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Sizable variations in circulatory disease mortality by region and country of birth in six European countries

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Background: Circulatory disease mortality inequalities by country of birth (COB) have been demonstrated for some EU countries but pan-European analyses are lacking. We examine inequalities in circulatory mortality by geographical region/COB for six EU countries. Methods: We obtained national death and population data from Denmark, England and Wales, France, the Netherlands, Scotland and Sweden. Mortality rate ratios (MRRs) were constructed to examine differences in circulatory, ischaemic heart disease (IHD) and cerebrovascular disease mortality by geographical region/COB in 35–74 years old men and women. Results: South Asians in Denmark, England and Wales and France experienced excess circulatory disease mortality (MRRs 1.37–1.91). Similar results were seen for Eastern Europeans in these countries as well as in Sweden (MRRs 1.05–1.51), for those of Middle Eastern origin in Denmark (MRR = 1.49) and France (MRR = 1.15), and for East and West sub-Saharan Africans in England and Wales (MRRs 1.28 and 1.39) and France (MRRs 1.24 and 1.22). Low ratios were observed for East Asians in France, Scotland and Sweden (MRRs 0.64–0.50). Sex-specific analyses showed results of similar direction but different effect sizes. The pattern for IHD mortality was similar to that for circulatory disease mortality. Two- to three-fold excess cerebrovascular disease mortality was found for several foreign-born groups compared with the local-born populations in some countries. Conclusions: Circulatory disease mortality varies by geographical region/COB within six EU countries. Excess mortality was observed for some migrant populations, less for others. Reliable pan-European data are needed for monitoring and understanding mortality inequalities in Europe’s multiethnic populations.
being an exception) or other proxy measure, excepting our work, no systematic analysis across European countries has been made.8

This study was originated in the Migrant and Ethnic Health Observatory (MEHO—project website: www.meho.eu.com), which is a EU funded methodological demonstration project. The aim of MEHO is to map, and if feasible analyse, routine data from EU countries, with the objective of generating ethnic group-specific health status indicators, including for circulatory diseases—we have already reported on differences in circulatory disease mortality by country of destination by comparing few selected COB groups across different EU countries.19 Here, we extend the investigation of within-country variation in circulatory disease mortality by COB to six EU member states simultaneously, including some for which little or no similar information has been published. Since the health status of migrant and ethnic populations is unlikely to be fixed across countries, international comparisons are crucial for making correct inferences about the aetiology and burden of ill health and mortality in migrant populations across Europe.20 Our objective was to determine whether within-country comparisons in one location are echoed in another.

Methods

Data

The mortality and population data used have been described elsewhere.19 Briefly, we selected six EU countries—Denmark, England and Wales, France (excluding the overseas departments), the Netherlands, Scotland and Sweden—after assessing the comparability of EU circulatory disease mortality data.8 Data on deaths by age, sex, COB and underlying cause of death were acquired. The mortality data were provided for variable time periods, in some countries being centred on the 3- to 5-year period around the last census year (table 1). Data were extracted using ICD-9 and/or ICD-10 codes (an exception being Denmark which used ICD-8

### Table 1
Overview of study design, time period and PYR by country or region of birth for selected European countries

<table>
<thead>
<tr>
<th>Country or region of birth, study design and data collection period</th>
<th>Individual countries of birth included in region of birth categories</th>
<th>Person-years at risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark, longitudinal, 1992–2001</td>
<td>Denmark</td>
<td>12 341 982 12 546 253</td>
</tr>
<tr>
<td>Asia, South</td>
<td>Afghanistan, Pakistan, Sri Lanka</td>
<td>34 283</td>
</tr>
<tr>
<td>Asia, Southeast</td>
<td>Thailand, Vietnam</td>
<td>11 264 19 243</td>
</tr>
<tr>
<td>Europe, Eastern</td>
<td>Bosnia/Herzegovina, Poland, Yugoslavia</td>
<td>66 585 83 156</td>
</tr>
<tr>
<td>Middle East</td>
<td>Iran, Iraq, Lebanon, Turkey</td>
<td>84 654 58 980</td>
</tr>
<tr>
<td>England and Wales, non-longitudinal data—fixed denominator, 1999–2003</td>
<td>England, Wales</td>
<td>52 409 325 54 207 730</td>
</tr>
<tr>
<td>Asia, South</td>
<td>India, Bangladesh, Pakistan, Sri Lanka</td>
<td>1 474 235 1 446 575</td>
</tr>
<tr>
<td>Caribbean</td>
<td>Belize, Guyana, Jamaica, Trinidad and Tobago, Windward Islands, Barbados, Leeward Islands, Northern Islands</td>
<td>446 620 537 875</td>
</tr>
<tr>
<td>Europe, Eastern</td>
<td>Poland, Ex-Yugoslavia, Romania, Hungary, Czech Republic, Slovakia, Albania, Bulgaria</td>
<td>125 150 166 010</td>
</tr>
<tr>
<td>North Africa</td>
<td>Egypt, Algeria, Libya, Tunisia, Morocco</td>
<td>108 140 71 080</td>
</tr>
<tr>
<td>Sub-Saharan Africa, East</td>
<td>Zambia, Malawi, Kenya, Tanzania, Uganda</td>
<td>441 410 418 940</td>
</tr>
<tr>
<td>Sub-Saharan Africa, South</td>
<td>The Republic of South Africa</td>
<td>103 345 124 300</td>
</tr>
<tr>
<td>Sub-Saharan Africa, West</td>
<td>Nigeria, Ghana, Sierra Leone, The Gambia</td>
<td>230 975 230 080</td>
</tr>
<tr>
<td>France, non-longitudinal data—fixed denominator, 2005–2007</td>
<td>France</td>
<td>35 936 542 38 717 357</td>
</tr>
<tr>
<td>Asia, East</td>
<td>China</td>
<td>37 258 45 219</td>
</tr>
<tr>
<td>Austria, South</td>
<td>Sri Lanka</td>
<td>33 834 25 894</td>
</tr>
<tr>
<td>Asia, Southeast</td>
<td>Mauritius, Cambodia, Laos, Vietnam</td>
<td>254 129 273 752</td>
</tr>
<tr>
<td>Caribbean</td>
<td>Haiti</td>
<td>22 578 27 881</td>
</tr>
<tr>
<td>Europe, Eastern</td>
<td>Poland, Romania, Ex-Yugoslavia, Ex-USSR</td>
<td>186 252 241 505</td>
</tr>
<tr>
<td>Latin America, Tropical</td>
<td>Brazil</td>
<td>9458 21 634</td>
</tr>
<tr>
<td>Middle East</td>
<td>Turkey</td>
<td>199 421 156 579</td>
</tr>
<tr>
<td>North Africa</td>
<td>Algeria, Morocco, Tunisia</td>
<td>2 814 391 2 570 138</td>
</tr>
<tr>
<td>Sub-Saharan Africa, Central</td>
<td>Congo, Democratic Republic of the Congo</td>
<td>93 331 99 183</td>
</tr>
<tr>
<td>Sub-Saharan Africa, East</td>
<td>Madagascar</td>
<td>76 143 99 183</td>
</tr>
<tr>
<td>Sub-Saharan Africa, West</td>
<td>Cameroon, Ivory Coast, Mali, Senegal</td>
<td>259 511 217 710</td>
</tr>
<tr>
<td>The Netherlands, longitudinal data, 1996–2006</td>
<td>The Netherlands</td>
<td>35 784 357 35 981 668</td>
</tr>
<tr>
<td>Caribbean</td>
<td>Antigua and Aruba, Surinam</td>
<td>1 094 570 1 046 872</td>
</tr>
<tr>
<td>Middle East</td>
<td>Turkey</td>
<td>564 497 458 149</td>
</tr>
<tr>
<td>North Africa</td>
<td>Morocco</td>
<td>484 206 339 418</td>
</tr>
<tr>
<td>Scotland, non-longitudinal data—fixed denominator, 1999–2003</td>
<td>Scotland</td>
<td>5 101 665 5 549 010</td>
</tr>
<tr>
<td>Asia, East</td>
<td>China</td>
<td>15 825 15 985</td>
</tr>
<tr>
<td>Asia, South</td>
<td>Pakistan, India, Bangladesh</td>
<td>43 325 38 215</td>
</tr>
<tr>
<td>Sweden, non-longitudinal data—variable denominator, 1990–2006</td>
<td>Sweden</td>
<td>28 982 698 28 925 653</td>
</tr>
<tr>
<td>Asia, East</td>
<td>China, North and South Korea</td>
<td>32 623 41 064</td>
</tr>
<tr>
<td>Asia, South</td>
<td>India</td>
<td>25 336 19 631</td>
</tr>
<tr>
<td>Asia, Southeast</td>
<td>Thailand, Vietnam</td>
<td>35 663 83 404</td>
</tr>
<tr>
<td>Europe, Eastern</td>
<td>Poland, Total former Yugoslavia, Former USSR-European part, Baltic States, Former USSR-Eastern part, Eastern Europe</td>
<td>1 062 768 1 390 244</td>
</tr>
<tr>
<td>Latin America, Southern</td>
<td>Chile</td>
<td>103 618 106 217</td>
</tr>
<tr>
<td>Middle East</td>
<td>Iraq, Iran, Lebanon, Turkey</td>
<td>597 713 425 171</td>
</tr>
<tr>
<td>Sub-Saharan Africa, East</td>
<td>Ethiopia, Eritrea, Somalia</td>
<td>78 120 55 807</td>
</tr>
</tbody>
</table>
and ICD-10): total circulatory disease ICD-9 390–459, ICD-10: I00–
199; ischaemic heart disease (IHD) ICD-9 410–414, ICD-
10 120–125 and cerebrovascular disease ICD-9 430–438, ICD-
10 I60–I69.

The following criteria were used to select COB groups: (i) the focus
of MEHO project, which was on predominantly socioeconomically
deprived migrant populations originating outside Western Europe
and the OECD countries; (ii) sufficient size of population for
meaningful analysis (see further below). We also adopted the Global
Burden of Disease project’s approach in constructing geographical
categories in order to harmonize the exposure categories—different
migration history and patterns have contributed to relative sizes of
different COB groups in different countries—and to reduce the
number of exposure categories per study country. Therefore, we
included only COBs with more than four deaths and person-years
at risk (PYR) equal or greater than 30 000 for men and women
combined. Any given geographical category could include a single
or more COBs (table 1).

The analysis was restricted to those aged 35–74 years because: (i)
few circulatory deaths occur in people under 35 years, (ii) there are
important differences in age structure between men and women
older than 74 years, (iii) there may be more inaccuracies in death
certification in those older than 75 years, (iv) for some ethnic
groups, younger age groups may have a significant proportion
born in the destination country and (v) older populations
may have significant number of European ethnic groups born
overseas.

Ethics
As our data were completely anonymized, ethical approval was
deemed unnecessary.

Statistical analysis
We computed mortality rate ratios (MRRs) for foreign- and
local-born persons in each study country based on Poisson
loglinear models using PASW Statistics version 17. We related the
number of deaths to the amount of observed PYR, using PYR as
offset and COB as an independent variable, in two sets of models:
sex-combined models adjusting for age and sex and sex-specific
models adjusting for age. Precision was estimated by the 95% CIs.
In table 2 and figures 1–3, comparisons of foreign- vs. local-born
populations were described as similar when the associated 95% CIs
included 1; findings were described as different when the 95% CIs
did not include 1.

Results
Circulatory disease mortality
Here, we focus on the results for foreign-born men and women
combined for each study country. Overall, as shown in table 2, we
observed a consistently high mortality in the South Asia and Eastern
Europe-born in Denmark, England and Wales, France and Sweden
(Eastern Europeans only). For example, the MRRs for Eastern
Europeans and South Asians in Denmark were 1.51 and 1.91,
respectively. Other COBs experiencing high mortality included the
Middle East-born in Denmark and France, and the East and West
sub-Saharan Africa-born in England and France. In contrast, we
found low mortality in East Asians in France, Scotland and
Sweden. For example, in France, the East Asia-born had 50% lower mortality than the local-born. More specifically, our
sex-specific analyses showed that the MRRs had a similar direction
for men and women although their size differed (figure 1A–F).

IHD mortality
As shown in table 2, we observed generally high mortality from IHD
among South Asians and Eastern Europeans in Denmark, England
and Wales, France and Sweden (Eastern Europeans only). For
example, MMRs for South Asians and Eastern Europeans in
Denmark were 2.02 and 1.39, respectively. Excess deaths were also
noted for the Middle East-born in Denmark and France. For
example, in Denmark, they had an MRR of 1.77. In contrast,
people born in the sub-Saharan African regions had low or only
moderately high mortality. As an example, West and South
Africans in England and Wales had an MRR equal to 0.68 and
0.75, respectively. The sex-specific analysis showed a similar
pattern for men and women (figure 2A–F).

Cerebrovascular disease mortality
We noted overall high mortality from cerebrovascular disease among
Southeast Asians in Denmark, France and Sweden; South Asians in
Denmark, England and Wales, France and Scotland; Eastern
Europeans in Denmark, England and Wales and Sweden and the
Middle East-born in Denmark. For example, in Denmark, the
MRRs for these groups ranged from 1.93 to 1.24, respectively.
East and West sub-Saharan Africans in England and Wales, France
and Sweden also had high mortality. In England and Wales, the MRRs
were 1.33 and 2.30, respectively. The sex-specific associations had a
similar direction for men and women although the ratios differed in
magnitude (figure 3A–F).

Discussion
Main findings
To our knowledge, this is the first time national death rates have
been calculated simultaneously for several European countries using
pre-defined data specification criteria to examine within-country
inequalities in total and cause-specific circulatory disease mortality
by birth country. Our results show considerable and fairly consistent
mortality inequalities between foreign- and local-born groups.
For example, the South Asia and Eastern Europe-born had consistently
high mortality across countries and cause of death. Other groups,
such as the East Asia-born, had low mortality when data were
available. Some COBs had low or high rates in some countries but
not all.

Comparison with previous studies
Published studies on circulatory mortality are country-specific and
only available for a few EU countries.12,13,15,17,18,22 Our data corrob-
orate previous findings from England and Wales where men and
women born in India, Pakistan, Bangladesh, Eastern Europe, East
and West Africa (West Africans had low IHD mortality) were found
to have high mortality.17 Dutch data also showed high circulatory
and cerebrovascular mortality in the Surinam-born but low among
the Morocco-born.16 The increase in mortality risk was only modest
in the India-, Pakistan- and Bangladesh-born residing in Scotland.11
In Sweden, high mortality was observed for Eastern European
women (especially from IHD) but not men.16 We also observed
high IHD mortality in women. In addition, we showed high cere-
brovascular disease mortality in Eastern Europeans in Sweden,
especially in women.

In contrast, very little research has been done previously on
mortality among immigrants in France, a country historically
resistant to examining statistics by ethnic group where it was not
considered as relevant variable for routine statistics. This consider-
ation may have the side-effect of hiding inequalities. One French
report noted how Moroccan men had relatively low circulatory
mortality; Moroccan women had high mortality from ‘other
diseases of the circulatory system’, but there were no differences in
either IHD or cerebrovascular mortality.23 We found similar
contrasted results for men and women from North Africa.
Furthermore, there is only limited previous information on
cause-specific mortality in migrants in Denmark. Possibly for the
first time, we showed high mortality in men and women of Middle Eastern and Eastern European origin. This pattern was observed for all three analyses of circulatory mortality.

**Study limitations**

Here, we consider the quality of the underlying data and the potential impact of selection bias. The data from Denmark and the Netherlands were based on linked population and death registers, where the denominator is exact. For England and Wales, France, Scotland and Sweden, this is not the case. Such data may be more prone to bias arising from COB misclassification, leading to numerator–denominator bias. Also, incomplete COB registration may underestimate the level of mortality. To reduce this risk, we examined mortality for broad geographical categories. Moreover, the data include different time periods. Although important declines in circulatory mortality have been achieved over time, our results may possibly reflect different risks than the current ones.

We used birth country as a proxy for ethnicity although COB tends to be less valuable in younger age groups. COB criteria also fail to distinguish between different ethnic groups coming from the same birth country. Recent work from the Scottish Health and Ethnicity Linkage Study shows that circulatory disease outcomes by ethnic group tend to be similar to those in COB analyses, although differences seem to be greater with ethnic group. We could not assess the completeness of COB coding on death certificates but the absence of such information would underestimate the size of the numerator. In the event of misclassification of COB, i.e. where the wrong COB was recorded, we would expect a reduction in the strength of our associations.
Figure 1 Inequalities in circulatory disease mortality by region of birth and sex in selected European countries. The graphs show age-adjusted MRRs and 95% CIs for men (white columns) and women (grey columns). (A) Denmark (MRR = 1 for local-born population), (B) England and Wales (MRR = 1 for local-born population), (C) France (MRR = 1 for local-born population), (D) the Netherlands (MRR = 1 for local-born population), (E) Scotland (MRR = 1 for local-born population) and (F) Sweden (MRR = 1 for local-born population)
Figure 1 (Continued)
Figure 2 Inequalities in IHD mortality by region of birth and sex in selected European countries. The graphs show age-adjusted MRRs and 95% CIs for men (white columns) and women (grey columns). (A) Denmark (MRR = 1 for local-born population), (B) England and Wales (MRR = 1 for local-born population), (C) France (MRR = 1 for local-born population), (D) the Netherlands (MRR = 1 for local-born population), (E) Scotland (MRR = 1 for local-born population) and (F) Sweden (MRR = 1 for local-born population)
Figure 2 (Continued)
Figure 3 Inequalities in cerebrovascular disease mortality by region of birth and sex in selected European countries. The graphs show age-adjusted MRRs and 95% CIs for men (white columns) and women (grey columns). (A) Denmark (MRR = 1 for local-born population), (B) England and Wales (MRR = 1 for local-born population), (C) France (MRR = 1 for local-born population), (D) the Netherlands (MRR = 1 for local-born population), (E) Scotland (MRR = 1 for local-born population) and (F) Sweden (MRR = 1 for local-born population)
Figure 3 (Continued)
The general lack of information on individual-level characteristics (such as education) in the data prevented us from examining the effects of these factors on COB and mortality. Some countries, e.g. Denmark and Sweden, and more recently Scotland through linked data, 24,25 have the possibility to enrich the data in this way for use in future studies although information on critical cardiovascular risk factors is usually lacking. Migrants from the same COB may differ in sociodemographic characteristics and health behaviours in different countries of settlement. This may be attributed to the specific background of the migrants or to the national context of the host country. 19,26

A delay or absence of recording of re-migration may underestimate mortality risk, i.e. so-called 'salmon bias'. In Sweden, this type of error has been estimated to be in the order of 3–7% of all migrants on a yearly basis. 27 It is possible that migrants from certain countries are more implicated than others. 17

Potential misclassification may result if a disease is more or less likely to be recorded as the underlying cause of death for a particular COB. Although further studies are required, there is evidence that the validity of cause of death coding varies by country. 28

Finally, the possibility of type 1 and type 2 errors affecting our results should be considered. Although our statistical analysis was based on a number of formal comparisons, type 1 error is an unlikely explanation for the main results which largely corroborate findings from previous studies. Similarly, in order to reduce the likelihood of type 2 error, we grouped individual birth countries into geographical regions if the number of deaths and underlying population size was less than our pre-specified criteria indicated.

Possible explanations

A number of explanations have been proposed for the observed migrant and ethnic inequalities in circulatory disease mortality. Major conventional vascular risk factors are likely to be important in ethnic minority populations although data on the prevalence and prospective relationship between these factors and mortality are still lacking for many groups and most European countries. 8,29 Moreover, emerging data suggest that the excess burden of IHD and cerebrovascular disease in some ethnic populations (e.g. South Asians in the UK) may not be fully accounted for by differences in conventional risk factors. 30

Prevalence data show high levels of smoking in Eastern European, Turkish and Middle Eastern migrants, 31,32 while South Asians in the UK tend to have similar or lower smoking levels than the general population, although important within-group sex differences also exist. 33 They also have low physical activity levels, especially Bangladeshis. 34,35 Eastern European, Turkish and Middle Eastern men, and African women, have high levels of overweight and obesity. 31,36,37 In Sweden, Turkish women have high body mass index (BMI), waist circumference and waist-to-hip ratio. 38 UK South Asians have more central obesity than Europeans for the same level of BMI. 30 Central obesity is a strong predictor of CHD in this population. 30,39 There are high levels of hyperinsulinaemia and diabetes in sub-Saharan African migrants, 72 and in Turkish and Middle Eastern migrants in Denmark. 40 Hypertension, the prevalence of which is increased in sub-Saharan Africans for unknown reasons, is thought to contribute to their high stroke risk. 17

In contrast, some migrant and ethnic populations have consistently low mortality from circulatory disease (or from particular causes) although there have been only limited efforts to account for these patterns. For some migrant groups, the low burden of circulatory disease might occur as a result of selective migration of healthy individuals, i.e. the so-called ‘healthy migrant effect’. However, why this would affect only some causes and migrant groups is not clear. Alternatively, more favourable risk factor levels may play a role here although more prevalence data are urgently needed. 37

In conclusion, our results describe inequalities in circulatory disease mortality between foreign-born and local-born populations in six European countries, with substantial excess mortality observed for some migrant populations (and lower mortality in others) which is consistent across countries. The results highlight the need for collecting better health information among migrant populations across the EU in order to help understand these inequalities. The MEHO project has illustrated not only the interest and value of such data but also that it is feasible to collect, analyse systematically, interpret and utilize such data to provide perspectives beyond that achievable by single-country analyses, invaluable as the latter are.

Acknowledgements

This article is a product of collaboration between Work Packages 5 and 6 of the MEHO project. We thank Dr Irina Stirbu for compiling the mortality data sets for Denmark, England and Wales and the Netherlands. This work has benefitted from numerous discussions within the MEHO collaboration and we acknowledge the MEHO project leaders, Marc Bruijnzeels, Semila Denktas and Marleen Foets (Erasmus Medical Centre, the Netherlands), and the leaders of other MEHO Work Packages and their teams: Laura Cacciani, Emanuela Forcella, Aldo Rosano (Agenzia di Sanità Pubblica della Regione Lazio, Italy); Allan Krasnik and Signe Nielsen (University of Copenhagen, Denmark); Oliver Razum, Jacob Spallek and Anna Reeke (University of Bielefeld, Germany); Alexander Kramer and Manas Akmatov (University of Bielefeld, Germany); Kvetoslava Rimarova (University of Slovenia) and Dineke Zeegers (European Public Health Association). We thank the members in the MEHO-CVD network for their ongoing support and contributions and whose names are listed in a previous publication. 27 This work has been presented in part orally at the following conferences: the second joint European Public Health Conference, Lodz, Poland (November 2009); the third European Migrant and Ethnic Health Conference, Pecs, Hungary (May 2010) and annual European Public Health conference, Copenhagen, Denmark (November 2011).

Funding

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Conflicts of interest: None declared.

Key points

- Europe is faced with many public health challenges, including the routine collection and production of ethnically disaggregated, national-level data on morbidity and mortality from chronic diseases.
- The MEHO project aimed to map, acquire and analyse routine data from EU countries with the objective of generating migrant and ethnic group-specific health status indicators for five independent health areas, including circulatory diseases and diabetes.
- Our analysis demonstrated inequalities in circulatory disease mortality between foreign-born and local-born populations in six EU countries, with substantial excess mortality observed for some migrant populations, and lower mortality in others.
- These results highlight the need for collecting better health information among migrant populations in order to help better understand the observed inequalities.
- By helping to fill the gap in available information, the present findings are highly relevant for European public health policies addressing migrant health issues.
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