Al-Azhar International Medical Journal

Volume 4 | Issue 8 Article 24

2023

Section: Obstetrics and Gynecology

Obesity (Body Mass Index) and Its Effect on Pregnancy Outcome

Ibrahim Abd Elhamid Abo Sikin
Professor of Obstetrics and Gynecology, Faculty of Medicine, Al-Azhar University

Tamer Salah El Sayed
Lecturer of Obstetrics and Gynecology, Faculty of Medicine, Al-Azhar University

Abd Elrahman Abd Elkarem Abd Elrahman El Moselhy
Al-Azhar University 2017, Resident of Obstetrics and Gynecology, Al-Galaa Teaching Hospital,
kozzika7@gmail.com

How to Cite This Article

Sikin, Ibrahim Abd Elhamid Abo; Sayed, Tamer Salah El; and Moselhy, Abd Elrahman Abd Elkarem Abd Elrahman El (2023) "Obesity (Body Mass Index) and Its Effect on Pregnancy Outcome," *Al-Azhar International Medical Journal*: Vol. 4: Iss. 8, Article 24.
DOI: https://doi.org/10.58675/2682-339X.1933

ORIGINAL ARTICLE

Obesity (Body Mass Index) and Its Effect on Pregnancy Outcome

Ibrahim Abd Elhamid Abo Sikin [a], Tamer Salah El Sayed [a], Abd Elrahman Abd Elkarem Abd Elrahman El Moselhy [b,*]

[a] Obstetrics and Gynecology, Faculty of Medicine, Al-Azhar University, Egypt
[b] Al-Azhar University 2017, Obstetrics and Gynecology, Al-Galaa Teaching Hospital, Egypt

Abstract

Background: **There are too many difficulties associated with obesity, including general and obstetric complications, which is a widespread health issue.**

Aim of the work: **To evaluate the impact of obesity and its effect on pregnancy outcome.**

Methods: **375 primigravidas in labour were enrolled in this prospective observational study. Using the WHO BMI categorization, they were divided into 5 groups with 75 patients each (Groups A, B, C1, C2, C3). The movement of work (estimated as the time from 4 cm to 10 cm cervical dilatation, the comparing determined pace of cervical dilatation, and the term of head plunge) and the improvement of peri-partum entanglements (cervical dystocia, shoulder dystocia, the capture of head plummet, the following possible requirement for CS, third and fourth-degree perineal tears, first postpregnancy discharge, held placenta) were checked in the patients who were enlisted.**

Results: **There was no statistically significant difference in the delivery method or postpartum issues, but there was for obese women in the progression of labour and the result of the newborn (C1, C2, and C3).**

Conclusion: **Obese women in labour should be regarded as high-risk situations that necessitate particular precautions, whether on a short-term or long-term basis. Additional research is required to determine any long-term repercussions.**

Keywords: Body mass index (BMI), Labour, Neonatal, Obesity, Primigravida

1. Introduction

The global health problem of obesity is getting worse. The World Health Organization (WHO) classifies people as obese if they have an abnormal or excessive deposit of fat that could be harmful to their health and have a body mass index (BMI) of 30 (kg/m^2) or greater.[1]

In 2013, the American Medical Association classified obesity as a disease. The prevalence of obesity among women of reproductive age is currently estimated to be anywhere between 20 and 36% globally.[2] The prevalence of pregnant women rises at the same pace as that of females in the reproductive age range.[3,4]

The risks of miscarriage, early birth, macrosomia, shoulder dystocia, congenital abnormalities, stillbirth, and neonatal death are higher in babies born to overweight or obese mothers.[5]

There is evidence that the likelihood that the unborn child will live a healthy life is substantially harmed by maternal obesity and overweight during pregnancy.[6]

Even though the underlying mechanisms of the association between maternal obesity and unfavourable pregnancy outcomes are not yet entirely understood, metabolic abnormalities are thought to play a significant factor.[7]

It would be fascinating to assess the financial impact that pregnancy-related obesity and overweight might have on the healthcare system given the substantial public health implications. Using population-attributable fractions, it is possible to quantify the effects of obesity and overweight on

Accepted 7 February 2023.
Available online 30 November 2023

* Corresponding author. Fax: +01068864882.
E-mail address: kozzika7@gmail.com (A.E.A.E. Abd Elrahman El Moselhy).

https://doi.org/10.58675/2682-339X.1933

unfavourable pregnancy outcomes at the population level (PAF). PAF provides an estimate of the percentage of outcomes that might theoretically be prevented if exposure to a particular risk factor, such as obesity, smoking, or alcohol use, were eliminated or decreased to its theoretical minimum. In a variety of foreign obstetric populations, the proportion of unfavourable pregnancy outcomes attributed to pregnant obesity and overweight was calculated.[8]

2. Patients and methods

This randomized controlled study was carried out at the Department of Obstetrics & gynecology at Al-Galaa Teaching Hospital & at Bab ALsharia University Hospital, starting from April 2021 till April 2022, including 375 patients. Randomization into 5 groups was made on the basis of maternal BMI. Women in groups A and B will have normal BMIs of [18.9–24.9], group B will have overweight BMIs of [25–29.9], group C will have obese BMIs of [30–34.9], group C2 will have obese BMIs of [35–39.9], and group C3 will have obese BMIs of [at least 40].

Pregnant females in reproductive period (20–40 years), Primigravidas and multi gravidas with No chronic diseases were included. All women who attended to the Obstetrics and gynecology emergency meeting the inclusion criteria, were chosen, and their (BMI) was computed. Based on BMI, we utilised Garrow's grade of obesity, which is (weight in kg/(height in m^2).[9]

2.1. General examination

Vital signs, measurements of the patient's height (in cm) and weight (in kg) (body mass was assessed using a calibrated scale), and BMI were estimated after a thorough physical examination. Fundal level, fundal grip to locate the portion of the foetus occupying the fundus, umbilical grip to locate the back and foetal limbs, first pelvic grip to locate the portion of the foetus occupying the lower uterine segment, and engagement are all examples of obstetric palpation (Maneuvers of Leopold).

2.2. Laboratory investigations

CBC, lipid profile, coagulation profile, kidney and liver function, FBS, PPBS, HBA1C, and urine analysis.

2.2.1. Ultrasound

Utilizing a SonoAceR3 ultrasound scanner, an ultrasound assessment was directed to quantify the Biophysical Profile (BPP), number of babies (barring various pregnancies), position of the placenta, biometry, gestational age, show (at term), assessed fetal weight utilizing the Hadlock recipe relying upon the BPD, AC, and FL to decide typical development, macrosomia, and IUGR, as well as the umbilical artery. Doppler flowmetry to survey the embryo's wellbeing.

Monitoring progress and complications (Primary outcome).

Patients had their height and weight measured. Instead of using pre-pregnancy weight, this study uses pre-labor weight. Based on WHO guidelines, patients were split into the groups previously stated using their BMI. To track the progression of labour in terms of cervical dilatation and head descent over time, the Friedman curve was used. With a total sample size of 375 individuals, recruitment continued until 75 patients were enrolled in each BMI group or subgroup.

Neonatal evaluation (secondary outcome).

The newborn's birth weight, the neonate's Apgar scores at 1 and 5 min, and the neonate's admittance to the intensive care unit.

2.3. Ethical approval

Once the study was approved by the university's ethics committee, each participant in the study provided a written, informed permission. When conducting this human study, the World Medical Association's code of ethics known as the Declaration of Helsinki was observed.

2.4. Statistical analysis

Data were tabulated, coded, and then analysed using the computer application SPSS (Statistical package for social research), version 23.0. As descriptive statistics for parametric quantitative data, mean, SD, median, interquartile range, and frequency (Number-percent) were created P 0.05 was considered significant in statistics.

3. Results

Concerning age there was genuinely tremendous distinction between gatherings, inside the gatherings between ordinary BMI and class 2,3 wt, among overweight and class 2,3 stoutness and between class 2 and class 3 corpulence with a P worth of <0.001 (Table 1).

Comparing between study groups as regards antenatal obesity-related complications, there were statistically significant differences in the

Table 1. Baseline characters of the studied groups.

Variable	BMI					*P* value[a]
	Group A	Group B	Group C1	Group C2	Group C3	
Age (mean ± SD)	**25.0** (3.8)	**25.2** (4.1)	**26.2** (3.8)	**26.9** (3.7)	**28.2** (3.3)	<0.001
Weight (mean ± SD)	59.9 (7.0)	71.6 (7.0)	85.1 (6.8)	97.4 (9.2)	115.4 (10.5)	<0.001
Height (mean ± SD)	162.1 (7.2)	165.3 (33.9)	160.5 (5.8)	162.4 (7.1)	165.7 (5.9)	0.2

[a] Using one way ANOVA with Bonferroni correction.

development of gestational HTN, gestational DM, miscarriage, excessive weight gain & obstructive sleep opnea (*P* values 0.03, 0.05,<0.001,<0.01 & 0.04) (Table 2).

There were statistically significant differences in cervical dilatation, time for cervical dilatation, and rate of cervical dilatation per hour between groups and within groups, with the exception of normal and overweight, class 2 and class 3 obesity, which had a *P* value of 0.001. (Table 3).

Regarding duration of head descent, there was statistically significant difference between groups and within the groups except between normal and overweight, class 2 and class 3 obesity with longer durations in obese groups (Table 4).

Increased risk of wound infection in group C3 may be increasing of subcutious fat increase risk of theroma formation (Table 5).

Regarding fetal weight there was statistically significant difference between and within the groups (Table 6).

There was a statistically significant difference in the APGAR score at 1 min across the groups and within all groups, with the exception of normal BMI

Table 2. Antenatal complications.

	Group A	Group B	Group C1	Group C2	Group C3	*P* value
Gest. HTN	2 (2.6%)	1 (1.1%)	5 (6.7%)	4 (5.3%)	7 (9.3%)	0.03
Gest. DM	1 (1.1%)	1 (1.1%)	4 (5.3%)	9 (12%)	13 (17.3%)	0.05
Metabolic syndrome	0 (0%)	0 (0%)	3 (4%)	4 (5.3%)	9 (12%)	0.093
Miscarriage	1 (1.1%)	2 (2.6%)	4 (5.3%)	7 (9.3%)	9 (12%)	<0.01
Excessive weight gain	0 (0%)	5 (6.7%)	19 (25.3%)	27 (36%)	38 (50.6%)	<0.01
Sleep apnea	0 (0%)	0 (0%)	1 (1.1%)	3 (4%)	7 (9.3%)	0.041

Table 3. Progress of labor in terms of duration and rate of cervical dilatation among studied groups.

	BMI					*P* value**
	Group A	Group B	Group C1	Group C2	Group C3	
Cervical dilation per hour (median (IQR))	**1.36** (1.3,1.5)	**1.33** (1.3,1.4)	**1.1** (1,1.2)	**0.88** (0.8,1)	**0.855** (0.8,1)	<0.001
Time of cervical dilation from 4 cm to 10 cm	4.44.1,4.7)	4.5 (4.3,4.7)	5.4 (4.9,5.8)	6.8 (5.9,7.7)	7 (6,7.8)	<0.001

***P* value highly significant.

Table 4. Progress of labor among studied groups regarding duration of head descent.

	BMI					*P* value[a]
	Group A	Group B	Group C1	Group C2	Group C3	
Duration of head descent from station 0 to +3 (median (IQR))	**2** (1.5,2.5)	**2.5** (1.8,3)	**3** (2.5,3.8)	**3.5** (3,4.3)	**3.75** (3.3,4.5)	<0.001

[a] Using Kruskal Wallis H test and Mann Whitney *U* test for adjustment.

Table 5. Delayed postpartum complications.

	A	B	C1	C2	C3	*P* value
Wound infections	0 (0%)	1 (1.1%)	3 (4%)	5 (6.6%)	17 (22%)	<0.01
2ndry postpartum hemorrhage	0 (0%)	2 (2.7%)	0 (0%)	1 (1.1%)	1 (1.1%)	0.812
Endometritis	1 (1.1%)	0 (0%)	1 (1.1%)	1 (1.1%)	2 (2.6%)	0.504
Anemia	6 (8%)	6 (8%)	4 (5.3%)	5 (6.7%)	6 (8%)	0.931
Prolonged hospitalization	0 (0%)	2 (2.6%)	3 (4%)	5 (6.7%)	10 (13.3%)	0.045

Table 6. Fetal birth weight among different study groups.

	BMI					**P value
	Group A	Group B	Group C1	Group C2	Group C3	
FBW median (IQR)	2.9 (2.7,3.2)	3.1 (2.8,3.4)	3.4 (3.0, 3.6)	3.6 (3.4,3.9)	3.9 (3.7, 4.1)	<0.001

**using Kruskal Wallis H test and Mann Whitney *U* test for adjustment.

Table 7. APGAR score at 1 and 5 min among different study groups.

Variable	BMI					**P value
	Group A	Group B	Group C1	Group C2	Group C3	
APGAR						
1 min	8.0	8.0	8.0	7.0	7.0	<0.001
Median (IQR)	(8.0, 8.0)	(7.0, 8.0)	(7.0, 8.0)	(7.0, 8.0)	(7.0, 8.0)	
APGAR						
5 min	9.0	9.0	8.0	8.0	8.0	<0.001
Median (IQR)	(8.0,9.0)	(8.0, 9.0)	(8.0, 9.0)	(8.0, 9.0)	(7.0,8.0)	

**P value highly significant.

Table 8. Nenonatal admission to NICU among different study groups.

Variable	BMI					**P value
	Group A	Group B	Group C1	Group C2	Group C3	
NICU Admission	4 (5.3%)	5 (6.6%)	10 (13.3%)	13 (17.3%)	16 (21.3%)	<0.001

and overweight, overweight, and obese class 1, class 2, and class 3 obesity. There were statistically significant differences in the groups and within each group for the APGAR score at five minutes, with the exception of those between normal BMI and overweight, class 1 and class 3 obesity, class 1 and class 2 obesity, and class 2 and class 3 obesity. (Table 7).

There were statistically significant differences between the groups and within each group, with the exception of the groups with normal BMI and overweight neonates who required NICU hospitalization. (Table 8).

4. Discussion

In the past 30 years, the prevalence of obesity has doubled, with rates rising among pregnant women as well.[10] Obesity in mothers has serious health repercussions and raises morbidity and mortality rates.[11]

In our analysis, we compared the results for the woman (work progress and recurrence of peri-partum difficulties), the newborn, and the five BMI gatherings (as an optional result as far as foetal birth weight, APGAR scores at 1 and 5 min and occurrence of neonatal requirement for NICU confirmation). As indicated by our discoveries, there were measurably tremendous contrasts among gatherings and inside bunches except for typical and overweight, class 2 and class 3 stoutness, with a *P* worth of 0.001 in regards to work progress (in regards to time and pace of cervical dilatation). Aside from among typical and overweight, class 2 and class 3 corpulence, there were genuinely massive contrasts in head plunge time across gatherings and among gatherings, with longer lengths in the corpulent classes. A couple of prior research found no connection between's maternal fat and work progress. As opposed to our discoveries, an English investigation of 8350 nulliparous ladies assessed the movement of work in hefty with typical and overweight ladies and tracked down no tremendous distinction inside the first or second periods of work.[12]

Be that as it may, most of prior examinations have tracked down a connection between maternal weight and the general length of dynamic work. The primary phase of work seems to endure longer with expanding BMI, which thusly makes work last longer by and large.[13–15]

This finding concurs with the consequences of our review for the primary stage however not for the subsequent stage. They did not characterize the second phase of work as we do, and that implies that their definition cannot be straightforwardly contrasted with our review's discoveries since we characterize the second phase of work as the second the cervix was completely widened.[16,17]

Concerning conveyance technique, stout gatherings (C1, C2, C3) had a higher level of cesarean segments, albeit the thing that matters was measurably inconsequential with a *P* worth of 0.1. In

our review, 61 out of 225 patients in the large classifications went through cesarean areas, contrasted with 26 out of 150 patients in the typical and overweight gatherings (17%). Regardless of the raised occurrence of cesarean areas done on fat ladies, these discoveries needed measurable importance. This study upholds a new report that uncovered that having a higher BMI builds the gamble of having a cesarean segment. The gamble is twice higher in stout ladies than in overweight and ordinary weight ladies (31.5% versus 11.5% and 8.8%, separately).[18]

Concerning partum issues, a few followed entanglements, (for example, cervical dystocia and fundamental post pregnancy drain) displayed more prominent occurrence among the gatherings with expanded BMI, but other followed intricacies didn't. In any case, none of the distinguished issues (even those with higher commonness in the stout gatherings) figured out how to separate the dissected gatherings genuinely essentially (*P* esteem 0.05). Cervical dystocia was more prevalent, however the difference between research groups was essentially meaningless, with a P value of 0.2. However, a review looking at the effects of obesity and other risk factors on labour dystocia in term primiparous women discovered that the dystocia group had a higher BMI.[19]

There was no genuinely tremendous contrast between research bunches for the capture of head fall, with a P worth of 0.9. There was no genuinely massive distinction between research bunches for shoulder dystocia, with a P worth of 0.3. As per a connected report, maternal heftiness was not a critical gamble factor for shoulder dystocia and head plunge capture, which are on a similar side of our review. Fetal macrosomia was recognized as the best indicator.[20]

Then again, a meta-examination did in 2017 assessed the connection between the gamble of shoulder dystocia and maternal pre-pregnancy stoutness (enveloping classes I, II, and III weight). The outcomes recommended that a higher probability of shoulder dystocia might be related with maternal pre-pregnancy fat. Furthermore, there was a significant reviewed relationship between shoulder dystocia and corpulence classes. Both associate examinations and case-control studies showed huge connections in subgroup examination.[21]

With a *P* worth of 0.8, there was no measurably massive contrast between the exploration bunches for third and fourth-degree perineal wounds. Likewise, a review taking a gander at the connection between maternal corpulence and the gamble of obstetric butt-centric sphincter injury reached the resolution that, in the wake of adapting to instrumental conveyance, birth weight, and late fetal head position, maternal stoutness in every one of the three heftiness classes will in general lower the gamble for each of the three levels of butt-centric sphincter wounds. High birth weight was the greatest gamble factor for butt-centric sphincter slash.[22] There was a rising occurrence of fundamental post pregnancy discharge, however there was no measurably huge contrast between the different review bunches with a P worth of 0.7. Other examination on corpulent nulliparous ladies detailed a twofold expansion in hazard of major PPH contrasted with ladies with typical BMI paying little heed to method of conveyance, which diverges from our discoveries on 1ry PPH.[23]

Their higher example size permitted the review to be more appropriate for distinguishing the event of an uncommon outcome, which could represent this error in results. Every one of the three factors we assessed for neonatal result showed a genuinely tremendous distinction between the review bunches with a P worth of 0.05. There were genuinely huge contrasts in fetal load between and inside the gatherings, with corpulent ladies frequently having bigger children upon entering the world. In opposition to our discoveries, a recent report tracked down that maternal corpulence, paying little mind to gestational diabetes, isn't connected with more prominent birth weight yet rather with expanded infant adiposity in just females.[24]

Except for people with a typical BMI and the individuals who were overweight or hefty in class 1, class 2, or class 3 robustness, there was a quantitatively massive contrast in the APGAR score at 1 moment across all gatherings and inside all gatherings. The APGAR score at 5 min uncovered really serious abberations in all classifications and inside each gathering, except for the distinctions between typical BMI and overweight, class 1 and class 3 wt, class 1 and class 2 beefiness, and class 2 and class 3 heftiness. We found that children with moms who had a BMI of 25 kg/m2 during pregnancy were bound to have low APGAR scores at 1 and 5 min, and that the 5 moment APGAR score is a preferable indicator of neonatal perseverance over the 1 moment APGAR score. In light of an extensive assessment and meta-examination of 11 friend studies with 2,586,265 members, this was made.[25]

There were measurably massive contrasts in all classifications in regards to the need of infant NICU hospitalization, except for those with ordinary BMI and overweight people. As per a meta-examination of four investigations, hefty mothers had a significantly higher pace of neonatal confirmations for basic consideration, which is in accordance with our

discoveries. A more prominent pace of NICU confirmation among fat ladies has previously been reported in Europe, the US, Canada, and Australia, even in term babies.[26,27] As per Hendler et al., all pregnancies in stout ladies ought to be perceived as high gamble and oversaw as per severe rules.[28]

4.1. Conclusion

Preventing obesity during pregnancy is the main goal of management. The ideal outcome would be for obese women to reduce weight through lifestyle modifications and reach a normal BMI prior to conception, but this is realistically rather challenging to do. To evaluate the relationship between maternal obesity and early-gestational illnesses including the risk of spontaneous abortion and congenital malformations as well as late-gestational disorders such gestational hypertension and gestational diabetes, more research is required. Because at parturition, the focus of our study, Due to the potential for slower labour progress and an increased frequency of peripartum issues, obese women in labour must be taken into consideration as high-risk cases for both short-term and long-term post-partum troubles.

Author contribution

Authors contributed equally in the study.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article.

Conflicts of interest

The authors declare no conflict of interest.

References

1. World Health Organization (WHO). *World Health Statistics 2015*. Geneva: WHO; 2018:101–111. http://www.who.int/gho/publications/world_health_statistics/2018/en/. Accessed November 30, 2018.
2. Ng M, Fleming T, Robinson M. Regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2014;384:766–781.
3. Jain D, Khuteta R, Chaturvedi V, et al. Effect of body mass index on pregnancy outcomes in nulliparous women delivering singleton babies: observational study. *J Obstet Gynaecol India*. 2012;62:429–431.
4. Quiner T, Perlow JH. The global burden of obesity on pregnancy outcomes in the developed world [17Q]. *Obstet Gynecol*. 2017;1:177S.
5. Denison FC, Reynolds RM. Pharmacological treatment for the obese gestational diabetes mellitus patient. In: Jovanovic LG, Di Renzo GC, de Leiva A, Langer O, eds. *eTextbook of Diabetes and Pregnancy*. third ed. 7. 2018:246–252. Boca Raton.
6. Gaillard R, Santos S, Duijts L. Influence of maternal obesity during pregnancy on childhood health outcomes. In: Patel MS, Nielsen JH, eds. *Fetal and Early Postnatal Programming and its Influence on Adult Health*. 7. 2017:237–253. Boca Raton.
7. Valsamakis G, Kyriazi EL, Mouslech Z. Effect of maternal obesity on pregnancy outcomes and long-term metabolic consequences. *Hormones*. 2015;14:345–357.
8. MacInnis N, Woolcott CG, McDonald S, Kuhle S. Population attributable risk fractions of maternal overweight and obesity for adverse perinatal outcomes. *Sci Rep*. 2016;6:22895. Published 2016 Mar 10. https://doi.org/10.1038/srep22895.
9. World Health Organization. Retrieved July 27, 2012, —BMI classification. In: *Global Database on Body Mass Index*. 2006.
10. Bhattacharya S, Campbell DM, Liston WA, et al. Effect of body mass index on pregnancy outcomes in nulliparous women delivering singleton babies. *BMC Publ Health*. 2007;7:168–176.
11. Ono T, Guthold R, Strong K. *WHO Global Comparable Estimates, 2010*. WHO GlobalInfobase; 2011. http://apps.who.int/infobase/. Accessed June 15, 2011.
12. Usha Kiran TS, Hemmadi S, Bethel J, et al. Outcome of pregnancy in a woman with an increased body mass index. *BJOG*. 2005;112:768–772.
13. Carlhall S, Kallen K, Blomberg M. Maternal body mass index and duration of labour. *Eur J Obstet Gynecol Reprod Biol*. 2013;171:49–53.
14. Norman SM, Tuuli MG, Odibo AO, et al. The effects of obesity on the first stage of labour. *Obstet Gynecol*. 2012;120:130–135.
15. Kominiarek MA, Zhang J, Vanveldhuisen P, et al. Contemporary labor patterns: the impact of maternal body mass index. *Am J Obstet Gynecol*. 2011;205:244.
16. Vahratian A, Zhang J, Troendle JF, et al. Maternal prepregnancy over-weight and obesity and the pattern of labor progression in term nulliparous women. *Obstet Gynecol*. 2004;104(5 Pt 1):943–951.
17. Vahratian A, Siega-Riz AM, Savitz DA, et al. Maternal prepregnancy overweight and obesity and the risk of cesarean delivery in nulliparous women. *Ann Epidemiol*. 2007;15:467–474.
18. Nuthalapaty FS, Rouse DJ, Owen J. The association of maternal weight with cesarean risk, labor duration and cervical dilation rate during labor induction. *Obstet Gynecol*. 2004;103:452–456.
19. Hautakangas T, Palomäki O, Eidstø K, et al. Impact of obesity and other risk factors on labor dystocia in term primiparous women: a case control study. *BMC Preg Childbirth*. 2018;18:1.
20. Robinson H. Is maternal obesity a predictor of shoulder dystocia? *Obstet Gynecol*. 2003;101:24–27.
21. Zhang C, Wu Y, Li S, et al. Maternal prepregnancy obesity and the risk of shoulder dystocia: a meta-analysis. *BJOG*. 2017;125:407–413.
22. Blomberg M. Maternal body mass index and risk of obstetric anal Sphincter injury. *BioMed Res Int*. 2014;9:1–8.

23. Elaine FM, Thompson J, Anderson NH, et al. Maternal obesity and postpartum haemorrhage after vaginal and caesarean delivery among nulliparous women at term: a retrospective cohort study. *BMC Preg Childbirth*. 2012;12:1–8.
24. Delphine M, Jacqueminet S, Nizard J, et al. Effect of maternal obesity on birthweight and neonatal fat mass: a prospective clinical trial. *PLoS One*. 2017;12:e0181307.
25. Tingting Z, Tang J, Zhao F, et al. Association between maternal obesity and offspring Apgar score or cord pH: a systematic review and meta-analysis. *Sci Rep*. 2015;5:1, 0.
26. Raatikainen K, Heiskanen N, Heinonen S. Transition from overweight to obesity worsens pregnancy outcome in a BMI-dependent manner. *Obesity*. 2006;14:165–171.
27. Callaway LK, Prins JB, Chang AM, et al. The prevalence and impact of overweight and obesity in an Australian obstetric population. *Med J Aust*. 2006;184:56–59.
28. Hendler I, Goldenberg RL, Mercer BM, et al. The Preterm Prediction Study: association between maternal body mass index and spontaneous and indicated preterm birth. *Am J Obstet Gynecol*. 2005;192:882–886.