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**Differences in caesarean delivery and neonatal outcomes among women of migrant origin in Finland: A population-based study**

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**Conflicts of interest**

The authors stated explicitly that there are no conflicts of to declare in connection with this article.

## Synopsis

### *Study question*

- We investigated differences in the prevalence of caesarean delivery and neonatal outcomes between women of migrant origin and Finnish women in Finland.

### *What's already known*

- Studies outside Finland have reported inconsistent results regarding differences in caesarean delivery and neonatal outcomes between women of migrant women and women in the native population
- There is limited information on this topic in Finland

### *What this study adds*

- This study identified three distinct vulnerable groups for emergency caesarean delivery and poor neonatal outcome: women of Sub-Saharan African, South Asian and East Asian origin.
- Women of Russian/former USSR origin had a lower prevalence of caesarean delivery and poor neonatal outcomes compared with women of Finnish origin.

**Social media quote**

Women of Sub-Saharan African, South Asian and East Asian origin are at higher risk of emergency caesarean delivery and poor neonatal outcome compared to women of Finnish origin in Finland.

### Abstract

**Background:** In Finland, limited information is available on neonatal disparities among women of migrant origin.

**Objective:** This study investigated differences in caesarean delivery and neonatal outcomes between women of migrant origin and Finnish women in Finland.

**Methods:** The study was based on nationwide data from the Medical Birth Register of Finland. Our study included information on the most recent singleton birth of women delivering between January 2004 and December 2014 (N=382,233). Women were classified into nine regional categories based on their country of origin. Generalized linear models were used to describe associations between country of origin and pregnancy outcomes adjusted for maternal age, socio-economic status, pre-pregnancy body mass index, parity, marital status, smoking during pregnancy, and delivery year. Finnish women were the reference group.

**Results:** Among the study population, almost 92% of women were of Finnish origin; the remaining 8% were of migrant origin. Among the migrant women, those of Russian/former USSR origin were the largest group (n=11 994); the smallest group was women of Latin American/Caribbean origin (n=739). Compared with Finnish women, women of Sub-Saharan African, South Asian and East Asian origin were at greater risk of emergency caesarean delivery, preterm birth, low birthweight and lower five-minute Apgar scores for newborns. Latin American/Caribbean-origin women were at increased risk of both elective and emergency caesarean delivery and lower five-minute Apgar scores compared with Finnish women. Women of Russian/former USSR origin overall had a lower risk of caesarean delivery and poor neonatal outcomes compared with Finnish women.

**Conclusions:** We identified Sub-Saharan African, South Asian and East Asian women as higher-risk groups, and women from Russia/former USSR as a lower-risk group, for emergency caesarean

delivery and poor neonatal outcome compared with Finnish women. More research is needed to identify the reasons for these differences by country of origin in Finland.

**Keywords:** Caesarean delivery; Neonatal outcomes; Migrants; Finland

Word count: 3207

## Background

Variations in caesarean delivery and neonatal outcomes persist among women of migrant origin and women in native populations. Some studies have shown that the prevalence of caesarean delivery is consistently higher for some groups of women, especially women of African and South Asian origin, compared with women in native populations.<sup>1-3</sup> A systematic review and meta-analysis including studies from the USA, Canada and 15 European countries (excluding Finland) found that women from Asia and Sub-Saharan Africa were at greater risk of preterm birth compared with women in the native population.<sup>4</sup> Another review of low birthweight among migrant women concluded that the prevalence of low birthweight varies by the host country and the characteristics of the migrant groups.<sup>5</sup> In European countries, some migrant groups were at higher risk of having low birthweight babies, but some groups did not differ from the general population, and some groups had a lower risk of low birthweight compared with women in the native population.<sup>5</sup>

Data on caesarean delivery and neonatal outcome among women of migrant origin living in Finland are limited. An earlier Finnish study found that women from Eastern Europe, the Middle East, North Africa, South Asia and Somalia had a significantly higher risk of low birthweight and preterm birth than Finnish women.<sup>2</sup> Some more recent studies with relatively small sample sizes among women of Somali, Kurdish and Russian origin in Finland found that women of Somali and Kurdish origin had a higher pre-pregnancy body mass index (BMI),<sup>6</sup> and Somali women had an increased risk of any delivery complication (obstructed labour, foetal stress, perineal laceration or postpartum haemorrhage)<sup>7</sup> compared with women in the general Finnish population. Based on these findings, we assumed that some differences would be observed in neonatal outcomes between women of migrant origin and women of Finnish origin.

We identify vulnerable groups at risk of caesarean delivery and poor neonatal outcome among women of migrant origin living in Finland. Identifying such vulnerable groups could help to improve maternal and child health services for migrant populations. In this study, we investigated differences in elective and emergency caesarean delivery, and neonatal outcomes including preterm birth, low birthweight, newborn care in a neonatal intensive care unit (NICU), and lower Apgar scores at five minutes between women of migrant and Finnish origin, using data on all registered births in Finland between 2004 and 2014.

## Methods

### *Selection of the study population*

This study was based on data from the national Medical Birth Register (MBR) of Finland. The MBR collects data on the mother's socio-demographic characteristics, previous pregnancies and deliveries, present pregnancy and its monitoring, delivery and complications, and information on the newborn health.<sup>8</sup> Our study included information on each woman's most recent birth in Finland between January 2004 and December 2014 (n=389 758). We excluded multiple births (n=7525) and included only singleton births (n= 382 233). We obtained data on country of origin and socio-economic position from Statistics Finland, and this information was linked using the personal identification code for each woman.

### *Exposure*

We defined migrant status based on country of origin using the United Nations classification of world regions.<sup>9</sup> In our data, country of origin is based on the country of birth of the woman's parents. If both parents were born abroad, the country of birth of the woman's biological mother

is considered to be the primary country of origin. If one of the parents was born in Finland, the country of origin is Finland.<sup>10</sup> This definition therefore includes both first and second-generation migrants. Women were classified into nine categories according to their country of origin: (i) Finland; (ii) Western Europe/North America/Oceania (i.e. other Western); (iii) Eastern Europe; (iv) Russia and the former Union of Soviet Socialist Republics (USSR); (v) South Asia; (vi) East Asia; (vii) Sub-Saharan Africa; (viii) Middle East/North Africa; and (ix) Latin America/Caribbean. A small number of women (n=231) had an unknown country of origin and were excluded from the analyses. A list of the countries and numbers of women in each group is presented in eTable 1.

### *Outcomes*

The primary outcomes that were examined included caesarean delivery, gestational age, low birthweight, five-minute Apgar score and NICU care. For the generalized linear models, we classified all outcome variables into binary variables. For caesarean delivery, we distinguished between elective caesarean deliveries (versus all other deliveries) and emergency caesarean delivery (versus all other deliveries except for elective caesarean). For elective caesarean delivery, the decision has been made before the labour started. Gestational age was classified as preterm ( $\leq 36$  week +6 days), full-term (37 weeks +0 days to 41 weeks +6 days) and post-term ( $\geq 42$  weeks +0 days), and further to preterm versus other deliveries. Birthweight was categorized as low birthweight ( $< 2500$  g), normal birthweight (2500–3999 g) and high birthweight ( $\geq 4000$  g), and further to low birthweight versus other. Apgar score at five minutes was categorized as 0–6 (lower) and 7–10. The variable for a transfer to a neonatal intensive care unit (NICU) either in level III or level II hospital was dichotomized as yes or no.

### *Background characteristics*



We defined background characteristics as follows. We classified the mother's age at the child's birth into four categories: <25 years, 25–29 years, 30–34 years and ≥35 years. We classified socio-economic position into five categories: upper-level employees (administrative, managerial, professional and related occupations), lower-level employees (administrative and clerical occupations), manual workers, other (including pensioners/homemakers/students) and unknown. Smoking during pregnancy was categorized as yes/no, and marital status as single/unmarried/widowed/divorced, married/cohabitating and unknown. Parity, numbers of previous abortions and previous miscarriages were categorized as 0, 1 and 2+. Pre-pregnancy BMI was categorized as underweight (<18.5 kg/m<sup>2</sup>), normal weight (18.5–24.9 kg/m<sup>2</sup>), overweight (25–29.9 kg/m<sup>2</sup>) and obese (≥30 kg/m<sup>2</sup>). We included age, socio-economic position, parity, pre-pregnancy BMI, marital status, smoking during pregnancy and year of delivery in our analyses because these variables have been associated with caesarean delivery and neonatal outcomes and are also associated with migrant origin.<sup>11–14</sup>

#### *Statistical analyses*

We reported descriptive data as numbers of observations and prevalence (%). We used generalised linear models with the log-link function to obtain relative risk (RR) estimates. Finnish women were the reference group. Initially, we used the traditional definition of confounding, i.e. we defined confounders as variables that were causally associated with the outcome and either causally or non-causally associated with the exposure, but which did not lie on the causal pathway between the exposure and the outcome.<sup>15</sup> We also drew a directed acyclic graph (DAG) to aid our selection of co-variables (eFigure 1). Final model was adjusted for age, socio-economic position, BMI, parity, smoking during pregnancy, marital status and delivery year. Assessing causality is challenging for our analysis, as parents' country of origin precedes other maternal characteristic

and these can be conceptualized as mediators. However, adjusting for them in the analyses informs us about whether the observed differences between the migrant groups are at least partly explained by these variables. We also present unadjusted results to show the overall differences between the migrant groups. We performed all analyses using Statistical Package for the Social Sciences (SPSS, version 23, SPSS Inc., Chicago, IL).

#### *Missing data*

The five-minute Apgar score was missing for 14–39% of the newborns in each group, mainly for those whose Apgar score at one minute was at least 7. In many hospitals in Finland, the five-minute score is often not reported if the one-minute score is 7 or higher. Therefore, we replaced the missing five-minute values with one-minute values for women whose one-minute value was at least 7. Consequently, <1% of participants had missing values at five minutes. The proportion of missing data of all other variables were <1%, except for pre-pregnancy BMI (4.5%).

#### *Ethics approval*

We obtained permission to use the data from the respective registries from the National Institute of Health and Welfare (THL) and Statistics Finland. We analysed and stored the data at THL, following THL's data safety regulations.

### **Results**

Among the study population, almost 92% of women were of Finnish origin, and the remaining 8% of migrant origin. Only 216 (0.01%) of all women were second-generation women of migrant origin. Among the migrant women, women of Russian/former USSR origin were the largest group

(n=11 994); the smallest group was women of Latin American/Caribbean origin (n=739; Table 1). Compared with Finnish women, the percentages of women in upper and lower level employees' categories were lower for all other migrant origin women except for women from other western countries. Finnish, Eastern European and Russian/former USSR origin women were more likely to smoke during pregnancy (16-17%) than other women. Russian/former USSR women had a higher and South Asian women a lower prevalence of at least one previous abortion compared with Finnish women. The percentage of women of having at least one previous miscarriage varied from 16.4% to 23% among the study groups. Sub-Saharan African and Middle Eastern women had a higher and East Asian woman a lower prevalence of overweight and obesity compared with Finnish women.

The percentage of vaginal deliveries varied from 73% to 87% (Table 2). Women from Latin America and the Caribbean were more likely to have a caesarean delivery (26.8%) compared with Finnish women (17.0%). The percentage of preterm birth varied from 4% to 5.8% among the study groups. Sub-Saharan African women had post-term births more often (9.1%) compared with Finnish women (4.4%). South Asian (6.3%) and Sub-Saharan African (5.0%) women were more likely to have low birthweight newborns compared with Finnish women (3.1%). Sub-Saharan African women were more likely to have infants who died (0.9%) and received NICU care (13.3%) than Finnish women (0.2% and 10.5%, respectively). Sub-Saharan African (4.4%), Latin American/Caribbean (3.8%) and South Asian (3.0%) newborns were more likely to get lower five-minutes Apgar score compared to Finnish newborns (1.8%).

The results of the unadjusted and adjusted models were broadly similar (eTables 2-7). The associations for elective caesarean delivery showed that Eastern European women and

Russian/former USSR women had a lower risk, while Latin American/Caribbean women had an increased risk, compared with Finnish women (Figure 1). Similarly, Russian/former USSR women had a lower risk of emergency caesarean delivery compared with Finnish women, while South Asian, East Asian, Sub-Saharan African, Middle Eastern, and Latin American women had a higher risk of emergency caesarean delivery compared with Finns.

We observed a higher risk of preterm birth among South Asian, East Asian and Sub-Saharan African women compared with Finnish women (Figure 2). We observed that Russian/former USSR women had a decreased risk of low birthweight newborns, whereas South Asian, East Asian, Sub-Saharan African and Middle Eastern women were at higher risk of low birthweight newborns (Figure 2).

Regarding the distribution of lower five-minute Apgar scores (Figure 3), newborns of Russian/former USSR women were at lower risk, whereas newborns of South Asian, East Asian, Sub-Saharan African, Middle Eastern and Latin American/Caribbean women were at increased risk compared with Finnish newborns. Compared with Finnish women, women from other Western countries, Eastern Europe and Russia/former USSR were at decreased risk of NICU care. Newborns of South Asian and Sub-Saharan African women had an increased risk of NICU care (Figure 3).

## **Comment**

### *Principal findings*

In this study, we observed differences in the risks of caesarean delivery and adverse neonatal outcome by women's country of origin. Women from Russia/former USSR were at lower risk while

women from Latin America and the Caribbean were at higher risk of both elective and emergency caesarean delivery compared with Finnish women. Women of South Asian, East Asian, Sub-Saharan African and Middle Eastern origin were at higher risk of emergency caesarean delivery than Finnish women. Women of South Asian, East Asian and Sub-Saharan African origin had a higher risk of preterm birth and low birthweight than Finnish women. Newborn of women from South Asia, East Asia, Sub-Saharan Africa, the Middle East and Latin America/the Caribbean had an increased risk of lower five-minute Apgar scores compared with Finnish newborn. Higher risks of care in the NICU were observed for newborn born to women of South Asian and Sub-Saharan African origin, compared with Finnish newborn.

#### *Strengths of the study*

This study contributes to the limited information available on caesarean delivery and neonatal outcome among women of migrant origin and Finnish women in Finland. We used information from the national MBR, which includes all the most recent births that occurred in Finland in 2004–2014 and has good data quality.<sup>16-17</sup> The sample size in our study was large and we were able to classify childbearing women into nine categories based on their parents' countries of origin. These findings are likely to be generalizable to populations of migrant origin in other countries with universal access to maternity care for all citizens.

#### *Limitations of the data*

Due to limitations in data availability, we had no information on several important migration indicators, such as migration status, length of stay and language skills, which might contribute to the differences between the groups. In addition, the MBR has limited information on other factors possibly related to poor neonatal outcomes – for example, women's other specific health

conditions – which might have some effect on the outcome variables. Also the information on the indication of caesarean delivery is not available in the MBR. The heterogeneity of the migrant groups means that multiple mechanisms and risk factors may be responsible for the observed associations and we were not able to address all these hypotheses.

### *Interpretation*

A meta-analysis of international migration and caesarean delivery found a consistently higher overall risk of caesarean delivery for Sub-Saharan African, Somali and South Asian migrant women, higher risk of emergency caesarean delivery for North African, West Asian and Latin American migrant women, and a lower overall risk of caesarean delivery for Eastern European women.<sup>1</sup> In Norway, all migrant groups except the Vietnamese had a higher overall risk of caesarean delivery compared with Norwegians.<sup>3</sup> In Sweden, women from Ethiopia, India, South Korea, Chile, Thailand, Iran and Finland had significantly higher odds of caesarean delivery compared with Swedish-born women, while women from Syria, former Yugoslavia and Germany had lower odds.<sup>18</sup> Our findings are broadly comparable to these findings, although we studied emergency and elective caesarean deliveries separately. Our previous study on delivery complications among Somali, Russian and Kurdish-origin migrant women in Finland reported that Russian women were less likely to have a caesarean delivery,<sup>7</sup> which is similar to the findings of this study. We had a smaller and individual country-specific sample in our previous study, whereas the current the study used a larger nationwide data set.

Previous literature suggests that the mechanisms leading to caesarean delivery are often complex and are likely to involve a combination of biological, cultural, physical and psychological factors that affect health.<sup>19</sup> The most common risk factors associated with caesarean delivery among migrants are low-level language skills, lower socio-economic position, poor maternal health,

higher BMI, foetopelvic disproportion and lack of prenatal care.<sup>1</sup> It has been suggested that the higher risk of elective caesarean deliveries among Latin American/Caribbean-origin women may also be related to their cultural preferences.<sup>1,19</sup> Our previous studies on prepregnancy BMI<sup>20</sup> and pregnancy complications (unpublished, under review) among migrant women in Finland showed that Russian women had lower prepregnancy BMI and statistically insignificant lower incidence of pregnancy related diabetes and pregnancy induced hypertension compared with women in the general population. Therefore, we assume that the healthy migrant effect might explain the better pregnancy and delivery outcomes among women of Russian origin in Finland.

An earlier systematic review found that Asian and Sub-Saharan African migrants had a greater risk of preterm birth.<sup>4</sup> A Swedish study reported that South Asian, Sub-Saharan African and East Asian migrants had an increased risk of early and late preterm births compared with Swedish-born women.<sup>21</sup> Our findings are in line with these studies. Previously, a Finnish study reported that women from the Middle East, North Africa and South Asia had higher percentages of preterm births.<sup>2</sup> Our results are similar for South Asian but not for Middle Eastern and North African women. This earlier study used data for the years 1999–2001, and used maternal country of birth to identify foreign origins. Since that time, Finland has become more diverse and multicultural (i.e. 4% versus 8% of those living in Finland are of foreign origin). Another review comparing the pregnancy outcomes of native and migrant women in European countries during 1966–2004 found that migrant women had a 24% higher risk of preterm delivery compared with the native populations.<sup>22</sup> The risk varied by country, according to the countries' integration policies.<sup>21</sup> The differences in the risk of preterm birth may be due to differences in genetics or other factors which were not measured in our study. Maternal height and body composition vary by ethnicity, and this may affect the risk of preterm birth.<sup>23</sup>

Previous studies have reported mixed results on the distribution of low birthweight among migrant women.<sup>5,24-26</sup> A previous systematic review reported that Sub-Saharan African, South/Central Asian and Latin American/Caribbean women had an increased risk of low birthweight newborns in European countries.<sup>24</sup> A Belgian study showed that migrant women had a lower risk of low birthweight newborns.<sup>25</sup> Another study from Sweden reported that foreign-born women had a higher risk of low birthweight babies than Swedish-born mothers.<sup>26</sup> This divergence in results could be partly explained by the use of different classifications of migrant groups, reference groups and adjustments for confounders.

There are very few studies reporting differences in lower five-minute Apgar scores and NICU care between migrant groups and native populations. A previous study from Italy reported that the five-minute Apgar score was lower among West and Sub-Saharan Africans and Central and Latin Americans compared with Italian women.<sup>27</sup> Overall our findings are similar. Merten and colleagues<sup>28</sup> found that African and Asian newborns were at increased risk of being transferred to a NICU. We found that newborns of women of other Western, East European and Russian/former USSR origin were at lower risk of NICU treatment, and newborns of women of Sub-Saharan African and South Asian origin at greater risk, compared with Finnish newborns. Merten and colleagues<sup>28</sup> grouped all mothers from South and East Asia together, which may explain this divergence in the results for Asian women.

Maternal body composition is one of the most important factors that account for geographical variation in neonatal outcomes.<sup>29</sup> Other factors, such as maternal diet, physical activity, alcohol consumption, illness and social class, vary across different migrant groups, and these along with



genetic mechanisms may explain differences in neonatal outcomes among women of migrant origin and Finnish women.<sup>29</sup>

### **Conclusions**

In conclusion, our study contributes to evidence on differences in caesarean delivery and neonatal outcomes among women of migrant origin in Finland. We found that being of Russian/former USSR origin was associated with lower risks of caesarean delivery and poor neonatal outcomes.

We identified three distinct vulnerable groups for emergency caesarean delivery and poor neonatal outcome: women of Sub-Saharan African, South Asian and East Asian origin. In addition, we found that women of Latin American/Caribbean origin had an excess risk of both elective and emergency caesarean delivery. More information is needed to better understand the reasons and mechanisms behind these differences to support the development of interventions to support higher-risk groups.

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**Figure legends**

Figure 1. Emergency and elective caesarean delivery among migrant origin women and Finnish women

Figure 2. Preterm birth and low birthweight among migrant origin women and Finnish women

Figure 3. Lower five minutes Apgar score and newborns in intensive care unit (NICU) among migrant origin women and Finnish women

eFigure 1. Directed Acyclic Graph (DAG) representing pathway from exposure to outcome variables

Table 1. Background characteristics of the migrant origin and Finnish origin women in the most recent delivery, all singleton births, 2004-2014, (number & crude percentage).

Variables	Finnish, (n=350 548)	Other Western <sup>a</sup> (n=2290)	Eastern Europe (n =2566)	Russia, former USSR (n=11994)	South Asia, (n =1904)	East Asia (n=4948)	Sub Saharan Africa (n =3548)	Middle East (n=3465)	Latin America, Caribbean (n =739)
Number (%)									
<b>Age at birth (years)</b>									
<25	44671 (12.7)	161 (7.0)	492 (19.2)	1924 (16.0)	355 (18.6)	538 (10.9)	743 (20.9)	682 (19.7)	73 (9.9)
25-29	93177 (26.6)	445 (19.4)	799 (31.1)	3666 (30.6)	728 (38.2)	1335 (27.0)	978 (27.6)	1009 (29.1)	167 (22.6)
30-34	122549 (35.0)	870 (38.0)	771 (30.0)	3614 (30.1)	583 (30.6)	1704 (34.4)	1010 (28.5)	929 (26.8)	256 (34.6)
≥35	90151 (25.7)	814 (35.5)	504 (19.6)	2790 (23.3)	238 (12.5)	1371 (27.7)	817 (23.0)	845 (24.4)	243 (32.9)
<b>Socioeconomic position</b>									
Upper level employees	72235 (20.6)	772 (33.7)	298 (11.6)	1253 (10.4)	313 (16.4)	716 (14.5)	139 (3.9)	156 (4.5)	177 (24.0)
Lower level employees	136900 (39.1)	556 (24.3)	439 (17.1)	2515 (21.0)	244 (12.8)	777 (15.7)	438 (12.3)	291 (8.4)	159 (21.5)
Manual workers	77953 (22.2)	436 (19.0)	885 (34.5)	4193 (35.0)	448 (23.5)	1813 (36.6)	683 (19.3)	889 (25.7)	160 (21.7)
Others	43168 (12.3)	269 (11.7)	559 (21.8)	2392 (19.9)	579 (30.4)	1072 (21.7)	1137 (32.0)	1146 (33.1)	163 (22.1)
Unknown	20292 (5.8)	257 (11.2)	385 (15.0)	1641 (13.7)	320 (16.8)	570 (11.5)	1151 (32.4)	983 (28.4)	80 (10.8)

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<b>Marital status</b>									
Single	19377 (5.5)	43 (1.9)	71 (2.8)	723 (6.0)	20 (1.1)	184 (3.7)	315 (8.9)	77 (2.2)	25 (3.4)
Married/cohabit ing	316743 (90.4)	2135 (93.2)	2438 (95.0)	10485 (87.4)	1868 (98.1)	4593 (92.8)	2974 (83.8)	3329 (96.1)	697 (94.3)
Unknown	14428 (4.1)	112 (4.9)	57 (2.2)	786 (6.6)	16 (0.8)	171 (3.5)	259 (7.3)	59 (1.7)	17 (2.3)
<b>Smoking in pregnancy</b>	56030 (16.0)	200 (8.7)	438 (17.1)	1992 (16.6)	19 (1.0)	209 (4.2)	72 (2.0)	226 (6.5)	43 (5.8)
<b>Parity</b>									
None	104720 (29.9)	887 (38.8)	833 (32.5)	4331 (36.1)	814 (42.8)	2004 (40.5)	879 (24.8)	955 (27.6)	329 (44.5)
One	142413 (40.6)	868 (38.0)	999 (38.9)	4992 (41.6)	670 (35.3)	1885 (38.1)	912 (25.7)	1187 (34.3)	275 (37.2)
Two or more	103251 (29.5)	530 (23.2)	734 (28.6)	2665 (22.2)	416 (21.9)	1057 (21.4)	1755 (49.5)	1320 (38.1)	135 (18.3)
<b>Previous abortions</b>									
None	302325 (86.4)	2033 (89.1)	2332 (90.9)	8847 (73.9)	1755 (92.4)	4296 (86.9)	3083 (87.0)	3107 (89.8)	654 (88.9)
One	37719 (10.8)	202 (8.9)	175 (6.8)	1884 (15.7)	122 (6.4)	477 (9.7)	309 (8.7)	281 (8.1)	58 (7.9)
Two or more	9975 (2.8)	46 (2.0)	58 (2.3)	1244 (10.4)	22 (1.2)	168 (3.4)	153 (4.3)	73 (2.1)	24 (3.3)
<b>Previous miscarriages</b>									
None	269845 (77.0)	1771 (77.5)	2069 (80.7)	9485 (79.2)	1574 (82.9)	4130 (83.6)	2804 (79.1)	2702 (78.0)	592 (80.1)
One	58998 (16.8)	367 (16.1)	373 (14.5)	1875 (15.6)	262 (13.8)	644 (13.0)	518 (14.6)	535 (15.5)	114 (15.4)

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Two or more	21425 (6.1)	146 (6.4)	123 (4.8)	623 (5.2)	63 (3.3)	168 (3.4)	223 (6.3)	225 (6.5)	33 (4.5)
<b>Pre-pregnancy BMI<sup>b</sup></b>									
Underweight	10393 (3.1)	112 (5.3)	146 (6.0)	857 (7.5)	106 (5.9)	674 (14.4)	143 (4.3)	106 (3.3)	30 (4.4)
Normal weight	203463 (60.7)	1420 (66.6)	1557 (63.9)	7725 (67.8)	1043 (58.1)	3406 (72.9)	1431 (43.2)	1561 (48.1)	489 (71.4)
Overweight	76324 (22.8)	383 (18.0)	531 (21.8)	1952 (17.1)	496 (27.6)	499 (10.7)	1059 (31.9)	1086 (33.5)	122 (17.8)
Obese	44826 (13.4)	218 (10.2)	201 (8.3)	860 (7.5)	150 (8.4)	94 (2.0)	682 (20.6)	489 (15.1)	44 (6.4)

<sup>a</sup> Western Europe, North America, & Oceania

<sup>b</sup> Missing Values for pre-pregnancy BMI in each category from the left to the right were 4.4%, 6.8%, 5.1%, 5.0%, 5.7%, 5.5%, 6.5%, 6.4%, and 7.3% respectively  
Missing values for all other variables were <1% in each categories

Table 2. Mode of delivery and neonatal outcomes among women of migrant origin and Finnish origin women in the most recent delivery, all singleton births, 2004-2014

Variables	Finnish, (n=350548)	Other Western <sup>a</sup> (n =2290)	Eastern Europe (n =2566)	Russia, former USSR (n=11994)	South Asia (n=1904)	East Asia (n=4948)	Sub Saharan Africa (n =3548)	Middle East (n=3465)	Latin America, Caribbean (n =739)
Number (%)									
<b>Mode of delivery</b>									
Spontaneous vaginal	265736 (75.8)	1690 (73.8)	2002 (78.0)	9355 (78.0)	1214 (63.8)	3420 (69.1)	2443 (68.9)	2531 (73.0)	458 (62.0)
Vacuum/forceps	25149 (7.2)	184 (8.0)	224 (8.7)	964 (8.0)	264 (13.9)	567 (11.5)	248 (7.0)	324 (9.4)	83 (11.2)
Elective CS	26293 (7.5)	173 (7.6)	129 (5.0)	643 (5.4)	108 (5.7)	357 (7.2)	269 (7.6)	260 (7.5)	78 (10.6)
Emergency CS	33183 (9.5)	241 (10.5)	208 (8.1)	1026 (8.6)	317 (16.6)	602 (12.2)	587 (16.5)	348 (10.0)	120 (16.2)
Unknown	187 (0.1)	2 (0.1)	3 (0.1)	6 (0.1)	1 (0.1)	2 (0.0)	1 (0.0)	2 (0.1)	0 (0.0)
<b>Gestational age</b>									
Preterm	15702 (4.5)	104 (4.6)	101 (4.0)	528 (4.4)	111 (5.8)	277 (5.6)	183 (5.2)	145 (4.2)	36 (4.9)
Full term	318777 (91.1)	2052 (90.0)	2307 (90.3)	10740 (89.7)	1706 (89.9)	4545 (92.0)	3039 (85.7)	3172 (91.7)	670 (90.7)
Post-term	15310 (4.4)	125 (5.5)	147 (5.8)	710 (5.9)	81 (4.3)	118 (2.4)	321 (9.1)	142 (4.1)	33 (4.5)
<b>Mortality</b>									

Stillbirths	496 (0.1)	3 (0.1)	3 (0.1)	13 (0.1)	7 (0.1)	7 (0.1)	16 (0.5)	11 (0.3)	3 (0.4)
Neonatal deaths	282 (0.1)	2 (0.1)	5 (0.2)	15 (0.1)	0 (0.0)	4 (0.1)	9 (0.3)	3 (0.1)	0 (0.0)
Post neonatal deaths	151 (0.0)	0 (0.0)	1 (0.0)	11 (0.1)	1 (0.1)	0 (0.0)	2 (0.1)	1 (0.0)	0 (0.0)
Survived 365 days	349619 (99.7)	2285 (99.8)	2557 (99.6)	11955 (99.7)	1896 (99.6)	4937 (99.8)	3521 (99.2)	3450 (99.6)	736 (99.6)
<b>Birthweight</b>									
<2500 g	10868 (3.1)	66 (2.9)	66 (2.6)	369 (3.1)	120 (6.3)	199 (4.0)	179 (5.0)	121 (3.5)	20 (2.7)
2500-3999 g	275355 (78.6)	1877 (82.1)	2085 (81.3)	9396 (78.4)	1645 (86.5)	4257 (86.1)	2945 (83.0)	2942 (85.0)	621 (84.0)
≥4000 g	64064 (18.3)	344 (15.0)	412 (16.1)	2219 (18.5)	137 (7.2)	486 (9.8)	423 (11.9)	398 (11.5)	98 (13.3)
<b>NICU care</b>	36794 (10.5)	206 (9.0)	215 (8.4)	1121 (9.3)	216 (11.3)	443 (9.0)	473 (13.3)	341 (9.8)	72 (9.7)
<b>Apgar Score</b>									
7-10	342846 (98.2)	2228 (98.1)	2511 (98.3)	11758 (98.4)	1831 (97.0)	4804 (97.8)	3352 (95.6)	3362 (97.6)	710 (96.6)
0-6	6254 (1.8)	43 (1.9)	43 (1.7)	186 (1.6)	56 (3.0)	107 (2.2)	155 (4.4)	81 (2.4)	25 (3.4)

<sup>a</sup> Western Europe, North America, & Oceania

Missing values for all variables were <1%

**Table legends**

Table 1. Background characteristics of the migrant origin and Finnish origin women in the most recent delivery, all singleton births, 2004-2014.

Table 2. Mode of delivery and neonatal outcomes among women of migrant origin and Finnish origin women in the most recent delivery, all singleton births, 2004-2014.

eTable 1. List of countries and numbers of women in each migrant group by country of origin.

eTable 2. Risk Ratio (RR) and 95% confidence interval (CI) for having an elective caesarean delivery in the most recent delivery in the migrant groups compared with Finnish women.

eTable 3. Risk Ratio (RR) and 95% confidence interval (CI) for having an emergency caesarean delivery in the most recent delivery in the migrant groups compared with Finnish women.

eTable 4. Risk Ratio (RR) and 95% confidence interval (CI) for having preterm birth in the most recent delivery in the migrant groups compared with Finnish women.

eTable 5: Risk Ratio (RR) and 95% confidence interval (CI) for low birthweight in the most recent delivery in the migrant groups compared with Finnish women.

eTable 6: Risk Ratio (RR) and 95% confidence interval (CI) for lower 5 minutes Apgar score among the newborns in the most recent delivery in the migrant groups compared with Finnish women.

eTable 7: Risk Ratio (RR) and 95% confidence interval (CI) for having NICU care in the most recent delivery in the migrant groups compared with Finnish women.

eTable1: List of countries and numbers of women in each migrant group by country of origin

<b>Migrant Group</b>	<b>Number of women</b>
<b>Finland</b>	<b>350548</b>
<b>Other Western/North America/Oceania</b>	<b>2290</b>
Australia	35
Austria	35
Belgium	17
Canada	64
Cyprus	1
Denmark	33
France	147
Germany	370
Greece	30
Hungary	212
Iceland	21
Ireland	23
Italy	103
Luxemborg	3
Malta	1
New Zealand	8
Norway	60
Papua New Guinea	1
Portugal	28
Solomon Island	1
Spain	132
Sweden	507
Switzerland	39
The Netherlands & Netherlands Antilles	54
UK	138
USA	230
<b>Eastern Europe</b>	<b>2566</b>
Albania	26
Bosnia- Herzegovina	89
Bulgaria	166
Croatia	20
Czech Republic (Czechia)	25
Czechoslovakia	71
Former. Yugoslavia	1410
Macedonia	24
Montenegro	1
Poland	413
Romania	277
Serbia	18
Slovakia	24
Slovenia	2
<b>Russia/former USSR</b>	<b>11994</b>
Armenia	17
Azerbaijan	14

Belarus	34
Estonia	3513
EX USSR	7154
Georgia	8
Kazakhstan	24
Kyrgyzstan	3
Latvia	202
Lithuania	122
Moldova	26
Russia	685
Tajikistan	3
Turkministan	1
Ukraine	173
Uzbekistan	15
<b>South Asia</b>	<b>1904</b>
Afghanistan	529
Bangladesh	262
Bhutan	1
India	624
Nepal	115
Pakistan	237
Sri Lanka	136
<b>East Asia</b>	<b>4948</b>
Cambodia	56
China	1138
Indonesia	89
Japan	230
Laos (Lao)	16
Malaysia	46
Mongolia	6
Myanmar	184
Philippines	479
Singapore	19
South Korea	57
Thailand	1662
Vietnam	964
<b>Africa including Sub-Saharan Africa</b>	<b>3548</b>
Angola	85
Benin	2
Botswana	3
Burundi	8
Cameron	108
Central African Republic	1
Comoros	1
Congo	256
Cote d'Ivoire	9
Djibouti	3
Eritrea	22
Ethiopia	208
Gabon	1

Gambia	53
Ghana	165
Guinea inc. Eq Guinea	9
Kenya	215
Liberia	18
Madagascar	2
Malawi	1
Mauritius	5
Mozambique	9
Namibia	6
Niger	1
Nigeria	182
Rwanda	25
Scycheles	3
Senegal	13
Somalia	1778
South Africa	23
Sudan	187
Tanzania	74
Togo	6
Uganda	30
Zambia	31
Zimbabwe	7
<b>Middle East &amp; North Africa</b>	<b>3465</b>
Algeria	98
Bahrain	1
Egypt	63
Iran	557
Iraq	1277
Israel	43
Jordan	36
Kuwait	14
Lebanon	55
Libya	24
Morocco	338
Oman	1
Palestinne	4
Qatar	1
Saudi Arabia	17
Sierra Leone	10
Syria	89
Tunisia	71
Turkey	757
UAE	4
Yemen	5
<b>Latin America &amp; Caribbean</b>	<b>738</b>
Antigua & Barbuda	1
Argentina	45
Bahamas	1
Bolivia	22

Brazil	219
Chile	44
Colombia	58
Costa Rica	9
Cuba	43
Dominican Republic	19
Ecuador	27
EL Salvador	12
Guatemala	8
Guyana	2
Haiti	1
Honduras	12
Jamaica	13
Mexico	77
Nicaragua	10
Panama	4
Paraguay	2
Peru	76
Saint Lucia	1
Samoa	1
Trinidad & Tobago	4
Uruguay	7
Venezuela	20
<b>Others</b>	<b>231</b>
Asylum seeker (unknown)	203
Unknown	28

eTable 2: Risk Ratio (RR) and 95% confidence interval (CI) for having an elective caesarean delivery in the most recent delivery in the migrant groups compared with Finnish women

	<b>Model I</b> <b>OR (CI)</b> <b>(N=381798)</b>	<b>Model II</b> <b>OR (CI)</b> <b>(N=365352)</b>
<b>Study groups</b>		
Finnish	Reference	Reference
Other Western	1.00 (0.86 – 1.17)	0.95 (0.81 – 1.12)
Eastern Europe	<b>0.65 (0.54 – 0.78)</b>	<b>0.71 (0.59 – 0.85)</b>
Russia, former USSR	<b>0.69 (0.64 – 0.75)</b>	<b>0.76 (0.70 – 0.82)</b>
South Asia	<b>0.74 (0.61 – 0.90)</b>	0.88 (0.72 – 1.08)
East Asia	0.95 (0.86 – 1.06)	1.08 (0.96 – 1.21)
Sub-Saharan Africa	1.01 (0.89 – 1.14)	1.06 (0.92 – 1.21)
Middle East	1.00 (0.88 – 1.13)	1.03 (0.90 – 1.17)
Latin America, Caribbean	<b>1.45 (1.15– 1.84)</b>	<b>1.46 (1.14 – 1.87)</b>

Model I: unadjusted model

Model II: model adjusted for age, socio-economic status, pre-pregnancy body mass index, previous births, marital status, smoking during pregnancy and delivery year

eTable 3: Risk Ratio (RR) and 95% confidence interval (CI) for having an emergency caesarean delivery in the most recent delivery in the migrant groups compared with Finnish women

	<b>Model I</b> <b>OR (CI)</b> <b>(N=353488)</b>	<b>Model II</b> <b>OR (CI)</b> <b>(N=338583)</b>
<b>Study groups</b>		
Finnish	Reference	Reference
Other Western	1.12 (0.98 – 1.29)	1.01 (0.88 – 1.17)
Eastern Europe	<b>0.81 (0.71 – 0.94)</b>	0.91 (0.78 – 1.05)
Russia, former USSR	<b>0.87 (0.81 – 0.93)</b>	<b>0.87 (0.81 – 0.93)</b>
South Asia	<b>1.88 (1.66 – 2.12)</b>	<b>2.17 (1.91 – 2.46)</b>
East Asia	<b>1.32 (1.21 – 1.44)</b>	<b>1.41 (1.28 – 1.54)</b>
Sub-Saharan Africa	<b>1.91 (1.74 – 2.09)</b>	<b>2.98 (2.70 – 3.29)</b>
Middle East	1.06 (0.95 – 1.19)	<b>1.23 (1.10 – 1.39)</b>
Latin America, Caribbean	<b>1.94 (1.59– 2.37)</b>	<b>1.74 (1.41 – 2.15)</b>

Model I: unadjusted model

Model II: model adjusted for age, socio-economic status, pre-pregnancy body mass index, previous births, marital status, smoking during pregnancy and delivery year



eTable 4: Risk Ratio (RR) and 95% confidence interval (CI) for having preterm birth in the most recent delivery in the migrant groups compared with Finnish women

	<b>Model I</b> <b>OR (CI)</b> <b>(N=381182)</b>	<b>Model II</b> <b>OR (CI)</b> <b>(N=365039)</b>
<b>Study groups</b>		
Finnish	Reference	Reference
Other Western	1.01 (0.83 – 1.23)	0.96 (0.78 – 1.18)
Eastern Europe	0.87 (0.71 – 1.06)	0.88 (0.72 – 1.08)
Russia, former USSR	0.98 (0.89 – 1.07)	0.94 (0.86 – 1.03)
South Asia	<b>1.32 (1.09 – 1.60)</b>	<b>1.45 (1.19 – 1.77)</b>
East Asia	<b>1.26 (1.11 – 1.42)</b>	<b>1.28 (1.13 – 1.45)</b>
Sub-Saharan Africa	1.15 (0.99 – 1.34)	<b>1.21 (1.03 – 1.42)</b>
Middle East	0.93 (0.78 – 1.10)	0.94 (0.79 – 1.12)
Latin America, Caribbean	1.09 (0.77 – 1.52)	1.10 (0.78 – 1.56)

Model I: unadjusted model

Model II: Model adjusted for age, socio-economic status, pre-pregnancy body mass index, previous births, marital status, smoking during pregnancy and delivery year

eTable 5: Risk Ratio (RR) and 95% confidence interval (CI) for low birthweight in the most recent delivery in the migrant groups compared with Finnish women

	<b>Model I</b> <b>OR (CI)</b> <b>(N=381712)</b>	<b>Model II</b> <b>OR (CI)</b> <b>(N=365281)</b>
<b>Study groups</b>		
Finnish	Reference	Reference
Other Western	0.92 (0.72 – 1.18)	0.87 (0.67 – 1.12)
Eastern Europe	0.82 (0.64 – 1.05)	0.80 (0.62 – 1.04)
Russia, former USSR	0.99 (0.89 – 1.10)	<b>0.89 (0.79 – 0.99)</b>
South Asia	<b>2.10 (1.74 – 2.53)</b>	<b>2.43 (2.08 – 2.94)</b>
East Asia	<b>1.31 (1.13 – 1.51)</b>	<b>1.25 (1.08 – 1.46)</b>
Sub-Saharan Africa	<b>1.66 (1.42 – 1.93)</b>	<b>1.99 (1.69 – 2.33)</b>
Middle East	1.13 (0.94 – 1.35)	<b>1.21 (1.00 – 1.46)</b>
Latin America, Caribbean	0.86 (0.55 – 1.35)	0.85 (0.53 – 1.34)

Model I: unadjusted model

Model II: model adjusted for age, socio-economic status, pre-pregnancy body mass index, previous births, marital status and smoking during pregnancy, and delivery year

eTable 6: Risk Ratio (RR) and 95% confidence interval (CI) for lower 5 minutes Apgar score among the newborns in the most recent delivery in the migrant groups compared with Finnish women

	<b>Model I</b> <b>OR (CI)</b> <b>(N=380352)</b>	<b>Model II</b> <b>OR (CI)</b> <b>(N=364382)</b>
<b>Study groups</b>		
Finnish	Reference	Reference
Other Western	1.05 (0.78 – 1.43)	1.02 (0.74 – 1.39)
Eastern Europe	0.93 (0.69 – 1.27)	0.92 (0.68 – 1.26)
Russia, former USSR	0.86 (0.74 – 1.00)	0.82 (0.71 – 0.96)
South Asia	<b>1.67 (1.28 – 2.19)</b>	<b>1.68 (1.27 – 2.21)</b>
East Asia	<b>1.22 (1.00 – 1.48)</b>	<b>1.30 (1.07 – 1.59)</b>
Sub-Saharan Africa	<b>2.53 (2.15 – 2.98)</b>	<b>2.59 (2.18 – 3.08)</b>
Middle East	<b>1.32 (1.05 – 1.64)</b>	<b>1.30 (1.04 – 1.64)</b>
Latin America, Caribbean	<b>1.93 (1.29 – 2.87)</b>	<b>1.95 (1.30 – 2.91)</b>

Model I: unadjusted model

Model II: model adjusted for age, socio-economic status, pre-pregnancy body mass index, previous births, marital status, smoking during pregnancy and delivery year

eTable 7: Risk Ratio (RR) and 95% confidence interval (CI) for having NICU care in the most recent delivery in the migrant groups compared with Finnish women

	<b>Model I</b> <b>OR (CI)</b> <b>(N=382002)</b>	<b>Model II</b> <b>OR (CI)</b> <b>(N=365365)</b>
<b>Study groups</b>		
Finnish	Reference	Reference
Other Western	<b>0.84 (0.73 – 0.97)</b>	<b>0.84 (0.73 – 0.98)</b>
Eastern Europe	<b>0.78 (0.67 – 0.89)</b>	<b>0.78 (0.67 – 0.90)</b>
Russia, former USSR	<b>0.87 (0.82 – 0.93)</b>	<b>0.86 (0.81 – 0.92)</b>
South Asia	1.09 (0.94 – 1.25)	<b>1.15 (1.00 – 1.33)</b>
East Asia	<b>0.83 (0.76 – 0.92)</b>	0.93 (0.84 – 1.03)
Sub-Saharan Africa	<b>1.31 (1.19 – 1.44)</b>	<b>1.36 (1.23 – 1.51)</b>
Middle East	0.93 (0.83 – 1.04)	0.89 (0.79 – 1.00)
Latin America, Caribbean	0.92 (0.72 – 1.17)	0.97 (0.76 – 1.24)

Model I: unadjusted model

Model II: model adjusted for age, socio-economic status, pre-pregnancy body mass index, previous births, marital status, smoking during pregnancy and delivery year