Title page:
International migration and adverse birth outcomes: role of ethnicity, region of origin and destination

Authors:
Marcelo Luis Urquia, Centre for Research on Inner City Health, St. Michael's Hospital, Toronto, Canada.
Richard Henry Glazier, Institute for Clinical Evaluative Sciences, Toronto, Canada.
Beatrice Blondel, Epidemiological Research Unit on Perinatal Health and Women's Health (INSERM), Paris, France.
Jennifer Zeitlin, Epidemiological Research Unit on Perinatal Health and Women's Health (INSERM), Paris, France.
Mika Gissler, National Research and Development Centre for Welfare and Health (STAKES), Helsinki, Finland.
Alison Macfarlane, City University London, United Kingdom
Edward Ng, Statistics Canada, Ottawa, Canada.
Maureen Heaman, Faculty of Nursing, University of Manitoba, Winnipeg, Canada.
Babill Stray-Pedersen, University of Oslo, Rikshospitalet, Oslo, Norway.
Anita J. Gagnon, McGill University/MUHC, Montreal, Canada for the ROAM collaboration*

* ROAM (Reproductive Outcomes And Migration) - An International Research Collaboration; members: Sophie Alexander (Université libre de Bruxelles-Belgium), Béatrice Blondel, (INSERM -France), Simone Buitendijk, (TNO Institute - Prevention and Care - Netherlands), Marie Desmeules (Public Health Agency of Canada), Dominico Di Lallo (Agency for Public Health of Rome - Italy), Anita Gagnon (McGill University and MUHC- Canada), Mika Gissler (STAKES -Finland), Richard Glazier (Institute for Clinical Evaluative Sciences - Canada), Maureen Heaman (University of Manitoba - Canada), Dineke Korfker (TNO Institute - Prevention and Care - Netherlands), Alison Macfarlane (City University of London - UK), Edward Ng (Statistics Canada), Carolyn Roth (Keele University - UK), Rhonda Small (La Trobe University -Australia), Donna Stewart (University Health Network of Toronto, University of Toronto - Canada), Babill Stray-Pedersen (University of Oslo - Norway), Marcelo Urquia (Institute for Clinical Evaluative Sciences - Canada), Siri Vangen (Department of Obstetrics and Gynaecology, The National Hospital of Norway), Jennifer Zeitlin (INSERM - France and EURO-PERISTAT), Meg Zimbeck (INSERM - France and EURO-PERISTAT).

Corresponding author:
Marcelo Luis Urquia
Centre for Research on Inner City Health, St. Michael's Hospital
70 Richmond St. E, 4th Floor
Toronto, ON M5C 1N8 Canada
Phone: (416) 864-6060 x 3340
Fax: (416) 864-5537
E-mail: marcelo.urquia@utoronto.ca
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ABSTRACT

Background
The literature on international migration and birth outcomes shows mixed results. We examined whether low birthweight (LBW) and preterm birth (PTB) differed between non-migrants and migrant subgroups, defined by race/ethnicity and world region of origin and destination.

Methods
We conducted a systematic review and meta-regression analyses using three-level logistic models to account for the heterogeneity between studies and between subgroups within studies.

Results
Twenty four studies, involving more than 30 million singleton births, met inclusion criteria. Compared to US-born Black women, Black migrant women were at lower odds of delivering LBW and PTB babies. Hispanic migrants also exhibited lower odds for these outcomes, but Asian and White migrants did not. Sub-Saharan African and Latin American and Caribbean women were at higher odds of delivering LBW babies in Europe but not in the US and South-Central Asians were at higher odds in both continents, compared with the native-born populations.

Conclusions
The association between migration and adverse birth outcomes varies by migrant subgroup and it is sensitive to the definition of the migrant and reference groups.
INTRODUCTION

About 95 million women are international migrants worldwide and female immigrants have recently outnumbered males in most industrialised countries. Nowadays, immigrant women contribute more than one fifth of all live births in the United States and several European countries. Despite a substantial body of literature focusing on the reproductive health of migrants to western industrialised countries, there is no obvious pattern describing the relation between migrant status and perinatal outcomes. The literature shows positive, negative, and null associations between migration and perinatal health, suggesting that different sources of heterogeneity may play a role. It is uncertain to what extent the association between foreign-born status and birth outcomes is a function of the characteristics of the migrant populations, of the baseline risk of the native-born reference groups, or of some combination of both. For example, foreign-born Blacks in the United States (US) compare favourably with US-born Blacks but not with US-born Whites. Such comparisons suggest that the influence of migration may be modified by ethnicity. Ethnic disparities in birth outcomes are well documented, particularly in the US, but the contribution of migration to these disparities is not well understood. In studies comparing native-born versus migrant groups defined by their regions of origin, there is uncertainty over whether the so-called healthy migrant effect applies to migrants from all or only some regions of the world, and what these regions are.

In addition, the vast majority of the studies on migration and birth outcomes grouped women according to their ethnicity or their country of origin but comparisons according to their country of destination have largely been neglected, with one recent European exception. Moreover, the interaction between sending and receiving countries has not previously been explored. International migration patterns may generate selection of particular migrants from and to certain countries, thus leading to differential health outcomes among migrants from one particular world region settling in different receiving countries. Health differences may also arise as a result of exposure to contrasting receiving environments.

Most studies devoted to migration and perinatal health have focused on birth outcomes defined by birthweight or gestational age or both. Our purpose was to conduct a systematic review to clarify the relation between migration and these birth outcomes by determining the differences in low birthweight (LBW) and preterm birth (PTB) between migrants and non-migrants by migrant subgroups, defined according to race/ethnicity, world region of origin and actual destination.

METHODS

This review was prepared following the MOOSE guidelines and draws on the material identified by the ROAM collaboration (Reproductive Outcome And Migration) for a series of systematic reviews on migration and reproductive health.

Study population

This study was restricted to published reports on any outcome requiring gestational age or infant birthweight to define it. The exposure was maternal
international migration to Western industrialised countries, assessed by evidence of
cross-border movement. Thus this definition excludes internal migration, ‘protectorates’
such as Puerto Rico, and second generation populations. Referent groups were the native-
born women of the receiving countries and White women when comparisons were made
between ethnic groups. We excluded case studies, clinical reports, reports without a
comparison group, and reports in which the results of the migrant group(s) were not
presented separately from the comparison group.

Search and study selection criteria

Studies were identified through electronic literature databases from 1995 through
October 2007 using Ovid (version 10.5.1) in the following order: Medline, Health Star,
Embase, and PsychInfo. Searches were supplemented with bibliographic citation hand-
searches of included articles published from 2004 onward and relevant articles referred to
the authors. No language exclusions were routinely applied. Articles in French, Italian,
and Spanish, were reviewed by the authors. Two ROAM members independently
assessed included studies for quality using the US Preventative Services Task Force
criteria for cohort and case-control studies and no discrepancies were found in the
overall score between raters.

All articles for the meta-analyses were selected by applying the following criteria:
1. Definitions of the outcomes: LBW was restricted to a birthweight less than 2500
   grams, and PTB to a gestational age of less than 37 completed weeks. Due to the
small number of studies it was not possible to choose a uniform definition of
small for gestational age (SGA), and therefore SGA was dropped from further
analysis. Varying definitions included SGA based on different percentiles of the
birth weight distribution of native-born populations or standard deviations,
full-term LBW infants, and revealed SGA, based on the fetuses at risk
approach.
2. Restriction to singleton births.
3. Information on race/ethnicity and foreign-born status or country of birth or
nationality
4. Descriptive tables including summary data on the outcomes with at least one
native-born and one foreign-born group.

Meta-analyses

Studies differed substantially in the way migrant groups were categorised. Unlike
the United States, where birth certificates include fields for parental race/ethnic origin
and birthplace, European Union’s legislation discourages the collection and reporting of
individual information on race/ethnicity. In the UK, ethnic origin is not collected in
birth records but some studies linked them to the census, where such information is
recorded. European studies thus relied on country of birth or nationality to assess
minority groups. These continental differences in the measurement of migrant groups
prevented us from combining all selected studies into one single meta-analysis and
therefore we conducted two meta-analyses, based on the two main approaches that have
been used to study the influences of international migration on birth outcomes.

In the first approach, studies conducted in the US used self-reported race/ethnicity
and foreign-born status, but not necessarily maternal birthplace. These studies allowed
the comparison of foreign-born versus native-born women of the same race/ethnicity. One UK study also reported these data for LBW but was excluded to restrict our analysis to the US context. We also excluded Hispanics from one US study to avoid data duplication with another study.

In the second approach, several studies conducted in Europe compared all migrants or migrants from particular regions of the world to the native-born population without reference to ethnic group (Table 3). This second meta-analysis excluded some US studies that did not provide information at the country level. In one study that stratified the outcomes by Asian countries of origin but not by foreign-born status we considered as foreign-born those national-origin groups with at least 90% of foreign-born women and therefore excluded Japanese and Filipino women. One UK study was removed to avoid data duplication with another national study.

Our searches identified eighty two studies. Of these, we excluded 11 studies that did not include LBW or PTB or used different definitions, 31 studies that did not discriminate between singleton and multiple births, four that did not ascertain migration appropriately, and seven that did not have appropriate tables for the extraction of the data. Finally, five studies reporting PTB by world region of birth were not used due to the small number of studies available for this outcome using the second approach. Thus, twenty four studies were included in the meta-analyses: 16 by race/ethnicity (Table 1), 16 by world region (Table 3), and 9 by both. None of the selected studies had poor internal validity.

**Data extraction**

For each outcome, we extracted summary birth data consisting of at least two records per study: one for the migrant and one for the native-born group, although many studies included several subgroups including maternal ethnic groups, world regions or countries of origin or infants’ year of birth. Each record contained a numerator and a denominator for the outcome, and indicators of migrant status (foreign-born, native-born), race/ethnicity as categorised in US studies (Asians, Blacks, Hispanics, and Whites), migrants’ country of birth or origin or nationality, place of destination (US or European countries), and infants’ year of birth. If the birth data aggregated more than one year, the midpoint was recorded, and for articles reporting numerators and denominators for different periods, one record was assigned to each period. We grouped countries of birth into world regions, following the classification of the United Nations in most cases. Asia was subdivided into South-Central Asia (mainly India, Pakistan, and Bangladesh) and East/South-East Asia, because women from the Indian subcontinent may differ in the risk of adverse birth outcomes compared to the rest of Asia. In the same vein, North Africans were separated from the rest of Africa (i.e., Sub-Saharan Africa) because of their particularly good birth outcomes and grouped with Middle Eastern countries, because some studies have grouped these regions together. Sensitivity analyses performed without these two studies did not affect the results regarding North Africans and therefore we did not exclude them.

**Statistical analyses**
In order to account for the potential heterogeneity between studies and subgroups within studies, we employed random effects meta-regression analysis, which involves the application of multilevel methods to meta-analysis. We used three-level models, with births at level 1, subgroups at level 2 and studies at level 3. The inclusion of random effects at the subgroup-level assumes that each subgroup represents a different population with its own distribution. Ignoring the hierarchical structure of these data would produce over-precise confidence intervals. Analyses were conducted with Proc GLIMMIX in SAS 9.1 (SAS Institute, Cary, NC) to fit multilevel logistic regression models for summary data.

In the first meta-analysis (migration and race/ethnicity) we fitted two models for each outcome: the first model had migrant status as the only predictor and a more complex model added race/ethnicity and a product term between race/ethnicity and migrant status to simultaneously obtain odds ratios comparing minority groups with Whites, by migrant status, and foreign-born with native-born within ethnic groups. All models were adjusted for infants’ year of birth. We quantified the percent of variance explained for logistic models by comparing the more complex model relative to the model including migrant status as the only predictor.

The second meta-analysis (migration and world regions) was based on studies which analyzed low birthweight in Europe or the US, categorizing migrants and non-migrants by their countries of birth, irrespective of their race/ethnicity. We could not analyze preterm birth due to the small number of studies and migrant groups. The low birthweight model included a product term between world region of origin and place of destination (Europe versus US) in order to test the hypothesis that the odds of LBW differ both according to the region of origin and destination, adjusted for infants’ year of birth. P-values < 0.10 were considered statistically significant for product terms.

RESULTS

Migration and race/ethnicity

We first fitted a three-level model with migrant status as the independent variable, adjusted for infant’s year of birth, but ignoring race/ethnicity. The odds ratios (95% confidence interval) for the comparisons between migrants and non-migrants were 0.81 (0.70-0.94) for LBW, and 0.85 (0.74-0.98) for PTB, respectively. These are inappropriate models that assume that the effect of migrant status can be averaged across racial/ethnic groups. Instead, Table 2 shows the results of the three-level models including race/ethnicity and a product term between race/ethnicity and migrant status for the two outcomes, adjusted for year of birth. The p-values of the product term for the models of LBW and PTB were 0.0611 and 0.0018, respectively. The percent of total variance explained by the introduction of race/ethnicity and the product term “migrant status * race/ethnicity” relative to a model including only migrant status, adjusted for year of birth, was 57% and 24% for LBW and PTB, respectively, suggesting that race/ethnicity and its interplay with migrant status explain substantial variability in the outcomes not accounted for by migrant status alone.

The first, second and third columns of odds ratios in Table 2 present ethnic disparities within first generation migrants, within US-born, and disparities between foreign-born and US-born of the same ethnic group, respectively.
Among foreign-born migrants, all minority groups were more likely to have adverse birth outcomes than Whites, with the exception of Hispanics migrants for LBW. Blacks were the group at the highest odds for the two outcomes both among foreign-born and US-born women. Despite baseline LBW and PTB rates that were higher for native-born Whites compared to White migrants, the Black-White gap was wider among the US-born than among international migrants. Conversely, the Asian-White gap narrowed among the US-born compared to first generation migrants, and there was no evidence that foreign-born Asians were protected for these outcomes compared to US-born Asians. Blacks presented the strongest protective effect of being foreign-born for the two outcomes, followed by Hispanics (last column). The Hispanic-White gap was wider among the native-born than among the foreign-born in LBW but not in PTB.
Table 1  Characteristics of the US-studies included in the meta-analysis by race/ethnicity

<table>
<thead>
<tr>
<th>Study (author, year, reference)</th>
<th>Country, state/region</th>
<th>Type of database</th>
<th>Year of data</th>
<th>Outcome</th>
<th>Migrants</th>
<th>US-born</th>
<th># of subgroups</th>
<th>Births*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexander et al. 1996</td>
<td>USA, regional NE</td>
<td>PBR</td>
<td>1983-1987</td>
<td>LBW</td>
<td>Asians</td>
<td>Asians</td>
<td>2</td>
<td>37941</td>
</tr>
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<td>Cervantes et al. 1999</td>
<td>USA, Chicago City</td>
<td>PBR</td>
<td>1994</td>
<td>LBW, PTB</td>
<td>Blacks, Hispanics, Whites</td>
<td>Blacks, Hispanics, Whites</td>
<td>8</td>
<td>52033</td>
</tr>
<tr>
<td>Crump et al. 1999</td>
<td>USA, Washington State</td>
<td>PBR</td>
<td>1989-1994</td>
<td>LBW, PTB</td>
<td>Hispanics</td>
<td>Hispanics</td>
<td>2</td>
<td>9572</td>
</tr>
<tr>
<td>English et al. 1997</td>
<td>USA, California</td>
<td>PBR + quest</td>
<td>1992</td>
<td>LBW, PTB</td>
<td>Hispanics</td>
<td>Hispanics</td>
<td>6</td>
<td>4404</td>
</tr>
<tr>
<td>Fang et al. 1999</td>
<td>USA, New York City</td>
<td>PBR</td>
<td>1988-1994</td>
<td>LBW, PTB</td>
<td>Blacks</td>
<td>Blacks</td>
<td>5</td>
<td>269863</td>
</tr>
<tr>
<td>Fuentes-Afflick et al. 1998</td>
<td>USA, California State</td>
<td>PBR</td>
<td>1992</td>
<td>LBW, PTB</td>
<td>Asians, Blacks, Hispanics, Whites</td>
<td>Asians, Blacks, Hispanics, Whites</td>
<td>8</td>
<td>573233</td>
</tr>
<tr>
<td>Gould et al. 2003</td>
<td>USA, California State</td>
<td>PBR</td>
<td>1995-1997</td>
<td>LBW, PTB</td>
<td>Asians, Hispanics</td>
<td>Blacks, Whites</td>
<td>4</td>
<td>105977</td>
</tr>
<tr>
<td>Kramer et al. 2006</td>
<td>USA, national</td>
<td>PBR</td>
<td>1998-2000</td>
<td>PTB</td>
<td>Blacks</td>
<td>Blacks</td>
<td>2</td>
<td>1754777</td>
</tr>
<tr>
<td>Madan et al. 2006</td>
<td>11 States</td>
<td>PBR</td>
<td>1995-1997</td>
<td>LBW, PTB</td>
<td>Asians, Hispanics</td>
<td>Asians, Hispanics</td>
<td>5</td>
<td>6424172</td>
</tr>
<tr>
<td>Palotto et al. 2000</td>
<td>USA, Illinois State</td>
<td>PBR</td>
<td>1985-1990</td>
<td>LBW</td>
<td>Blacks</td>
<td>Blacks, Whites</td>
<td>3</td>
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</tr>
<tr>
<td>Rosenberg et al. 2005</td>
<td>USA, New York City</td>
<td>PBR</td>
<td>1996-1997</td>
<td>LBW</td>
<td>Hispanics</td>
<td>Hispanics</td>
<td>14</td>
<td>156084</td>
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<td>Wingate et al. 2006</td>
<td>USA, national</td>
<td>PBR</td>
<td>1995-1999</td>
<td>LBW, PTB</td>
<td>Hispanics</td>
<td>Hispanics</td>
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<tr>
<td>TOTAL</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>111</td>
</tr>
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*When the sample size varies by outcome, the denominator for LBW was reported, followed by PTB if LBW was not reported.
Table 2  Percent and Odds ratios (and 95% confidence intervals)* for adverse birth outcomes for ethnic minority women compared with white women, by migrant status; and Odds ratios of migrants compared with US-born women, by ethnic group

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=6 487 938</td>
<td>N=11 702 432</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low birthweight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LBW %</td>
<td>OR (95% CI)</td>
<td>LBW %</td>
<td>OR (95% CI)*</td>
</tr>
<tr>
<td>Whites</td>
<td>4.0</td>
<td>1.00</td>
<td>4.6</td>
<td>1.00</td>
</tr>
<tr>
<td>Asians</td>
<td>5.4</td>
<td>1.37 (1.05-1.79)</td>
<td>5.8</td>
<td>1.28 (1.02-1.60)</td>
</tr>
<tr>
<td>Blacks</td>
<td>8.2</td>
<td>2.14 (1.61-2.41)</td>
<td>12.3</td>
<td>2.94 (2.36-3.67)</td>
</tr>
<tr>
<td>Hispanics</td>
<td>4.4</td>
<td>1.10 (0.85-1.43)</td>
<td>5.6</td>
<td>1.26 (1.02-1.55)</td>
</tr>
<tr>
<td>Preterm birth</td>
<td>N=4 009 158</td>
<td>N=8 587 564</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PTB %</td>
<td>OR (95% CI)</td>
<td>PTB %</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Whites</td>
<td>7.9</td>
<td>1.00</td>
<td>9.5</td>
<td>1.00</td>
</tr>
<tr>
<td>Asians</td>
<td>11.1</td>
<td>1.44 (1.15-1.81)</td>
<td>10.2</td>
<td>1.08 (0.88-1.33)</td>
</tr>
<tr>
<td>Blacks</td>
<td>12.3</td>
<td>1.62 (1.30-2.03)</td>
<td>16.6</td>
<td>1.89 (1.64-2.19)</td>
</tr>
<tr>
<td>Hispanics</td>
<td>10.5</td>
<td>1.35 (1.10-1.66)</td>
<td>11.6</td>
<td>1.24 (1.07-1.44)</td>
</tr>
</tbody>
</table>

LBW: Low Birthweight, PTB: Preterm Birth, OR: Odds Ratio, CI: Confidence Intervals
*Obtained with the full three-level model including random effects (subgroup and studies), and fixed effects (migrant status, race/ethnicity, migrant status x race/ethnicity, and infant's year of birth.
**US-born is the reference group

Migration and world regions

This meta-analysis is based on 16 studies that measured foreign-born status and country or region of birth, irrespective of their ethnicity (Table 3). Table 4 and 5 present the results of a three-level model of LBW assessing the interaction between world region of origin and destination, which was highly significant (p-value <0.0001). A few comparisons were not possible because some subgroups migrating to the US were not represented in the selected studies. Table 4 shows the LBW percent as predicted by the model, by migrant subgroup.
Table 3  Characteristics of the studies included in the meta-analysis of low birthweight by World regions

<table>
<thead>
<tr>
<th>Study</th>
<th>Country, state/region</th>
<th>Type of database</th>
<th>Year of data</th>
<th>Migrants' world regions</th>
<th># of subgroups</th>
<th>Births</th>
<th>% migrants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crump/ 1999</td>
<td>USA, Washington State</td>
<td>PBR</td>
<td>1989-1994</td>
<td>Latin America (Mexico)</td>
<td>2</td>
<td>9 572</td>
<td>50.0</td>
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<tr>
<td>Fang/ 1999</td>
<td>USA, New York City</td>
<td>PBR</td>
<td>1988-1994</td>
<td>Caribbean, South America, Africa (excl North)</td>
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<td>35.9</td>
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<tr>
<td>Fuentes-Afflick/ 1997</td>
<td>USA, California State</td>
<td>PBR</td>
<td>1992</td>
<td>Cambodia, China, India, Korea, Laos, Thailand, Vietnam</td>
<td>8</td>
<td>253 592</td>
<td>12.5</td>
</tr>
<tr>
<td>Gissler/2003</td>
<td>Sweden, national</td>
<td>PBR</td>
<td>1987-1988</td>
<td>Finland</td>
<td>6</td>
<td>140 390</td>
<td>23.8</td>
</tr>
<tr>
<td>Gould/ 2003</td>
<td>USA, California State</td>
<td>PBR</td>
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<td>India, Mexico</td>
<td>4</td>
<td>1 057 977</td>
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<td>Belgium, national</td>
<td>PBR</td>
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<td>107 968</td>
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<td>PBS</td>
<td>1995</td>
<td>North Africa</td>
<td>2</td>
<td>11 802</td>
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<td>Latin America (Mexico)</td>
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<td>8.4</td>
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<td>Landale/ 1999</td>
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<td>PBR</td>
<td>1989-1991</td>
<td>Latin America, China, Philippines, Japan</td>
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<td>2 390 430</td>
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<td>Madan/ 2006</td>
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<td>India, Latin America (Mexico)</td>
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<td>PBR</td>
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<td>West Europe/North America, East Europe, North Africa/Middle East, Sub-Saharan Africa, Latin America,</td>
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<td>Rosenberg/ 2005</td>
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</table>

TOTAL 143 31 021 461 19.9

HR: hospital record, PB: population-based, PBR: population-based registry, PBS: population-based survey
Table 4  Infants and percent of low birthweight infants born in Europe and the United States, by migrant group

<table>
<thead>
<tr>
<th>Infants born in Europe</th>
<th>Infants born in the US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Births</td>
<td>LBW % *</td>
</tr>
<tr>
<td>Native-born women</td>
<td>13 439 223 4.3</td>
</tr>
<tr>
<td>Migrants from:</td>
<td></td>
</tr>
<tr>
<td>Western Europe and North America</td>
<td>284 372 3.9</td>
</tr>
<tr>
<td>East Europe</td>
<td>40 224 4.3</td>
</tr>
<tr>
<td>North Africa / Middle East</td>
<td>62 622 3.4</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>172 936 7.3</td>
</tr>
<tr>
<td>South-Central Asia</td>
<td>508 208 7.7</td>
</tr>
<tr>
<td>East / South-East Asia</td>
<td>3 283 5.1</td>
</tr>
<tr>
<td>Latin America / Caribbean</td>
<td>67 788 6.2</td>
</tr>
</tbody>
</table>

* Obtained with a three-level model including random effects (subgroup and studies), and fixed effects (migrant status, maternal region of origin, place of destination, maternal region of origin x place of destination, and infant's year of birth)

Table 5  Odds ratios (and 95% confidence intervals)* for low birthweight for migrant women compared with European-born and US-born women, and for various World Regions according to their place of destination (Europe versus the United States)

<table>
<thead>
<tr>
<th>Infants born in Europe</th>
<th>Infants born in the US</th>
<th>Infants born in Europe versus in the US**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Native-born women</td>
<td>1.00 1.00</td>
<td>0.61 (0.47-0.79)</td>
</tr>
<tr>
<td>Migrants from:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western Europe &amp; North America</td>
<td>0.91 (0.77-1.07)</td>
<td>-</td>
</tr>
<tr>
<td>East Europe</td>
<td>0.99 (0.79-1.25)</td>
<td>-</td>
</tr>
<tr>
<td>North Africa &amp; Middle East</td>
<td>0.78 (0.60-1.01)</td>
<td>-</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>1.75 (1.44-2.12)</td>
<td>0.75 (0.55-1.02)</td>
</tr>
<tr>
<td>South-Central Asia</td>
<td>1.84 (1.54-2.20)</td>
<td>1.33 (1.01-1.77)</td>
</tr>
<tr>
<td>East &amp; South-East Asia</td>
<td>1.20 (0.72-2.02)</td>
<td>0.89 (0.73-1.09)</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>1.46 (1.17-1.83)</td>
<td>0.72 (0.62-0.82)</td>
</tr>
</tbody>
</table>

OR: Odds Ratio, CI: Confidence Interval
* Obtained with a three-level model including random effects (subgroup and studies), and fixed effects (migrant status, maternal region of origin, place of destination, maternal region of origin x place of destination, and infant's year of birth)
** Infants born in the US are the reference group
Table 5 presents Odds Ratios for LBW according to maternal region of origin and destination. Women from Western countries and North Africa compared favourably with European-born women but there were no data available for the US. Women from Sub-Saharan Africa and Latin America and the Caribbean were at higher odds for LBW if migrating to European countries but at lower odds if migrating to the US, compared to the respective native-born women. Unlike other groups, South-Central Asians were at higher odds in both contexts but the association was stronger in Europe. The direction and strength of these associations are affected by the different baseline risk of the European and US reference groups, with European-born women less likely to deliver LBW infants compared to US-born women (OR = 0.61 [95% CI = 0.47-0.79]). Despite this, Sub-Saharan African and Latin American and Caribbean women migrating to Europe seemed to be more likely to deliver LBW babies compared to those from the same region who migrated to the US, although these trends did not reach statistical significance in the 3-level model (Table 5, third column).

DISCUSSION

Main findings

One of the main findings of this systematic review is that the association between foreign-born status and birth outcomes is not uniform but depends on the migrant subgroup, either defined by a combination of maternal race/ethnicity and migrant status or by the world region of origin and actual destination. We found that infants born to first-generation Black and Hispanic migrant women were at lower risk of adverse birth outcomes than their US-born counterparts, but did not find evidence of such protective effect among Asians and Whites. Migrants from these ethnicities were at higher risk than White migrants overall. Regarding subgroups defined by region of origin, Sub-Saharan African and Latin American and Caribbean migrants were at higher odds of LBW in Europe but not in the US and South-Central Asians were at higher odds in both continents.

Strengths and limitations

Unlike most meta-analyses of observational studies, instead of combining adjusted odds ratios we used summary data stratified by key predictors. This approach made it possible to examine comparisons not explored in previous studies, such as the assessment of ethnic disparities by migrant status and comparisons within migrant subgroups according to their place of destination. Another advantage is that our analyses used the same set of covariates and definitions for each study thus making interpretation of results less problematic than in meta-analyses based on effect estimates adjusted for varying number of covariates with heterogeneous definitions. However, the limitation of our approach was the inability to extract birth data stratified by potential confounders.

Immigration policies in the receiving countries and social class dynamics in the source countries may favour the selection of women or couples for migration, based on certain characteristics for which distributions may differ both from those of the source and the receiving population (e.g., maternal age, maternal and paternal social class, marital status, overall health) and that are also associated with birth outcomes. For example, differences in maternal age may explain part of the foreign-born advantage of Hispanics in the US, since they have lower teenage pregnancy rates than their US-born counterparts. Foreign-born Hispanics and Blacks had lower proportions of single
mothers. Despite these favourable characteristics foreign-born Mexicans but not foreign-born Blacks in the US had lower education, less prenatal care, and lower income compared to US-born mothers. This phenomenon makes up part of the so-called “Latino paradox”, that also can be extended to the birthweight advantage of North Africans in France and Belgium. It is clear that any adjusting for risk factors should be undertaken with caution since the same factors cannot be assumed to have the same effects in different populations or different contexts.

Since the social and historical complexity involved in each migrant population could not be adequately explored in a meta-analysis searching for overarching trends, our findings should be regarded as global tendencies that may not apply to particular migrant subgroups settling in particular countries, regions, or cities. Part of such complexity involves heterogeneity of source countries within ethnic and migrant subgroups. In addition, ethnic groups differ according to generational status, with US-born Hispanics and Asians more likely to be first or second generation than US-born Blacks or Whites, who are mostly fourth or higher generation. Even first generation migrants may differ in their risk of adverse birth outcomes according to their length of residence in the receiving country, information that was rarely collected. Another potential source of bias is measurement error, mainly resulting from self-reported race/ethnicity and country of birth and nationality in birth certificates. Validation studies suggest that the misclassification is less than 10% for any ethnic group. The meaning and limitations of the racial/ethnic classification for epidemiologic research had been extensively discussed. The reviewed literature on birth outcomes tended to consider the racial/ethnic categories as markers for a social process external to individual physiology rather than indicators of biological types.

**Migration and ethnic disparities**

The protective effect in the immigrant generation has a clear gradient: It is stronger for Black migrants, still present among Hispanics, but virtually absent among Asians and Whites. This gradient mirrors the ethnic group hierarchy in the US, which places people of African descent at the bottom, Hispanics in the middle, and gives (East) Asians a favourable treatment close to that of Whites. These findings are at odds with the classical assimilation theory that predicts a convergence of the outcomes of migrant groups towards the level observed in the mainstream White society. Instead, the observed pattern is more consistent with the segmented assimilation theory that suggests that migrants are selectively incorporated into the system of stratification of the American society based on their ethnic affiliation.

The better birth outcomes of foreign-born Blacks versus their US-born counterparts cannot be explained by the ‘genetic hypothesis’, which would predict that US-born Blacks be an intermediate risk group between foreign-born Blacks and US-born Whites because of intermarriage and genetic mixing over previous generations. Among the environmental explanations, assimilation theories cannot fully account for US-Black disadvantage, since these theories focus on how migrants and their offspring are incorporated into the host society and about 97% of US-born Blacks were fourth or higher generation in 1990. A few studies have proposed a socio-historic hypothesis, pointing to continuous exposure to socioeconomic and structural discrimination, from past historical periods to the urban underclass. Such explanation is consistent with a substantial sociological literature indicating that racial
segregation concentrates deprivation in Black neighbourhoods by concentrating people who fit negative racial stereotypes and by restricting the poverty created by economic downturns into a small number of visible minority neighbourhoods, mainly through discrimination in the housing market. \(^{107,108}\) Residential racial segregation has been positively associated with infant mortality among Blacks but negatively among Whites, \(^{109}\) and the Black-White gap in PTB was found to be higher in hypersegregated areas.

Because international migration barely contributes to the number of Blacks in the US, the relative advantage of foreign-born Blacks have little impact on the birth outcomes of Blacks as a whole. In contrast, migrant women contributed to nearly 60% of births among Hispanics, thus shaping the birth outcomes of this ethnic group.

**Migration and region of origin and destination**

Regarding subgroups defined by region of origin and destination, Sub-Saharan African and Latin American and Caribbean migrants were at higher odds of LBW in Europe but not in the US and South-Central Asians were at higher odds in both continents, although their disadvantage was somewhat attenuated in the US. Part of these differences can be explained by the ethnic composition of the native-born populations in these analyses, defined by their place of birth but not by their ethnic groups, and by the patterns of emigration. Thus, US-born compare unfavourably with European-born partly due to the heavier weight of their ethnic minorities. In the same vein, the Latin American advantage in the US may be driven by the disproportionate representation of Mexicans in the US, but not in Europe. Low birthweight rates of Mexicans were among the lowest among Latin American immigrants. \(^{85}\) It is believed that Mexicans in the US are protected because of their residential proximity with co-ethnics, social support systems, and cultural orientation, \(^{16,17,59,111}\) all of which is facilitated by the spatial contiguity with the home country. The safeguarding of such protective traits may be more difficult to achieve in transatlantic Europe.

The reasons for the higher odds of LBW of Sub-Saharan Africans in Europe compared with those settling in the US are not clear. Differential migration could not be assessed because, with one exception, \(^{83}\) studies did not provide information at the country-level. It is unlikely that the distribution of reported risk factors accounts for the difference, since the rates of anaemia, tobacco smoking, marital status, maternal education, and low income were comparable in both continents. \(^{4,15,25,81,83}\) Unmeasured factors or a differential effect of the receiving environments may likely play a role. The same receiving environment may also affect some migrant groups favourably and others unfavourably, as suggested in a Swedish study. \(^{88}\)

**Further research**

It remains to be determined whether and to what extent the risk of adverse birth outcomes differs for particular migrant groups according to their actual destination and whether such an effect, if existent, is due to selective migration or to differential exposures in the receiving environment. The existence of differences in the risk of adverse birth outcomes within migrant groups according to place of migration remains a plausible hypothesis to be further investigated.

Our analyses imply that the definition of the migrant groups and the choice of the reference groups have a decisive impact on the direction and strength of the effect estimates for the migrant groups. Although the comparison between migrants and
majority populations may be of interest in itself for highlighting disparities by migrant status as a single category, summary statistics representing the effect of foreign-born status may result in misleading conclusions regarding particular migrant groups. Future research should thus strive to distinguish subgroups defined by their regions and, when feasible, by their countries of origin since there may be heterogeneity between countries within the same world region.²²,⁸⁵ Distinguishing appropriate comparison subgroups within the receiving-country population is also recommended, especially in countries highly stratified by race/ethnicity such as the US.¹⁰¹

Further research on migration and adverse birth outcomes may advance knowledge by examining why some migrant groups experience poor outcomes and why others do not and what are the dynamics leading to worse outcomes among the offspring of some migrant groups but not of others. Future studies will benefit from obtaining longitudinal measurements on migrants, including pre-migration characteristics and circumstances of immigration, and social environment, medical care and health behaviour after arrival.
What is already known on this subject?
- Immigrant women contribute more than one fifth of all live births in several industrialised countries.
- Studies comparing birth outcomes of migrants with those of native-born women show mixed results.

What does this study add?
- The use of foreign-born status as a single category is not informative.
- Compared with native-born women, Sub-Saharan African and Latin American and Caribbean migrants were at higher odds of LBW in Europe but not in the United States and South-Central Asians were at higher odds in both continents.
- The direction and strength of the associations between foreign-born status and birth outcomes depend on the choice of the reference group and on the definition of the migrant subgroup, either defined by maternal race/ethnicity, world region of origin, and place of destination.

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Competing interests:
None declared.

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Ethics
Since data used for this study were extracted from published literature it does not require ethics approval

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