods: This retrospective case-control study was conducted from September 2024 to January 2025 at the Third Obstetrics and Gynecology Clinic of the Medical School of Aristotle University of Thessaloniki, Greece. The study included women with low-risk pregnancies and women who gave birth to SGA neonates. Medical records were retrieved and underwent statistical analysis.

Results: A total of 46 women participated in the study. Of these, 23 had uncomplicated pregnancies and appropriate-for-gestational-age (AGA) neonates, while the remaining 23 gave birth to SGA neonates. SGA neonates underwent induction of labor more often than the AGA ones (0,036), while smoking was identified as an independent risk factor for SGA neonates (OR: 8.430, 95% CI: 1,902 – 37,357, p=0.005). Of note, maternal age, parity, body mass index and aspirin use during pregnancy were not significantly associated with SGA.

Conclusion: Our study highlighted the association between smoking and SGA neonates. The recommendation for smoking cessation has been shown to be crucial in reducing the incidence of SGA neonates.

Keywords: SGA, risk factors, neonates, smoking, BMI, aspirin, labor induction

Introduction

The incidence of small for gestational age (SGA) neonates has remained a significant concern in recent decades, with an increasing recognition of its association with adverse neonatal outcomes. SGA refers to neonates with birthweight below the 10th percentile for their gestational age and it is common, especially in low- and middle – income countries. [1] Risk factors include maternal health conditions such as hypertension, diabetes, and smoking, as well as placental insufficiency and pregnancy complications such as premature membrane rupture. [2]

In 2020, 23.4 million livebirths were small-for-gestational-age (SGA), representing approximately 16.3% of global livebirths. [3] The global prevalence of SGA is influenced by several factors, including maternal age, socioeconomic status, prenatal care and access to healthcare services. In addition, maternal undernutrition or overnutrition, chronic diseases, and substance use are also known to significantly increase the risk of having an SGA neonate. [4, 5]

SGA neonates face an increased risk of perinatal mortality, neonatal morbidity, long-term developmental delays, and cognitive impairments. These infants are more likely to experience complications such as respiratory distress syndrome (RDS), hypoglycemia, and infections. Additionally, SGA infants often face difficulties in adapting to extrauterine life, with a higher incidence of admission to neonatal intensive care unit (NICU) compared to appropriate for gestational age (AGA) neonates. [6, 7]

Because of the serious risks associated with SGA pregnancies, early detection through routine screening and appropriate surveillance is essential to improve outcomes. Yet, despite advances in prenatal care, SGA neonates continue to require a high level of neonatal support and long-term follow-up to address potential developmental concerns.

The aim of this study was to investigate the risk factors for SGA neonates in an Academic obstetric department of a tertiary hospital.

Material and methods

This was a retrospective case-control study conducted from September 2024 to January 2025 at the Third Department of Obstetrics and Gynecology, School of Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Greece. The study included low risk pregnancies and uncomplicated deliveries of AGA and SGA neonates.

All medical files were reviewed and digitized data were retrieved. The criteria for selecting the cases were that the patients had undergone ultrasound scans in the 1st and 2nd trimesters to reduce the likelihood of genetic syndromes. Additionally, there had to be documentation regarding the use or non-use of aspirin and smoking habits, as well as the calculation of the mother's booking body mass index (BMI), along with the number of previous deliveries.

Regarding the selection criteria for the analysis on the fetal/neonatal side, only fetuses that, based on birthweight and using the ASTRAIA computer software (NEXUS/ASTRAIA GmbH, Munich, Germany), were between the 3rd and 10th percentile for birthweight at delivery were included. Newborns below the 3rd percentile for birthweight at delivery, i.e., those with severe fetal growth restriction, were not included in the study. Furthermore, deliveries for which there was incomplete documentation of the mother's history and characteristics were excluded. Pregnancies that were expected to result in SGA neonates based on the third trimester ultrasound, but this was not confirmed at delivery, were also excluded. Additionally, pregnancies that were either unmonitored or partially monitored were excluded, as well as moderately or extremely preterm newborns.

All women consented to participate in the study,

Table 1. The demographic and obstetric characteristics of the sample population

	AGA	SGA	P VALUE
Maternal age	31,6 (5,3)	30,7 (6,5)	0,586
BMI	27,8 (6,6)	27,9 (7,1)	0,945
Parity	2 (1)	2 (1)	0,897
Smoking	4 (17,3%)	13 (56,5%)	0,01
Aspirin	5 (21,7%)	6 (26%)	0,730
Cesarean Section	9 (39,1%)	11 (47,8%)	0,552
Induction of labor	6 (26%)	13 (56,5)	0,036
NICU	0	0	0,999

willingly and the data were directly anonymized during statistical analysis, after first retrieval. Under no circumstances were any incentives provided to any of the participants. In accordance with standard protocols (https://www.hra.nhs.uk/approvals-amendments/what-approvals-do-i-need/) for observational studies that do not involve interventions or modifications to routine patient care the study was exempt from institutional board review. [8]

Categorical variables are expressed as n(%) and continuous variables as mean (SD). Continuous variables such as maternal age and BMI were treated as numeric variables and were expressed as means with standard deviations. Categorical variables such as the smoking habit, the use of aspirin and mode of delivery were coded as binary variables. Univariate analyses of qualitative variables were conducted using the chi-square or Fisher's exact test; univariate analyses for continuous variables were conducted using the independent samples t-test. A multivariate logistic regression model (Enter method) was employed to identify factors independently associated with SGA. Estimated associations were reported as odds ratios (OR) with 95% confidence intervals (CIs). Statistical significance was set at 0.05 and all analyses were carried out using the Statistical Package SPSS v. 28.0.

Results

In total, 46 women were found eligible to participate. 23 pregnancies were normal and uneventful, with AGA neonates, while the remaining 23 women gave birth to SGA neonates (Table 1).

Following multivariate logistic regression analysis, by using SGA outcome as a dependent categorical variable, smoking was identified as an independent risk factor for small for gestational age neonates (OR: 8,430; 95% CI: 0,902- 37,357; p=0,005). Advancing maternal age (OR: 0,958; 95% CI: 0,848 – 1,083; p=0,494), parity (OR: 1,241; 95% CI: 0,635 – 3,427; p=0,528), advancing BMI (OR: 1,027; 95% CI: 0,929 – 1,135; p=0,607) and aspirin use (OR: 2,032; 95% CI: 0,428 – 9,648; p= 0,372) were not associated with SGA (Table 2).

Discussion

The main findings of this study were: i) smoking is associated with SGA neonates and ii) pregnancies complicated by SGA are more likely to undergo induction of labor.

Our findings support previous literature on the impact of smoking during pregnancy, highlighting it as a significant risk factor for SGA neonates. [9] Smoking was found to be associated with an increased likelihood of delivering an SGA infant, consistent with the well-established body of research demonstrating the detrimental effects of tobacco use on fetal growth. [10, 11, 12] Smoking is known to restrict blood flow to the placenta, leading to lower oxygen and nutrient

Table 2. Multivariate logistic regression analysis

	P value	OR	95% CI
Maternal age	0,494	0,958	0,848 – 1,083
Parity	0,528	1,241	0,635 – 2,427
BMI	0,607	1,027	0,929 – 1,135
Smoking	0,005	8,430	1,902 – 37,357
Aspirin use	0,372	2,032	0,428 – 9,648

supply to the fetus, which impairs its growth and development. [13] The observed association in our study adds further weight to the growing consensus that smoking cessation is a critical intervention for reducing the incidence of SGA births.

Additionally, we found that SGA neonates were more likely to experience induction of labor, a result that aligns with clinical practice where healthcare providers often opt for induction, since it is frequently recommended for cases where fetal well-being is compromised as it can reduce the risks of stillbirth or perinatal complications. However, this association is more of a clinical response to the presence of SGA rather than a direct risk factor contributing to fetal growth restriction.[14]

This study did not find a significant link between maternal body mass index (BMI), maternal age, or aspirin use and the occurrence of SGA in the specific sample. This result contrasts with previous research suggesting that maternal obesity is associated with a decreased risk of having an SGA neonate and low maternal BMIs is associated with the risk of delivering a SGA neonate. [15, 16] However, it is important to note that the relationship between BMI and fetal growth is complex and may be influenced by factors such as the severity of maternal obesity or the presence of comorbidities like gestational diabetes. Our lack of significant findings on BMI may reflect the relatively homogenous nature of the sample in terms of weight and statistical errors due to the small sample. As for the advancing maternal age and parity, this study does not associate these factors with SGA neonate, however this contradicts previous results and is subjected to the limitations of this study. [17]

Similarly, while aspirin use is often linked to improved pregnancy outcomes in high-risk pregnancies, particularly in cases at high-risk for preeclampsia, our study did not find a statistically significant association with SGA. [18, 19]

This study has limitations due to its retrospective design, the small sample size, the inclusion of participants from a single center in Greece and its restricted geographic scope, which may affect the broader applicability of the results.

Conclusion

This study underscores the significant impact of smoking on the risk of SGA and the likelihood of induction of labor in these pregnancies. However, the lack of significant associations with maternal BMI, maternal age, and aspirin use suggests that other, more complex factors may be at play in determining fetal growth. Future studies with larger sample sizes and more comprehensive data on maternal health, lifestyle, and prenatal care are needed to further elucidate the multifactorial nature of SGA and its associated risk factors. Moreover, interventions targeting smoking cessation during pregnancy remain essential for reducing the incidence of SGA neonates and improving overall maternal and fetal health outcomes.

Conflicts of interest

The authors declare no conflicts of interest.

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