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# Caesarean sections among immigrant women with different levels of education

ORIGINAL ARTICLE

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**BACKGROUND**
Studies have shown a high incidence of emergency caesarean sections among immigrant women, especially those born in Sub-Saharan Africa, but the risk of planned and emergency caesarean section varies with the mother's level of education. The proportion of women with little or no education is higher among those born in Sub-Saharan Africa and other low- and middle-income countries than those born in Norway. We therefore wanted to investigate the relationship between maternal birthplace, level of education and risk of caesarean section.

**MATERIAL AND METHOD**
The study was based on all births recorded in the Medical Birth Registry of Norway between 2008 and 2017 linked to data from Statistics Norway. Maternal birthplace, divided into four categories, was the exposure variable. The outcome was planned or emergency caesarean section. We used multinomial logistic regression and stratified the analyses by level of education. Norwegian-born women constituted the reference group.

**RESULTS**
Of 572 349 births, immigrant women accounted for 26.6 %. Caesarean sections and emergency caesareans made up 15.1 % and 9.6 % of all births respectively. Norwegian-born women had the highest proportion of planned caesarean sections (5.7 %), while women born in Sub-Saharan Africa had the highest proportion of emergency caesareans (16.3 %). Among women with a higher education, the proportion of emergency caesareans was 8.3 % among Norwegian-born women and 18.1 % among women born in Sub-Saharan Africa (adjusted relative risk 2.41, 95 % confidence interval 2.18 to 2.66).

**INTERPRETATION**
The impact of education level on risk of caesarean section differed between immigrant women and Norwegian-born women.

## Main findings

Women born in Sub-Saharan Africa and other low- and middle-income countries were found to have a high risk of emergency caesarean section regardless of reported education level compared to Norwegian-born women (adjusted relative risk from 1.06 to 2.41).

Among women with a higher education, those born in Sub-Saharan Africa had more than twice the risk of emergency caesarean section compared to Norwegian-born women (adjusted relative risk 2.41, 95 % CI 2.18 to 2.66).

Among women whose highest level of education was upper secondary school or below, those born abroad had a lower risk of planned caesarean section than Norwegian-born women (adjusted relative risk from 0.47 to 0.80).

According to the Norwegian Directorate of Health, the proportion of caesareans without a clear medical indication should be kept as low as possible (1). Caesarean section helps to reduce mortality and morbidity, but can lead to complications (2). The risk of complications is greater for emergency caesarean sections than for planned caesarean sections (3). In Norway, the proportion of caesarean sections has decreased slightly in the past ten years, from 16.5 % in 2011 to 15.8 % in 2020 (4).

Studies have shown that some immigrant groups have a significantly higher risk of caesarean section (5). This particularly applies to immigrant women born in Sub-Saharan Africa, whose caesarean section rate was 22.3 % between 2008 and 2018, compared to 15.6 % for Norwegian-born women (6, 7). This can only be partially explained by known medical risk factors such as obesity (8), gestational diabetes (9) and previous caesarean section. Non-medical factors such as education, health literacy, communication challenges and different cultural understandings of health and pregnancy also play an important role (10–12).

Previous studies have often excluded immigrant women (12, 13). We therefore wanted to investigate the relationship between maternal birthplace, education level and risk of emergency and planned caesarean section in Norway.

## Material and method

### Study population

We included all births in Norway between 2008 and 2017 (N = 608 980). A total of 36 631 births were excluded in accordance with the criteria shown in Figure 1. The study population consisted of 572 349 births, which were categorised according to maternal birthplace.

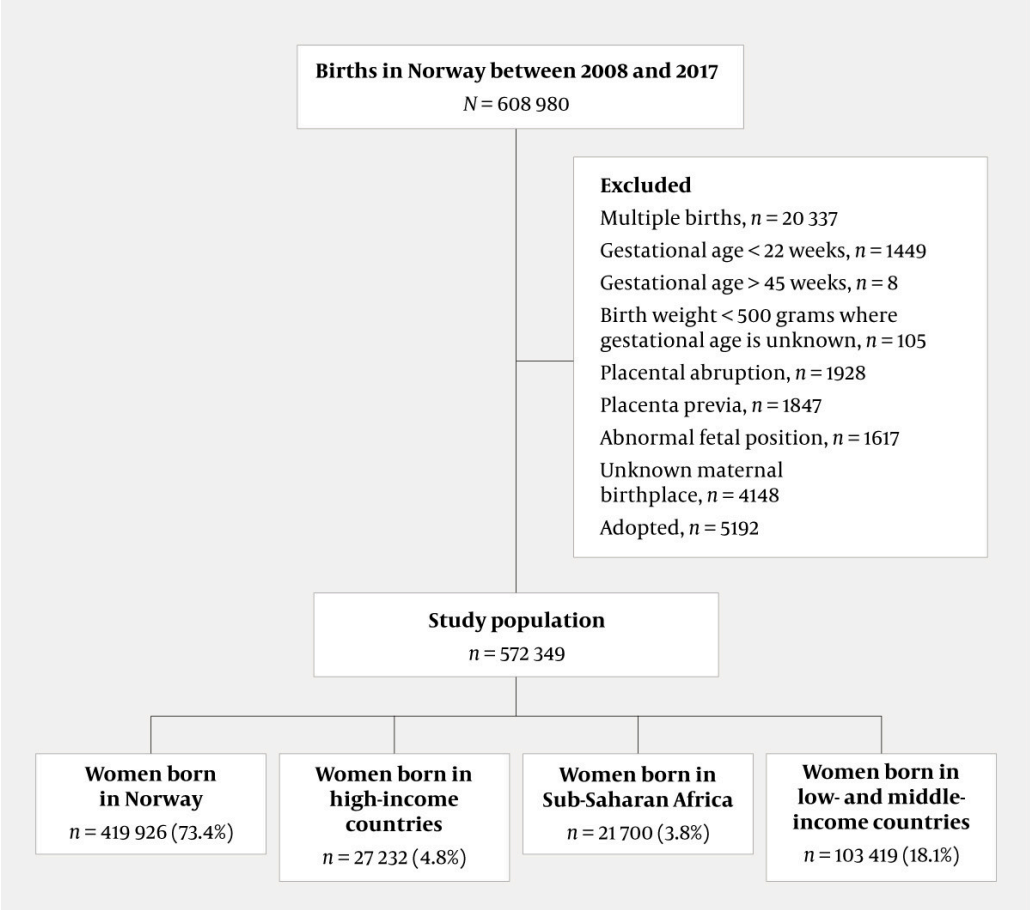


**Figure 1** Exclusion criteria, study population and category of maternal birthplace.

## Exposure

The exposure variable was maternal birthplace as recorded in the Norwegian Population Register. Maternal birthplace was categorised according to the WHO's Global Burden of Disease (GBD) framework, which consists of super-regions based on two criteria: geographic closeness and epidemiological similarity (14). Previous studies have shown that women born in Sub-Saharan Africa are a particularly vulnerable group, with a high incidence of adverse pregnancy outcomes (15), such as a high stillbirth rate (16) and a high risk of caesarean section (17). A large proportion of the women in this group also have little or no education (18, 19). Based on these findings, we wanted to investigate the relationship between education level and risk of caesarean section, with the main focus on women born in Sub-Saharan Africa. In order to draw comparisons with other immigrant populations, as well as women born in countries defined by the GBD index as high-income, we grouped the remaining GBD regions into the category '*other low- and middle-income countries*, referred to as '*low- and middle-income countries*' in the figures and tables. Norwegian-born women were used as the reference group (Figure 1).

Information on maternal level of education was based on the highest completed level of education, and was obtained from Norway's National Education Database, which contains education statistics at individual level dating back to 1970. Every ten years since 1991, Statistics Norway has collected information on completed education for immigrants in Norway for whom this information has not previously been reported (19).

The following four categories were used for education level: No completed education or below upper secondary education, Upper secondary education, Higher education and Unknown. Only 0.4 % had no completed education, and this group consisted solely of immigrant women. The proportion of immigrant women with unreported education was 18.4–21.3 % (Figure 2).

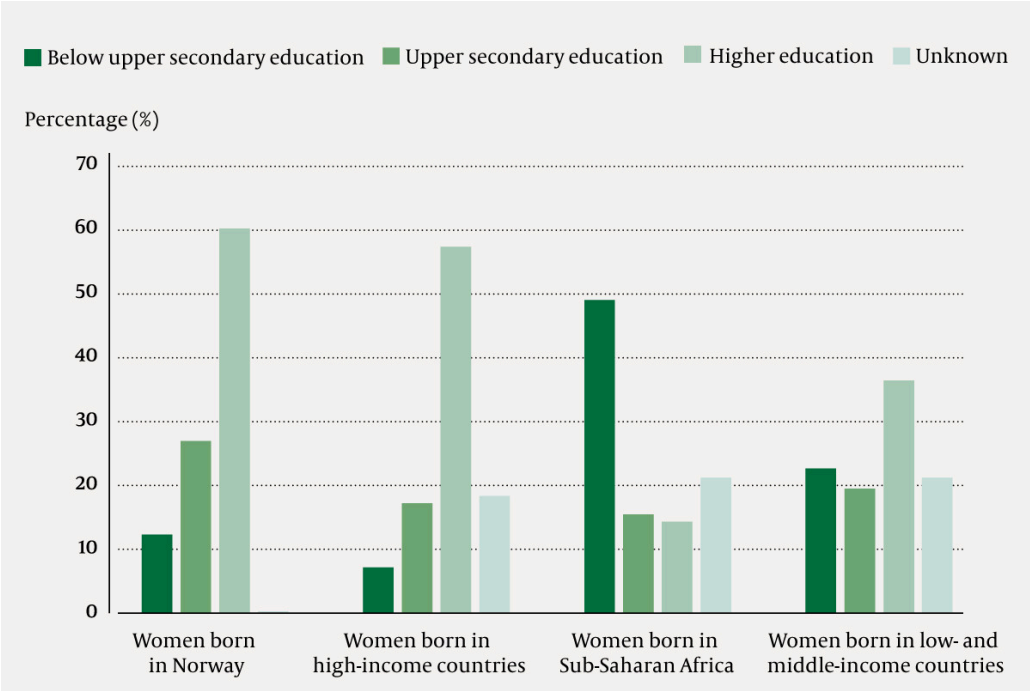


**Figure 2** Distribution of maternal education level by maternal birthplace for 572 349 births between 2008 and 2017.

## Outcome

Information on mode of delivery was obtained from the Medical Birth Registry of Norway and categorised as vaginal delivery, planned caesarean section or emergency caesarean section (defined as an emergency if the decision was made less than eight hours before the onset of labour). Unspecified caesareans ($n$ = 45) were included in the emergency caesarean section group. The caesarean section variable in the Medical Birth Registry proved to have a high level of validity (20).

## Other variables from the Medical Birth Registry

Maternal age and year of delivery were included as continuous variables, while body mass index (BMI) was categorised in line with the WHO classification. Health region was included due to differences in the caesarean section rate and immigrant population across hospital trusts. Women whose health region was not reported were placed in Southern and Eastern Norway Regional Health Authority. To reflect the differing risk of caesarean section between primiparous and multiparous women, parity was categorised as primiparous, multiparous without previous caesarean section or multiparous with previous caesarean section.

### Statistical analyses

We used multinomial logistic regression analysis and present the results as relative risk (RR) with a 95 % confidence interval (CI). Norwegian-born women with a vaginal delivery formed the reference groups. The analyses were stratified by education level and adjusted for maternal age, year of delivery, health region, parity, and BMI. We wanted to examine the direct association between maternal birthplace and caesarean section in different educational strata and have therefore not adjusted for intermediate factors such as fetal position and pregnancy complications.

We carried out two sensitivity analyses to investigate the significance of fetal position and pregnancy complications for mode of delivery according to maternal birthplace. First, we only included births with normal cephalic presentation ($n$ = 522 116). We then excluded pregnancy complications such as preeclampsia, gestational diabetes, chronic hypertension, and gestational hypertension, as these conditions increase the risk of caesarean section ($n$ = 524 612).

All analyses were performed using STATA IC version 16 (Stata Statistical Software, College Station, TX, USA). The project was approved by the Regional Committees for Medical and Health Research Ethics (REK south-east, 2018/1086) and the Data Protection Officer at Oslo University Hospital (18 - 15786).

## Results

The total study population included 572 349 births. Foreign-born women accounted for 26.6 % of the births: 4.8 % of the women were born in high-income countries, 3.8 % were born in Sub-Saharan Africa and 18.1 % were born in other low- and middle-income countries (Figure 1).

Table 1 describes the study population by mode of delivery. Caesarean sections accounted for 15.1 % of births, and 9.6 % were emergency caesarean sections. Norwegian-born women had the highest proportion of planned caesareans (5.7 %), while women born in Sub-Saharan Africa had the highest proportion of emergency caesareans (16.3 %). Women with unknown education had the highest proportion of emergency caesareans (11.3 %) and the lowest proportion of planned caesareans (4.7 %). A higher proportion of caesareans was seen for breech presentation, abnormal cephalic presentation, and pregnancy complications.

**Table 1**

Sociodemographic and obstetric variables for 572 349 births between 2008 and 2017 by mode of delivery. Number (%) if not otherwise specified. SD = standard deviation, BMI = body mass index.

| Variable | Vaginal delivery ($n$ = 485 875) | Emergency caesarean ($n$ = 54 671) | Planned caesarean ($n$ = 31 803) | Total ($n$ = 572 349) |
|---|---|---|---|---|
| Maternal birthplace | | | | |
| Norway | 359 107 (85.5) | 37 043 (8.8) | 23 776 (5.7) | 419 926 (73.4) |
| High-income country | 22 972 (84.4) | 2 777 (10.2) | 1 483 (5.5) | 27 232 (4.8) |
| Sub-Saharan Africa | 17 090 (78.8) | 3 534 (16.3) | 1 076 (5.0) | 21 700 (3.8) |
| Low- or middle-income country | 86 706 (83.8) | 11 317 (10.9) | 5 468 (5.3) | 103 491 (18.1) |
| Year of delivery | | | | |
| 2008–11 | 197 982 (84.7) | 21 968 (9.4) | 13 836 (5.9) | 233 786 (40.9) |
| 2012–14 | 145 090 (84.8) | 16 545 (9.7) | 9 421 (5.5) | 171 056 (29.9) |
| 2015–17 | 142 803 (85.3) | 16 158 (9.7) | 8 546 (5.1) | 167 507 (29.3) |
| Age, mean (SD) | 29.7 (5.1) | 30.4 (5.3) | 32.2 (5.1) | 29.9 (5.2) |
| BMI category | | | | |
| Underweight | 12 575 (89.4) | 926 (6.6) | 573 (4.1) | 14 074 (2.5) |
| Normal weight | 182 523 (87.2) | 17 118 (8.2) | 9 721 (4.6) | 209 362 (36.6) |
| Overweight | 61 943 (82.7) | 8 429 (11.3) | 4 561 (6.1) | 74 933 (13.1) |
| Obese | 31 602 (77.5) | 6 071 (14.9) | 3 096 (7.6) | 40 769 (7.1) |
| Unknown | 197 232 (84.6) | 22 127 (9.5) | 13 852 (5.9) | 233 211 (40.8) |
| Parity | | | | |
| Primiparous | 201 805 (82.9) | 33 476 (13.8) | 8 206 (3.4) | 243 487 (42.5) |
| Multiparous | 257 775 (93.8) | 9 948 (3.6) | 7 171 (2.6) | 274 894 (48.0) |
| Multiparous with previous caesarean section | 26 295 (48.7) | 11 247 (20.8) | 16 426 (30.4) | 53 968 (9.4) |
| Education level | | | | |
| Below upper secondary education | 73 898 (83.8) | 9 496 (10.8) | 4 828 (5.5) | 88 222 (15.4) |
| Upper secondary education | 119 285 (84.1) | 14 183 (10.0) | 8 423 (5.9) | 141 891 (24.8) |

| Variable | Vaginal delivery (*n* = 485 875) | Emergency caesarean (*n* = 54 671) | Planned caesarean (*n* = 31 803) | Total (*n* = 572 349) |
|---|---|---|---|---|
| Higher education | 265 622 (85.7) | 27 358 (8.8) | 17 056 (5.5) | 310 036 (54.2) |
| Unknown | 27 070 (84.1) | 3 634 (11.3) | 1 496 (4.7) | 32 200 (5.6) |
| Fetal position | | | | |
| Normal cephalic presentation | 459 731 (88.1) | 39 082 (7.5) | 23 303 (4.5) | 522 116 (91.2) |
| Breech presentation | 6 117 (30.4) | 6 360 (31.6) | 7 680 (38.1) | 20 157 (3.5) |
| Abnormal cephalic presentation | 19 804 (66.9) | 9 019 (30.5) | 795 (2.7) | 29 618 (5.2) |
| Pregnancy complications | | | | |
| Yes | 33 936 (71.1) | 10 319 (21.6) | 3 482 (7.3) | 47 737 (8.3) |
| No | 451 939 (86.2) | 44 352 (8.5) | 28 321 (5.4) | 524 612 (91.7) |

Table 2 shows the unadjusted and adjusted relative risk for emergency and planned caesarean section by maternal birthplace, stratified by education level. Women with a higher education born in Sub-Saharan Africa had the highest risk of emergency caesarean section, with an adjusted relative risk of 2.41 (95 % CI 2.18 to 2.66).

**Table 2**

Unadjusted and adjusted relative risk (RR) with 95 % confidence interval (CI) for emergency and planned caesarean section by maternal birthplace, stratified by education level. Adjusted for health region, year of delivery, maternal age, parity and BMI. Norwegian-born women with a vaginal delivery form the reference group.

| Education level | Maternal birthplace | Emergency caesarean | | | Planned caesarean | | |
|---|---|---|---|---|---|---|---|
| | | | RR (95%-CI) | | | RR (95%-CI) | |
| | | *n* (%) | Unadjusted | Adjusted | *n* (%) | Unadjusted | Adjusted |
| Below upper secondary education | Norway | 5 078 (9.7) | Reference | | 3 052 (5.9) | Reference | |
| | High-income country | 204 (10.5) | 1.08 (0.93 to 1.25) | 0.93 (0.79 to 1.08) | 98 (5.1) | 0.86 (0.70 to 1.06) | 0.63 (0.51 to 0.79) |
| | Sub-Saharan Africa | 1 700 (16.0) | 1.74 (1.64 to 1.85) | 1.59 (1.49 to 1.70) | 476 (4.5) | 0.81 (0.74 to 0.90) | 0.47 (0.42 to 0.53) |
| | Low- or middle-income country | 2 514 (10.7) | 1.11 (1.05 to 1.16) | 1.06 (1.01 to 1.12) | 1 202 (5.1) | 0.88 (0.82 to 0.94) | 0.63 (0.58 to 0.68) |
| Upper secondary education | Norway | 10 814 (9.5) | Reference | | 6 866 (6.0) | Reference | |
| | High-income country | 537 (11.5) | 1.24 (1.13 to 1.35) | 1.08 (0.98 to 1.19) | 261 (5.6) | 0.95 (0.83 to 1.07) | 0.77 (0.67 to 0.88) |
| | Sub-Saharan Africa | 579 (17.4) | 1.99 (1.82 to 2.19) | 1.92 (1.74 to 2.12) | 181 (5.4) | 0.98 (0.84 to 1.14) | 0.67 (0.57 to 0.79) |
| | Low- or middle-income country | 2 253 (11.1) | 1.18 (1.13 to 1.24) | 1.17 (1.11 to 1.23) | 1 115 (5.5) | 0.92 (0.86 to 0.98) | 0.80 (0.75 to 0.86) |
| Higher education | Norway | 21 101 (8.3) | Reference | | 13 818 (5.5) | Reference | |
| | High-income country | 1 506 (9.6) | 1.18 (1.12 to 1.25) | 1.04 (0.98 to 1.10) | 885 (5.7) | 1.06 (0.99 to 1.14) | 0.88 (0.81 to 0.95) |
| | Sub-Saharan Africa | 560 (18.1) | 2.48 (2.26 to 2.72) | 2.41 (2.18 to 2.66) | 195 (6.3) | 1.32 (1.14 to 1.53) | 1.07 (0.91 to 1.26) |
| | Low- or middle-income country | 4 191 (11.1) | 1.38 (1.34 to 1.43) | 1.31 (1.26 to 1.36) | 2 158 (5.7) | 1.09 (1.04 to 1.14) | 1.06 (1.01 to 1.12) |
| Unknown education | Norway | 50 (9.9) | Reference | | 40 (8.0) | Reference | |
| | High-income country | 530 (10.6) | 1.03 (0.76 to 1.40) | 0.77 (0.56 to 1.06) | 239 (4.8) | 0.58 (0.41 to 0.82) | 0.48 (0.32 to 0.71) |
| | Sub-Saharan Africa | 695 (15.0) | 1.55 (1.14 to 2.10) | 1.58 (1.15 to 2.17) | 224 (4.8) | 0.62 (0.44 to 0.89) | 0.48 (0.32 to 0.71) |

| Education level | Maternal birthplace | Emergency caesarean | | | Planned caesarean | | |
|---|---|---|---|---|---|---|---|
| | | | RR (95%-CI) | | | RR (95%-CI) | |
| | | *n* (%) | Unadjusted | Adjusted | *n* (%) | Unadjusted | Adjusted |
| | Low- or middle-income country | 2 359 (10.7) | 1.04 (0.77 to 1.40) | 0.89 (0.66 to 1.21) | 993 (4.5) | 0.55 (0.39 to 0.76) | 0.45 (0.31 to 0.66) |

Among women with upper secondary education or below as their highest completed education, immigrant women had a lower risk of planned caesarean section than women born in Norway. Among those with a higher education, a slight difference in the risk of planned caesarean section was observed for women born in Sub-Saharan Africa and other low- and middle-income countries. The lowest risk of planned caesarean section was found in women with unknown education who were born in low- and middle-income countries (adjusted relative risk 0.45, 95 % CI 0.31 to 0.66).

Women who were born in Norway but whose education was unknown had a higher proportion of planned caesareans than other groups (8.0 %).

Figure 3 shows that among women with upper secondary education or below as their highest completed education, the risk of planned caesarean section was lower in foreign-born women than in Norwegian-born women. The risk of emergency caesarean section was significantly higher for women born in low- and middle-income countries, particularly women born in Sub-Saharan Africa, than for women born in Norway, regardless of education level.

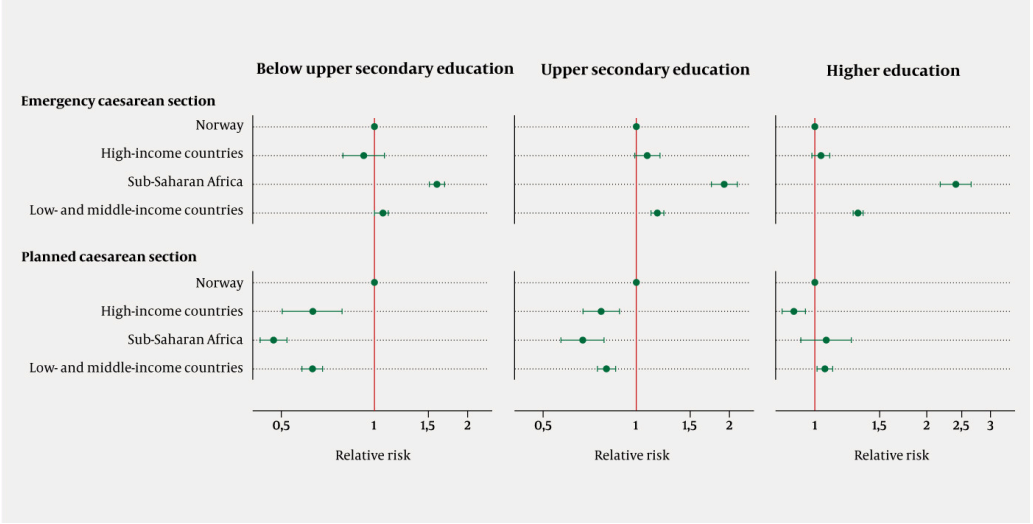


**Figure 3** Adjusted relative risk (RR) of emergency and planned caesarean section by maternal birthplace, stratified by maternal education level, for 572 349 births between 2008 and 2017. Adjusted for health region, year of delivery, maternal age, parity and BMI. Error bars represent 95 % confidence intervals. Norwegian-born women with a vaginal delivery constitute the reference group. Note the logarithmic scale.

Small changes were identified in the risk estimates when we limited the analyses to deliveries with normal cephalic presentation and when we excluded women with pregnancy complications (Tables 3 and 4).

**Table 3**

Deliveries with normal cephalic presentation ($n$ = 522 116). Unadjusted and adjusted relative risk (RR) with 95 % confidence interval (CI) for emergency and planned caesarean section by maternal birthplace, stratified by education level. Adjusted for health region, year of delivery, maternal age, parity and BMI. Norwegian-born women with a vaginal delivery form the reference group.

| | | Emergency caesarean | | | Planned caesarean | | |
|---|---|---|---|---|---|---|---|
| Education level | Maternal birthplace | $n$ (%) | RR (95%-CI) Unadjusted | Adjusted | $n$ (%) | RR (95%-CI) Unadjusted | Adjusted |
| Below upper secondary education | Norway | 3 654 (7.7) | Reference | | 2 336 (4.9) | Reference | |
| | High-income country | 135 (7.6) | 0.99 (0.83 to 1.18) | 0.85 (0.71 to 1.03) | 73 (4.1) | 0.84 (0.66 to 1.06) | 0,62 (0,47 to 0,80) |
| | Sub-Saharan Africa | 1 318 (13.5) | 1.86 (1.74 to 1.99) | 1.68 (1.56 to 1.81) | 387 (4.0) | 0.86 (0.77 to 0.95) | 0,45 (0,40 to 0,51) |
| | Low- or middle-income country | 1 850 (8.6) | 1.13 (1.06 to 1.20) | 1.08 (1.02 to 1.16) | 889 (4.1) | 0.85 (0.78 to 0.92) | 0.57 (0.52 to 0.62) |
| Upper secondary education | Norway | 7 715 (7.4) | Reference | | 5 172 (5.0) | Reference | |
| | High-income country | 381 (9.0) | 1.23 (1.11 to 1.37) | 1.10 (0.98 to 1.23) | 194 (4.6) | 0.94 (0.81 to 1.08) | 0.77 (0.65 to 0.90) |
| | Sub-Saharan Africa | 457 (14.9) | 2.18 (1.96 to 2.41) | 2.13 (1.91 to 2.38) | 139 (4.5) | 0.99 (0.83 to 1.17) | 0,65 (0,54 to 0,79) |
| | Low- or middle-income country | 1 656 (9.0) | 1.22 (1.15 to 1.29) | 1.22 (1.15 to 1.29) | 792 (4.3) | 0.87 (0.80 to 0.94) | 0.74 (0.68 to 0.80) |
| Higher education | Norway | 14 778 (6.4) | Reference | | 9 905 (4.3) | Reference | |
| | High-income country | 1 049 (7.4) | 1.17 (1.10 to 1.25) | 1.03 (0.96 to 1.10) | 635 (4.5) | 1.06 (0.98 to 1.15) | 0.86 (0.79 to 0.95) |
| | Sub-Saharan Africa | 436 (15.4) | 2.71 (2.45 to 3.01) | 2.67 (2.39 to 2.98) | 159 (5.6) | 1.48 (1.26 to 1.74) | 1,20 (1,01 to 1,44) |
| | Low- or middle-income country | 3 040 (8.8) | 1.43 (1.37 to 1.48) | 1.36 (1.31 to 1.42) | 1 581 (4.6) | 1.11 (1.05 to 1.17) | 1.11 (1.04 to 1.18) |

| Education level | Maternal birthplace | Emergency caesarean | | | Planned caesarean | | |
|---|---|---|---|---|---|---|---|
| | | | RR (95%-CI) | | | RR (95%-CI) | |
| | | *n* (%) | Unadjusted | Adjusted | *n* (%) | Unadjusted | Adjusted |
| Unknown education | Norway | 46 (9.8) | Reference | | 33 (7.1) | Reference | |
| | High-income country | 358 (7.9) | 0.75 (0.54 to 1.04) | 0.53 (0.38 to 0.75) | 151 (3.3) | 0.44 (0.30 to 0.65) | 0.33 (0.21 to 0.53) |
| | Sub-Saharan Africa | 531 (12.4) | 1.26 (0.92 to 1.74) | 1.21 (0.87 to 1.69) | 188 (4.4) | 0.62 (0.42 to 0.92) | 0,37 (0,23 to 0,59) |
| | Low- or middle-income country | 1 678 (8.4) | 0.80 (0.59 to 1.09) | 0.64 (0.47 to 0.89) | 669 (3.3) | 0.44 (0.31 to 0.64) | 0.31 (0.20 to 0.48) |

**Table 4**

Births without pregnancy complications (preeclampsia, gestational diabetes, chronic hypertension and hypertension) ($n$ = 524 612). Unadjusted and adjusted relative risk (RR) with 95 % confidence interval (CI) for emergency and planned caesarean section by maternal birthplace, stratified by education level. Adjusted for health region, year of delivery, maternal age, parity and BMI. Norwegian-born women with a vaginal delivery form the reference group.

| Education level | Maternal birthplace | Emergency caesarean | | | Planned caesarean | | |
|---|---|---|---|---|---|---|---|
| | | | RR (95%-CI) | | | RR (95%-CI) | |
| | | *n* (%) | Unadjusted | Adjusted | *n* (%) | Unadjusted | Adjusted |
| Below upper secondary education | Norway | 4 048 (8.5) | Reference | | 2 702 (5.7) | Reference | |
| | High-income country | 162 (9.0) | 1.05 (0.89 to 1.24) | 0.89 (0.75 to 1.06) | 90 (5.0) | 0.88 (0.71 to 1.09) | 0.63 (0.49 to 0.79) |
| | Sub-Saharan Africa | 1 415 (14.7) | 1.82 (1.71 to 1.95) | 1.66 (1.55 to 1.78) | 409 (4.2) | 0.79 (0.71 to 0.88) | 0.46 (0.41 to 0.52) |
| | Low- or middle-income country | 2 024 (9.6) | 1.12 (1.06 to 1.19) | 1.08 (1.02 to 1.15) | 1 008 (4.8) | 0.84 (0.78 to 0.90) | 0.61 (0.56 to 0.66) |

| Education level | Maternal birthplace | Emergency caesarean | | | Planned caesarean | | |
|---|---|---|---|---|---|---|---|
| | | | RR (95%-CI) | | | RR (95%-CI) | |
| | | *n* (%) | Unadjusted | Adjusted | *n* (%) | Unadjusted | Adjusted |
| Upper secondary education | Norway | 8 563 (8.3) | Reference | | 6 068 (5.9) | Reference | |
| | High-income country | 440 (10.4) | 1.28 (1.15 to 1.41) | 1.12 (1.01 to 1.24) | 227 (5.3) | 0.93 (0.81 to 1.06) | 0.76 (0.66 to 0.88) |
| | Sub-Saharan Africa | 468 (15.7) | 2.06 (1.86 to 2.28) | 1.96 (1.76 to 2.19) | 154 (5.2) | 0.96 (0.81 to 1.13) | 0.65 (0.54 to 0.78) |
| | Low- or middle-income country | 1 855 (10.1) | 1.24 (1.17 to 1.30) | 1.21 (1.15 to 1.28) | 971 (5.3) | 0.91 (0.85 to 0.98) | 0.80 (0.74 to 0.86) |
| Higher education | Norway | 17 112 (7.3) | Reference | | 12 506 (5.3) | Reference | |
| | High-income country | 1 288 (8.9) | 1.24 (1.17 to 1.31) | 1.08 (1.02 to 1.15) | 803 (5.5) | 1.06 (0.98 to 1.14) | 0.87 (0.80 to 0.94) |
| | Sub-Saharan Africa | 447 (16.1) | 2.45 (2.21 to 2.72) | 2.41 (2.16 to 2.69) | 157 (5.6) | 1.18 (1.00 to 1.39) | 0.99 (0.83 to 1.18) |
| | Low- or middle-income country | 3 504 (10.2) | 1.45 (1.39 to 1.50) | 1.36 (1.31 to 1.41) | 1 897 (5.5) | 1.07 (1.02 to 1.13) | 1.05 (0.99 to 1.11) |
| Unknown | Norge | 42 (8.9) | Reference | | 36 (7.6) | Reference | |
| | High-income country | 453 (9.7) | 1.07 (0.77 to 1.50) | 0.81 (0.58 to 1.15) | 221 (4.8) | 0.61 (0.42 to 0.88) | 0.49 (0.33 to 0.75) |
| | Sub-Saharan Africa | 572 (13.7) | 1.57 (1.13 to 2.18) | 1.61 (1.14 to 2.27) | 178 (4.3) | 0.57 (0.39 to 0.83) | 0.43 (0.28 to 0.65) |
| | Low- or middle-income country | 1 959 (9.7) | 1.06 (0.77 to 1.46) | 0.91 (0.65 to 1.27) | 894 (4.4) | 0.57 (0.40 to 0.80) | 0.46 (0.31 to 0.68) |

## Discussion

The risk of emergency and planned caesarean section varied according to maternal birthplace and education level. Among Norwegian-born women, those with a higher education had the lowest incidence of both emergency and

planned caesareans. Foreign-born women, particularly those born in Sub-Saharan Africa, had a high risk of emergency caesarean section regardless of education level. Among those with a lower level of education, foreign-born women had a lower risk of planned caesarean section compared to Norwegian-born women. This difference in risk estimates for planned caesarean section was not seen among women with a higher education.

Few studies have examined the relationship between maternal birthplace, education and the risk of caesarean section. A Norwegian study (12), which only included Norwegian-born women, found that the risk of both emergency and planned caesarean section was highest among women with the lowest level of education. This is consistent with our findings. However, we found higher risk estimates for emergency caesarean section among women from Sub-Saharan Africa and other low- and middle-income countries with a higher education, than for Norwegian-born women with the same level of education.

The incidence of planned caesarean sections was lower among foreign-born than Norwegian-born women but increased for foreign-born women in line with their education level. The difference in estimated risk for planned caesarean section between foreign-born and Norwegian-born women was less pronounced among those with a higher education. This has not been shown previously.

There may be several reasons why the education gradient had a differential impact on the risk of caesarean section among foreign-born women. Several studies have found a higher incidence of obesity (8), gestational diabetes (21) and previous caesarean sections among certain groups of immigrant women. Maternal BMI, parity and previous caesarean sections were all factored into our analyses. Adjustment for parity and previous caesarean sections affected the risk estimates, particularly for planned caesarean sections and for those with a low level of education. Adjusting for BMI led to small changes in our study, which is consistent with a recently published Norwegian study (22) showing a high risk of emergency caesarean section among women born in Sub-Saharan Africa in all BMI strata.

In addition to parity, maternal age had some significance for the risk estimates for both emergency and planned caesarean sections. When adjusting for maternal age, we accounted for the fact that maternal education level increases with age, regardless of maternal birthplace. Together with the results of the sensitivity analyses, this suggests that the high risk in women born in Sub-Saharan Africa cannot solely be explained by medical factors.

Studies have shown that non-medical factors such as language barriers, poorer health literacy and cultural attitudes to pregnancy can partly explain the higher risk of caesarean section in foreign-born women (7). Lack of communication can adversely affect interaction during childbirth, and healthcare personnel may consequently fail to identify women with a medical indication for a planned caesarean section prior to delivery. The high proportion of emergency caesareans combined with the low proportion of planned caesareans may indicate underuse of planned caesareans among foreign-born women.

A long residence period can have a bearing on language skills and degree of integration. A recently published Norwegian study based on the same sample showed that women born in Sub-Saharan Africa with both long and short residence periods were at more than twice the risk of emergency caesarean section (22). Some immigrant women have poorer health literacy than women in the country they migrate to (23). This can impact on their confidence in the health service and treatment providers, use of healthcare services and understanding of symptoms of pregnancy complications. Different cultural understandings of pregnancy and modes of delivery among foreign-born women can also impact on the risk of caesarean section (24). Our study lacks information on various non-medical factors.

## Strengths and limitations

The large study population is an important strength of this study. Using data from the Medical Birth Registry of Norway, where registration of all births is mandatory, enables a prospective approach with little likelihood of selection bias. Linking to other registries provides detailed information on maternal birthplace, education, and immigration background, and makes it possible to examine several potential confounding factors. It also enables analyses of subgroups without losing statistical power.

A significant weakness of the study was the high proportion of foreign-born women with unknown education (Figure 2). This group is included as a separate category in the analyses. Unknown education largely relates to education taken abroad, and this could lead to misclassification. Statistics Norway has carried out extensive work to obtain additional, correct information for this group (19). The group of Norwegian-born women with unknown education was small and had a higher proportion of both emergency and planned caesareans compared to other Norwegian-born women. No such difference was observed among foreign-born women, which means that the estimates for the group with unknown education should be interpreted with caution.

Unknown job status, occupation and income may have affected our results, as these variables are closely linked to socioeconomic status. Education is often used as a measure of socioeconomic status in Norway due to the country's comparatively small social differences and free health service. Nevertheless, education may not be an adequate measure of the socioeconomic status of immigrants (25, 26). This could be because the number of years of education does not necessarily correspond to a person's line of work or income, and this particularly applies to immigrants who end up in occupations with a low status and low pay as a result (18).

## Conclusion

This study found that the risk of caesarean section varies according to maternal birthplace and education level, and that the impact of education level on risk of caesarean section differed between immigrant women and Norwegian-born women. Women born in low-income countries, particularly in Sub-Saharan Africa, have a high risk of emergency caesarean section regardless of education

level, even when known risk factors are considered. The study sheds light on how maternal education as a measure of socioeconomic status affects pregnancy outcomes differently depending on where the mother was born.

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