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Evaluation of Preeclampsia Risk in Gestational Weight Gain

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Abstract

Background: The incidence of obesity worldwide has increased over the last 20 years. The increase in obesity in maternal pregnancy is causing a major challenge to obstetrics practices. The aimed study was to evaluate gestational weight gain as a risk for preeclampsia in pregnant women. Methods: This cross-sectional study was conducted on 2756 pregnant women with gestational age≥37 weeks. The selection of women was categorized into two groups, 1528 normal-weight women with BMI less than 25kg/m2 and 1228 pregnant women with a BMI of 25kg/m2 or more. SPSS software version 26.0 was used to analyze data. Multivariate logistic regression described the relation of weight change to pregnancy course and outcomes. Results: A comparison between study groups shows an increase in antepartum complications in obese women. Besides that, arterial hypertension, pre-eclampsia, and gestational diabetes were more frequent in overweight women compared to normal-weight women. The incidence of cesarean was highest in

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overweight and obese women with a statistically significant difference from normal weight women (p-value <0.005). In addition, maternal overweight and obese were at twice the risk for delivering infants with macrosomia (OR = 3.1, 95%CI = [1.09-5.8]). The difference in mean birth weight of the babies between normal and overweight women was statistically significant (p<0.05). Conclusion: The results of this study show that obesity during pregnancy is associated with pregnancy complications. To optimize all complications for the mother and fetus, weight gain during the pregnancy must be controlled and appropriate. Furthermore, studies are recommended to explore maternal obesity complications and risk factors for obesity to minimize the adverse effect of this risk.

Keywords: Maternal obesity, perinatal outcome, complications

Introduction

The incidence of obesity worldwide has increased over the last 20 years (WHO, 2022). In a report in 2020, the WHO indicates that approximately 1 billion people worldwide present with obesity at various stages, regardless of age, gender, and ethnicity (WHO, 2020). Maternal obesity has also increased significantly over the past decade, in line with the general uptrend of obesity (Abraham & Romani, 2022). The increase in obesity in maternal pregnancy is causing a major challenge to obstetric practices. It has reached a point at which 50% of women of childbearing age are either overweight (BMI 25-29.9) or obese (BMI >30) (Abraham & Romani, 2022). There is a similar increasing burden of obesity in developing countries as a consequence of over-nutrition, a sedentary lifestyle, and maternal-fetal factors (Misra & Khurana, 2008).

Maternal overweight and obesity cause pregnancy complications such as gestational diabetes, hypertension, and preeclampsia and affect fetal growth (Tenenbaum-Gavish & Hod, 2013). The development of hypertension and proteinuria after 20 weeks of gestation is defined as Preeclampsia (Hutcheon et al., 2011), which affects up to 8% of all pregnancies worldwide (Shao et al., 2017). Various studies have highlighted that maternal obesity increases the risk of pre-eclampsia by three-four times, compared with normal-weight mothers (Abraham & Romani, 2022; Bodnar et al., 2005, Mbah et al., 2010; Bodnar et al., 2007). According to the WHO systematic review and analysis, between 2003 and 2009, hypertensive disorders during pregnancy were the second direct cause of maternal death worldwide, accounting for 14% of maternal deaths (Say et al., 2014). The mortality rate among babies born to mothers with preeclampsia is five times higher than that among babies born to healthy mothers (Roberts et al., 2003; Das et al., 2015). Kuciene & Dulskiene (2022), highlight that pre-eclampsia contributed to fetal and neonatal

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morbidity and mortality (Kuciene R & Dulskiene, 2022; Williams et al., 2018). Additionally, preeclampsia is the leading cause of prematurity and fetal growth restriction (Redman et at., 2003; Park et al., 2018) and is also the second leading cause of pregnancy-related intensive care unit admissions after obstetric hemorrhage (Porrero et al., 2010) Preeclampsia is also associated with an elevated risk of cardiovascular disease later in life (Irgens et al., 2001; Haugen et al., 2014). The aim of this study was to verify the association between preeclampsia during pregnancy, and maternal and neonatal outcomes in normal, overweight, and obese women in Kosovo.

Methods

Sample

In this cross-sectional study included data from 2756 pregnant mothers at Ferizaj Maternity and Child Care Hospital, living in Ferizaj city, Kosovo, all between January 2014 and October 2019. Eligible criteria for all participants of this study stipulated being pregnant and presenting to the hospital for delivery at a gestational age ≥ 20 weeks, and being 18-45 years old. Excluded from the study were all pregnant women less than 18 years old, and those with pre-existing chronic hypertension before pregnancy. All pregnant women under the inclusion criteria were invited to participate. Some refused or were unable to complete the interview and a total of 2756 eligible women were identified and participated. Participants in this survey were informed through verbal communication during their first admission to the hospital. In this survey, no personal data were recorded, and all questionnaires were completed anonymously. Additionally, participants were informed that participation in the study was voluntary and that they could withdraw from the study at any moment. All study procedures were approved by the Human Investigation Committees at the Ferizaj Hospital. All methods were applied in accordance with relevant guidelines and regulations.

Data collection

A standardized and structured questionnaire was used to collect information on demographic factors, occupational history, medical and reproductive history, smoking and alcohol consumption, physical activity, and diet. Information on pregnancy complications and maternal and neonatal birth outcomes was taken from medical records in the hospital. Mothers' information on sociodemographic characteristics (age at delivery, residential areas, education level, employment or occupation, monthly income). Medical and reproductive history, family history of hypertension, parity, gestational hypertension, heart diseases, diabetes mellitus, and pre/early pregnancy body weight information was obtained from medical records. Women were divided

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into groups by age at delivery (less than 25 years, 25–35 years, and over 35 years old).

All blood pressure and anthropometric measurements were performed on pregnant women by the same team of trained staff (physicians and nurses). Preeclampsia was defined as hypertension (two separate blood pressure readings ≥ 140/90 mmHg taken at least 6 h apart) and proteinuria (≥ 1+ on dipstick test in two urine samples or ≥ 300 mg of protein in a 24 h urine sample) after 20 weeks of gestation. Preeclampsia was further subcategorized as early-onset preeclampsia and late-onset. Preeclampsia was defined as raised blood pressure (≥ 140/90 mmHg and < 18.5 kg/ m^2), normal weight (18.5 kg/m^2 ≤ BMI < 24.9 kg/m^2), and overweight (BMI≥25-29.9 kg/m^2), obese class I (BMI≥30-34.9 kg/m^2), obese class II (BMI≥35-39.9 kg/m^2) and obese class III (BMI≥40 kg/m^2) developing after 20 weeks of gestation with no signs of proteinuria and without evidence of end-organ damage in a previously normotensive woman. Gestational weight gain (GWG) in kg was calculated by subtracting pre-pregnancy weight from maternal weight at delivery. The average of three BP measurements was calculated. BP measurements were performed with the subject being in a sitting position after the subjects had been sitting still for 10 min. According to body weight status, pregnant women in this study were separated into 2 groups: those with and without obesity. Maternal obesity was defined as a BMI≥25 kg/m^2.

Neonatal data (sex, birth date, gestational age, birth weight and length, and Apgar scores at 5 min) were extracted from medical records. Three groups were used to categorize the newborns based on birthweight percentiles by gestational age and sex: small for gestational age <2500g, normal birth weight was defined as a birth weight between≥2500g and≤4000g, while high birth weight was defined as birth weight>4000 g.

Statistical analysis

Statistical maternal and neonatal data analysis was performed using the statistical software package SPSS version 26.0 for Windows. The categorical variables were presented in numbers (n) and percentages (%), while means and standard deviations (SD) were presented for the normally distributed continuous variables. The chi-square ($\chi 2$) test was used to compare variables, and the t-test was used to compare the mean values of normally distributed variables. Univariate and multivariate logistic regression analyses were conducted to evaluate the associations of maternal gestational weight with high blood pressure (HBP), and overweight/obesity in offspring during pregnancy. Crude odds ratios (OR) and adjusted odds ratios, and their 95% confidence intervals (CI) were calculated. Confounding factors including maternal age, employment during pregnancy, monthly income, maternal education level, parity, and family history of hypertension were adjusted for

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in the unconditional logistic regression models. P values of less than 0.05 were regarded as statistically significant.

Results

The participants (2756) with gestational age≥37 weeks were categorized into two groups, 1528 normal-weight women with BMI less than 25kg/m2 and 1228 pregnant women with BMI over 25kg/m2. Figure 1 shows gestational weight gain during pregnancy across the different BMI categories. Of 1228 in the obese women group, 50.4% were overweight, 32.3% were obese class I, and 17.3% were obese class II.

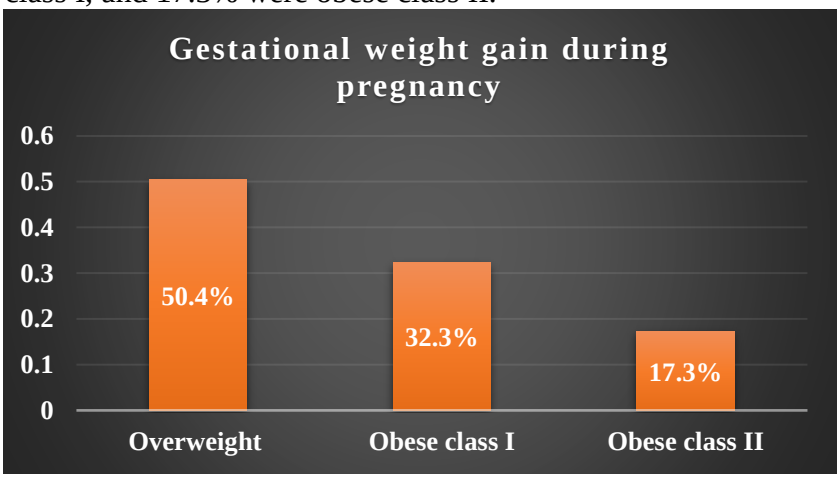

Figure 1. Gestational weight gain during pregnancy

Table 1 shows the socio-demographic characteristics of two groups of pregnant women normal weight (control group) and obese. The mean age of all 2756 pregnant women was 27.9 ± 3.2 years, while the mean age in normal-weight women was 25.2± 2.27, and in obese women 30.6 ± 4.3. Women classified as the obese group was significantly older than the normal-weight group (p= 0.01).

Pregnant obese women appeared to have a predominance of living in rural areas compared to the control group (normal-weight pregnant women) with a significant association between them (p =0.02). Regarding the education level, women with secondary education are predominant compared to those with primary or higher education for both study groups. No significant association between the education level and the two study groups (obese pregnant women and the control group) was found (p >0.05).

The pregnant women were asked about their employment status and the monthly income of their families. Pregnant women with normal weight present a higher percentage of employment than obese women, and their incomes are higher. There was a significant association between the two

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groups and employment status and also monthly income (p<0.05). Pregnant multiparous women were predominant compared to pregnant primiparous women (p=0.04).

The mean weight gain during pregnancy was 9.2 ± 3.7 kg. It was seen that being underweight resulted in 3.4% in the control group and 2.5% in obese pregnant women, normal weight resulted in 65.8% of the control group and 13.6% in obese pregnant women, overweight resulted in 16.8% in the control group and 40.9% in obese pregnant women, obese class I resulted in 9% in the control group and 30.9% in obese pregnant women, while in obese class I &II resulted in 4.9% in the control group and 12.1% in the obese group. There is a significant association between the obesity category and both study groups. Family history of cardiovascular disease was seen in 26.4% of the control group and 38.1% in the obese group. Furthermore, the family history of hypertension was 39.8% in the control group and 43.7% in the obese group. There was a significant association (p<0.05) between smoking and physical activity during pregnancy.

Table 1. Socio-demographic characteristics of the study sample

Variables	Normal weight women (1528)		Obese women (1228)		P value
Age (mean±StD)	25.2± 2.27		30.6 ± 4.3		P=0.01
Age group < 25 years old	570	37.3%	287	23.4%	
25–35 years old	833	54. 5%	792	64.5%	
> 35 years old	125	8.2%	149	12.1%	
Residence					0.02
Rural	724	47.4	651	53%	
Urban	804	52.6%	577	47%	
Education					0.5
Primary level	156	10.2%	219	17.8%	
High school	845	55.3%	638	52%	
University	527	34.5%	371	30.2%	
Employment					0.001
No	691	45.2%	730	59.4%	
Yes	837	54.8%	498	40.6%	
Monthly income					0.025
Low Income	409	26.8%	317	25.8%	
Moderate	622	40.7%	581	47.3%	
High Income	497	32.5%	330	26.9%	
Parity					0.04
Primiparous	590	38.6%	500	40.7%	
Multiparous	938	61.4%	728	59.3%	
BMI (mean ± StD)	24.2 ± 3.3		34.4 ± 4.8		< 0.001
underweight (BMI: ≤18.4kg/ m2)	52	3.4%	31	2.5%	
normal weight (BMI: 18.5–24.9kg/m2)	1006	65.9%	167	13.6%	
overweight (BMI: 25.0–29.9kg/m2)	257	16.8%	503	40.9%	
obese class I (BMI: 30.0– 34.9kg/m2)	138	9.0%	379	30.9%	
obese class II–III (BMI: ≥35.0kg/m2)	75	4.9%	148	12.1%	

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Family history of cardiovascular disease					0.03
No	1124	73.6%	760	61.9%	
Yes	404	26.4%	468	38.1%	
Family history of hypertension					0.01
No	920	60.2%	691	56.3%	
Yes	608	39.8%	537	43.7%	
Smoking					
No	1370	89.6%	1082	88.1%	
Yes	158	10.4%	146	11.9%	
Physical activity during pregnancy					0.01
No	534	34.9%	399	32.5%	
Yes	994	65.1	829	67.5%	

Table 2 shows the maternal outcomes and details of labor and delivery. The hyperglycemic disorders appeared as Diabetes Mellitus Tip 1&2 in 2.2% of women in the control group and 8.4% in the obese group, while gestational diabetes in 5.3% in the control group and 27.6% in the obese group. Gestational hypertension was diagnosed in 11.9% of the control group and 34.6% in the obese group. There was a significant association between both groups and hyperglycemic disorders, with a p-value of <0.0001. Preeclampsia appeared in 15.7 % of the control group and 47% of women in the obese group. Early and late onset of preeclampsia among pregnant women was also evaluated. Early onset preeclampsia for both groups (control versus obese group) was diagnosed in 6.2%, and 19.4% respectively, while late-onset preeclampsia was diagnosed in 10% versus 30.13 % of women respectively. A significant p-value <0.05 was found between obese and control women and the presence of preeclampsia (early and late onset). Another maternal outcome was the induction of labor. In the control group induction of labor took place in 24% of the women and in 41% of the obese group. Moreover, bleeding during labor was evaluated in 5.4% of the control group and 11.6% in the obese group. Gestation week delivery means among women resulted in 39.6 ±1.4 in the control group and 37.4 ±1.9 with a significant association between them with p-value < 0.001.

Table 2. Maternal outcomes: Details of labor and delivery

Variables	Normal weight women (1528)		Obese women (1228)		P value
	N	%	N	%	
Hyperglycemic disorders					<0.0001
Diabetes Mellitus Tip 1&2	34	2.2%	103	8.4%	
Gestational Diabetes	81	5.3%	339	27.6%	
Gestational hypertension	182	11.9%	423	34.4%	0.003
Preeclampsia	240	15.7%	577	47%	<0.001
Early-onset preeclampsia	94	6.2%	238	19.4%	0.002

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Late-onset preeclampsia	153	10%	370	30.13 %	0.001
Induction of labor	367	24%	503	41%	0.28
Bleeding during labor	82	5.4%	142	11.6%	0.8
Gestation (weeks) (mean)	39.6 ±1.4		37.4 ±1.9		< 0.001
Caesarian section	229	15%	786	64%	0.005
Epidural analgesia	520	34.03%	729	59.36 %	0.044
Shoulder dystocia	109	7.13%	71	5.8	0.6
Length of stay <7 days	481	31.5%	847	69%	0.054
Length of stay >7 days	89	5.8%	159	12.9%	0.03

Caesarian section, epidural analgesia, and shoulder dystocia in the obese group were found in 64%, 59.36%, and 5.8% respectively, while in the control group were found in 15%, 34.03%, and 7.13% respectively, with a significant $p<0.05$. Last but not least was the length of stay in the hospital less or more than 7 days. More than 69% of obese women stay in hospital for less than 7 days while 12.9% stay more than 7 days, with a p-value =0.03.

Table 3 shows the neonatal outcomes. Preterm delivery ≤ 37 weeks appeared in 5.7% of the control group (normal-weight pregnant women) and 10.5% of the obese group, with a p-value =0.009. Meconium-stained amniotic fluid was more predominant in neonatal delivery from maternal obesity in 12.4% than from mothers with normal weight in 4.3%(p=0.048). Apgar's score ≤7 at 5 min does not present significant differences between the two groups. In the control group, only 9.8% of obese women presented an Apgar's score ≤7 at 5 min, while in the control group only 7.1%.

Neonatal with a low birth weight of less than 2500kg resulted in 5% in the control group and 8.1% in maternal obesity. There was no significant association between them, with a p-value =0.4. Additionally, a difference in macrosomia ≥4000kg was 45.6% in obese women and 12.4% in the control group, and macrosomia ≥4500kg with a significant association p-value < 0.05. Moreover, a predominance was seen for the admission of the baby to the neonatal intensive care unit. Approximately 17.5% of babies delivered from maternal obesity were admitted to intensive unit care and only 8.2% from mothers with normal weight. Only a few cases resulted in stillbirth among the control group and the obese group.

Table 3. Neonatal outcomes

Variables	Normal weight women (1528)		Obese women (1228)		P value
	N	%	N	%	
Preterm delivery ≤ 37 weeks	87	5.7%	129	10.5%	0.009
Meconium-stained amniotic fluid	66	4.3%	152	12.4%	0.048
Apgar score ≤7 at 5 min	108	7.1%	120	9.8%	0.02
Low birth weight<2500kg	76	5.0%	99	8.1%	0.4
Macrosomia ≥4000kg	189	12.4%	560	45.6%	0.001

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Macrosomia ≥4500kg	50	3.3%	242	19.7%	<0.001
Admission of the baby to the neonatal intensive care unit	125	8.2%	215	17.5%	0.007
Stillbirth	3	0.2%	17	1.4%	0.4

Table 4 shows the pregnancy and neonatal outcomes related to maternal obesity. The pregnancy and neonatal outcomes were several times riskier in maternal obesity than in normal-weight pregnant women.

Table 4. Pregnancy and neonatal outcomes related to the maternal obesity

Variables	Normal weight		Obese	
	Odds ratio (95 CI)	P value	Odds ratio (95 CI)	P value
Gestational Diabetes	1.5 [0.78-2.4]	0.03	12 [5.8-19.1]	<0.0001
Gestational hypertension	4.2 [2.0-7.5]	0.001	18 [11.4-24.3]	<0.0001
Preeclampsia	3.9 [2.0-7.5]	0.03	21 [9.2-35.4]	0.0005
Caesarian section	1.8 [0.9-3.6]	0.04	5.2 [1.7-8.6]	0.008
Length stay >7 days	2.2 [0.8-5.0]	0.02	3.3 [1.2-6.4]	0.001
Preterm delivery ≤ 37 weeks	0.6 [0.02-1.5]	0.8	4 [1.7-6.9]	0.003
Apgar score ≤7 at 5 min	0.74 [0.1-2.4]	0.9	1.3[0.5-2.9]	0.048
Birth weight ≥4000kg	0.2 [0.01-1.2]	0.4	3.1 [1.09-5.8]	0.005
Birth weight ≥4500kg	1.9 [1.0-3.5]	0.02	6.7 [3.05-7.9]	<0.0001
Admission of the baby to the neonatal intensive care unit	1.9 [0.72-2.8]	0.03	9.5 [4.1-15.5]	<0.0001

Discussion

Obesity is considered an emerging problem globally and it may have a profoundly significant impact on pregnancy and its outcome (Jagan et al., 2020). The pre-pregnancy BMI and gestational weight gains may increase oxidative stress levels, stimulate a systemic inflammatory response, and accelerate damage to vascular endothelial cells, resulting in preeclampsia (Das et al., 2015). The risk of preeclampsia increases as maternal body mass index (BMI) increases. The link between increasing maternal BMI and preeclampsia with severe features is less well-established (Durst et al., 2016). In this study, the prevalence of obesity among 2756 pregnant women resulted in 44.56%. This high rate was almost the same as another study conducted in Jordan, in 2014 (44% BMI prevalence) (Badran et al., 2014), but lower than in a study conducted in the UK in 2009, 46% (24). Our findings present an association between obesity and risk for both gestational hypertension and pre-eclampsia (OR = 18 95% [11.4-24.3] and 21 p9.2-35.4] times respectively) compared to the control group.

Various studies have reported similar findings, as Khashan & Kenny (2020) and Doherty et al, (2006) namely an increased risk of both gestational hypertension and pre-eclampsia in the control group and the obese group (Khashan & Kenny, 2020; Doherty et al, 2006). Maternal age is a factor risk

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factor for pregnancy outcomes, such as gestational diabetes mellitus, preeclampsia, and premature delivery as shown in previous studies (Sun et al., 2022; Marozio et al., 2019; Wei et al., 2015; Vinturache et al., 2014). Despite that, Claramonte et al. (2019), in their study reported that maternal age was associated with a high risk of cesarean section, and gestational diabetes (Claramonte et al.,2019). In our study, a considerable number of obese mothers (12.1%) and normal weight (8.2%) were aged ≥35 years. The analysis data of the mothers' age revealed that obese women aged ≥35 years were more likely to give birth to infants with macrosomia, and were at risk of gestational hypertension and preeclampsia. Furthermore, these findings suggest that advanced female age is associated with adverse perinatal and neonatal outcomes with a P value of <0.05.

Aside from the maternal age, which we highlighted previously, there are other non-modifiable factors like body weight, maternal height, the number of births, socioeconomic status, physical activity, and ethnicity associated with maternal obesity (Shrestha et al., 2021; Syngelaki et al., 2019). Our findings show a significant association between obesity and some of the non-modifiable factors such as residence, socioeconomic level, parity, and the presence of obesity with a p-value <0.05.

Bracken and Langhe (2021) evaluated the maternal and perinatal outcomes in pregnancy with high BMI in Irish mothers. They found significant variations in maternal and perinatal outcomes such as the onset of labor, emergency cesarean section (CS), stillbirth, and fetal macrosomia between obese and non-obese mothers (Bracken and Langhe,2021). Furthermore, fetal macrosomia is a well-established adverse consequence of maternal obesity (Heslehurst et al., 2008). Obese mothers are more likely to undergo obstetric interventions such as induction of labor (IOL), operative vaginal delivery (OVD), and CS (35, 36). Moreover, Melchor et al. (2019) in a systematic review of the effects of maternal obesity on pregnancy outcomes found that obese women were 1.6 times more likely to be induced compared to normal-weight mothers (Melchor et al.,2019). The findings in this study, are similar to the previous study (Bracken and Langhe,2021; Heslehurst et al., 2008; Melchor et al.,2019; Ramonienė et al., 2017). An association was found between maternal obesity and cesarean section, macrosomia, and stillbirth.

Conclusion

In this study, obesity during pregnancy was associated with pregnancy complications. To avoid complications for the mother and fetus, weight gain during the pregnancy must be controlled and appropriate. Due to the increasing rate of maternal obesity worldwide, it is important that a national rate in a larger study be explored as to the maternal obesity complications and

risk factors that influence obesity to minimize the adverse negative effect of this risk.

Ethical Considerations

This study was approved by the Ferizaj Hospital Ethical Committee. Before the enrollment of all participants, the researcher explained the purpose of the study. During this study, we followed the guidelines of the Declaration of Helsinki of 1975, as revised in 2008. No personal data was identifiable. We warrant that all ethical guidelines for medical research "On the protection of personal data" were strictly respected.

Author contributions

All the authors have accepted responsibility for the entire content of this submitted manuscript and approved the submission.

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Competing interests

All the authors played a significant role in the study design, in the collection, analysis, and interpretation of data, in the writing of the report, and or in the decision to submit the report for publication.

Conflicts of interest

The authors have no potential conflicts of interest to report in connection with this article.

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