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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 BMI over 25kg/m2. 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 appears an increase in antepartum complications in obese weight women. Besides that, arterial hypertension, pre-eclampsia, and gestational diabetes were more frequent in obese weight women compared to normal-weight women obese women. The incidence of cesarean was highest in obese women statistically significant

difference from normal women with a p-value <0.005. In addition, maternal obese pregnancies were at twice the risk for delivery of infants who were macrosomia with higher odds (OR = 3.1, 95%CI = [1.09-5.8]). In perinatal outcomes, the difference in mean birth weight of the babies among normal and obese women was statistically significant (p<0.05). **Conclusion:** As we saw from the results of this study obesity during pregnancy was associated with pregnancy complications. To optimize all complications to maternal and fetus, weight gains during the pregnancy must be controlled and appropriate. Furthermore, studies are recommended to explore the maternal obesity complication and risk factors that influence obesity to minimize the adverse negative effect of this risk.

Keywords: Maternal obesity, perinatal outcome, complication

Introduction

The incidence of obesity worldwide has increased over the last 20 years (WHO, 2022). WHO in a report in 2020, 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 obstetrics 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). Moreover, in middle or high-income countries, one-third of women of reproductive age are overweight or obese (Ramonienė, et al., 2017). 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, et al., 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 (7), which has affected 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 (Saz, 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; Shao, et al., 2017). Kuciene & Dulskiene highlight that pre-eclampsia contributed to fetal and neonatal morbidity (Kuciene & Dulskiene, 2022) and mortality (William, et al., 2018). Additionally, Preeclampsia is the leading cause of prematurity and fetal growth restriction (Redman & Sargent, 2005; Park, et al., 2018) and is also the second leading cause of pregnancy-related intensive care unit admissions after obstetric hemorrhage (Porreco & Barkey, 2010). Despite that preeclampsia is associated with an elevated risk of cardiovascular disease later in life (Irgens, et al., 2001; Haugen, et al., 2014). The aimed study was to investigate the association between preeclampsia during pregnancy and to compare maternal and neonatal outcomes in normal and obese weight women.

Methods

Study population: In this cross-sectional study, we included data from 2756 pregnant at Ferizaj Maternity and Child Care Hospital, living in Ferizaj city, Kosovo, which were carried out from January 2014 to October 2019. Eligible criteria for all participants of this study were pregnant women who came to the hospital for delivery with gestational age ≥ 20 weeks, and who were 18 years or older until 45 years old. While excluding criteria were all pregnant women less than 18 years old, and those with pre-existing chronic hypertension before pregnancy. After the refusion or did not complete the interview by medical staff, a total of 2756 eligible women were identified and invited to participate. Participants in this survey were informed through verbal communication during the first the hospital. In this survey, no personal data were recorded, and all questionnaires were completed anonymously. Additionally, they were informed that participation in the study was voluntary and participants could withdraw 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.

Collected data: 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 were taken from medical records in the hospital. Mothers' information on sociodemographic characteristics (age at delivery, residential areas, education level, employment or occupation, monthly income, etc). To medical and reproductive history collected information for family history of hypertension, parity, gestational hypertension, heart diseases, diabetes mellitus, and pre/early pregnancy body weight status was obtained from medical records. Women were divided into

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

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) groups 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 we have grouped 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, Apgar scores at 5 min, etc) 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 GH with 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 in the

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

Data availability According to the Statute of the Ferizaj Hospital, the authors cannot share the data underlying this study.

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 obese women, 50.4% were overweight, 32.3% were obese class I, and 17.3% were obese class II.

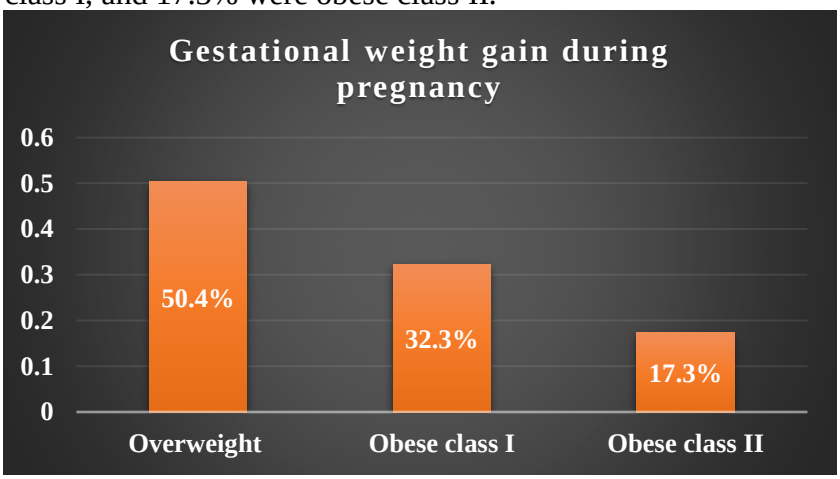

Figure 1. Gestational weight gain during pregnancy

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 normal-weight women, P= 0.01.

Pregnant obese women appeared to have a predominance in living in rural areas compared to the control group (normal weight pregnant women) with a significant association between them, a p-value of 0.02. Regarding the education level, women with secondary education are predominance compared to those with primary or higher education for both study groups. There is not found a significant association between the education level and the two study groups (obese pregnant women and the control group), p-value >0.05.

The pregnant women were asked related to their employment status and monthly income in their families. Pregnant women with normal weight present a higher percentage of employment than obese women, and their incomes are higher. There was found a significant association between the two groups and employment status and also monthly income with a p-value of <0.05. Pregnant women that referred to multiparous parity were in predominance with pregnant women in primiparous parity. There is found a significant association with a p-value of 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 found a significant association between the obesity category and both study groups. Family history of cardiovascular disease was seen in 26.4% in 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.

In all medical record data of pregnant women highlighted previously, there was found a significant association of p-value <0.05. Related to smoking and physical activity during pregnancy, there was found also a significant association, with a p-value of <0.05.

Table 1. Baseline socio-demographic characteristics of the study population

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	65.8%	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%	
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% 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% in the control group and 34.6% in the obese group. There was found a significant association between both groups and hyperglycemic disorders, with a p-value of <0.0001. Preeclampsia appeared 15.7in % of the control group and 47% of the obese group. We evaluated also the early and late onset of preeclampsia among pregnant women. 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 % respectively. A significant p-value <0.05 were 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 was 24% and in the obese group at 41%. Moreover, bleeding during labor was evaluated in 5.4% in the control group and 11.6% in the obese group. There was not found significant association p-value >0.05. Gestation week mean among women resulted in 39.6 ±1.4 in the control group and 37.4 ±1.9 with a significant association between them 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
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. There was found a significant association with a p-value <0.05. Last but not least was the length of stay in the hospital less than 7 days hours more than7 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 in maternal with normal weight in 4.3%. There was found a significant association with a p-value =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 not found a

significant association between them, with a p-value =0.4. Additionally, we saw a difference in macrosomia ≥4000kg 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
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. As we saw the pregnancy and neonatal outcomes were several times in risky 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 (Shao, et al., 2017). 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% (25). 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, so Jagan et al in 2020 (Jagan, et al., 2020) and Doherty et al, in 2006 (Doherty, et al., 2006) reported an increased risk of both gestational hypertension and pre-eclampsia in the control group and the obese group). Maternal age as a factor risk factor for pregnancy outcomes, such as gestational diabetes mellitus, preeclampsia, and premature delivery is shown in previous studies (Sun, et al., 2022; Wei, et al., 2015; Vinturache, et al, 2014). Despite that, Claramonte et al, 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 presentational body weight, maternal height, the number of births, socioeconomic status, physical activity, and ethnicity associated with maternal obesity (Shprestha et al., 2021; Syngelaki, et al.,, 2019). Our findings show a significant level between obesity and some of the non-modifiable factors such as residence, socioeconomic level, parity, physical activity, and the presence of obesity with a p-value <0.05.

Bracken and Langhe 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 were also demonstrated between obese and non-obese mothers (Bracken & Langhe, 2021). Furthermore, fetal macrosomia is a well-established adverse consequence of maternal obesity (Bracken & Langhe, 2021). Obese mothers

are more likely to undergo obstetric interventions such as induction of labor (IOL), operative vaginal delivery (OVD), and CS (Marchi, et al., 2015; Heslehurts, et al., 2008). 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 & Langhe, 2021; Marchi, et al., 2015; Heslehurts, et al., 2008; Melchor, et al., 2019). There was found an association between maternal obesity and cesarean section, macrosomia, and stillbirth.

Conclusion

As we saw from the results of this study obesity during pregnancy was associated with pregnancy complications. To optimize all complications to the maternal and fetus, weight gains 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 to explore the maternal obesity complication 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 contributors, 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 were recorded. 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; 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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