Introduction

Respiratory diseases are dominant health problems.1,2 Globally, for example, chronic obstructive pulmonary disease (COPD) was the third ranking cause of death, and ninth for years of life lost in 2010. Other respiratory disorders are also top ranking causes of death and years of life lost.1

As most urban societies have become ethnically diverse, and risk factors for respiratory disease vary by ethnic group, we would expect a sizeable and growing literature on ethnicity and respiratory health.3 Yet, with the main exceptions of tuberculosis4 and asthma,5 the evidence is sparse, especially in Europe. This may be because, for most respiratory problems, ethnic minority groups are perceived to have similar, and sometimes lower, risks of disease than non-ethnic minority groups.6

Risk of respiratory hospitalization and death, readmission and subsequent mortality: scottish health and ethnicity linkage study

Raj Bhopal1, Markus F.C. Steiner2, Genevieve Cezard1, Narinder Bansal1,3, Colin Fischbacher1,4, Colin R. Simpson1, Anne Douglas1, Aziz Sheikh1,5 on behalf of the SHELS researchers

1 Edinburgh Migration, Ethnicity and Health Research Group, Centre for Population Health Sciences, The University of Edinburgh, Edinburgh, UK
2 Department of Child Health, School of Medicine, University of Aberdeen, Aberdeen, UK
3 Cardiovascular Epidemiology Unit, The Department of Public Health and Primary Care, The Cambridge Institute of Public Health, University of Cambridge, Cambridge, UK
4 Intelligence Information Services Division, NHS National Services, Edinburgh, UK
5 Division of General Internal Medicine and Primary Care, Brigham and Women’s Hospital/Harvard Medical School, Boston, MA, USA

Correspondence: Raj Bhopal, Edinburgh Ethnicity and Health Research Group, Centre for Population Health Sciences, The University of Edinburgh, Teviot Place, Edinburgh, EH8 9AG, UK, Tel: (0)131 650 3216, Fax: (0)131 650 3216, e-mail: raj.bhopal@ed.ac.uk

Background: Limited and dated evidence shows ethnic inequalities in health status and health care in respiratory diseases. Methods: This retrospective, cohort study linked Scotland’s hospitalization/death records on respiratory disorders to 4.65 million people in the 2001 census (providing ethnic group). For all-respiratory diseases and chronic obstructive pulmonary disease (COPD) from April 2001 to 2010 we calculated age, country of birth and Scottish Index of Multiple Deprivation (SIMD) adjusted risk ratios (RRs), by sex. We calculated hazard ratios (HRs) for death following hospitalization and for readmission. We multiplied ratios and confidence intervals (CIs) by 100, so the reference Scottish White population’s RR/HR = 100. Results: RRs were comparatively low for all-respiratory diseases in Other White British (84.0, 95% CI 79.6, 88.6) and Chinese (67.4, 95% CI 55.2, 82.3) men and high in Pakistani men (138.1, 95% CI 125.5, 151.9) and women (132.7, 95% CI 108.8, 161.8). For COPD, White Irish men (142.5, 95% CI 123.5, 162.1) and women (141.9, CI 124.8, 161.3) and any Mixed Background men (161, CI 127.1, 203.9) and women (215.4, CI 158.2, 293.3) had high RRs, while Indian men (54.5, CI 41.9, 70.9) and Chinese women (50.5, CI 31.4, 81.1) had low RRs. In most non-White groups, mortality following hospitalization and readmission was similar or lower than the reference. Conclusions: The pattern of ethnic variations in these respiratory disorders was complex and did not merely reflect smoking patterns. Readmission and death after hospitalization data did not signal inequity in services for ethnic minority groups.
the usual comparison group of high risk, locally born (usually White) populations. Lower risks might reflect lower smoking prevalence in nearly all ethnic minority groups in women and in some groups of men. The Health Survey for England in 2004, for example, showed that the highest prevalence was in men in the Bangladeshi (40%), Irish (30%), Pakistani (29%) and general (predominantly White) population (24%) groups. Chinese (21%), Black Caribbean (21%) and Indian men (20%) reported a lower prevalence. In women, the prevalence was exceptionally low in Indian (5%), Pakistani (5%) Bangladeshi (2%) and Chinese (8%) compared with 23% in the general population. Data by sex from Glasgow, Scotland, though not available with the same quality or quantity, corroborate these patterns.7

Ethnic variations in respiratory conditions need periodic documentation because disease patterns are altering from changing environments and risk factor patterns following migration.3 There are, however, few data across Europe, and none from Scotland, on how frequency, quality of care and outcomes of respiratory disorders vary by ethnic group.

The Scottish Health and Ethnicity Linkage Study (SHELS)8 has analysed respiratory data on hospital discharges and mortality. Lung cancer was less common in most ethnic minority groups, though high in mixed ethnic groups.9 We report here on all non-cancer respiratory diseases and COPD. (We will report on asthma and respiratory infections in future). We had hypothesized that there would be 10% or more differences in comparisons of each ethnic group with the reference White Scottish population that would not be removed by adjustment for socio-economic factors.

Methods

Linkage methods

The methods of SHELS have been documented.8–10 We linked National Health Service (NHS) Scotland’s hospital discharge and death records (Scottish Morbidity Record-SMR01) to the 2001 census creating a retrospective cohort study of 4.65 million individuals. An overview of the linkage techniques is shown in Supplementary figure S1 (on-line Supplementary).10 Overall, 95% linkage was achieved with 85% or more for every ethnic group. The cohort represented over 90% of the estimated Scottish population in 2001. Personal identifiers were removed for analysis.

Ethnicity: concept, categories and nomenclature

We applied standard concepts and terminology relating to ethnicity, including capitalizing ethnic group labels.5 The ethnic group categories were from the 14 reported in the 2001 census. Given small populations, we combined Bangladeshi with Other South Asians and the Caribbean, African and Black Scottish or Other Black as African origin. We removed the category All Other Ethnic Group because of heterogeneity and small numbers.

Respiratory outcomes

We selected conditions responsible for ≥1000 hospitalizations/year, to provide sufficient outcomes. Events were identified from up to six hospital diagnosis codes or from up to 11 causes in death records. Analysis for COPD (International Classification of Diseases (ICD) codes J40-J44 and J47) was restricted to ages ≥40 years, with no age restrictions for all-respiratory diseases (ICD codes J00-J99).

We identified first hospitalizations from May 2001 to April 2010 without excluding those with previous events to allow for the recurrent nature of respiratory diseases, so our cases are not necessarily new ones. Of respiratory hospitalizations and deaths (654 000) ~59% (348 000) were for infections, 22% (145 000) were for asthma and 22% (142 000) were for COPD (figures are rounded). In this article, we present data on COPD cases ≥40 years comprising a subset of 17.4% of respiratory cases (N = 114 000).

Demographic and socio-economic factors

Census data included age, sex, Scottish Index of Multiple Deprivation (SIMD) and country of birth (CoB). SIMD uses 38 indicators across 9 domains including health to rank areas based on full postcode (zipcode) (www.Scotland.gov.uk/topics/statistics/SIMD; accessed 16 July 2014).

Analysis

Using Poisson regression models with robust variance, we calculated age-adjusted rates/100 000 person years (PYs) and risk ratios (RRs) with 95% confidence intervals (CIs), by sex. The PYs at risk denominators were calculated after adjusting (censoring) for death, occurrence of an event and transfers of patients from NHS Scotland to other parts of the UK, as appropriate. We multiplied RRs and CIs by 100 for easy interpretation so the reference White Scottish population’s RR = 100.

Following our analysis plan, we combined hospitalization and mortality outcomes, as the latter were uncommon (0.68% of all respiratory outcomes, and 3.82% of COPD outcomes in our age group). The age-adjusted analysis was the primary analysis. We then examined the effect of adjustment by socio-economic variables and CoB separately and in combination. We explored the association between eight measures of socio-economic status and health outcomes following our published approach11 and we selected SIMD as, unlike other relevant variables which were not collected for younger and older age groups, SIMD was available for everyone. Our analysis used quintile of socio-economic deprivation. We adjusted for UK or not UK birth to explore whether this altered RRs (there were not enough events for stratified analysis by CoB and ethnicity).

We calculated hazard ratios (HRs) using Cox regression for dying following hospitalization and for readmission for the same diagnostic codes, checking the proportional hazards assumption using -loglog plots. We calculated the mean number (95% CIs) of hospitalizations over 9-years.


Ethics and permissions

Approval was by Scotland A Research Ethics Committee, Privacy Advisory Committee (PAC) and the Community Health Index (CHI) Advisory Group. Access to data, analyses and release of outputs followed written protocols.

Role of the funding source and sponsor

Funders and sponsor had no influence on the content of this article.

Results

Population studied and adjustment with SIMD

Web Supplementary table S1 shows that some characteristics of our linked population (all ages). The White Scottish group comprised 88.6% of the population, the other White British for 7.3%, the White Irish for 0.9% and all non-White minority ethnic group for ~2%, in line with Census 2001. The mean age of non-White groups was lower than the White Scottish group (38 years), especially for those of Any Mixed Background (21 years). Many non-White people were UK born, e.g. 58% of Pakistani males. On the three (of eight available) indicators of socio-economic status shown the Other White British and Other White groups had the highest socio-economic status, with the picture being dependent on the indicator, and different by sex for non-White ethnic groups.

Web Supplementary table S2 shows the association between all-respiratory disorders and eight indicators of socio-economic position. A similar table was created for COPD (not shown). We
chose SIMD as the association was in the predicted direction, i.e. as area socio-economic deprivation increased so did the risk of respiratory events. This applied for all ethnic groups. For example, for each quintile of increase in SIMD there was a 14.7% increase in respiratory events in Indian men.

### All first respiratory events

We focus on findings where the 95% CI around the RR/HR does not include 100.

There were ~8.7 million respiratory records during 2001—10 with a CHI number, of which 7.3 million (85%) were linked to the census (the unlinked cases would be those who did not complete the census form, those where the census-CHI linkage did not work, visitors and new migrants).

Table 1 and figure S2 panel (a) (provided as an on-line Supplementary) show that RRs in males were, compared with the White Scottish reference population (henceforth, this population is not specified but presumed), lower in Other White British, Other White and Chinese populations. RRs were higher in White Irish, Pakistani and Other South Asian males. Adjustment for SIMD and/or CoB (table 1) largely attenuated the difference in White Irish males but mostly this was not so in other ethnic groups. In Indian males adjustment for SIMD led to a small increase in the RR with CIs excluding 100.

In females [table 1 and Supplementary figure S2 panel (a)], the pattern was similar to that in males, except that African Origin females had higher RRs and Irish females had RRs similar to the reference. Adjustment for SIMD and/or CoB made little difference to the patterns.

Web Supplementary table S3 shows that in males HRs for readmission for a second respiratory disorder were similar or lower across ethnic minority groups compared with the reference. In females, HRs were similar or lower across ethnic groups except for the African origin group where the HR was higher (Mean hospitalization rates did not add insights so are not shown-available on request).

Table 2 shows that HRs for death from respiratory causes following respiratory hospitalization were similar or lower in most minority groups, especially so in the South Asian (with the exception of Other South Asian women) and Chinese groups where HRs were 50—70% of reference.

### Chronic obstructive airways disease (COPD)

Table 3 and Supplementary figure S2 panel (b) show that for COPD RRs in men were lower in Other White British and Indian men. RRs were higher in White Irish and Any Mixed Background men. Adjustment for SIMD (table 3), effectively, eliminated the lower risk in Other White British men, and adjustment for SIMD and CoB did this for Irish men. Differences in Any Mixed Background and Indian men were diminished but persisted on adjustment.

Table 3 and Supplementary figure S2 panel (b) show higher RRs in White Irish and Any Mixed Background women and lower RRs in Chinese women. Adjustment greatly attenuated the difference in White Irish women but not in Any Mixed Background or Chinese women.

Web Supplementary table S4 shows that in men the HRs for re-admission for COPD were slightly lower or similar in all minority groups with 95% CIs including 100. The one exception was African Origin women, where the HR was higher (but numbers were small).

Table 4 shows that HRs for death from COPD after COPD hospitalization were lower in Other White British, Indian and Pakistani men. In women, HRs were lower in all White minority groups and similar in other minority groups (the lower HR in Pakistani women is based on only seven deaths and imprecise).

### Discussion

We have provided rare, national estimates of respiratory hospitalization/death. Sizeable, sometimes unexpected, ethnic variations were observed. Some findings merit detailed examination, e.g. the higher risks in Pakistani, and lower risks in Chinese, populations, notwithstanding their similar migrant and socio-economic
status. The findings are discussed after we summarize the strengths and limitations of SHELS.\textsuperscript{8,9}

The strengths include the: analysis at national level, cohort design, availability of ethnic group and socio-demographic data, analyses of many ethnic groups, and a process for selecting socio-economic confounders.\textsuperscript{11} We used SIMD as data were available for all ages, unlike other alternatives such as educational and economic status which are only collected from 16 to 74 years of age, which is a

\begin{table}[h]
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\begin{tabular}{llll}
\hline
\textbf{Ethnic group} & \textbf{Male} & \textbf{Female} \\
\hline
\textbf{Deaths} & \textbf{HR and 95% CI} & \textbf{Deaths} & \textbf{HR and 95% CI} \\
\hline
White Scottish & 15844 & 100.0 & 16167 & 100.0 \\
Other White British & 965 & 90.8 (85.0, 96.9) & 830 & 89.5 (83.5, 96.0) \\
White Irish & 244 & 105.2 (92.7, 119.4) & 229 & 85.4 (74.9, 97.3) \\
Other White & 172 & 86.2 (74.1, 100.2) & 101 & 79.6 (65.5, 96.9) \\
Any Mixed Background & 14 & 125.6 (74.4, 212.2) & 16 & 78.0 (47.8, 127.4) \\
Indian & 6 & 39.8 (17.9, 88.5) & 7 & 50.8 (24.2, 106.6) \\
Pakistani & 23 & 55.8 (37.1, 84.1) & 7 & 109.0 (52.0, 228.8) \\
Other South Asian & 7 & 59.0 (28.1, 123.9) & 6 & 111.2 (50.0, 247.6) \\
African origin & 6 & 89.0 (40.0, 198.2) & 7 & 112.0 (53.5, 152.6) \\
Chinese & 14 & 90.3 (53.5, 152.6) & 6 & 56.6 (36.9, 86.8) \\
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\end{tabular}
\caption{Deaths from respiratory causes following hospitalization for any COPD disorder}
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\begin{tabular}{llll}
\hline
\textbf{Ethnic group} & \textbf{Male} & \textbf{Female} \\
\hline
\textbf{Deaths} & \textbf{HR and 95% CI} & \textbf{Deaths} & \textbf{HR and 95% CI} \\
\hline
White Scottish & 48361 & 100.0 & 50243 & 100.0 \\
Other White British & 3259 & 83.8 (80.8, 86.8) & 3013 & 81.5 (78.6, 84.6) \\
White Irish & 730 & 1010.9 (93.9, 108.6) & 747 & 95.4 (88.8, 102.6) \\
Other White & 562 & 87.3 (80.4, 94.9) & 364 & 73.8 (66.6, 81.8) \\
Any Mixed Background & 40 & 97.4 (71.4, 132.8) & 41 & 75.9 (55.9, 103.1) \\
Indian & 45 & 58.3 (43.7, 78.1) & 23 & 48.0 (31.9, 72.3) \\
Pakistani & 87 & 58.2 (47.1, 71.8) & 43 & 48.7 (36.1, 65.7) \\
Other South Asian & 20 & 53.6 (34.6, 82.0) & 24 & 90.8 (60.8, 135.5) \\
African origin & 24 & 93.9 (62.6, 139.3) & 20 & 98.2 (63.4, 152.3) \\
Chinese & 33 & 65.6 (46.6, 92.2) & 21 & 56.6 (36.9, 86.8) \\
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\end{tabular}
\caption{Age-adjusted rates per 100 000 PYs and RR for first COPD event or death for the population \( \geq 40 \) years by sex and ethnic group}
\end{table}

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\hline
\textbf{Sex and ethnic group} & \textbf{Number of events} & \textbf{Deaths HR and 95% CI} & \textbf{Deaths HR and 95% CI} \\
\hline
\textbf{Men} & & & \\
White Scottish & 50269 & 7262052 & 692.0 & 100.0 & 100.0 & 100.0 & 100.0 \\
Other White British & 3171 & 695093 & 587.3 & 100.0 & 100.0 & 100.0 & 100.0 \\
White Irish & 759 & 91586 & 986.6 & 100.0 & 100.0 & 100.0 & 100.0 \\
Other White & 505 & 88986 & 722.9 & 100.0 & 100.0 & 100.0 & 100.0 \\
Any Mixed Background & 47 & 6309 & 1114.5 & 100.0 & 100.0 & 100.0 & 100.0 \\
Indian & 37 & 16418 & 377.3 & 100.0 & 100.0 & 100.0 & 100.0 \\
Pakistani & 94 & 27226 & 671.6 & 100.0 & 100.0 & 100.0 & 100.0 \\
Other South Asian & 34 & 8455 & 872.3 & 100.0 & 100.0 & 100.0 & 100.0 \\
African origin & 23 & 7069 & 656.1 & 100.0 & 100.0 & 100.0 & 100.0 \\
Chinese & 46 & 16299 & 545.6 & 100.0 & 100.0 & 100.0 & 100.0 \\
\hline
\textbf{Female} & & & \\
White Scottish & 54153 & 8584513 & 630.8 & 100.0 & 100.0 & 100.0 & 100.0 \\
Other White British & 3032 & 758023 & 589.9 & 100.0 & 100.0 & 100.0 & 100.0 \\
White Irish & 796 & 113282 & 895.2 & 100.0 & 100.0 & 100.0 & 100.0 \\
Other White & 390 & 112236 & 528.4 & 100.0 & 100.0 & 100.0 & 100.0 \\
Any Mixed Background & 71 & 8871 & 1358.9 & 100.0 & 100.0 & 100.0 & 100.0 \\
Indian & 32 & 14588 & 471.1 & 100.0 & 100.0 & 100.0 & 100.0 \\
Pakistani & 56 & 24189 & 552.6 & 100.0 & 100.0 & 100.0 & 100.0 \\
Other South Asian & 24 & 5931 & 806.3 & 100.0 & 100.0 & 100.0 & 100.0 \\
African origin & 21 & 6625 & 670.0 & 100.0 & 100.0 & 100.0 & 100.0 \\
Chinese & 25 & 17404 & 318.5 & 100.0 & 100.0 & 100.0 & 100.0 \\
\hline
\end{tabular}
\caption{Deaths from respiratory causes till April 2010 following hospitalization for any respiratory disorder}
\end{table}
Asian groups, or for COPD in Any Mixed Background populations. These studies did not signal the raised risk seen in our data for Pakistani men. More recent analyses have not been published. UK-born groups, e.g. for Chinese women the SMR was 44 and for around the 1991 census SMRs for COPD were lower in all non-UK CoB groups was about 100 or lower. SMR for chronic bronchitis, acute bronchitis and asthma, including smoking, e.g. in South Asian and Chinese women the prevalence of smoking is low. We would, therefore, anticipate ethnic variations in respiratory disorders. We found only one comprehensive review, from the US, showing differences in respiratory diseases on comparing the whole population and Blacks (African Americans), American Indian/Alaska Natives, Asian-Pacific Islanders and Hispanics. The differences in categorization of race/ethnicity and system of health care in the US prevent comparisons with our data. In a cohort study of COPD hospitalizations in the US, Asian American populations (mainly Far Eastern people) had low risks, according to our data on Chinese. UK mortality data have been analysed by CoB, a proxy for ethnicity. Analysis around the 1981 census with those born in England and Wales as reference (SMR 100) reported that Ireland-born and Scotland-born residents had the highest SMRs for respiratory mortality, e.g. 157 in Ireland-born men. Men born in the Indian Subcontinent (SMR 88) and Caribbean (SMR 61) had lower respiratory mortality but for such women SMRs were about 100. The SMR for chronic bronchitis, acute bronchitis and asthma, combined, for all non-UK CoB groups was about 100 or lower. Around the 1991 census SMRs for COPD were lower in all non-UK-born groups, e.g. for Chinese women the SMR was 44 and for Pakistani men 64. More recent analyses have not been published. These studies did not signal the raised risk seen in our data for respiratory hospitalization/death in Pakistani and Other South Asian groups, or for COPD in Any Mixed Background populations (this category was only introduced in the 2001 census).

Hospital episode statistics have not been analysed by ethnic group for respiratory disorders nationally in the UK. Jackson et al. however, studied respiratory admissions (1974—79) by CoB in 30–59 year olds in a Birmingham, England hospital. The proportion of admissions for acute and chronic bronchitis and emphysema was 9.8% for Asians (born in India, Pakistan and Bangladesh), 9.5% in Whites (northern European) and 3.3% in Blacks (West Indian). Our data augment Jackson et al.’s study, and show a difference among South Asian subgroups, but we did not find lower risk of COPD in African origin people. Donaldson and Taylor reported a high odds ratio for respiratory disease hospitalization during 1977–1978 in patients with Asian names in Leicester. We estimated the OR from their diagram as about 1.4 (exact figure is unavailable; e-mail communication from Donaldson, 31 March 2014). Our data support this in Pakistani men and women, but not Indians. Hospitalization risks might be reflected in primary care data. Primary care consultation rates for respiratory disorders were above the reference value for every ethnic minority group in 1991 National Morbidity Statistics from general practice. Our findings, in contrast, show some ethnic minority groups have higher, and others lower, risks.

Community surveys show ethnic variations. In the Health Survey for England 2004, in seven ethnic minority groups long-standing respiratory illness was lower than that in the predominantly White General Population. In the fourth National Survey of Ethnic Minorities in 1994, using the Medical Research Council respiratory questionnaire, there was a lower prevalence of wheezing or coughing up phlegm in Indian/African Asian, Pakistani/Bangladeshi and Caribbean groups than in White populations but the difference was in non-smokers. In a 1980s survey in Glasgow, Scotland, South Asians combined, especially men, were less likely to bring up phlegm than White controls. However, their self-reported respiratory health was only slightly better, with little difference in women, which was surprising given their low prevalence of smoking.

Overall, respiratory health assessed in the community seems to be similar or better in non-White ethnic minority groups, but primary care consultation rate is higher, and subsequent hospitalization variable. We have shown substantial differences between ethnic groups, with low risks in Chinese and surprisingly high risks in Pakistani populations. This finding in Pakistani populations is surprising as the reference White Scottish population is at high risk of respiratory diseases and has a high prevalence of smoking.

The disease variations sometimes reflect ethnic variations in smoking. The highest risks for COPD, for example, were in White Irish, Any Mixed Background and White Scottish groups, probably reflecting smoking patterns. Mixed ethnic group populations are rarely studied but have high prevalence of smoking and high risk for lung cancer, and in this study also in COPD (doubled in women). In contrast, the prevalence of smoking in Pakistani men is about the same as White men, and that in Pakistani women much lower than White Women (5% or less), so the higher risk of all respiratory hospitalization/death and the similar risk of COPD cannot be explained by smoking. Possibly, COPD in Pakistani and Other South Asian women is triggered by other causes, e.g. cooking time and methods, reflecting upbringing on the Indian subcontinent and possibly cooking practices in the UK. Alternatively, it might be related to their high risk of asthma, with miscategorization as COPD. Chinese men and women mostly had good respiratory health probably related to their low smoking prevalence. This fits with others’ findings, including in the US.

Risk of death following all-respiratory and COPD hospitalization was mostly comparatively less likely in non-White groups (we found no similar published data). Readmission for the same diagnosis was similar across ethnic groups or favoured the ethnic minority groups, possibly indicating similar quality of care (we found no related published data). These outcomes suggest that hospitalization occurs in non-White groups at a lower level of severity, or the prevalence of risk factors such as smoking that might impair prognosis is lower, or there is less comorbidity in such groups, or there is re-migration (salmon bias) following admission.

In conclusion, ethnic variations need more study including the interplay of risk factors, respiratory symptoms, lung function, the prevalence of respiratory diseases and comorbidities, healthcare seeking behaviour, quality of care, variations in prognosis and data biases. There are potentially lessons for all ethnic groups.

Supplementary data

Supplementary data are available at EURPUB online.

Acknowledgements

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Other Contributions: These contributors served on the Steering Group and some on other important subgroups of SHELS, so gave general direction that helped this analysis. Chris Povey was a co-applicant and the originator of the idea of linking the census data to the data held by ISD and he performed most of the linkage work including developing linkage methods. Prof. Jamie Pearce (co-applicant) advised especially on socio-economic adjustment. Duncan Buchanan (co-applicant) chaired the analysis subgroup. Ganka Mueller (part study), Alex Stannard (part study) and Kirsty MacLachlan advised particularly in relation to NRS contributions. These important contributions did not meet ICMJE authorship requirements.

Access to data: The data are not open access. They are only available with restricted access at National Records Scotland, and governed by strict ethical and other restrictions. Individual consent for linking these records was not sought. Access to SHELS is under consideration but researchers wishing to utilize the data should write to Prof. RB with a brief proposal.

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**Conflicts of interest:** None declared.

### Key points

- The literature on respiratory health by ethnic/migrant group is small and old.
- Using data linkage at a national level, we found sizeable, sometimes unexpected, ethnic variations in respiratory diseases and mortality outcomes following hospitalization.
- Readmission data indicated equity in quality of care for ethnic minority groups.
- Ethnic variations in respiratory health need more study including the interplay of risk factors, lung function, disease and healthcare seeking behaviour.
- These data could help develop public health priorities, guide clinical diagnosis and refine policies for the prevention, control and management of respiratory diseases.

### References