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ORIGINAL ARTICLE

The association of pre-pregnancy overweight and obesity with delivery outcomes: a comparison of immigrant and non-immigrant women in Berlin, Germany

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Abstract
Objectives To analyse the influence of maternal overweight/obesity on delivery outcomes among first- and second-generation immigrant women and non-immigrant women.
Methods We used perinatal data from Berlin/Germany ($n = 1987$ first generation, $n = 687$ second generation, $n = 2185$ non-immigrants; gestational age: 24+ weeks; maternal age: 18+ years). Poisson models were fitted to estimate the effect of pre-pregnancy overweight/obesity (categorised according to WHO) on mode of delivery (vaginal vs. emergency caesarean section (ECS)) and labour onset (spontaneous vs. induced).
Results First generation, second generation and non-immigrant women were more likely to have their labour induced when obese [first generation: RR = 1.41 (95 % CI: 1.15–1.72); second generation: RR = 1.51 (95 % CI: 1.14–2.00); non-immigrants: RR = 1.53 (95 % CI: 1.28–1.81)] compared to normal weight. There were also indications of obese women being more likely to deliver by ECS than women of normal weight, irrespective of migrant status.
Conclusions An elevated RR for obese and in parts for overweight women of labour induction and ECS pertains irrespective of migrant status. This warrants further research looking into pathophysiological in addition to health-system factors. Weight control interventions addressed at overweight/obese women planning pregnancies are urgently needed.

Keywords Pre-pregnancy BMI · Overweight/obesity · Immigrants · Emergency caesarean section · Induction of labour

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Introduction

The prevalence of overweight and obesity among adults is increasing in most countries. World-wide, 38 % of men and 40 % of women are overweight—the prevalence of obesity is 11 % for men and 15 % for women. In all countries women are more likely to be obese than men (WHO 2014).

Overweight and obesity are associated with several unfavourable health outcomes and with increased mortality risk. Pre-pregnancy excessive weight is even more harmful as it negatively affects both mother and child. Adverse outcomes can occur during pregnancy, during labour and post-partum. Maternal overweight/obesity is associated with the development of pre-eclampsia and gestational diabetes, induction of labour and delivery by planned or emergency caesarean section, as well as with giving birth to a large-for-gestational-age child, a macrosomic child or one with a low Apgar score (Ovesen et al. 2011; Athukoral et al. 2010; Sebire et al. 2001; Bautista-Castaño et al. 2013; Lu et al. 2001).

In Germany, 29 % of women are overweight (BMI 25–<30 kg/m^2), 24 % are obese (BMI ≥ 30 kg/m^2) and 3 % are severely obese with a BMI of 40 kg/m^2 or higher. As in many other western European countries,

the prevalence of overweight among women remained stable over time; the prevalence of obesity, however, increased during the last 25 years (Mensink et al. 2013). This also applies to pregnant women in Germany: the prevalence of obesity increased from 8 to 13 % between 1995 and 2011 (Scholz et al. 2013). Negative effects of maternal overweight/obesity on pregnancy outcomes were also found in Germany (Voigt et al. 2011), although very few studies focused on delivery outcomes so far.

Germany is one of the main receiving countries of migration today. In 2013, 15.9 million persons or 20 % of the entire population of Germany had a migration background: two-thirds, and thus the majority, were born outside Germany (10.5 million)—the so-called first generation; one-third, the so-called second generation, was born in Germany with parents born abroad (5.4 million). The two largest immigrant groups (1st and 2nd generation combined) originate from Turkey and from Eastern European countries (Federal Statistical Office of Germany 2014).

Immigrant women from low- and middle-income countries are assumed to have a higher prevalence of overweight and obesity and a higher average BMI than non-immigrant women in Germany (Razum et al. 2008). A higher pre-pregnancy obesity prevalence and an excessive weight gain during pregnancy were also found among pregnant immigrant women (Reeske et al. 2012, 2013). It is still unknown whether there are differences between first- and second-generation immigrant women. Studies from the USA and the Netherlands, for example, indicate an increase in overweight prevalence between first and subsequent immigrant generations (Hosper et al. 2007; Dijkshoorn et al. 2014; Gordon-Larsen et al. 2003).

Contrary to what their higher overweight prevalence would suggest, pregnant immigrant women are less likely to deliver by (planned or emergency) caesarean section than pregnant non-immigrant women (David et al. 2006, 2014). In Germany, a comparison between immigrant and non-immigrant women regarding pre-pregnancy excessive weight and adverse pregnancy outcomes has only been carried out for neonatal outcomes (Reiss et al. 2015) but not yet for outcomes, such as labour induction or caesarean section.

To resolve the contradiction of a higher prevalence of overweight/obesity among immigrant women and at the same time a lower probability to deliver by caesarean section, we aimed to investigate possible differences among pregnant immigrant (separately for first and second generation) and non-immigrant women in Germany regarding the association of pre-pregnancy overweight/obesity and mode of delivery as well as type of labour onset.

Methods

Data source

Data from the study "The influence of migration and acculturation on pregnancy and birth" was used which was conducted in a 12-month period in 2011/2012 in Berlin/Germany. Eligible for study participation were pregnant women aged 18 years and above with a permanent residence in Germany who were admitted for delivery to one of three participating maternity hospitals with a foetus with an intact pregnancy (24+ completed weeks of gestation). The women were approached directly after admission. Women who agreed to participate were interviewed in two standardised face-to-face interviews by trained, multilingual study staff using questionnaires available in nine different languages. Interviews were carried out before the onset of labour pain and again after delivery. The questionnaires comprised socio-demographical and socio-economical questions, questions on antenatal care, breastfeeding, migration history, acculturation, and smoking during pregnancy. Of 8157 women delivering in the three hospitals, 2.9 % ($n = 235$) did not meet the inclusion criteria. Of the remaining women, 7100 participated in the main study (response rate: 89.6 %) (David et al. 2014).

Outcome variables

The main outcome variables were mode of delivery and type of labour onset. Mode of delivery was classified in three categories: spontaneous vaginal delivery, operative vaginal delivery, and emergency caesarean section. Type of labour onset was classified in two categories: spontaneous versus induced labour.

Exposure variables

Pre-pregnancy BMI was estimated based on height and weight measured and documented by medical doctors during the first antenatal care visit which, on average, took place during the first trimester (9th/10th gestational week). According to Rasmussen and Yaktine (2009), women do not gain more than 0.5–2 kg in weight during the first trimester, which corresponds to normal fluctuations in body weight. Information on height was missing in 12.4 % and information on weight was missing in 6.1 % of the cases. Missing values were imputed using linear regression analyses with five iterations, respectively. Pre-pregnancy BMI was categorised according to WHO recommendations in underweight (<18.5 kg/m^2), normal weight (18.5–<25 kg/m^2), overweight (25–<30 kg/m^2) and obesity (≥ 30 kg/m^2).

Other variables were maternal age (18–24, 25–29, 30–34, 35+ years), education, relationship status (with vs. without partner), smoking during pregnancy (occasional smoker, regular smoker, non-smoker), high risk pregnancy, foetal macrosomia (birth weight <4000 g vs. birth weight ≥4000 g), and parity (nullipara vs. primi-/bi-/multipara). High-risk pregnancy is defined by the following: maternal age (<18 years, primipara >35 years, multipara >40 years), complications during present pregnancy (e.g. gestational diabetes), complications during past pregnancy/pregnancies and delivery/deliveries (e.g. preterm delivery), diseases of the pregnant women, use of medication, and substance abuse (e.g. nicotine, alcohol, drugs). Education was classified in three categories: low (no graduation/primary education), medium (lower secondary education), and high (upper secondary education and higher).

Women with a personal or familial history of migration were identified by their own and their parents' country of birth. Women who were born abroad and immigrated to Germany were classified as first generation immigrants. Women who were born in Germany but with parents born outside Germany were classified as second generation immigrants. The reference group (hereinafter referred to as non-immigrant women) were women who themselves and whose parents were born in Germany and (a small number of) women who were born in Germany but with one parent born abroad.

Statistical analyses

Log-binomial models had questionable convergence. Thus, Poisson regression models with robust error estimates were fitted to estimate relative risks (RR) for the influence of pre-pregnancy overweight/obesity on outcomes of delivery. Women with normal weight served as reference group in all analyses; underweight women and preterm deliveries (<37 weeks gestation) were excluded from the analyses.

The outcomes were operationalised as mode of delivery (vaginal vs. emergency caesarean) and type of labour onset (spontaneous vs. induced). Spontaneous vaginal and operative vaginal deliveries were combined to one category for the regression analysis. Among both immigrant and non-immigrant women the number of operative vaginal deliveries was small and no differences between spontaneous and operative vaginal deliveries were observed. As the study aimed to compare immigrant and non-immigrant women regarding the effect of pre-pregnancy overweight/obesity on delivery outcomes and the interaction analysis between migrant status and overweight/obesity was statistically significant, all models were stratified by migrant status. All models were adjusted for maternal age, education, relationship status, smoking during pregnancy, high risk pregnancy, foetal macrosomia, and parity. Linear regression models showed no evidence of multicollinearity between the variables selected for Poisson regressions.

Results

1849 pregnant women were excluded from analyses (multiple birth: $N = 225$, gestational age <37 weeks: $N = 623$, elective caesarean section: $N = 765$, BMI < 18.5: $N = 236$). Remaining difference to complete data is due to missing values, in particular for smoking ($N = 295$). Complete data was available for 4859 pregnant women of whom 1987 women or 40.9 % were first generation immigrants and 687 or 14.1 % were second generation immigrants. Second generation immigrants were on average the youngest of all survey participants. The proportion of women with a low educational level was highest in first generation immigrants (26.7 vs. 3.2 % among non-immigrants). Moreover, immigrant women were more often overweight (first generation: 31.1 %; second generation: 28.0) and obese (first generation: 13.3 %; second generation: 16.8) than non-immigrant women (22.3 and 10.9 %, respectively). The smoking prevalence during pregnancy was highest among second generation immigrants (27.4 %) and comparable between first generation (18.6 %) and non-immigrant women (18.2 %) (see Table 1). Differences between the comparison groups were also observed regarding obstetric characteristics. Immigrant women were less often nulliparous at the time of the survey compared to non-immigrant women, irrespective of generation. The proportion of induced labour was comparable between first generation (27.5 %), second generation (30.9 %) and non-immigrant women (29.9 %). However, differences were observed regarding mode of delivery. Whereas 25.0 % of the non-immigrant women delivered their child by emergency caesarean section, this applied to only 16.7 % of the first generation and 18.6 % of the second generation immigrant women (see Table 2).

Table 3 shows the adjusted relative risks (RR) for labour induction separately for the two immigrant groups and non-immigrant women. Pre-pregnancy BMI was significantly associated with labour induction in some subgroups. Both first- and second-generation immigrant women had a high relative risk of labour induction when they were obese [RR = 1.41 (95 % CI: 1.15–1.72), RR = 1.51 (95 % CI: 1.14–2.00)]. This association was also observed among overweight immigrant women of both generations, although results were not significant. Similar patterns applied to non-immigrant women. They also had a high relative risk of labour induction when they were overweight [RR = 1.36 (95 % CI: 1.17–1.57)] or obese [RR = 1.53 (95 % CI: 1.28–1.81)].

Table 1 Socio-demographic and lifestyle characteristics of the study population, by migrant status (Berlin, Germany 2011–2012)

	1st generation women ($N = 1987$)	2nd generation women ($N = 687$)	Non-immigrant women ($N = 2185$)	Total sample ($N = 4859$)
Maternal age (years)				
18–24	438 (22.0 %)	230 (33.5 %)	371 (17.0 %)	1039 (21.4 %)
25–29	608 (30.6 %)	220 (32.0 %)	552 (25.3 %)	1380 (28.4 %)
30–34	524 (26.4 %)	160 (23.3 %)	709 (32.5 %)	1393 (28.7 %)
35+	417 (21.0 %)	77 (11.2 %)	553 (25.3 %)	1047 (21.5 %)
Mean (SD)	29.6 (5.8)	27.6 (5.3)	30.6 (5.7)	29.7 (5.8)
Pre-pregnancy BMI (kg/m^2)				
18.5–<25	1104 (55.6 %)	380 (55.3 %)	1458 (66.7 %)	2942 (60.5 %)
25–<30	618 (31.1 %)	192 (28.0 %)	487 (22.3 %)	1297 (26.7 %)
≥30	265 (13.3 %)	115 (16.8 %)	240 (10.9 %)	620 (12.8 %)
Mean (SD)	25.1 (4.6)	25.4 (5.0)	24.4 (5.1)	24.8 (4.9)
Education level				
High	681 (34.3 %)	120 (17.5 %)	1127 (51.6 %)	1928 (39.7 %)
Medium	776 (39.1 %)	509 (74.1 %)	989 (45.3 %)	2274 (46.8 %)
Low	530 (26.7 %)	58 (8.4 %)	69 (3.2 %)	657 (13.5 %)
Living in a partnership				
No	112 (5.6 %)	30 (4.4 %)	106 (4.9 %)	248 (5.1 %)
Yes	1875 (94.4 %)	657 (95.6 %)	2079 (95.2 %)	4611 (94.9 %)
Smoking during pregnancy				
No	1618 (81.4 %)	499 (72.6 %)	1789 (81.9 %)	3906 (80.4 %)
Regularly	274 (13.8 %)	122 (17.8 %)	279 (12.8 %)	675 (13.9 %)
Occasionally	95 (4.8 %)	66 (9.6 %)	117 (5.4 %)	278 (5.7 %)

Numbers may not add up to exactly 100.0 % due to rounding errors

Age, educational level, relationship status, smoking behaviour and high-risk pregnancy were not significantly associated with labour induction among immigrant women, irrespective of generation. Primi-/bi-/multiparity was negatively associated with labour induction among both immigrant groups. Foetal macrosomia (among 1st generation immigrants) and the presence of a high-risk pregnancy (among 2nd generation immigrants) were positively associated with labour induction among immigrants. Also among non-immigrant women, primi-/bi-/multiparity was negatively associated with labour induction. Moreover, non-immigrant women without a partner were significantly more likely to have their labour induced compared to those with a partner.

Table 4 presents the adjusted relative risks (RR) for emergency caesarean section among both immigrant groups and non-immigrant women. Obese immigrant women of the first generation had a high relative risk of delivering by emergency caesarean section [RR = 1.62 (95 % CI: 1.25–2.10)]. There were also indications of a high relative risk among overweight first generation and among overweight/obese second generation women, although the results were not significant. Among non-immigrant women, obesity [RR = 1.44 (95 % CI: 1.17–1.77)] was also positively associated with an emergency caesarean section. Here, too, overweight seemed to have an—albeit not significant—influence on the delivery by emergency caesarean section.

Moreover, older women were more likely and primi-/bi-/multiparous women were less likely to deliver by emergency caesarean section compared to younger women and nulliparous women, irrespective of migrant status. Foetal macrosomia and the presence of a high-risk pregnancy were positively associated with emergency caesarean section among first generation and non-immigrant women, as was occasional smoking among both immigrant groups. Additionally, education and relationship status were significantly associated with emergency caesarean section among first generation immigrant women.

Discussion

This study has three main findings. First, we confirmed that first- and second-generation immigrant women are more often overweight/obese than non-immigrant women but

Table 2 Obstetric characteristics of the study population, by migrant status (Berlin, Germany 2011–2012)

	1st generation women ($N = 1987$)	2nd generation women ($N = 687$)	Non-immigrant women ($N = 2185$)	Total sample ($N = 4859$)
Parity[a]				
Nullipara	695 (35.0 %)	325 (47.3 %)	1285 (58.8 %)	2305 (47.4 %)
Primi-/bi-/multipara	1292 (65.0 %)	362 (52.7 %)	900 (41.2 %)	2554 (52.6 %)
High-risk pregnancy[b]				
No	1377 (69.3 %)	469 (68.3 %)	1436 (65.7 %)	3282 (67.5 %)
Yes	610 (30.7 %)	218 (31.7 %)	749 (34.3 %)	1577 (32.5 %)
Type of labour onset				
Spontaneous	1440 (72.5 %)	475 (69.1 %)	1531 (70.1 %)	3446 (70.9 %)
Induced	547 (27.5 %)	212 (30.9 %)	654 (29.9 %)	1413 (29.1 %)
Induced by medication	545 (99.6 %)	207 (97.6 %)	651 (99.5 %)	1403 (99.3 %)
Amniotomy[c]	9 (1.7 %)	9 (4.3 %)	14 (2.1 %)	32 (2.3 %)
Mode of delivery				
Spontaneous vaginal delivery	1477 (74.3 %)	474 (69.0 %)	1364 (62.4 %)	3315 (68.2 %)
Operative vaginal delivery	178 (9.0 %)	85 (12.4 %)	275 (12.6 %)	538 (11.1 %)
Emergency caesarean section	332 (16.7 %)	128 (18.6 %)	546 (25.0 %)	1006 (20.7 %)
Foetal macrosomia				
Birth weight <4000 g	1766 (88.9 %)	618 (90.0 %)	1914 (87.6 %)	4298 (88.5 %)
Birth weight ≥4000 g	221 (11.1 %)	69 (10.0 %)	271 (12.4 %)	561 (11.5 %)

Numbers may not add up to exactly 100.0 % due to rounding errors

[a] Without present pregnancy

[b] High risk pregnancy defined by age of the mother (<18 years, primipara >35 years, multipara >40 years), complications during present pregnancy (e.g. gestational diabetes), complications during past pregnancy/pregnancies and delivery/deliveries (e.g. preterm delivery), diseases of the pregnant women, use of medication, and substance abuse (e.g. nicotine, alcohol, drugs)

[c] More than one method was used in a small proportion of women

they are indeed less likely to deliver their child by an emergency caesarean section compared to non-immigrant women. Second, pre-pregnancy obesity significantly increases the likelihood for labour induction—both among first- and second-generation immigrant and non-immigrant women. Third, pre-pregnancy obesity is also associated with a high relative risk of delivering by emergency caesarean section, again, regardless of migrant status.

The higher prevalence of overweight/obesity among immigrant compared to non-immigrant women was also observed among other studies in Germany (see "Introduction") and among a study in the Netherlands (Djelantik et al. 2012). Two studies from England (UK) and Florida (USA) observed a high prevalence of overweight/obesity only among certain immigrant groups. Heslehurst et al. (2010) found that black British women were the only immigrant group in their study to have increased odds of pre-pregnancy overweight/obesity compared to white British women. Kim et al. (2013) reported a higher prevalence of maternal excessive weight only among Mexican, non-Hispanic black and Haitian women as compared to the total migrant study population. In contrast to the studies from the Netherlands and USA (Hosper et al. 2007; Dijkshoorn et al. 2014; Gordon-Larsen et al. 2003) we did not find indications of an increase in overweight/obesity prevalence between pregnant first and second generation immigrant women.

In this study, the rate of emergency caesarean section was lower in both first- and second-generation immigrants compared to non-immigrants. Here, too, studies report diverse results depending on the specific immigrant group(s) under study. Some observed higher risks of having a caesarean section among certain immigrant groups compared to non-immigrant women, some observed lower risks and some studies found similar patterns between immigrant and non-immigrant women (Bernis et al. 2013; Merten et al. 2007; Walsh et al. 2011; Kanthasamy et al. 2013). An insufficient proficiency in the language of the host country might also affect the decision for or against a caesarean delivery among immigrant women (Merry et al. 2013). However, in this study we did not find substantial differences between immigrant women with different self-rated German language proficiency. Thus, communication barriers between immigrant women and medical staff are unlikely to account for the observed findings.

Vinturache et al. (2014), in a study that did not consider migration background, showed that only obese women who were induced were more likely to deliver by emergency

Table 3 Association between labour induction and socio-economic status, lifestyle and obstetric characteristics, by migrant status (Berlin, Germany 2011–2012)

	First generation women ($N = 1987$, events = 547)				Second generation women ($N = 687$, events = 212)				Non-immigrant women ($N = 2185$, events = 654)			
	N	RR	95 % CI	*p* value	*N*	RR	95 % CI	*p* value	*N*	RR	95 % CI	*p* value
Age (years)												
18–24	438	1.00			230	1.00			371	1.00		
25–29	608	1.12	0.90–1.38	0.2891	220	1.02	0.77–1.35	0.8790	552	1.01	0.84–1.22	0.9309
30–34	524	1.22	0.98–1.52	0.0807	160	1.10	0.80–1.50	0.5713	709	0.95	0.78–1.16	0.5980
35+	417	1.17	0.92–1.48	0.1946	77	1.03	0.68–1.58	0.8788	553	1.06	0.86–1.32	0.5718
Education												
High	681	1.00			120	1.00			1127	1.00		
Medium	776	1.06	0.90–1.26	0.4818	509	1.28	0.91–1.81	0.1548	989	1.11	0.96–1.29	0.1555
Low	530	0.91	0.74–1.12	0.3760	58	1.28	0.76–2.16	0.3588	69	1.38	0.99–1.92	0.0589
Living in a partnership												
Yes	1875	1.00			657	1.00			2079	1.00		
No	112	0.98	0.71–1.36	0.9052	30	0.84	0.45–1.56	0.5846	106	1.28	1.01–1.63	0.0400
Smoking during pregnancy												
No	1618	1.00			499	1.00			1789	1.00		
Regularly	274	0.98	0.78–1.22	0.8252	122	1.10	0.81–1.49	0.5494	279	1.18	0.98–1.42	0.0751
Occasionally	95	0.88	0.63–1.23	0.4505	66	1.08	0.76–1.51	0.6786	117	1.06	0.81–1.41	0.6612
Pre-pregnancy BMI (kg/m^2)												
18.5–<25	1104	1.00			380	1.00			1458	1.00		
25–<30	618	1.16	0.99–1.36	0.0725	192	1.29	1.00–1.66	0.0508	487	1.36	1.17–1.57	<0.0001
≥30	265	1.41	1.15–1.72	0.0009	115	1.51	1.14–2.00	0.0046	240	1.53	1.28–1.81	<0.0001
High-risk pregnancy[b]												
No	1377	1.00			469	1.00			1436	1.00		
Yes	610	1.09	0.93–1.26	0.2910	218	1.30	1.03–1.63	0.0257	749	1.05	0.92–1.20	0.4474
Parity[a]												
Nullipara	695	1.00			325	1.00			1285	1.00		
Primi-/Bi-/multipara	1292	0.66	0.57–0.76	0.0001	362	0.65	0.51–0.83	0.0005	900	0.70	0.60–0.80	<0.0001
Foetal macrosomia												
Birth weight <4000 g	1766	1.00			618	1.00			1914	1.00		
Birth weight ≥4000 g	221	1.47	1.22–1.77	<0.0001	69	1.25	0.89–1.75	0.1933	271	1.12	0.93–1.35	0.2392

[a] Without present pregnancy

[b] High risk pregnancy defined by age of the mother (<18 years, primipara >35 years, multipara >40 years), complications during present pregnancy (e.g. gestational diabetes), complications during past pregnancy/pregnancies and delivery/deliveries (e.g. preterm delivery), diseases of the pregnant women, use of medication, and substance abuse (e.g. nicotine, alcohol, drugs)

caesarean section. They found no significant association between maternal excessive weight and emergency caesarean section in women delivering spontaneously. Stratification by type of labour onset was also performed in this study and resulted in no significant differences between spontaneous and induced labour.

Unfortunately, none of the studies cited above explicitly focused on the relationship between maternal excessive weight and delivery outcomes among different immigrant generations and non-immigrant women. This study implies a high relative risk for overweight/obese women to receive a labour induction and deliver by emergency caesarean section—irrespective of migrant status. A systematic review and meta-analysis on the association between immigration and caesarean deliveries also reported that a high maternal BMI was frequently postulated as a risk factor for caesarean section (Merry et al. 2013). In general, rates of both labour induction and emergency caesarean deliveries tend to be higher among overweight and obese women as compared to women of normal weight (Usha

Table 4 Association between emergency caesarean section and socio-economic status, lifestyle and obstetric characteristics, by migrant status (Berlin, Germany 2011–2012)

	First generation women ($N = 1987$, events = 332)				Second generation women ($N = 687$, events = 128)				Non-immigrant women ($N = 2185$, events = 546)			
	N	RR	95 % CI	*p* value	*N*	RR	95 % CI	*p* value	*N*	RR	95 % CI	*p* value
Age (years)												
18–24	438	1.00			230	1.00			371	1.00		
25–29	608	1.47	1.09–1.99	0.0127	220	1.23	0.82–1.84	0.3160	552	1.02	0.77–1.30	0.8905
30–34	524	1.61	1.17–2.21	0.0037	160	1.37	0.86–2.18	0.1817	709	1.27	1.00–1.61	0.0504
35+	417	2.18	1.58–3.00	<0.0001	77	2.28	1.36–3.83	0.0017	553	1.44	1.12–1.84	0.0042
Education												
High	681	1.00			120	1.00			1127	1.00		
Medium	776	0.79	0.63–0.98	0.0349	509	1.18	0.76–1.84	0.4629	989	0.89	0.75–1.06	0.2023
Low	530	0.61	0.45–0.81	0.0009	58	1.06	0.49–2.26	0.8836	69	1.37	0.89–2.11	0.1523
Living in a partnership												
Yes	1875	1.00			657	1.00			2079	1.00		
No	112	1.87	1.37–2.57	0.0001	30	1.22	0.66–2.26	0.5218	106	1.28	0.96–1.70	0.0971
Smoking during pregnancy												
No	1618	1.00			499	1.00			1789	1.00		
Regularly	274	1.29	0.98–1.69	0.0712	122	1.21	0.79–1.86	0.3731	279	1.08	0.85–1.38	0.5256
Occasionally	95	1.54	1.08–2.20	0.0177	66	1.60	1.03–2.48	0.0374	117	1.04	0.74–1.46	0.8071
Pre-pregnancy BMI (kg/m^2)												
18.5–<25	1104	1.00			380	1.00			1458	1.00		
25–< 30	618	1.15	0.92–1.44	0.2260	192	1.23	0.85–1.77	0.2690	487	1.14	0.95–1.36	0.1544
≥30	265	1.62	1.25–2.10	0.0002	115	1.40	0.93–2.12	0.1047	240	1.44	1.17–1.77	0.0006
High-risk pregnancy[b]												
No	1377	1.00			469	1.00			1436	1.00		
Yes	610	1.52	1.25–1.85	<0.0001	218	1.34	0.97–1.87	0.0779	749	1.30	1.13–1.51	0.0004
Parity[a]												
Nullipara	695	1.00			325	1.00			1285	1.00		
Primi-/bi-/multipara	1292	0.43	0.35–0.53	<0.0001	362	0.49	0.34–0.70	<0.0001	900	0.52	0.44–0.62	<0.0001
Foetal macrosomia												
Birth weight <4000 g	1766	1.00			618	1.00			1914	1.00		
Birth weight ≥4000 g	221	1.36	1.02–1.82	0.0334	99	1.23	0.77–1.97	0.3892	271	1.22	1.01–1.49	0.0428

[a] Without present pregnancy

[b] High risk pregnancy defined by age of the mother (<18 years, primipara >35 years, multipara >40 years), complications during present pregnancy (e.g. gestational diabetes), complications during past pregnancy/pregnancies and delivery/deliveries (e.g. preterm delivery), diseases of the pregnant women, use of medication, and substance abuse (e.g. nicotine, alcohol, drugs)

Kiran et al. 2005; Morken et al. 2013; Gaillard et al. 2013; Sheiner et al. 2004; Vassilaki et al. 2015). Thus, there is a substantial contribution of pre-pregnancy excessive weight to delivery outcomes. Unexpectedly, we found it to be independent of migrant status, obstetric characteristics or the socio-economic situation and lifestyle of the women. Thus, besides potential social and health system-related factors, there seems to be a pathophysiological component that might be linked to e.g. poor uterine contractility among overweight/obese women in general (Zhang et al. 2007; Lowe and Corwin 2011).

Strengths and limitations

To our knowledge, this is the first study to analyse the relationship between pre-pregnancy overweight/obesity and mode of delivery as well as type of labour onset among first- and second-generation immigrant and non-immigrant women in Germany. Another strength of this study is the response rate of almost 90 %, which is high for studies aiming to enrol immigrants. Still, the absolute number of immigrant women was too small to allow for stratified analyses by country of origin, which is a limitation.

Another limitation is that pre-pregnancy weight had to be approximated by measuring weight during the first trimester (9th/10th gestational week). Therefore, weight and BMI of the pregnant women might be somewhat overestimated. However, our sensitivity analysis showed that women who booked after the 13th gestation week did not change the results. Moreover, Shin et al. (2014) showed a significantly high correlation between weight measurements during the first trimester and self-reported pre-pregnancy weight.

Implications for public health practise and future research

The present and several other international analyses demonstrate the major impact of maternal excessive weight on delivery outcomes and thus on the health of mother and child. In terms of a life-course perspective many studies also postulate a higher risk of childhood overweight/obesity among the offspring of women with excessive pre-pregnancy weight—also in immigrant women (Mehta et al. 2011; Schellong et al. 2012). Thus, there is need for interventions addressed at women with a high BMI who are pregnant or planning a pregnancy. These women, as well as their offspring, would benefit from preventive programmes that aim to change their lifestyle by integrating exercise strategies and healthy dietary habits (Dodd et al. 2014; Thangaratinam et al. 2012). Given the already high and still increasing prevalence of overweight and obesity among women in high-income countries, such as Germany, this poses a great challenge to women's health and to public health practise.

Research on the relationship between maternal overweight/obesity and delivery outcomes with a special focus on immigrant and non-immigrant women is scarce—not only in Germany but also in other countries. Thus, more research is needed to confirm the associations we found in our study. Although this study suggests that the association between maternal excessive weight and delivery outcomes is independent of migrant status, there might still be differences within immigrant groups, such as among women from different countries of origin. Given the barriers that immigrant women face when accessing health care (Razum et al. 2008), system-related factors as well as women's perspectives should receive more attention. Future research on obesity in pregnancy among immigrants should also focus on pathophysiological mechanisms—in addition to effect modification by migrant status, social and contextual factors—to explain a potential causal relationship between excessive maternal weight and increased risks during labour. Finally, as some investigations also report a relationship between excessive gestational weight and adverse pregnancy outcomes, future research should focus on both pre-pregnancy overweight/obesity and gestational weight gain (Ferraro et al. 2012; Li et al. 2013).

Compliance with ethical standards

Ethical standards The Charité Ethics Committee, Berlin, approved the study on Feb 18, 2009, reference EA1/235/08. Data protection regulations were observed in the survey and in the linkage to hospital data.

Conflict of interest The authors declare that they have no conflicts of interest.

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