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High weight gain during pregnancy increases the risk for emergency caesarean section – Population-based data from the Swedish Maternal Health Care Register 2011–2012

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ABSTRACT

Objective: The aim was to investigate maternal background factors' significance in relation to risk of elective and emergency caesarean sections (CS) in Sweden.
Study design: Population-based, retrospective, cross-sectional study. The Swedish Maternal Health Care Register (MHCR) is a national quality register that collects data on pregnancy, delivery and postpartum period. All women registered in MHCR 2011 to 2012 were included in the study sample (N = 178,716).
Main outcomes: The risk of elective and emergency caesarean section in relation to age, parity, education, country of origin, weight in early pregnancy and weight gain during pregnancy was calculated in logistic regression models.
Results: Multiparous women demonstrated a doubled risk of elective CS compared to primiparous women, but their risk for emergency CS was halved. Overweight and obesity at enrolment in antenatal care increased the risk for emergency CS, irrespective of parity. Weight gain above recommended international levels (Institute of Medicine, IOM) during pregnancy increased the risk for emergency CS for women with normal weight, overweight or obesity.
Conclusion: There is a need of national guidelines on recommended weight gain during pregnancy in Sweden. We suggest that the usefulness of the IOM guidelines for weight gain during pregnancy should be evaluated in the Swedish context.

Introduction

Caesarean section rates have been increasing rapidly in many countries in the last decades. Almost all industrial countries have experienced consistently increasing caesarean section rates for the last 20 years. In 2007, a large number of industrialized countries reported CS rates of more than 25%. However, currently the rates seem to be slowing down and in several countries have levelled off [1]. Sweden demonstrates a relatively low prevalence of caesarean sections (CS) in an international perspective [2]. In the beginning of the 1970s, 5% of pregnant women were delivered by CS. During the last ten years, the rate of CS has been around 17%. Since 1991, the Swedish Medical Birth Register (MBR) reports annually the distribution between elective and emergency CS [3], and the prevalence of elective and emergency CS have shown a parallel increase, but with more rapid increase for elective CS [3]. About one third of the increase in CS can be explained by increasing age and body mass index (BMI) of pregnant women [4]. Caesarean section performed without a medical indication should be avoided, as the potential risk of damage is higher than the potential advantage [5]. Accordingly it is important to investigate risk factors for CS in order to enhance the preventive work to decrease the CS rate.

The medical consequences of caesarean sections

There are well-known adverse outcomes related to CS, such as increased risks for severe haemorrhage, infections and thrombosis. The long-term consequences after repeated caesarean sections

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are significant and the risk of uterine rupture, placenta praevia and placenta accreta increase with the number of CS [6,7]. Children born by elective CS have an increased risk for neonatal respiratory morbidity [8], as well as asthma during childhood [9].

Antenatal care in Sweden and the Swedish Maternal Health Care Register

The Swedish antenatal care is mainly organized within the primary health care system and is provided by the County Councils (60.4%) or private primary health care (27.5%), while a smaller part of antenatal care (ANC) is affiliated with Departments of Obstetrics and Gynaecology in hospitals (15.6%) [10]. Antenatal care visits are voluntary, free of charge and nearly 100% of pregnant women attend. There are national guidelines stating frequency and contents of check-ups for normal pregnancies.

The Swedish Maternal Health Care Register (MHCR) is a national quality register established in 1999. The intention is that every pregnant woman is informed about the existence of the register, its purpose and content and that providing data to the MHCR is voluntary. At the first visit at ANC, with the permission of the pregnant woman, the midwives register background characteristics such as educational level, country of origin, body weight, height and smoking habits in the MHCR. The second set of data is entered in the MHCR, by the midwife at 4–16 weeks postpartum, when the postpartum check-up is provided. At this occasion information on outcomes of pregnancy and delivery is registered. If the woman does not attend the postpartum visit, information from the woman's medical record is collected and registered in MHCR. Almost all antenatal care clinics participate in the register, and in 2012, 85.2% of all births were included in MHCR. A study of the internal validity of the register shows a high agreement between register data and data in the medical journal [11]. Hence the MHCR provides high quality data of pregnancy and birth outcomes in Sweden.

The determinants of the increasing caesarean section rates are multifactorial. Obesity is a growing problem in Sweden, 25% of pregnant women are overweight and 13% are obese [3]. This increases the risk of pregnancy complications including delivery with CS [12]. Even if we know that obesity adds to the risk for both elective and emergency caesarean sections we still have a limited knowledge whether low weight gain during pregnancy can decrease the risk [13]. Previous Swedish studies have shown that a low weight gain, i.e. less than 8 kg weight increase, can lower the risk for CS for overweight and obese women [14], and that women with BMI ≥40.0 kg/m^2 who lost weight had a decreased risk for CS [15]. However, these studies did not separate between elective and emergency CS. The aim of the study was to examine how socioeconomic and obstetric background factors, and weight gain during pregnancy influenced the risk of delivery with elective or emergency caesarean section for women giving birth during 2011–2012 in Sweden.

Method

Study design

This study is a population-based, retrospective, cross-sectional study using national data from the Maternal Health Care Register.

Participants

From January 2011 to December 2012, data from 185,027 women who gave birth were registered in the MHCR. Women with multiple pregnancies, gestational age shorter than 22 + 0 weeks or longer than 43 + 0 weeks, no reported gestational age or mode of delivery were excluded from the sample. The final dataset comprised 178,716 women. Anonymized data were excerpted from the MHCR on the following variables: woman's age at delivery (i.e. maternal age), number of previous births, country of origin, level of education, maternal height and weight at first visit in ANC, smoking at 32 weeks in pregnancy, last registered maternal weight after 35 weeks, gestational age, mode of delivery and birth weight. The Regional Ethical Board at Umeå University approved the study (Dno 2012-44-31 M).

Definitions of variables

Elective caesarean section. In this register study it was defined as CS before onset of labour.

Premature delivery was defined as <37 gestational weeks and *post term delivery* as ≥42 gestational weeks according to World health Organization (WHO) classification 1977.

Body mass index (BMI) was calculated as: weight in kilograms/height in metre squared. BMI was categorized according to the WHO classification: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), obesity grade 1 (30.0–34.9 kg/m^2), obesity grade 2 (35.0–39.9 kg/m^2) and obesity grade 3 (≥40.0 kg/m^2). Small for gestational age (SGA) was defined as infants whose birth weight was <10th percentile, adequate for gestational age (AGA) was birth weight >10th percentile up to the 90th percentile and large for gestational age (LGA) was infants >90th percentile. We used the guidelines from the Institute of Medicine (IOM) to estimate *weight gain during pregnancy*, where the recommendations relate to prepregnancy BMI [16]. The recommended weight gain for underweight pregnant women is 12.5–18 kg, for normal weight 11.5–16 kg, overweight 7–11.5 kg and for obese women 5–9 kg. *Country of origin* was categorized in the following groups: Nordic countries, Europe except the Nordic countries, Africa, Asia and the rest of the world.

Smoking in pregnancy. Women were asked at 32 weeks of gestational age whether they were smoking. They could respond yes/no.

Level of education was categorized into the following groups of highest level of education: elementary school, secondary school and college/university education.

Statistical analysis

Continuous variables were presented with mean and 95% confidence interval (CI). Categorical variables were presented in numbers and percentages. The probability of elective or emergency caesarean sections in relation to socioeconomic and obstetric background variables was analysed with simple logistic regression and the results are presented with odds ratios (OR) and their 95% CI. When analysing country of origin, women born in the Nordic countries were used as a reference. Multiple logistic regression analysis was used in order to analyse the association between background variables and emergency caesarean section in primiparous women. In the multiple logistic regression analyses we included the variables that were significantly associated with emergency caesarean section in the simple logistic regression analysis. Level of significance was set at 0.05.

Results

Socioeconomic status, parity and country of origin

Socioeconomic and obstetric background data of participants are presented in Table 1. The probability to be delivered by an elective caesarean section was nearly doubled (OR 1.88; 95% CI: 1.81–1.96), and to have an emergency CS was reduced to less than half (OR 0.44; 95% CI: 0.42–0.45) for multiparous compared to primiparous women. African women had a lower risk of having an elective CS (OR 0.81; 95% CI: 0.73–0.91). Women born in Europe, with exception of the Nordic countries, demonstrated a lower risk for

Table 1
Socioeconomic background characteristics and pregnancy outcomes (N = 178,716).

Variable	Total number (N = 178,716)
Maternal age, mean (95% CI)	30.73 (30.70–30.75)
Parity (n, %)	
Nulliparous	76,149 (43.7)
Multiparous	97,925 (56.3)
Level of education (n, %)	
Elementary school	12,904 (8.8)
Senior high school	58,316 (39.9)
College/university	74,857 (51.2)
Smoking at 32 gestational weeks (n, %)	7,981 (4.4)
Country of origin (n, %)	
Nordic countries	142,196 (82.5)
Europe except Nordic countries	7,525 (4.4)
Africa	5,945 (3.4)
Asia	14,968 (8.7)
The rest of the world	1,810 (1.0)
BMI at enrolment in ANC, mean (kg/m^2), (95% CI)	24.77 (24.75–24.79)
BMI groups (n, %)	
Underweight : BMI <18.5 kg/m^2	4,204 (2.5)
Normal weight: BMI 18.5–24.9 kg/m^2	101,861 (59.4)
Overweight: BMI 25.0–29.9 kg/m^2	43,453 (25.3)
Obesity class 1: BMI 30.0–34.9 kg/m^2	15,368 (9.0)
Obesity class 2: BMI 35.0–39.9 kg/m^2	4,889 (2.7)
Obesity class 3: BMI ≥40.0 kg/m^2	1,724 (1.0)
Weight gain during pregnancy, mean kg (95% CI)	12.62 (12.59–12.65)
Mode of delivery (n, %)	
Vaginal delivery	137,914 (77.2)
Instrumental delivery (vacuum extraction or forceps)	12,549 (7.0)
Elective caesarean section	12,256 (6.9)
Emergency caesarean section	15,997 (9.0)
Duration of pregnancy in weeks (n, %)	
Delivery <37 gestational weeks	9,387 (5.3)
Delivery gestational weeks 37–41	157,966 (88.4)
Delivery >41 gestational weeks	11,363 (6.4)

emergency CS (OR 0.83; 95% CI: 0.76–0.91), while women born in Africa or Asia had an increased risk for emergency CS (OR 1.49; 95% CI: 1.38–1.61 and OR 1.16; 95% CI: 1.09–1.23) respectively.

Maternal age and level of education

The risk of elective and emergency CS was increased for both primiparous and multiparous women as the maternal age increased. Primiparous women of age ≥40 years were five times more likely to be delivered by an elective CS compared to 25–29 years old primiparous women (Table 2).

When level of education was adjusted for age and BMI, primiparous women with a university education demonstrated a lower risk of elective CS compared to women with lower level of education (OR 0.77; 95% CI: 0.66–0.90). However, for multiparous women no difference could be demonstrated. Both primiparous and multiparous women with a university education had decreased risks (OR 0.69; 95% CI: 0.63–0.76; OR 0.80; 95% CI: 0.72–0.89) of delivery with an emergency CS (Table 3).

Body mass index (BMI) at enrolment in ANC

The probability to be delivered by an emergency CS was increased for overweight or obese women irrespective of parity. As the obesity increased, increasing risks for emergency CS could be demonstrated (Table 4).

Weight gain during pregnancy

Pregnant women with a weight gain exceeding the recommendations from IOM for each BMI group had an increased risk for delivery with an emergency CS. All pregnant women who were overweight or obese had an increased risk for emergency CS due to excessive weight gain in comparison with pregnant women with normal weight and characterized by the recommended level of weight gain (Table 5).

Probability for primiparous women to be delivered by an emergency CS

All significant risk factors in the univariate analysis persisted as significant risk factors in multiple logistic regression analyses. Gestational age and fetal growth were used to classify birth weight as either SGA, AGA or LGA, and were also included as factors in the logistic regression model. Disproportional fetal growth and gestational age demonstrated the largest influence on risk for emergency CS (Table 6).

Discussion

The aim of the study was to investigate how socioeconomic and obstetric background factors as well as weight gain during pregnancy influenced the rate of elective and emergency CS in population-based sample in Sweden. We found that every third pregnant woman in Sweden had a weight gain that exceeded IOM guidelines for weight gain during pregnancy. Excess weight gain during pregnancy increased the risk for emergency CS. Moreover, the risk for emergency CS was linear to the woman's BMI at enrolment in ANC. We also found that weight gain above IOM

Table 2
Elective and emergency caesarean section in relation to age of mother and analysed with simple logistic regression. The results are presented with OR and their 95% CI.

Maternal age	Elective caesarean section				Emergency caesarean section			
	Number	%	OR	CI 95 %	Number	%	OR	CI 95 %
Primiparous								
≤19 years	63	2.8	**0.76**	0.58–0.98	162	7.4	**0.60**	0.51–0.71
20–24 years	467	2.8	**0.76**	0.68–0.85	1507	9.4	**0.78**	0.73–0.83
25–29 years	1000	3.7	1		3089	11.8	1	
30–34 years	1160	5.5	**1.53**	1.41–1.67	3093	15.6	**1.38**	1.31–1.46
35–39 years	648	8.6	**2.46**	2.22–2.73	1544	22.4	**2.16**	2.01–2.31
≥40 years	244	15.9	**4.95**	4.26–5.76	422	32.7	**3.63**	3.22–4.11
Multiparous								
≤19 years	9	3.8	0.65	0.33–1.26	10	4.4	0.85	0.45–1.61
20–24 years	270	3.7	**0.62**	0.54–0.71	292	4.1	**0.79**	0.69–0.90
25–29 years	1392	5.8	1		1167	5.2	1	
30–34 years	3038	8.1	**1.44**	1.34–1.53	2108	6.1	**1.20**	1.11–1.29
35–39 years	2825	11.9	**2.19**	2.05–2.35	1692	8.1	**1.62**	1.50–1.75
≥40 years	801	15.3	**2.93**	2.67–3.21	487	11.0	**2.26**	2.02–2.53

Table 3
Elective and emergency caesarean section in relation to BMI at enrolment and analysed with simple logistic regression. The results are presented with OR and their 95% CI.

BMI at enrolment	Elective caesarean section				Emergency caesarean section			
	Number	%	OR	CI 95 %	Number	%	OR	CI 95 %
Primiparous								
Underweight	107	4.8	1.02	0.84–1.25	182	8.5	**0.73**	0.63–0.86
Normal weight	2200	4.7	1		5060	11.2	1	
Overweight	806	4.7	1.00	0.92–1.09	2745	16.7	**1.58**	1.50–1.66
Obesity class 1	283	4.9	1.06	0.94–1.21	1083	19.9	**1.96**	1.82–2.11
Obesity class 2	85	4.8	1.03	0.83–1.29	412	24.5	**2.56**	2.28–2.87
Obesity class 3	37	6.0	1.32	0.94–1.84	143	24.8	**2.61**	2.16–3.16
Multiparous								
Underweight	131	6.8	0.88	0.74–1.06	73	4.0	0.80	0.63–1.01
Normal weight	4128	7.6	1		2516	5.0	1	
Overweight	2316	8.9	**1.19**	1.13–1.25	1718	7.2	**1.48**	1.39–1.57
Obesity class 1	1046	10.9	**1.49**	1.38–1.60	878	10.2	**2.17**	2.00–2.35
Obesity class 2	398	12.8	**1.78**	1.60–1.99	325	12.0	**2.58**	2.28–2.91
Obesity class 3	164	14.8	**2.12**	1.79–2.51	138	14.7	**3.26**	2.71–3.16

Table 4
Elective and emergency caesarean section in relation to level of education and analysed with simple and multiple logistic regression (adjusted for age and BMI). The results are presented with OR and their 95% CI.

Level of education	Elective caesarean section				Adjusted OR	
	Number	%	Crude OR			
			OR	CI 95 %	OR	CI 95 %
Primiparous						
Elementary school	204	3.9	1		1	
Senior high school	1043	4.0	1.03	0.88–1.20	**0.84**	0.72–0.98
College/university	1735	5.2	**1.35**	1.16–1.56	**0.77**	0.66–0.90
Multiparous						
Elementary school	574	7.5	1		1	
Senior high school	2547	7.9	1.06	0.96–1.16	1.05	0.96–1.16
College/university	3762	9.1	**1.24**	1.13–1.36	1.06	0.96–1.16
Level of education	Emergency caesarean section				Adjusted OR	
	Number	%	Crude OR			
			OR	CI 95 %	OR	CI 95%
Primiparous						
Elementary school	633	12.7	1		1	
Senior high school	3279	13.2	1.05	0.96–1.15	**0.85**	0.77–0.93
College/university	4275	13.6	1.08	0.99–1.18	**0.69**	0.63–0.76
Multiparous						
Elementary school	510	7.2	1		1	
Senior high school	1947	6.5	0.91	0.82–1.00	0.92	0.83–1.02
College/university	2228	5.9	**0.81**	0.74–0.90	**0.80**	0.72–0.89

recommendations increased the risk for CS for all maternal weight classes except for underweight pregnant women.

It is reported earlier that the higher BMI of the pregnant woman in early pregnancy, the higher is the risk for CS [17–19]. However, these studies include both elective and emergency CS in the analyses, in contrast to our study. We analysed the 2 different modes of CS separately, and could show that there was an increased risk for elective CS for multiparous women who were overweight or obese, but not for primiparous women. Both primiparous and multiparous women with overweight or obesity had an increased risk for emergency CS; a risk that was doubled or tripled for severely obese pregnant women compared to pregnant women with normal weight.

An American study using the IOM recommendations shows an increased risk for CS for women of normal weight or overweight at enrolment in ANC and who gained more than recommended weight gain [20], while a Canadian study indicates that high weight gain during pregnancy increases the risk for CS for all WHO weight classes [21]. However the Canadian study classified a weight gain of 7.0–11.5 kg for pregnant women with BMI >27 as normal. We also found that the CS rate was increased for all groups of pregnant women who gained weight above the IOM recommendations except for women who were underweight at enrolment in ANC.

It is of interest to evaluate whether low weight gain during pregnancy can modify the association between high BMI and CS. Two Swedish studies using data from the Swedish Medical Birth Register

Table 5
Emergency caesarean section (CS) in relation to weight gain within or exceeding IOM recommendations. Analyses are done with logistic regression and adjusted for maternal age. Results are presented with OR and their 95% CI.

Variable	Number in each group	Number (%) with emergency CS	OR[a]	95% CI	OR[b]	95% CI
Underweight at enrolment in ANC	3,965 (2.5)					
Weight gain ≤18.0 kg	3,528 (91.3)	216 (6.1)	1		0.90	0.78–1.03
Weight gain > 8.0 kg	338 (8.7)	30 (8.9)	**1.49**	1.00–2.23	1.38	0.95–2.02
Normal weight at enrolment in ANC	95,506 (59.8)					
Weight gain ≤16.0 kg	71,756 (77.6)	5,267 (7.3)	1		1	
Weight gain >16.0 kg	20,746 (22.4)	2,021 (9.7)	**1.36**	1.29–1.44	**1.42**	1.35–1.50
Overweight at enrolment in ANC	40,325 (25.2)					
Weight gain ≤11.5 kg	16,639 (42.4)	1,647 (9,9)	1		**1.36**	1.28–1.44
Weight gain >11.5 kg	22,593 (57.6)	2,672 (11.8)	**1.22**	1.14–1.30	**1.71**	1.63–1.80
Obesity at enrolment in ANC	19,967 (12.5)					
Weight gain ≤9 kg	9,527 (49.0)	1,259 (13.2)	1		**1.90**	1.78–2.03
Weight gain >9 kg	9,897 (51.0)	1,628 (16.4)	**1.29**	1.19–1.40	**2.52**	2.38–2.68
All women						
Weight gain within recommendations	101,450 (65.4)	8,389 (8.3)	1			
Weight gain above recommendations	53,574 (34.6)	6,351 (11.9)	**1.49**	1.44–1.54		

[a] Analysis within each weight group.
[b] Analysis with 8 weight groups where women with normal weight and weight gain within recommendations is the reference group.

Table 6
Simple and multiple logistic regression analysis for emergency caesarean section for primiparous women.

Variable	Crude OR (95 % KI)	Adjusted OR (95 % KI)
Maternal age	**1.08** (1.07–1.08)	**1.09** (1.08–1.09)
Smoking at pregnancy week 32		
No	1	1
Yes	**0.83** (0.74–0.93)	0.88 (0.76–1.01)
Level of education		
Elementary school/senior high school	1	1
College/university	1.04 (0.99–1.09)	**0.84** (0.79–0.89)
Country of origin		
Nordic countries/Europe except Nordic countries	1	1
Africa/Asia/rest of the world	**1.34** (1.26–1.43)	**1.49** (1.38–1.61)
BMI at enrolment in ANC	**1.07** (1.06–1.07)	**1.05** (1.05–1.06)
Weight gain during pregnancy		
Within recommendation	1	1
Above recommendation	**1.46** (1.40–1.53)	**1.42**(1.35–1.50)
Duration of pregnancy		
Delivery <37 gestational weeks	**3.35** (3.13–3.59)	**2.96** (2.72–3.23)
Delivery 37–41 gestational weeks	1	1
Delivery >41 gestational weeks	**2.75** (2.58–2.92)	**2.48** (2.31–2.67)
Proportional growth		
Small for gestational age	**2.96** (2.71–3.24)	**2.58** (2.30–2.88)
Adequate for gestational age	1	1
Large for gestational age	**2.45** (2.20–2.72)	**1.80** (1.58–2.05)

have reported that overweight or obese women who limit their weight gain during pregnancy can diminish their risk for a CS delivery [14]. Further, severely obese women, i.e. BMI ≥40. 0 kg/m^2, who lose weight during pregnancy also diminish their risk for CS [15]. One American [22] and one Canadian study [17] indicate that BMI at enrolment in ANC is more strongly associated with the CS rate than weight gain during pregnancy. Our study indicated that weight gain exceeding the IOM recommendations for each BMI class had a higher impact on emergency CS rate than the pregnant woman's weight at entrance of pregnancy.

More than 50% of women in Sweden reach a college or university education level. Higher education level was associated with a lower risk for both elective and emergency CS. This association was also reported in the annual report from the Swedish MBR [3] .

We could show that Sub-Saharan pregnant women demonstrated a lower level of elective CS but an increased level of emergency CS compared to women born in the Nordic countries. Our findings are in line with other studies that show that Sub-Saharan women have a higher risk of adverse pregnancy outcome [23,24], compared to Swedish women. Somali women report a fear of giving birth by CS [25]. At the same time they have an increased risk to have a delivery ending with emergency CS [26].

In many countries in Europe and the United States the rate of CS is exceeding 30% [1]. Similar prevalence rates are also reported from many countries in South America [27]. In an international perspective the rate of CS in Sweden is not alarming. From a Swedish perspective, it is more remarkable that there are large differences (from 9.2% up to 22%) in CS rates between regions and hospitals within the country [28]. Hopefully, using the Robson classification in the clinical work will facilitate better comparisons and critical analysis of the CS rates [29]. It is especially important that delivery with CS is avoided for primiparous women as an operative delivery increases the risk for complications at subsequent pregnancies and deliveries [7].

A strength in this study is the high coverage rate of the Swedish Maternal Health Care Register, 85.2% of all deliveries in 2012 in Sweden were included. The quality of data in MHCR is evaluated as good, level of missing data is relatively low, and very few variables indicate systematic errors in the register [11]. Unfortunately, there is no information in MHCR whether a woman has been exposed to a previous CS. Therefore, the interpretation of CS risk estimates for multiparous women should be cautious.

In this study we used the guidelines from IOM concerning recommendations on weight gain during pregnancy, as there are no Swedish guidelines available on recommended weight gain. We consider it as important for international comparisons to implement the IOM guidelines in Sweden. Achieving appropriate weight gain during pregnancy has not only positive implications on CS rates, but it also decreases the risk of gestational hypertension, preeclampsia and large for gestational age [20]. Pregnant women have the right to be informed about the advantage of an appropriate weight gain in order to minimize complications.

Conclusions

Overweight and obesity in early pregnancy as well as weight gain above the IOM recommendations implicated an increased risk for CS in a population-based sample of pregnant women in Sweden. More than a third of the pregnant women gained more weight during pregnancy than the IOM recommendations; hence they were at increased risk of delivery with CS. Pregnant women are entitled to get adequate information and recommendations from obstetricians and midwives about weight gain during pregnancy as part of the medical surveillance of pregnancy. Currently there are no Swedish national guidelines on recommended weight gain during pregnancy. Thus, there is a need to evaluate the usefulness of IOM guidelines in the Swedish context. However, more knowledge of how to best support weight gain within recommendations is needed for a successful implementation of the IOM guidelines.

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