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# **Ethnic variations in falls and road traffic injuries resulting in hospitalisation or death in Scotland: the Scottish Health and Ethnicity Linkage Study (SHELS)**

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## **Abstract**

**Objectives** To investigate ethnic differences in falls and road traffic injuries in Scotland.

**Study design** A retrospective cohort of 4.62 million people, linking the Scottish Census 2001, with self-reported ethnicity, to hospitalisation and death records for 2001-2013.

**Methods** We selected cases with ICD-10 diagnostic codes for falls and road traffic injuries (RTIs). Using Poisson regression, age-adjusted rate ratios (RRs, multiplied by 100 as percentages) and 95% confidence intervals (CIs) were calculated by sex for 10 ethnic groups with the White Scottish as reference. We further adjusted for country of birth and socio-economic status (SES).

**Results** During about 49 million person-years, there were 275,995 hospitalisations or deaths from fall-related injuries and 43,875 from RTIs. Compared to the White Scottish, RRs for falls were higher in most White and Mixed groups, e.g. White Irish males (RR 131; 95% CI 122-140) and Mixed females (126; 112-143), but lower in Pakistani males (72; 64-81) and females (72; 63-82) and African females (79; 63-99). For RTIs, RRs were higher in Other White British males (161; 147-176) and females (156; 138-176) and Other White males (119; 104-137) and females (143; 121-169) and lower in Pakistani females (74; 57-98). The ethnic variations differed by road user type, with few cases among non-White motorcyclists and non-White female cyclists. The RRs were minimally altered by adjustment for country of birth or SES.

**Conclusion** We found important ethnic variations in injuries due to falls and RTIs, with generally lower rates in non-White groups. Culturally related differences in behaviour offer the most plausible explanation, including variations in alcohol use. The findings do not point to the need for new interventions in Scotland at present. However, as the ethnic mix of each country is unique, other countries could benefit from similar data linkage-based research.

## Highlights

- Ethnic inequalities in injuries are demonstrated in Scotland based on a large sample size and a fine ethnic granularity including distinct White ethnic groups.
- White minority ethnic groups had the highest rates of fall-related injuries in Scotland.
- Fall-related injuries were the least likely in the Pakistani population.
- Ethnic differences in road traffic injuries varied by the type of road user.
- Ethnic differences in injuries were not explained by socio-economic status or country of birth.

## Introduction

Ethnicity has been defined as “the social group a person belongs to and either identifies with or is defined by others as a result of a mix of cultural and other factors including language, diet, religion, ancestry and physical features” (1). These factors have the potential to influence health in many ways and important differences between ethnic and migrant groups have been found for all-cause mortality (2-4) and numerous other health problems (5). The Global Burden of Disease Injury and Risk Factors Study reported that in 2013 there were an estimated 56.2 million injuries requiring hospitalisation. The commonest causes were falls (36%) and road traffic injuries (RTIs) (20%) (6). Of 4.8 million deaths, about 29% were due to RTIs and 11% to falls. In Scotland in 2017, 61% of admissions to hospital for unintentional injury were due to falls and 5% due to RTIs (7). Whilst the incidence of falls increases markedly in old age, many risk factors are involved, some of which may differ by ethnic group (8-10). RTI rates vary according to mode of transport; intoxication with alcohol or other drugs is also a risk factor (11). In 2016, 13% of all road deaths in Great Britain involved at least one driver with an alcohol level over the drink-drive limit (12). As these factors are socially mediated, it is reasonable to hypothesise that ethnicity could influence RTI rates. However, few studies have used whole populations or large representative samples to compare rates of fall-related injuries or RTIs in different ethnic or migrant groups (13-15). Most have typically involved smaller, often unrepresentative, samples, and self-reported falls rather than injuries (16). Several more robust studies of RTIs have been conducted in different countries, often showing clear differences between ethnic groups (15, 17-19). However, no consistent picture emerges from these studies, probably indicating that the national context affects the patterns found.

The Scottish Health and Ethnicity Linkage Study (SHELS) was established in 2003 as a means of exploring in detail the relationships between ethnic group and health in Scotland. A retrospective cohort was created including 4.62 million people who took part in the Scottish Census 2001, and whose ethnic group was recorded (20). By linking the Census results to hospitalisation and death

records, it has provided a unique opportunity to explore differences in many health outcomes between the larger ethnic groups in Scotland (21-28). The published findings have provided an important evidence base for developing Race Equality policy in Scotland (29). In this paper, we examine whether rates of injury or death due to falls or RTIs vary between ethnic groups in Scotland. Large differences could have implications for accident prevention policy.

## **Methods**

### *Data sources*

The SHELS methods have been published (20, 30) and are described in more detail in Supplementary File A. Individual records from the Scottish Census 2001, which included self-defined ethnic group, were linked to the Scottish Community Health Index (CHI), a unique identifier for everyone registered with the National Health Service in Scotland (NHS Scotland). A total of 4.62 million records were successfully linked, 91% of the estimated population of Scotland at that time and at least 85% of each ethnic group (Supplementary File A, Table A1). This enabled confidential linkage of the Census records to health-related datasets that included the CHI identifier.

### *Outcomes*

The Information Services Division of NHS Scotland provided data on hospitalisations and deaths for 12 years from May 2001 to April 2013. We used International Classification of Diseases 10<sup>th</sup> Revision (ICD-10) codes for injuries due to falls (W00-W19) and RTIs (V01-89), selecting all cases with a relevant code in any of the six diagnosis positions in the hospitalisation records or the 11 cause positions in the death records. Deaths were combined with hospitalisations as the number of deaths was too small to enable separate analyses. All injuries of sufficient severity to at least require a stay in hospital were thus included.

### *Ethnic Groups*

After extensive research and public consultation, the Scottish Census 2001 used an ethnic classification with 14 main groups. These reflect the pattern of immigration to Scotland over the past 70 years. Because of small numbers of cases, we added the Bangladeshi group to the Other South Asian group and combined the Caribbean, Black African, Black Scottish and Other Black groups into an "African Origin" group. We did not report on the "All Other Ethnic Groups" category due to its heterogeneity. The study therefore examined 10 ethnic groups: White Scottish, Other White British, White Irish, Other White, Any Mixed Background, Chinese, Indian, Pakistani, Other South Asian and African Origin.

### *Analysis*

An analysis protocol was agreed before the data extraction and followed without modification (21). We hypothesised we would find differences of at least 10% in the outcomes between the White Scottish majority group (reference) and minority ethnic groups, which could potentially be of public health importance. We analysed fall-related injuries and RTIs for males and females separately. We also conducted sub-analyses of RTIs involving pedestrians (V01-V09), cyclists (V10-V19), motorcyclists (V20-29) and car occupants (V40-V49).

Person-years at risk over 12 years were used as the denominator, adjusted for either death or known departure from NHS Scotland, mostly to elsewhere in the United Kingdom (UK). We calculated age-adjusted rates and rate ratios (RRs) and their 95% confidence intervals (CIs) using Poisson regression with robust variance and stratified by sex. RRs were multiplied by 100 to be interpretable as percentages. We first interpret ethnic differences in our health outcome of interest based on a baseline model adjusted for age and further include additional risk factors in order to gauge their contribution in explaining the observed ethnic differences.

Following previously described methods (31), we used a proxy measure of socio-economic status (SES), combining three indicators which were consistently associated in the same direction with the outcomes across ethnic groups and by sex: the Scottish Index for Multiple Deprivation (an area-based measure) , household tenure and a combined measure of highest educational level. Country of birth was categorised as those who were born in the UK or the Republic of Ireland (RoI) compared with those who were born elsewhere. We examined the influence of SES and UK/RoI-birth by adjusting for both separately and in combination.

Data were analysed using SAS V9.4 (SAS Institute Inc, Cary, North Carolina, USA).

#### *Ethics, Security and Reporting*

The Multicentre Research Ethics Committee for Scotland (REC 13/SS/0225) and the Privacy Advisory Committee of NHS National Services Scotland (PAC 36/13) approved the study. Individual consent for linking these records was not sought. Researchers with appropriate security clearance (GC, MS) carried out the analyses in a secure environment at National Records of Scotland (NRS). An NRS disclosure committee reviewed all outputs before release. For disclosure reasons, numerators and denominators were rounded to the nearest five in the tables; numbers of cases of five or less and their associated results were not released. However, the RRs were calculated using the real number of cases.

In reporting, we complied with the STROBE/RECORD checklist (Supplementary File B).

## **Results**

#### *Characteristics of the study population*

The ethnic distribution of the SHELS cohort was similar to that of the Scottish Census 2001 population, including 89% White Scottish, 9% other White groups and 2% non-White groups (Table 1). The White groups were on average older than the non-White groups. Around 25% of White Scottish and Pakistani



groups had the highest level of educational qualification compared with 40-52% in several other groups. People of African Origin were the most likely to live in the most disadvantaged areas, but almost as many lived in the least disadvantaged. Household ownership was highest in the Indian and Pakistani groups. The proportion of people who were born in the UK/RoI was over 95% for the White Scottish, Irish, and Other British groups, 75% for the Any Mixed Background group and 30-60% for other groups.

### *Hospitalisations and deaths*

During 12 years of follow-up and about 49 million person-years at risk, there were 275,995 hospitalisations and deaths due to falls and 43,865 to RTIs. The RTIs included 17,965 car occupants, 10,630 cyclists, 7,375 pedestrians and 6,575 motorcyclists.

### *Falls*

Table 2 shows ethnic differences in hospitalisations and deaths due to falls. With 95% CIs that did not overlap with the reference value 100, age-adjusted RRs were higher for males in the White Irish (131) and Any Mixed Background (124) groups and lower in the Pakistani group (72). For females, RRs were higher for the Other White British (114), White Irish (118), Other White (110), and Any Mixed Background (126) groups and lower for the Pakistani (72) and African Origin (79) groups. Adjustment for UK/RoI-birth and SES either separately or combined resulted in small and inconsistent changes in the RRs in either direction.

### *RTIs*

Table 3 shows ethnic differences in hospitalisations and deaths for all RTIs combined. With 95% CIs that did not overlap with the reference value, age-adjusted RRs were higher for males in the Other White British (161) and Other White (119) groups. Among females, RRs were higher for the Other White British (156) and Other White (143) groups and lower for Pakistani (74) groups. Adjusting for

UK/RoI birth and SES either separately or combined resulted in small and inconsistent changes in either direction.

When sub-grouped into car occupants, cyclists, pedestrians and motorcyclists, there were typically fewer than 50 events in the non-White ethnic groups, including almost none among female cyclists and motorcyclists (Supplementary File C, Tables C1-4). Among the other ethnic groups there were contrasting patterns. The Other White British group had higher RRs for car occupants (males 132; females 124), cyclists (males 195; females 245), and male motorcyclists (242) but lower for pedestrians (males 79; females 71). The Other White group had higher RRs for female car occupants (128), cyclists (males 138, females 281) and male motorcyclists (199) but lower for female pedestrians (54). Pakistani males had higher RRs for car occupants (135) and lower for cyclists (56). Adjusting for UK/RoI birth or SES made very little difference.

## **Discussion**

We found unexpectedly large differences between ethnic groups in Scotland in rates of hospitalisation and death due to falls and RTIs over a 12 year period. Compared with the White Scottish population, age-adjusted rates for falls were higher for White Irish and Mixed males, and for Other White British, White Irish, Other White, and Mixed females; they were lower for Pakistani males and females and African females. For RTIs overall, rates were higher for Other White British and Other White males and females, but lower for Pakistani females. There were differing patterns for RTIs of car occupants, cyclists, pedestrians and motorcyclists, with virtually no recorded cases among non-White female cyclists and motorcyclists. Adjustment for SES or UK/RoI-birth had little effect on the rates.

### *Strengths and limitations*

The strengths and limitations of the SHELS methods have been discussed in detail (3, 26). Their strengths include using a national census-based retrospective cohort of 4.62 million people with

reliable recording of self-reported ethnicity, SES and country of birth. By linking the cohort to 12 years of hospitalisation and death data we had enough cases to compare 10 ethnic groups, including four distinct White groups. However, the numbers of cases in some ethnic groups were too small to be analysed or confidence intervals were very wide, particularly for transport sub-groups.. We combined hospitalisations and deaths as there were too few deaths to analyse separately. Limiting the analysis to hospitalisations was not part of our analysis plan but given the relatively small proportion of deaths, we think it unlikely this would have altered the findings. We addressed the differing age structure of the ethnic groups by adjustment for age: had there been enough cases to allow it, stratification by age could have revealed age-related differences. Some individuals may have left the UK during the follow-up period which we could not account for, possibly introducing some denominator bias. Individuals in some ethnic groups might be more reluctant than others to attend hospital but as the injuries were severe enough to warrant hospital admission, we think this is unlikely.

#### *Findings in the light of the published literature*

##### *Falls*

A review of published studies of ethnic and racial differences in falls in older adults found most studies involved small samples, restricted by age group and/or gender and relying on self-reporting falls rather than related injuries (16). For example, in a study of mainly elderly women, African Americans reported 23% fewer falls than Whites (32). Elderly Italian-born men in Australia were about 40% less likely to report repeated falls than their Australian-born counterparts (33). A study of self-reported falls in the elderly comparing Chinese people in Taiwan, Hong Kong and Australia with White people in Australia found 50-70% lower rates among the Chinese (34). In none of the studies was socio-economic status found to be an important associated factor. A national study of deaths due to falls in the Netherlands found no clear-cut differences between native-born Dutch and four minority ethnic groups (15). However, as it only included 62 deaths across all ethnic minorities, the study had limited statistical power. Thus, although these studies are more limited in scope and statistical power, the

overall picture of lower rates of falls in some ethnic minorities is consistent with our findings.

### *RTIs*

Most previously published studies of RTIs and ethnicity have reported higher rates among disadvantaged ethnic or indigenous minorities. In the Netherlands, higher death rates due to pedestrian RTIs were found among Turkish, Moroccan, Surinamese and Antillean groups (15). In Arizona, compared to non-Hispanic Whites, rates among Hispanics and African-Americans were broadly similar but American Indians had much higher death rates among both car occupants and pedestrians, often associated with high blood-alcohol levels (17). In New Zealand, rates of hospitalisation or death due to RTIs were 65% higher among Māoris than the European/Other group; Pacific Islanders and Asians had lower rates (19). In Australia, Aborigines had overall RTIs rates about twice that of non-Aborigines (18). In London, both children and adults defined as Black were more likely than Whites to sustain RTIs, whereas Asians were less likely (35). The increased rate among Black children was associated with higher neighbourhood deprivation, poorer local road conditions and a riskier commute to school (36, 37). In Israel, Arab children were 36% more likely to be hospitalised for a RTI than Israeli children and 57% more likely to be severely injured (38). Poorer road conditions, more careless driving and less supervision of children in Arabic communities were highlighted.

### *Possible causes of the ethnic differences in this study*

Although a descriptive study such as this cannot prove causation, it can usefully stimulate hypotheses for further research. In a major review, Davey Smith and colleagues considered the possible causes of apparent health differences between ethnic groups under the following headings: artefactual; migration; socio-economic factors; culture, beliefs and behaviours; racism; biology; and health service use and access (39). Given the fall-related injuries and RTIs in this study were fatal or sufficiently severe to require hospitalisation, we can expect their assessment and recording to have been consistent regardless of ethnic group and therefore the observed differences are likely to be real. Adjusting for

whether individuals were born outside the UK made little difference to either set of findings, suggesting that recent migration to Scotland was not a major explanatory factor, although a smaller effect cannot be excluded.

We found that adjusting for SES, including the socio-economic profile of place of residence, had little effect on our age-adjusted findings for falls. This is supported by the findings of a review by Todd et al (40) who did not find a consistent relationship between SES and falls in the elderly. Adjusting our RTI data for SES also had little effect. As noted above, this may appear to contrast with the findings of many other studies where disadvantaged ethnic minorities had higher RTI rates. However, the SES of the larger ethnic minority groups in Scotland is notably different from that of many other countries, typically being characterised by larger than average proportions with high educational attainment and home-ownership (Table 1).

Differences in culture, beliefs and behaviours may provide a more plausible explanation for the differences in rates of fall-related injuries, such as the 70% higher rate among White Irish than Pakistani males or the 40-70% higher rates among the White minority females compared to the Pakistani and African females, even after adjusting for SES. One possible contributor is alcohol, long recognised as a risk factor for falls (11, 40). A health survey of ethnic minorities in Glasgow found 91% of Pakistanis reported they did not use alcohol compared to 30% in the general (White) population (41). Another SHELS study found that White Irish males and females had rates of alcohol related diseases 3.1 times and 3.6 times higher than their respective Pakistani counterparts (22). Many other factors are associated with falls in the elderly, such as gait problems, vertigo, Parkinson's disease and anti-epileptic drug use (8). However, there appears to be no evidence currently to relate these to ethnicity. As for RTIs, differential use of modes of transport may largely explain the very low number of cases of cycle or motorbike injuries among Indians and Pakistanis, especially females. UK and Scottish data show much lower cycle use among these minorities (42, 43). The lower levels of alcohol consumption by some ethnic minorities may also play a part.

As rates of falls and RTIs were lower in the non-White minorities, racism does not appear to be a plausible contributor to the findings. Given the acute nature of the injuries, and the availability of emergency health services to all in Scotland, it also seems unlikely that differential access to or use of health services would play a part. This is supported by another SHELS analysis showing broadly equitable rates of all-cause hospitalisation between ethnic groups (26).

## **Conclusions**

We found unexpected and sometimes large ethnic variations in rates of fall-related injuries and RTIs in Scotland, being typically lower among the non-White groups. Cultural and behavioural differences offer the most plausible explanation but would require further research to be confirmed. While the findings may not suggest the need for new accident prevention initiatives in Scotland at present, they demonstrate that unintentional injury rates can vary considerably between ethnic groups. As every country's ethnic mix is unique and many are undergoing considerable demographic change due to migration, other countries could benefit from similar data linkage based research.

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## **Competing interests**

None declared.

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## **Ethical approval**

Ethical approval for the data linkage, security and analyses was granted by the Scottish Multicentre Ethics Committee and the Privacy Advisory Committee of NHS National Services Scotland.

## **Authors' contributions**

All authors contributed to the design of the study. GC and LG drafted the paper. RB was the principal investigator. LG chaired the study group including all the authors. AD managed the study. GC and MS, carried out the statistical analysis. All authors commented on the drafts and approved the final

version.

### **Data sharing**

Researchers who wish to access the data should apply to National Records of Scotland (<https://www.nrscotland.gov.uk/>) and ISD (<http://www.isdscotland.org/>). They are maintained in a secure environment and governed by ethical and other restrictions on access.



## References

1. Johnson M, Bhopal R, Ingleby J, Gruer L, Petrova-Benedict R. A glossary for the first World Congress on Migration, Ethnicity, Race and Health. 2019.
2. Aldridge RW, Nellums LB, Bartlett S, Barr AL, Patel P, Burns R, et al. Global patterns of mortality in international migrants: a systematic review and meta-analysis. *The Lancet*. 2018;392(10164):2553-66.
3. Bhopal RS, Gruer L, Cezard G, Douglas A, Steiner MFC, Millard A, et al. Mortality, ethnicity, and country of birth on a national scale, 2001–2013: A retrospective cohort (Scottish Health and Ethnicity Linkage Study). *PLOS Medicine*. 2018;15(3):e1002515.
4. Ikram UZ, Mackenbach JP, Harding S, Rey G, Bhopal RS, Regidor E, et al. All-cause and cause-specific mortality of different migrant populations in Europe. *European journal of epidemiology*. 2016;31(7):655-65.
5. Gruer L. 1st World Congress on Migration, Ethnicity, Race and Health: Abstract Supplement: Oxford University Press; 2018.
6. Haagsma JA, Graetz N, Bolliger I, Naghavi M, Higashi H, Mullany EC, et al. The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease study 2013. *Injury Prevention*. 2016;22(1):3-18.
7. Davis C, Wrigglesworth S. Unintentional injuries in Scotland. Edinburgh: Information Services Division, NHS National Services Scotland; 2018 6 March 2018.
8. Deandrea S, Lucenteforte E, Bravi F, Foschi R, La Vecchia C, Negri E. Review article: risk factors for falls in community-dwelling older people: "a systematic review and meta-analysis". *Epidemiology*. 2010;21(5):658-68.
9. Kwan MMS, Close JC, Wong AKW, Lord SR. Falls incidence, risk factors, and consequences in Chinese older people: a systematic review. *Journal of the American Geriatrics Society*. 2011;59(3):536-43.

10. Oliver D, Daly F, Martin FC, McMurdo ME. Risk factors and risk assessment tools for falls in hospital in-patients: a systematic review. *Age and Ageing*. 2004;33(2):122-30.
11. Hingson R, Howland J. Alcohol as a risk factor for injury or death resulting from accidental falls: a review of the literature. *Journal of Studies on Alcohol*. 1987;48(3):212-9.
12. NHS Digital. Statistics of Alcohol 2019. NHS Digital; 2019 5 February 2019.
13. Kyobutungi C, Ronellenfitsch U, Razum O, Becher H. Mortality from external causes among ethnic German immigrants from former Soviet Union countries, in Germany. *The European Journal of Public Health*. 2006;16(4):376-82.
14. Norredam M, Olsbjerg M, Petersen JH, Laursen B, Krasnik A. Are there differences in injury mortality among refugees and immigrants compared with native-born? *Injury Prevention*. 2013;19(2):100-5.
15. Stirbu I, Kunst A, Bos V, van Beeck EF. Injury mortality among ethnic minority groups in the Netherlands. *Journal of Epidemiology & Community Health*. 2006;60(3):249-55.
16. Han BH, Ferris R, Blaum C. Exploring ethnic and racial differences in falls among older adults. *Journal of Community Health*. 2014;39(6):1241.
17. Campos-Outcalt D, Bay C, Dellapena A, Cota MK. Motor vehicle crash fatalities by race/ethnicity in Arizona, 1990–96. *Injury Prevention*. 2003;9(3):251-6.
18. Cercarelli L, Knuiman M. Trends in road injury hospitalisation rates for Aboriginal and non-Aboriginal people in Western Australia, 1971–97. *Injury Prevention*. 2002;8(3):211-5.
19. Hosking J, Ameratunga S, Exeter D, Stewart J, Bell A. Ethnic, socioeconomic and geographical inequalities in road traffic injury rates in the Auckland region. *Australian and New Zealand Journal of Public Health*. 2013;37(2):162-7.
20. Bhopal R, Fischbacher C, Povey C, Chalmers J, Mueller G, Steiner M, et al. Cohort profile: Scottish Health and Ethnicity Linkage Study of 4.65 million people exploring ethnic variations in disease in Scotland. *International journal of epidemiology*. 2010;40(5):1168-75.

21. Scottish Health and Ethnicity Linkage Study website [Available from: <https://www.ed.ac.uk/usher/scottish-health-ethnicity-linkage>].
22. Bhala N, Cézard G, Ward HJ, Bansal N, Bhopal R. Ethnic variations in liver-and alcohol-related disease hospitalisations and mortality: the Scottish Health and Ethnicity Linkage study. *Alcohol and Alcoholism*. 2016;51(5):593-601.
23. Bhopal R, Steiner MF, Cezard G, Bansal N, Fischbacher C, Simpson CR, et al. Risk of respiratory hospitalization and death, readmission and subsequent mortality: scottish health and ethnicity linkage study. *European Journal of Public Health*. 2015;25(5):769-74.
24. Bhopal RS, Bansal N, Steiner M, Brewster DH, Scottish H, Ethnicity Linkage S. Does the 'Scottish effect' apply to all ethnic groups? All-cancer, lung, colorectal, breast and prostate cancer in the Scottish Health and Ethnicity Linkage Cohort Study. *BMJ Open*. 2012;2(5).
25. Cezard GI, Bhopal RS, Ward HJ, Bansal N, Bhala N. Ethnic variations in upper gastrointestinal hospitalizations and deaths: the Scottish Health and Ethnicity Linkage Study. *The European Journal of Public Health*. 2015;26(2):254-60.
26. Gruer LD, Millard AD, Williams LJ, Bhopal RS, Katikireddi SV, Cézard GI, et al. Differences in all-cause hospitalisation by ethnic group: a data linkage cohort study of 4.62 million people in Scotland, 2001&#x2013;2013. *Public health*. 2018;161:5-11.
27. Katikireddi SV, Cezard G, Bhopal RS, Williams L, Douglas A, Millard A, et al. Assessment of health care, hospital admissions, and mortality by ethnicity: population-based cohort study of health-system performance in Scotland. *The Lancet Public Health*. 2018.
28. Sheikh A, Steiner MF, Cezard G, Bansal N, Fischbacher C, Simpson CR, et al. Ethnic variations in asthma hospital admission, readmission and death: a retrospective, national cohort study of 4.62 million people in Scotland. *BMC medicine*. 2016;14:3.
29. Scottish Government. A fairer Scotland for all: race equality action plan and highlight report 2017-2021. Edinburgh 2017.

30. Fischbacher C, Bhopal R, Povey C, Steiner M, Chalmers J, Mueller G, et al. Record linked retrospective cohort study of 4.6 million people exploring ethnic variations in disease: myocardial infarction in South Asians. *BMC Public Health*. 2007;7(1):142.
31. Fischbacher CM, Cezard G, Bhopal RS, Pearce J, Bansal N. Measures of socioeconomic position are not consistently associated with ethnic differences in cardiovascular disease in Scotland: methods from the Scottish Health and Ethnicity Linkage Study (SHELS). *International journal of epidemiology*. 2014;43(1):129-39.
32. Hanlon JT, Landerman LR, Fillenbaum GG, Studenski S. Falls in African American and white community-dwelling elderly residents. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*. 2002;57(7):M473-M8.
33. Stanaway FF, Cumming RG, Naganathan V, Blyth FM, Handelsman DJ, Le Couteur DG, et al. Ethnicity and falls in older men: low rate of falls in Italian-born men in Australia. *Age and Ageing*. 2011;40(5):595-601.
34. Kwan MM, Tsang WW, Lin S-I, Greenaway M, Close JC, Lord SR. Increased concern is protective for falls in Chinese older people: the chopstix fall risk study. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*. 2013;68(8):946-53.
35. Steinbach R, Edwards P, Green J, Grundy C. Road safety of London's Black and Asian minority ethnic groups. A report to the London Road Safety Unit, London School of Hygiene and Tropical Medicine, London. 2007.
36. Steinbach R, Edwards P, Green J. Controlling for exposure changes the relationship between ethnicity, deprivation and injury: an observational study of child pedestrian injury rates in London. *Injury prevention*. 2014;20(3):159-66.
37. Steinbach R, Green J, Edwards P, Grundy C. 'Race' or place? Explaining ethnic variations in childhood pedestrian injury rates in London. *Health & place*. 2010;16(1):34-42.
38. Abdel-Rahman N, Siman-Tov M, Group IT, Peleg K. Ethnicity and road traffic injuries: differences between Jewish and Arab children in Israel. *Ethnicity & health*. 2013;18(4):391-401.

39. Smith GD, Chaturvedi N, Harding S, Nazroo J, Williams R. Ethnic inequalities in health: a review of UK epidemiological evidence. *Critical public health*. 2000;10(4):375-408.
40. Todd C, Ballinger C, Whitehead S. Reviews of socio-demographic factors related to falls and environmental interventions to prevent falls amongst older people living in the community. World Health Organization, Geneva, 2007.
41. Jarvis L. Alcohol consumption in Black and Minority Ethnic groups and recent immigrants in Scotland: current situation on information available. Scottish Alcohol Research Framework, unpublished; 2008.
42. Transport Scotland. Transport and Travel in Scotland. Results from the Scottish Household Survey 2018. Edinburgh 2019.
43. Cycling UK. Cycling UK's Cycling Statistics. Occupation, income, ethnicity and impairment. Surrey, UK: Cycling UK's press office; 2019 [updated November 2019. Available from: <https://www.cyclinguk.org/statistics>.

**Table 1. Socio-demographic profile of the linked 2001 Scotland Census population by sex and ethnic group.**

Sex and ethnic group	Population	Ethnic distribution	Age at Census	UK/Rol-born <sup>1</sup>	SIMD <sup>2</sup>		Highest Qualification (individual)	Highest Qualification (household)	Household tenure (owned)	
	N	%	Mean (SD)	%	Most Deprived	Least Deprived	%	%	%	
<b>MALES</b>										
White Scottish	1949484	88.5	38 (22)	99.1	20.1	19.8	24.4	39.0	68.6	
Other White British	160235	7.3	42 (20)	95.3	8.0	29.6	48.4	61.9	72.3	
White Irish	20341	0.9	45 (20)	98.4	22.2	21.7	36.8	51.4	65.4	
Other White	29944	1.4	36 (21)	30.5	12.4	32.6	49.2	66.2	56.6	
Any mixed background	5310	0.2	21 (18)	76.0	19.7	26.1	36.8	59.7	57.1	
Indian	6448	0.3	31 (19)	48.4	9.7	38.5	50.9	64.5	72.2	
Pakistani	12929	0.6	27 (19)	58.0	15.8	24.8	26.5	47.5	76.2	
Other South Asian	3549	0.2	29 (19)	38.9	24.2	28.3	46.4	58.7	53.7	
African origin	3277	0.1	30 (18)	39.9	27.6	22.4	52.4	68.2	43.1	
Chinese	6532	0.3	30 (18)	38.4	13.4	38.5	31.8	48.3	69.8	
<b>FEMALES</b>										
White Scottish	2138643	88.6	41 (24)	99.1	21.3	19.2	23.8	37.8	65.2	
Other White British	174748	7.2	44 (21)	95.0	8.2	28.9	40.8	58.5	69.5	
White Irish	23162	1.0	49 (21)	98.6	20.1	22.8	38.0	53.4	64.1	
Other White	35711	1.5	37 (21)	26.4	10.8	33.4	51.3	68.7	58.7	
Any mixed background	5799	0.2	24 (20)	74.5	18.7	27.3	37.8	60.2	55.8	
Indian	5888	0.2	30 (19)	51.1	9.6	39.0	40.7	61.9	73.6	
Pakistani	12702	0.5	26 (18)	60.5	15.4	24.6	22.8	47.1	75.9	
Other South Asian	2963	0.1	29 (20)	44.5	22.0	28.9	36.7	55.2	54.5	
African origin	3056	0.1	30 (18)	42.1	27.5	24.5	46.1	67.6	45.1	
Chinese	6672	0.3	31 (18)	33.9	12.1	39.1	33.3	50.3	70.1	

<sup>1</sup> UK/Rol-born = Born in the UK or Republic of Ireland

<sup>2</sup> SIMD = Scottish Index of Multiple Deprivation

**Table 2. Age adjusted rates per 100,000 person years at risk (PY) and risk ratios (RR) for hospitalisations and deaths due to falls (W00-W19) by sex and ethnic group. RRs are adjusted for age and additionally for socio-economic status (SES), born in the UK/Ireland (UK/RoI-born) and both, with 95% CIs.**

Sex and ethnic group	Cases	PY	Rates/100,000 PY	RR (95% CI) Age	RR (95% CI) Age + SES	RR (95% CI) Age + UK/RoI-born	RR (95% CI) Age + SES + UK/RoI-born
<b>MALES</b>							
White Scottish	123410	21179755	583	100	100	100	100
Other White British	6595	1571080	581	102 (97, 107)	107 (101, 112)	99 (94, 104)	103 (98, 109)
White Irish	1315	202190	743	131 (122, 140)	127 (118, 136)	126 (117, 135)	122 (114, 132)
Other White	1035	278515	579	102 (95, 110)	103 (96, 111)	105 (97, 113)	106 (98, 114)
Any mixed background	275	56265	707	124 (110, 141)	121 (107, 138)	122 (107, 138)	119 (105, 135)
Indian	205	65945	570	100 (88, 115)	107 (93, 122)	102 (89, 117)	108 (95, 124)
Pakistani	335	146430	411	72 (64, 81)	75 (67, 84)	73 (65, 82)	76 (67, 85)
Other South Asian	105	35500	517	91 (76, 109)	89 (75, 106)	92 (77, 110)	90 (76, 107)
African origin	95	32160	539	95 (77, 117)	89 (72, 110)	96 (78, 118)	90 (72, 111)
Chinese	120	68685	485	85 (73, 100)	88 (75, 103)	88 (75, 103)	90 (77, 105)
<b>FEMALES</b>							
White Scottish	130075	22581190	576	100	100	100	100
Other White British	8745	1644435	638	114 (108, 120)	115 (109, 121)	111 (105, 117)	113 (107, 119)
White Irish	1600	216905	660	118 (110, 125)	116 (109, 124)	114 (109, 122)	114 (106, 122)
Other White	1310	319915	617	110 (103, 117)	110 (103, 118)	112 (105, 120)	112 (105, 120)
Any mixed background	210	59970	710	126 (112, 143)	124 (109, 140)	124 (110, 140)	122 (108, 138)
Indian	110	59925	498	89 (75, 105)	90 (77, 107)	90 (76, 107)	92 (78, 108)
Pakistani	200	143940	402	72 (63, 82)	73 (64, 83)	72 (64, 82)	74 (65, 84)
Other South Asian	70	28610	558	99 (80, 123)	99 (80, 123)	99 (80, 124)	99 (80, 123)
African origin	60	28590	442	79 (63, 99)	77 (62, 97)	79 (63, 99)	77 (62, 97)
Chinese	125	68010	577	103 (82, 129)	104 (83, 131)	105 (84, 132)	107 (85, 134)

**Table 3. Age adjusted rates per 100,000 person years at risk (PY) and risk ratios (RR) for hospitalisations and deaths due to road traffic injuries (V00-V89) by sex and ethnic group. RRs are adjusted for age and additionally for socio-economic status (SES), born in the UK/Ireland (UK/Rol-born) and both, with 95% Cis.**

Sex and ethnic group	Cases	PY	Rates/100,000 PY	RR (95% CI) Age	RR (95% CI) Age + SES	RR (95% CI) Age + UK/Rol-born	RR (95% CI) Age + SES + UK/Rol-born
<b>MALES</b>							
White Scottish	26350	21179755	124	100	100	100	100
Other White British	1950	1571080	195	161 (147, 176)	151 (138, 165)	163 (149, 179)	153 (139, 167)
White Irish	155	202190	110	91 (77, 107)	93 (79, 110)	93 (78, 110)	94 (80, 112)
Other White	270	278515	144	119 (104, 137)	117 (101, 134)	117 (101, 135)	115 (100, 132)
Any mixed background	60	56265	100	82 (65, 105)	83 (65, 106)	83 (65, 106)	84 (66, 107)
Indian	40	65945	96	79 (59, 105)	75 (57, 100)	79 (59, 105)	75 (57, 100)
Pakistani	115	146430	110	90 (75, 108)	91 (76, 109)	90 (75, 108)	91 (76, 109)
Other South Asian	40	35500	153	126 (95, 168)	129 (97, 171)	125 (94, 167)	128 (96, 170)
African origin	20	32160	92	76 (52, 112)	80 (54, 118)	75 (51, 111)	80 (54, 118)
Chinese	35	68685	119	98 (73, 133)	98 (72, 132)	97 (72, 132)	97 (72, 131)
<b>FEMALES</b>							
White Scottish	13170	22581190	58	100	100	100	100
Other White British	1230	1644435	89	156 (138, 176)	141 (125, 160)	163 (144, 185)	146 (128, 165)
White Irish	90	216905	51	90 (72, 112)	91 (74, 114)	95 (76, 118)	95 (76, 118)
Other White	195	319915	81	143 (121, 169)	133 (112, 157)	136 (114, 161)	128 (108, 152)
Any mixed background	25	59970	41	73 (50, 105)	73 (51, 106)	75 (52, 108)	75 (52, 108)
Indian	20	59925	53	93 (62, 140)	91 (60, 137)	91 (61, 137)	90 (59, 135)
Pakistani	50	143940	42	74 (57, 98)	79 (60, 103)	74 (57, 97)	79 (60, 103)
Other South Asian	15	28610	56	98 (60, 160)	97 (60, 159)	97 (60, 159)	97 (60, 159)
African origin	15	28590	60	105 (65, 170)	111 (69, 180)	103 (63, 167)	110 (68, 178)
Chinese	20	68010	66	115 (78, 170)	118 (80, 174)	111 (75, 164)	115 (78, 170)