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Country of birth and county of residence and association with overweight and obesity – a population based study of 219 555 pregnancies in Norway

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Background

The aim was to study the effect of country of birth, educational level and county of residence on overweight and obesity among pregnant women in Norway.

Methods

Observational study based on Medical Birth Registry Norway and Statistics Norway. The study population consisted of 219 555 deliveries in 2006-2014. BMI was registered at the first antenatal care visit. Multivariate regression analysis was used to explore the study aims.

Results

Overweight (BMI 25-29.9) was recorded in 22.3% of the women, obesity (BMI ≥30) in 12.2%. Highest rates of overweight (30.8%) and obesity (13.5%) was recorded among women from the Middle East and North Africa or with no education (30.7% and 17.2%). The prevalence of overweight and obesity was 39.5% in sparsely populated counties and 26.4% for women living in Oslo. Adjusted for country of birth, education level, age, parity, smoking and marital status, the relative odds of overweight and obesity were 65% (95% CI 59% to 72%) higher in sparsely populated counties compared to Oslo.

Conclusions

The prevalence of overweight (BMI ≥25) was 34.5 %. The factors associated with overweight were living in rural districts in Norway, lower education and being born in countries in the Middle East or Africa.

Introduction

The prevalence of overweight and obesity has increased worldwide, and is a notable public health challenge. The trend shows an increasing prevalence globally (1). Women are more likely to have overweight and obesity than men in all WHO-regions (2). Previous research in Norway indicates an increasing rate of overweight and obesity, especially among the youngest age groups (20-39 years) (3,4). The same tendency of increasing weight has also been observed among pregnant women in other countries (5,6). Maternal overweight and obesity is associated with adverse pregnancy outcomes such as gestational diabetes, pregnancy-induced hypertension, preeclampsia and caesarean delivery. These women also have a higher risk of complications such as congenital anomalies, miscarriage, stillbirth and preterm birth (7-9).

Overweight and obesity are inversely related to socioeconomic status. Previous studies from different countries conclude that high Body Mass Index (BMI) is correlated with low socioeconomic status and education level (10-14). Increased prevalence of obesity in all socioeconomic groups from the 1980s up to present time in Norway has been described (15). Previous studies show a higher prevalence of overweight and obesity among pregnant immigrant women in Sweden, Germany and the United States, compared with non-immigrant women (6,16,17). A previous smaller study with 3019 participants assessed maternal BMI among immigrants from Turkey, Pakistan and Sri Lanka in Norway. This study reported 1320 women from these three countries, and showed increased BMI among the immigrant women compared with Norwegian women (18).

Population distribution can be a contributing factor for the prevalence of overweight and obesity. An urban-rural gradient of overweight and obesity has been previously described. Living in rural districts increases the risk of overweight and obesity, and the inequality persists when adjusted for education level (6,15,19,20).

The aim of this study was to investigate the prevalence of overweight and obesity among pregnant women in Norway and to assess how maternal country of birth and county of residence are associated with overweight.

Methods

This study is a part of the PURPLE Study, which was evaluated and approved by the Regional Committee for Medical Research Ethics in South-Eastern Norway (ref 2015/681) and the Institutional Personal Data Officer in Oslo University Hospital. All parts of the study have followed Norwegian Health Research legislation.

Medical Birth Registry Norway (MBRN) is a national health registry containing information on all pregnancies and deliveries in Norway since 1967 (21). It is mandatory for all maternity units in Norway to report data to MBRN, using standardized forms completed by midwives immediately after delivery. Home births are also reported to MBRN by the midwife attending the delivery. The registry contains demographic information and a large amount of various data, including information on maternal health before and during pregnancy, previous obstetric history (including pregnancy loss), complications during pregnancy and birth, newborn outcomes including information on congenital abnormalities and any neonatal diagnoses.

Variables that in previous research have been described to be associated with overweight and obesity were included in the study, and the prevalence of BMI groups was calculated for all the subgroups of women.

Variables from MBRN

Recording of maternal weight and height in the MBRN database started in 2006. Registration of weight and height has gradually increased during the years after 2006, and more than 70% of deliveries had maternal weight and height recorded in 2014. The missing values of weight

and height are randomly distributed between the different categories of BMI, and therefore low risk of bias is likely. From 2006 to 2014, weight and height was recorded in 219 555 pregnancies, and these were included in the present study.

Weight and height are registered at the first antenatal care visit in Norway, which usually takes place in gestational week 8-12 (22). The weight is either self-reported pre-pregnancy weight or measured at the first visit. Body Mass Index (BMI) is calculated by using weight in kilograms divided by the square of the height in meters (kg/m^2). The WHO classification was used to define underweight <18.5 kg/m^2, normal weight 18.5- 24.99 kg/m^2, overweight 25-29.99 kg/m^2 and obesity class I 30-34.99 kg/m^2, obesity class II and III ≥ 35 kg/m^2. Only 1.1% of the study population had a BMI ≥40 kg/m^2, and these women were analyzed together with the obesity class II.

MBRN records pregnant women's county of residence. There are 19 counties in Norway, all of which are very diversified in terms of size and demography. Based on population density and the largest cities in Norway, six population areas were defined (Table 1). Oslo is the capital of Norway with 634 463 inhabitants (2014), and has the highest population density (used as reference group). The county in group 2 includes the metropolitan area surrounding Oslo. The counties in group 3 include Bergen and Stavanger which are the second and third largest cities after Oslo. The following groups 4-6 were classified based on the county's population density. There were no notable changes in the counties' population density during the study years. Missing data on smoking status 1st trimester was coded as "No", as in previous a Norwegian study based on MBRN data (23).

The MBRN is routinely linked with the Central Population Register to ensure data quality.

Variables from SSB

Statistics Norway (SSB) is a central agency which produces official statistics in Norway. Information on maternal educational level and country of birth was obtained from Statistics Norway, and this data was merged with the data from MBRN.

Woman's country of birth was categorized to world regions defined by The World Bank, and Europe was further divided to EEA, non-EEA and Nordic countries. Norway was used as the reference in all analyses.

Education was used as a proxy measure of socioeconomic status. The Norwegian Standard Classification of Education includes Norwegian education codes and corresponding codes from the International Standard Classification of Education (ISECD-2011) (24). The eight levels used in ISECD-2011 were merged into 5 levels in this study, according to numbers of years of highest completed education. No education, compulsory (grades 1-10th), secondary education (11th-13th), higher education (Bachelor level) and highest education (Master/PhD). Secondary education was used as reference group.

The descriptive analysis

The prevalence of underweight, normal weight, overweight and obesity was calculated in each subgroup of women according to the assessed variables, and presented in percentages.

The regression analysis

The unadjusted odds ratios (OR) with 95% confidence intervals (CI) were estimated by regression analysis with overweight (BMI≥25 kg/m^2) as the dependent variable. Bivariate regression analysis was used to explore the association of the main exposures (maternal education, country of birth and county of residence in Norway) with overweight, as well as maternal covariates such as age, parity, smoking and marital status. Significant covariates were included in the logistic regression analysis to estimate the adjusted ORs with 95% confidence intervals.

Continuous data were categorized when appropriate. Inter-correlation between the variables were controlled with collinearity test in SPSS. No multicollinearity was found between the variables. All statistical analyses were performed using IBM® SPSS® Statistics, version 23.

Results

This study included 219 555 pregnancies registered with maternal BMI in MBRN between years 2006-2014. Overweight was recorded in 22.3 % (48 984) of the pregnancies (BMI 25-29.9), and 12.2 % (26 711) were recorded with obesity (BMI ≥30). Obesity distribution was 8.4 % (18 335) in class I, and 3.8 % (8 376) in class II or III. Normal weight was recorded among 61.4 % (134 765) and 4.1 % (9 095) were underweight. (Table 2).

Crude analyses

Country of birth

Women born in Middle East and North Africa (OR 1.42, CI 1.34-1.50) or Sub-Saharan Africa (OR 1.37, CI 1.30-1.44) had the highest OR and prevalence of overweight. East Asia and Pacific-born women had the lowest OR and prevalence of overweight (OR 0.34, CI 0.32-0.36) (Table 3).

Place of residence in Norway

The highest prevalence of overweight (39.5%) was observed among women living in counties with the lowest population (group 6 in table 1), and the lowest prevalence of overweight was registered in Oslo, the capital of Norway (26.4%). Group 6 had a notably increased OR of being overweight compared to women in Oslo (OR 1.81, CI 1.74-1.88) (Table 3).

Educational level

There was an inverse association between pre-pregnancy BMI and education level. Women with no education had the highest prevalence (47.9%) and OR of being overweight (OR 1.30,

CI 1.18-1.43). In contrast, women with highest education had the lowest prevalence (22.3%) and OR for being overweight (OR 0.42, CI 0.41-0.44) (Table 2 and 3).

Maternal Age, parity and smoking

Increasing maternal age significantly increased the prevalence (Table 2) and OR of overweight (Table 3), similarly, women with higher parity had higher prevalence and OR of being overweight compared with primiparous women. Daily smoking was associated with a 42% and occasional smoking with a 18% increase in OR for overweight.

Multivariate regression analysis

All the statistically significant variables were entered in the multivariate regression analysis. The main findings remained unchanged after adjustment for the significant covariates (Table 3). Maternal country of birth from Middle East and North Africa, lower education, advanced age, higher parity and living outside the biggest cities in Norway were the main factors associated with overweight. In contrast, Non-Norwegian-born European women had lower OR of being overweight compared to Norwegian-born women. After multivariate regression analyses the adjusted ORs remained significant for educational level, except for "Compulsory (gr 1-10)" education, (aOR 1.01, CI 0.99-1.04). In the adjusted analyses, the association between overweight among daily smokers was reduced from 42% to 19%, and among occasional smokers from 18% to 9%.

Discussion

Main finding

In this large population based study, overweight was significantly associated with maternal country of birth and county of residence in Norway. Women born in Sub-Saharan Africa, Middle East and North Africa had the highest prevalence of and odds ratio for overweight and obesity. Overweight and obesity was inversely associated with educational level and population density in county of residence. These findings remained significant after

adjustment with known risk factors. The prevalence of overweight was 22.3% among the pregnant women and 12.2% were recorded with obesity.

What is known on this topic

Similar results were observed for years 2008-2012 in The Danish Medical Birth Registry, with 22 % overweight and 12 % obesity among the registered women (25). Also data from the Swedish Medical Birth Registry showed that 25 % of pregnant women were registered with overweight and 12 % with obesity during 2008-2010 (6). The similarity in prevalence of overweight and obesity in these countries support our findings. The Norwegian Mother and Child Cohort Study (MoBa study) enrolled pregnant women in Norway from 1999 to 2008. The women reported their height and pre-pregnancy weight on a questionnaire, and 22 % of the women were overweight and 9 % were obese (26), slightly lower prevalence than in our study. Women attending the MoBa study were a selected group with a higher educational level than the general female population in Norway, which may explain this difference (27). It is challenging to study prevalence of overweight and obesity covering a population in a non-selected manner. The Hunt study has followed a large non-selected adult population in central Norway during a 22-year period. This study included both genders over 20 years of age, pregnant women were excluded. Participants underwent a clinical examination, and weight and height were measured. In the period 2006-2008, 37.7 % of the women were overweight and 23.1 % were obese (3). The participants of that study were mainly from rural district, where the mean income and educational levels are slightly lower than the national average. Knowing that occurrence of overweight and obesity differs regarding county of residence, results from HUNT study might not be representative of the entire Norwegian population.

Our study showed a significant nationwide urban-rural gradient in prevalence and OR for overweight, an inverse association between prevalence of overweight and population density,

and the finding remained significant after adjusting for maternal covariates. This finding is line with the conclusions from a study from the neighbouring Nordic country, Sweden (6). Significant differences in prevalence of overweight between Norwegian and non-Norwegian born women giving birth in Norway was observed. Women from Middle East, North Africa and Sub-Saharan Africa had increased OR of being overweight compared with Norwegian women, and women born in East Asia Pacific had the lowest OR for overweight. Our results are supported by previous findings in mean BMI in the Cohort of Norway study (CONOR) (28), although the women in the CONOR study were in age group 40-65 years. As mentioned earlier, the prevalence of overweight and obesity among pregnant women living in the Nordic countries are similar. However, after multivariate regression analysis, we found statistically significant lower OR of overweight in women born in the other Nordic countries. This might be explained by the fact that high-educated people easily move across the borders in the Nordic countries, and women from other Nordic countries who immigrate to Norway have higher education than the Norwegian women in general (data not shown). Our study also showed that overweight and obesity were inversely associated with educational level. This is in line with previous studies showing similar association with education and obesity among women in high-income countries (11,29). Previous studies in Norway have shown a higher prevalence of obesity in groups with lower socioeconomic status. Although obesity has increased in all social groups during the last three decades (15,30), the social gradient in obesity is has remained as a risk factor (6,13,31).

What this study adds

To best of our knowledge, no previous studies have assessed overweight in a multivariate regression analysis including both socioeconomic status, country of birth and county of residence in the analysis, adjusted for other important factors. This design allowed us to evaluate the complex covariation and effect of these important factors with BMI, and revealed

a true association with overweight and maternal background, socioeconomic status and even place of residence in the country. This is important knowledge for health care professionals and for health care authorities planning actions and measures to improve public health, especially when planning antenatal care.

The strength of our study is the magnitude and validity of data obtained from MBRN giving us a large non-selected study population. All births are registered to MBRN before the child gets the mandatory and unique personal identity number in Norway. MBRN data are considered to be of high quality and suitable for research (32) (RW.ERROR - Unable to find reference:1717). We were able to assess all Norwegian counties as well as all socioeconomic groups and women from different countries in the world.

Overweight and obesity are global health problems and weight loss is challenging. Previous studies show that with individual counselling regarding diet and physical activity during pregnancy, weight gain during pregnancy can be limited. Unfortunately, the studies have not shown any reduction of adverse pregnancy outcomes (33) (32). Interventions to prevent overweight and obesity probably should start earlier in life. Good nutritional habits and daily physical activity and should be established in childhood.

Limitation of this study

Socioeconomic status is generally measured by education, income or occupation. A weakness of the study is that we did not have access to both income and occupation in addition to education level in our study. However, in other previous studies from Europe, education was a better predictor of overweight than occupational class or income for both sexes aged 25-64 years (34) (33). Another weakness of the study is the paucity of recorded maternal weight and height during the first years after MBRN started to collect these measures routinely. However, we have explored the distribution of the BMI categories (normal weight, overweight and

obesity) throughout the years, and the missing values seem to be randomly distributed in the BMI categories. Information bias by BMI categories is therefore unlikely.

Weight gain in the first trimester is usually 0.5-2 kg, which corresponds to normal fluctuations in bodyweight (35) (34). Although no changes in BMI the first trimester have been observed in a study (36) (35), our data are based on self-reported or measured height and weight at the first antenatal care visit. The frequency of self-reported weight is not known. Previous studies have questioned the validity of BMI based on self-reported data. BMI calculated on self-reported weight and height have been found to be close to real weight (37) (36), and even though women tend to underestimate their BMI (38) (37), the discrepancy between self-reported and measured weight seems to be of minimal magnitude for research purposes (39) (38).

A limitation of the study is also that due to the study design - a register study - we do not have information on the women's dietary or exercise habits.

Conclusion

In our study, early pregnancy overweight and obesity were associated with maternal country of birth. Overweight and obesity were inversely associated with educational level and population density in the county of residence, even after controlling for possible confounders. We have identified specific groups of reproductive-aged women in Norway with higher odds of being overweight. Given the known adverse obstetric outcomes associated with overweight and obesity, significant public health measures should focus on preventing overweight in women with low education, women living in rural districts and African and Middle Eastern-born women in Norway.

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Table 1 Norwegian counties categorized according to population density (Source: Statistics Norway)*

County		**Population density** (Inhabitants/km^2)	**Description**
1	Oslo	1488	County with capital/largest city in Norway
2	Akershus	126	County surrounding Oslo
3	Rogaland, Hordaland	Rogaland: 54 Hordaland: 35	Counties in Western Norway
4	Vestfold, Østfold	Vestfold: 112 Østfold: 73	Counties close to Oslo
5	Vest Agder, Buskerud, Møre og Romsdal, Sør-Trøndelag, Aust Agder, Telemark	30-10	Less densely populated counties
6	Hedmark, Oppland, Nordland, Troms, Nord-Trøndelag, Sogn og Fjordane, Finnmark	<10	Sparsely populated counties

*https://www.ssb.no/statistikkbanken/SelectVarVal/Define.asp?MainTable=FolkemengdAreal&KortNavnWeb=folkemengde&PLanguage=1&checked=true

Table 2 Maternal characteristics and prepregnancy/early pregnancy body mass index (BMI) (n=219 555).

	BMI kg/m^2					
	< 18.5 % (N=9 095)	18.5-24.9 % (N=134 765)	25.0-29.9 % (N=48 984)	30.0-34.9 % (N=18 335)	≥35.0 % (N=8 376)	Total 219 555
	4.1	61.4	22.3	8.4	3.8	219 555
Country of birth by region						
Norway	3.4	60.6	22.8	8.9	4.3	165 136
Nordic countries[1]	3.8	66.7	19.5	6.9	3.2	5 129
Europe, EEA[2]	6.2	69.3	17.1	5.2	2.1	14 179
Europe, non-EEA[3]	5.6	66.1	19.8	6.3	2.2	6 136
North America[4]	4.4	63.3	20.9	6.0	5.4	814
Latin America and Caribbean[5]	4.3	63.3	20.5	8.3	3.5	2 292
Middle East and North Africa[6]	3.8	51.9	30.8	10.1	3.4	5 158
Sub-Saharan Africa[7]	6.4	50.2	28.2	10.9	4.3	6 743
Transcaucasia and Central Asia[8]	5.8	71.7	16.7	3.6	2.2	276
South Asia[9]	7.2	58.1	26.0	6.8	1.9	4 588
East Asia Pacific[10]	11.6	72.4	13.5	2.0	0.5	7 430
Oceania[11]	1.4	74.8	12.9	7.2	3.6	139
Unknown country of birth	4.4	60.8	23.8	8.7	2.3	1 535
Educational level						
No education	5.9	46.1	30.7	13.5	3.7	828
Compulsory (gr 1-10)	6.2	54.4	23.4	10.5	5.5	1 221
Secondary education (gr. 11-13)	3.7	55.9	24.6	10.6	5.3	95 076
Higher education (Bachelor)	3.1	64.2	22.2	7.4	3.0	81 628
Higher education (Master/PhD)	3.8	73.8	16.8	4.2	1.3	28 384
Unknown educational level	7.4	62.2	20.9	6.7	2.8	12 418
County of residence						
1. County with capital/largest city (Oslo)	5.3	68.2	18.6	5.7	2.1	22 454
2. County surrounding Oslo	4.4	63.9	21.3	7.2	3.2	29 937
3. Counties in Western Norway	4.0	62.9	21.9	7.8	3.4	49 860
4. Counties close to Oslo	4.1	58.8	23.5	9.3	4.3	29 273
5. Less densely populated counties	4.0	60.1	22.9	8.8	4.2	50 974
6. Sparsely populated counties	3.6	56.9	24.2	10.3	5.0	36 955
Other/Unknown	3.9	63.7	24.5	6.9	1.0	102
Maternal age, years						
<20	11.4	63.4	17.4	5.6	2.3	4 260
20-24	6.7	59.9	21.1	8.4	3.9	32 578
25-29	4.6	62.4	21.4	7.9	3.7	70 611
30-34	3.2	63.0	22.1	8.2	3.5	70 789
35-39	2.4	58.6	25.3	9.2	4.5	34 525
40 or more	1.8	53.6	27.8	11.7	5.1	6 770
Parity						
Para 0	5.1	64.3	20.1	7.4	3.2	96 610
Para 1	3.8	60.6	23.0	8.5	4.0	79 411

Para 2	2.8	58.6	25.0	9.4	4.2	32 375
Para 3 or more	2.4	49.7	28.8	12.8	6.3	11 159
Smoking 1st trimester [13]						
No	4.0	62.2	22.1	8.0	3.6	199 255
Sometimes	4.3	58.1	23.4	9.7	4.4	2 461
Daily	5.8	52.2	24.1	11.6	6.3	17 839
Marital status						
Married	4.2	62.2	22.1	8.0	3.5	102 090
Cohabiting	3.7	61.2	22.6	8.5	4.0	101 668
Single, divorced or widowed	6.7	57.3	21.8	9.7	4.6	14 363
Unknown marital status	4.9	59.8	21.0	9.2	5.1	1 434

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[4]**North America**: Canada, Saint Pierre and Miquelon, United States

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[6]**Middle East and North Africa**: Algeria, Egypt, Djibouti, Libya, Morocco, Tunisia, Bahrain, United Arab Emirates, Iraq, Iran, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Yemen

[7]**Sub-Saharan Africa**: Angola, Botswana, Saint Helena, Burundi, Comoros, Benin, Equatorial Guinea, Côte d'Ivore, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Cameroon, Cape Verde, Kenya, Congo-Brazzaville, Congo, Lesotho, Liberia, Madagascar, Malawi, Mali, Western Sahara, Mauritania, Mauritius, Namibia, Niger, Nigeria, Mozambique, Mayotte, Réunion, Zimbabwe, Rwanda, Sao Tome and Principe, Senegal, Central African Republic, Seychelles, Sierra Leone, Somalia, South Sudan, Sudan, Swaziland, South Africa, Tanzania, Chad, Togo, Uganda, Zambia, Burkina Faso

[8]**Transcaucasia and Central Asia**: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

[9]**South Asia**: British Indian Ocean Territory, Afghanistan, Bangladesh, Bhutan, Sri Lanka, India, Maldives, Nepal, Pakistan

[10]**East Asia Pacific**: Brunei, Myanmar, Philippines, Taiwan, Hong Kong, Indonesia, Japan, Cambodia, China, North Korea, South Korea, Laos, Macao, Malaysia, Mongolia, Timor-Leste, Singapore, Thailand, Vietnam, Solomon Islands, Fiji, Vanuatu, Tonga, Kiribati, Tuvalu, Nauru, Federated States of Micronesia, Papua New Guinea, Samoa, Marshall Islands, Palau

[11]**Oceania**: American Samoa, Australia, Christmas Island, Cocos (Keeling) Islands, Cook Islands, French Polynesia, Guam, United States Minor Outlying Islands, New Zealand, Niue, Norfolk Island, Pitcairn, Tokelau, Wallis and Futuna Islands, New Caledonia, Northern Mariana Islands

[12] Categorized by **population density**

[13] **smoking 1st trimester**: missing data coded as "No".

Table 3 Association between maternal overweight (BMI≥25) and country of birth, county of residence and maternal characteristics among women who gave birth in Norway in 2006-2014. Crude and adjusted odds ratios and 95% confidence interval.

	BMI >25 kg/m²					
	Crude analyses			Multiple regression analyses		
Country of birth by region	OR	CI	P	aOR	CI	p
Norway	ref			ref		
Nordic countries[1]	0.75	0.70-0.80	0.00	0.79	0.74-0.84	0.00
Europe, EEA[2]	0.58	0.56-0.60	0.00	0.63	0.60-0.66	0.00
Europe, non-EEA[3]	0.70	0.67-0.74	0.00	0.70	0.66-0.74	0.00
North America[4]	0.85	0.73-0.99	0.03	0.94	0.81-1.10	0.44
Latin America and Caribbean[5]	0.85	0.78-0.93	0.00	0.85	0.78-0.93	0.00
Middle East and North Africa[6]	1.42	1.34-1.50	0.00	1.34	1.27-1.43	0.00
Sub-Saharan Africa[7]	1.37	1.30-1.44	0.00	1.18	1.11-1.24	0.00
Transcaucasia and Central Asia[8]	0.52	0.39-0.69	0.00	0.60	0.45-0.80	0.00
South Asia[9]	0.95	0.89-1.01	0.08	0.98	0.92-1.05	0.63
East Asia Pacific[10]	0.34	0.32-0.36	0.00	0.32	0.30-0.34	0.00
Oceania[11]	0.56	0.38-0.82	0.00	0.64	0.43-0.94	0.03
Unknown country of birth	0.95	0.86-1.06	0.35	0.96	0.85-1.08	0.48
Education level						
Secondary education (gr. 11-13)	ref			ref		
No education	1.35	1.23-1.47	0.00	1.30	1.18-1.43	0.00
Compulsory (gr 1-10)	0.95	0.92-0.97	0.00	1.01	0.99-1.04	0.34
Higher education (Bachelor)	0.71	0.70-0.73	0.00	0.69	0.68-0.71	0.00
Higher education (Master/PhD)	0.42	0.41-0.44	0.00	0.43	0.41-0.44	0.00
Unknown educational level	0.65	0.62-0.67	0.00	0.80	0.76-0.84	0.00
County of residence						
1. County with capital/largest city (Oslo)	ref			ref		
2. County surrounding Oslo	1.29	1.24-1.34	0.00	1.20	1.16-1.25	0.00
3. Counties in Western Norway	1.37	1.32-1.42	0.00	1.32	1.28-1.37	0.00
4. Counties close to Oslo	1.64	1.58-1.70	0.00	1.47	1.42-1.53	0.00
5. Less densely populated counties	1.55	1.50-1.61	0.00	1.43	1.38-1.48	0.00
6. Sparsely populated counties	1.81	1.74-1.88	0.00	1.65	1.59-1.72	0.00
Unknown/missing data	1.33	0.88-2.01	0.18	1.31	0.86-2.00	0.21
Maternal age, years						
25-29	ref			ref		
<20	0.69	0.64-0.74	0.00	0.54	0.50-0.58	0.00
20-24	1.02	0.99-1.05	0.19	0.87	0.84-0.89	0.00
30-34	1.04	1.02-1.06	0.00	1.14	1.12-1.17	0.00
35-39	1.30	1.27-1.34	0.00	1.41	1.37-1.45	0.00
≥40	1.64	1.56-1.72	0.00	1.73	1.64-1.82	0.00
Parity						
Para 0	ref			ref		
Para 1	1.25	1.22-1.27	0.00	1.13	1.11-1.16	0.00
Para 2	1.42	1.38-1.46	0.00	1.14	1.11-1.18	0.00
Para 3 or more	2.08	2.00-2.16	0.00	1.39	1.33-1.45	0.00
Smoking 1st trimester [12]						
No	ref			ref		
Sometimes	1.18	1.09-1.28	0.00	1.09	1.01-1.19	0.04
Daily	1.42	1.38-1.47	0.00	1.19	1.15-1.23	0.00
Marital status						

Married	ref			ref		
Cohabiting	1.07	1.05-1.09	0.00	0.99	0.97-1.01	0.25
Single, divorced or widowed	1.11	1.07-1.15	0.00	0.97	0.93-1.01	0.11
Unknown marital status	1.08	0.96-1.20	0.19	1.03	0.92-1.16	0.57

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[12] **smoking 1st trimester**: missing data coded as "No".