BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (http://bmjopen.bmj.com).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

BMJ Open

Are there age, period or cohort effects in deaths due to assault in Scotland?

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-030064
Article Type:	Research
Date Submitted by the Author:	28- Feb-2019
Complete List of Authors:	Parkinson, Jane ; NHS Health Scotland, Public Health Observatory Minton, Jon; NHS Health Scotland, Public Health Observatory McCartney, Gerry; NHS Health Scotland, Public Health Observatory
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, SOCIAL MEDICINE

SCHOLARONE™
Manuscripts

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Are there age, period or cohort effects in deaths due to assault in Scotland?

Jane Parkinson, Jon Minton, Gerry McCartney

Public Health Observatory, NHS Health Scotland, Meridian Court, 5 Cadogan Street, Glasgow, G2 6QE, UK

Correspondence to Dr Jane Parkinson Public Health Observatory, NHS Health Scotland, Meridian Court, 5 Cadogan Street, Glasgow, G2 6QE, UK, jane.parkinson@nhs.net, 07500 854571

Keywords assault, violence, excess mortality, age-period-cohort effects, Scotland

Word count 1793

ABSTRACT (282 words)

Objectives: Mortality rates in Scotland are higher, and health inequalities greater, than in the rest of Western and Central Europe. There was a marked divergence during the 1980s and 1990s in the Scottish rates partly due to rises in alcohol- and drug-related deaths, suicide and deaths by assault. This study examines whether age, period or cohort effects account for the trends in death by assault in Scotland.

Design: We calculated crude and age-standardised mortality rates for deaths by assault for Scottish men and women from 1974 to 2015 for the population overall and for populations stratified by Carstairs area of deprivation. We examined age-sex stratified trends to identify obvious age-period-cohort effects.

Setting: Scotland.

Participants: Men and women whose registered death by the International Classification of Diseases was due to assault from 1974 to 2015 (n = 3936).

Results: Whereas age-standardised mortality rates from this cause fell gradually for females since 1974, for males they increased in the early 1990s and remained high until around 2006, before falling. Death by assault was substantially more common amongst males aged around 15-50 years and in the most deprived areas. There was little change in the age groups most impacted over time, which made cohort effects unlikely. A period effect for the fifteen years until 2006, with a consistent age-sex-area deprivation patterning, was evident.

Conclusions: Mortality due to assault in Scotland is unequally felt, with young men living in the most deprived areas suffering the highest rates. There is a fifteen year period effect up until 2006, impacting on young men as an age-period interaction, with no obvious cohort effects. Exploration of the demographics of criminological data may identify age, period or cohort effects amongst perpetrators of assault.

Strengths and limitations of this study

- This study uses a complete record of all deaths in Scotland occurring over long time period (1974-2015)
- Deaths are carefully coded using the International Classification of Diseases and recorded as individual digital records which provides a robust dataset to examine
- There were insufficient deaths by assault to undertake more detailed visual analysis or statistical modelling and the conclusions are based on descriptive analyses of aggregated age-groups and periods
- Aggregating across periods to reduce fluctuations in the data means that such incidents that cause a noticeable increase in deaths by assault in a specific year can appear of prominence across a time period
- Our analysis focused on the victims rather than perpetrators of assaults who could display APC effect, exploration of the demographics of criminological data (such as conviction rates by sex, age, and year) may be able to illuminate further.

INTRODUCTION

Around 1950 the rate of improvement in Scotland's mortality started to lag behind that of the rest of Britain and other Western European countries, and some areas experienced an increase in mortality rates in the 1980s.[1, 2] Scotland now has higher mortality rates and wider health inequalities than the rest of Western Europe.[1, 3] Since 1981 less of the higher mortality compared to England and Wales has been able to be explained by area deprivation.[4, 5] This excess mortality (i.e. after accounting for deprivation), slower rate of improvement in mortality and greater health inequalities has been attributed to higher mortality from alcohol- and drug-related deaths, violence (assault) and suicide (particularly in young adults) and higher mortality from heart disease, stroke and cancer throughout adulthood.[6, 7]

Using age, period, cohort (APC) analysis to seek to understand the reasons behind the trends in these health outcomes, we have shown age-period interactions in the rise and fall of alcohol-related deaths[8] and cohort effects and sex-area deprivation interactions in the recent trends in suicide and drug-related deaths.[9][10] In this paper we extend this exploration of APC patterns in external causes of death and the existing epidemiological analysis of deaths from assault in Scotland to consider whether age, period or cohort effects may be present in the trends in death due to assault since 1974.

METHODS

Data sources

Data on the number of deaths due to assault by sex, single year of age at death, year of registration of death and postcode of residence for Scotland from 1974-2015 were obtained from the National Records of Scotland (NRS) (n = 3936). Deaths were

coded by International Classification of Diseases 8 (ICD 8) E960-E969 for 1974-1978 and by ICD9 E960-E969 for 1979-1999 for deaths where the underlying cause was homicide and injury purposely inflicted by other persons and by ICD10 X85-Y09 and Y87.1 for 2000 onward for deaths where the underlying cause was assault or sequelae of assault, collectively referred to in this paper as deaths due to assault. Deaths due to the Lockerbie bombing of December 1988, coded as assault by other specific explosive E9658 (n = 267), were excluded. Data manipulation was performed using IBM SPSS Statistics version 19 and Microsoft Excel 2013.

Mid-year population estimates for Scotland by sex and single year of age, from age 0 to 90+ years were obtained from NRS. Population data by Carstairs area deprivation, from age 0 to 85+ years, were obtained from ISD with interpolation between the censuses. The age structure of the population data determined the upper age limit for analyses so analyses were restricted to those aged 0-89 years or 0-90+ years, or aged 0-84 years or 0-85+ years for the deprivation analysis.

Patient and Public Involvement statement

This study used de-identified secondary data. Patients were not involved in this study.

Descriptive analysis

We calculated age-standardised mortality rates for all ages from 1974 to 2015 by sex using the 2013 European Standard Population. For age effects analysis, data from 1974-1994 and data from 1995-2015 were separately combined for presentation of crude death rates by five year age groups (from 0-4 years to 90+ years) for age at death by sex. Further age effects investigation involved analysis by specified age groups for three year periods from 1974-76 to 2013-15.

Carstairs

Analyses by deprivation were based on Carstairs area deprivation scores (calculated using data from the nearest census on the prevalence of male unskilled social class, housing overcrowding, unemployment and car ownership) for postcode sectors, which were then ranked and divided into fifths.[11] Carstairs look-up files were obtained from ISD and deaths assigned to a Carstairs deprivation category. Cases with no associated Carstairs scores (6.2% of dataset) were removed from the analyses by deprivation.

RESULTS

Trends over time

Age-standardised rates for assault deaths were higher amongst males than females for the entire period from 1974 to 2015 (Figure 1). Rates amongst males fell from 1974 to the mid-1980s, rose slightly until 1991, after which they increased rapidly and fluctuated at this higher level until 2006, and thereafter have steadily fallen. Rates for females in contrast have gradually fallen over the period.

[insert Figure 1 about here]

Age effects

Rates of deaths by assault are patterned by age for both males and females (Figure 2). Amongst males, rates were highest for those aged 20-24 years, falling steadily with increasing age until rising again amongst those over eighty. Between 1974-1994 and 1995-2015, the age profile for males did not change markedly, although higher rates extended across those aged 20 to 49 years in the later period and were lower for those aged 60+ years. There was some fluctuation amongst the oldest age groups over time. The age profile for females differed to that for males for both periods with an absence of a peak in rates for those aged 20 to 24 years and all rates except that for those aged 5-9 years were lower over the 1995-2015 period.

[insert Figure 2 about here]

The contribution of males aged 15-49 years to the increase in male mortality rate by assault from 1992-94 to the end of 2004-06 is clear from the age-stratified trend data (online supplementary Figure S1), with a greater contribution from those aged 15-29 years (Figure 3).

[insert Figure 3 about here]

Inequalities

Deaths by assault for males are very unequal, with the overall rise in mortality during the late 1980s and the fall in the 2000s almost entirely due to a rise and fall in the most deprived areas (Figure 4). There are also inequalities in deaths from assault amongst females, but these are much less than for males.

[insert Figure 4 about here]

The deprivation gradient for deaths by assault amongst males is largely a result of the distribution of deaths for those aged 15-49 years with contribution from deaths among those aged 50-69 years (Figure 5).

[insert Figure 5 about here]

DISCUSSION

Main results

Rates of death by assault are greater among males than females over the period 1974-2015. Death rates increased dramatically for males from the start of the 1990s and remained elevated until 2006, and have since fallen. Those for females remained low and gradually fell over the period. Males of around 15 to 50 years of age substantially contribute to the higher rates observed among males and young adult males especially to the period of elevated death rate from the mid-1980s. The age groups most impacted did not change markedly over time, making cohort effects unlikely. Deaths by assault are very unequal and the rise in rate of death for males between the start of the 1990s and the mid-2000s is clearly driven by deaths in the

two most deprived quintiles. The results for males reflect a fifteen year age-period interaction effect evident for a specific sex-area deprivation group.

Strengths and weaknesses of the analysis

All deaths within Scotland are carefully coded and this provides a robust and long time series to examine the potential for APC effects. There were insufficient deaths by assault to use Lexis surface plots of age-year specific rates by age in a single year or to undertake formal statistical modelling of the data stratified by APC as we have previously undertaken for suicide and alcohol- and drug-related deaths.[8-10] These methods require a level of disaggregation which would likely be disclosive, 'noisy' and too underpowered to clearly identify APC patterns. As a result, the conclusions in relation to APC effects are based on descriptive analyses of aggregated age-groups and periods alone. A consequence of the small number of deaths is that incidents that cause a noticeable increase in deaths by assault in a specific year will be evident in the data and appear of prominence causing the trends to fluctuate. Aggregating across periods to reduce the fluctuations in the data however means that such incidents can appear of prominence across a time period rather than just a single year. Although both these are evident in our analysis, we do not feel that these consequences of dealing with small numbers affect our overall APC conclusions and the trends observed. While coded as deaths due to assault, we removed deaths resulting from the Lockerbie bombing of December 1988 (which involved an aircraft crash in Scotland from a overflying aeroplane in which a bomb exploded) as these were unrelated to the deaths due to assault in Scotland that were the focus of this research and had a noticeable effect on the results.

Subsequent to our analysis, an error was identified by NRS in their Scottish mid-year population estimates for 2002-2010, which affected the age distribution for those aged 81 years and above (see https://www.nrscotland.gov.uk/files//statistics/population -estimates/mid-year-corrections/correction-to-age-distribution-mid-year%20pop-estimates-2002-2010.pdf). Sensitivity analysis showed that this had no effect on our results.

Our analysis looks at mortality in deaths due to assault, and therefore the victims rather than the perpetrators of assaults. It may be that an APC analysis of perpetrators may be more likely to display cohort effects.

Comparison with other studies

Our results are consistent with and extend previous research demonstrating the most pronounced increase in death by assault for males aged 15-44 years in Scotland from 1980-2005.[12] Social patterning of deaths due to assaults was evident for both individual occupational socioeconomic status and area deprivation, with steeper deprivation gradients amongst men aged 20-39 years. Male death rates by assault are dominated by deaths due to a sharp object, most notably a knife and has accounted for around fifty percent of all homicides in the last ten years.[13] Increases in deaths due to sharp objects have been shown to have contributed to the increase in deaths by assault observed over the period 1980-2005.[12, 14] The

rate of homicides involving knives being especially high in Glasgow, a city with areas of high deprivation. The rise in mortality due to assault occurred at a similar time to the rise in alcohol- and drug-related mortality and suicide in Scotland, all of which have been attributed to the changing political and social conditions of the 1980s.[7] There has been some suggestion that the recent decline in deaths from assault as we observed may be due to 'a public health approach' to violence, knife crime and gang culture adopted by the violence reduction unit which was created by Strathclyde police in 2005 and later rolled out across Scotland.[15-17] Laws around the carrying of knives were also extended in 2006.[15] However, there is little evaluative evidence available to ascertain what, if any, contribution these initiatives had.

Implications and conclusions
Mortality due to assault is substantially more common amongst young men in deprived areas than for women, at older ages or for people living in less deprived areas. Mortality rates, and inequalities, increased markedly in the early 1990s and remained high until the mid-2000s before subsequently falling, but the age profile of victims changed little over time. There is therefore evidence of age and period effects, but little evidence of cohort effects, in deaths due to assault in Scotland.

Acknowledgements We would like to thank Julie Ramsay and Frank Dixon at NRS for the dataset and for advising on details of Scottish deaths due to assault statistics, and also David Readhead and Laura Kate Campbell at NHS National Services Scotland for assistance in providing data by deprivation groupings.

Contributors GM generated the initial idea for the study. Analyses of data were conducted by JP. JP interpreted the data and drafted the manuscript. Both JM and GM provided critical input into the interpretation of the data and intellectual content to the redrafting of the manuscript. All authors read and approved the final draft.

Ethics approval No ethical approval was required or sought for the analyses in this paper.

Funding This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing Interests None declared.

Data sharing statement The original data used for this study are owned by the NRS and can be obtained by researchers from them on request. No additional data are available.

REFERENCES

1 McCartney G, Walsh D, Whyte B, et al. Has Scotland always been the 'sick man' of Europe? An observational study from 1855 to 2006. *Eur J Public Health*

2010;22:756-760 doi:10.1136/jech-2014-204185 [published Online First: 12 September 2014].

2 Norman P, Boyle P, Exeter D, et al. Rising premature mortality in the UK's persistently deprived areas: Only a Scottish phenomenon? *Soc Sci Med* 2011;73:1575-1584 doi:10.1016/j.socscimed.2011.09.034 [published Online First: 13 October 2011].

3 Popham F, Boyle P. *Assessing socio-economic inequalities in mortality and other health outcomes at the Scottish national level: Final report.* Edinburgh: Scottish Collaboration for Public Health Research and Policy, 2011.

4 Hanlon P, Lawder R, Buchanan D, et al. Why is mortality higher in Scotland than in England & Wales? Decreasing influence of socioeconomic deprivation between 1981 and 2001 supports the existence of a 'Scottish effect'. *J Public Health (Oxf)* 2005;27:199-204 doi:10.1093/pubmed/fdi002 [published Online First: 17 March 2005].

5 Schofield L, Walsh D, Munoz-Arroyo R, et al. Dying younger in Scotland: Trends in mortality and deprivation relative to England and Wales,1981–2011. *Health Place* 2016;40:106-115 doi: 10.1016/j.healthplace.2016.05.007 [published Online First: 5 May 2016].

6 McCartney G, Collins C, Walsh D, et al. *Accounting for Scotland's excess mortality: towards a synthesis.* Glasgow: Glasgow Centre for Population Health, 2011.

7 Walsh D, McCartney G, Collins C, et al. *History, politics and vulnerability: explaining excess mortality in Scotland and Glasgow.* Glasgow: Glasgow Center for Population Health, 2016.

8 McCartney G, Bouttell J, Craig N, et al. Explaining trends in alcohol-related harms in Scotland, 1991-2011 (I): the role of incomes, effects of socio-economic and political adversity and demographic change. *Public Health* 2016;132:13-23 doi: 10.1016/j.puhe.2015.12.013 [published Online First: 23 February 2016].

9 Parkinson J, Minton J, Lewsey J, et al. Recent cohort effects in suicide in Scotland: a legacy of the 1980s? *J Epidemiol Community Health* 2017;71:194-200 doi: 10.1136/jech-2016-207296 [published Online First: 18 July 2016].

10 Parkinson J, Minton J, Lewsey J, et al. Drug-related deaths in Scotland 1979–2013: evidence of a vulnerable cohort of young men living in deprived areas. *BMC Public Health* 2018;18:357-365 doi: 10.1186/s12889-018-5267-2 [published Online First: 27 March 2018].

11 Carstairs V, Morris R. Deprivation: explaining differences in mortality between Scotland and England and Wales. *BMJ* 1989;299:886-9 doi: https://doi.org/10.1136/bmj.299.6704.886.

12 Leyland AH, Dundas R. The social patterning of deaths due to assault in Scotland, 1980-2005: population-based study. *J Epidemiol Community Health* 2010;64:432-439 doi:10.1136/jech.2009.095018 [published Online First: 5 May 2010].

13 Scottish Government. *Homicide in Scotland 2017-18.* Edinburgh: Scottish Government, 2018.

14 Leyland AH. Homicides involving knives and other sharp objects in Scotland, 1981-2003. *J Public Health* 2006;28:145-147 doi:10.1093/pubmed/fdl004 [published Online first; 5 April 2005].

15 McCallum F. *Knife crime, SPICe Briefing.* Edinburgh: The Scottish Parliament, 2011.

16 Younge G, Barr C. *How Scotland reduced knife deaths among young people*. The Guardian, 2017.

17 Kmietowicz K. Glasgow gang members offered way out of violent lifestyle. *BMJ* 2008;337:a2972 doi: https://doi.org/10.1136/bmj.a2972 [published Online first: 10 December 2008].

FIGURE LEGENDS

Figure 1 European age-standardised rate of death by assault per 100,000 population per year in Scotland, 1974-2015, by sex

Figure 2 Age distribution of crude rates of death by assault per 100,000 population per year in Scotland over periods 1974-1994 and 1995-2015 combined data, by sex.*
* These age profiles show general trends with age across two time periods 1974-1994 and 1995-2015 and will have been affected by any age-period-cohort effects occurring during those periods

Figure 3 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years

Figure 4 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015, by sex and Carstairs quintile

Figure 5 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males, by age group and Carstairs quintile

ONLINE SUPPLEMENTARY FIGURE LEGENDS

Figure S1 Age profiles of crude rates of death by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and age

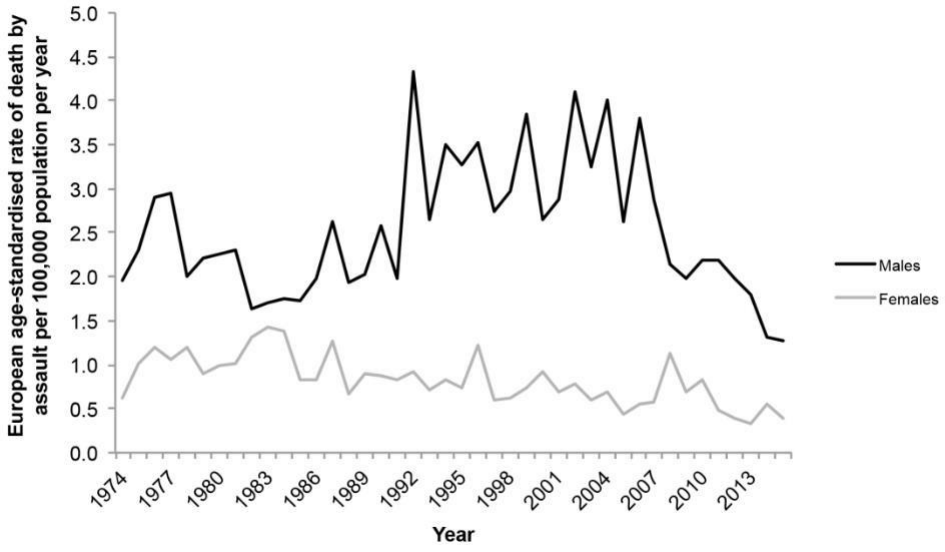


Figure 1 European age-standardised rate of death by assault per 100,000 population per year in Scotland, 1974-2015, by sex

174x105mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

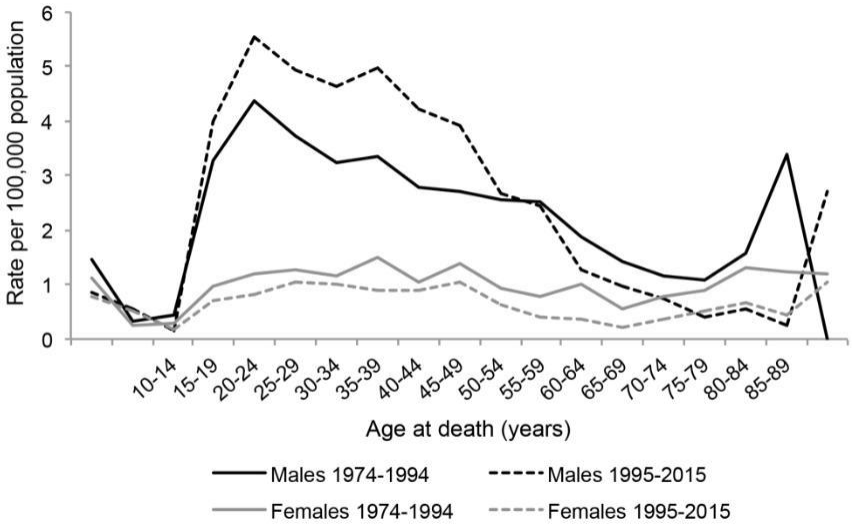


Figure 2 Age distribution of crude rates of death by assault per 100,000 population per year in Scotland over periods 1974-1994 and 1995-2015 combined data, by sex.*
* These age profiles show general trends with age across two time periods 1974-1994 and 1995-2015 and will have been affected by any age-period-cohort effects occurring during those periods

171x104mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

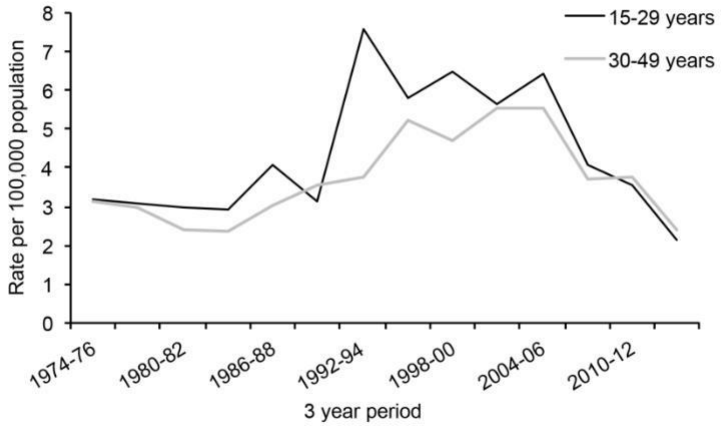


Figure 3 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years

174x105mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

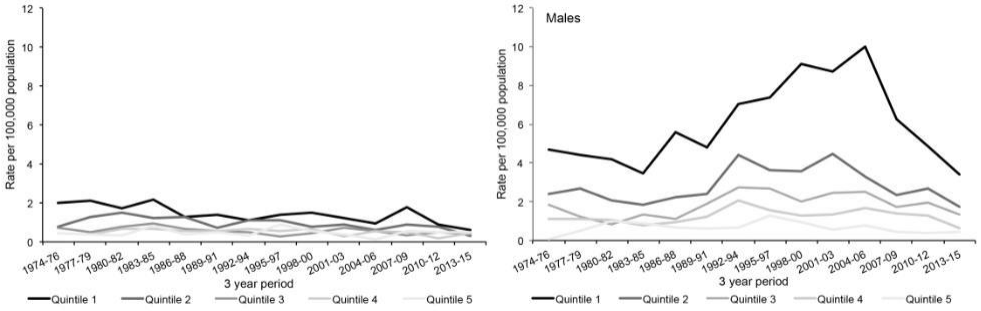


Figure 4 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015, by sex and Carstairs quintile

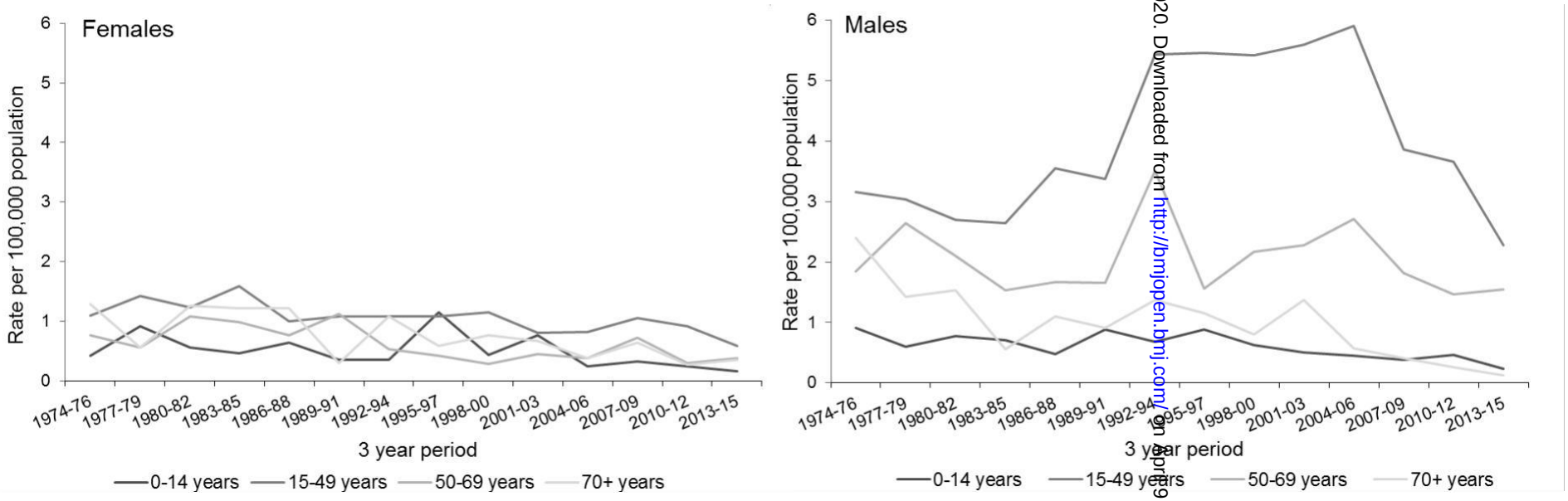
299x105mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Supplementary Figure

Figure S1 Age profiles of crude rates of death by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and age



36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	2
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	n/a
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	3
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	2-3
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	n/a
		(b) Indicate number of participants with missing data for each variable of interest	3

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Outcome data	15*	Report numbers of outcome events or summary measures	2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	3-4 – see figures also
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5
Discussion			
Key results	18	Summarise key results with reference to study objectives	4
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	4-5
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6
Generalisability	21	Discuss the generalisability (external validity) of the study results	5
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	6

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

Analysis of age-sex and deprivation stratified trends in assault deaths in Scotland (1974-2015) to identify age, period or cohort effects

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-030064.R1
Article Type:	Research
Date Submitted by the Author:	15- May-2019
Complete List of Authors:	Parkinson, Jane ; NHS Health Scotland, Public Health Observatory Minton, Jon; NHS Health Scotland, Public Health Observatory McCartney, Gerry; NHS Health Scotland, Public Health Observatory
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, SOCIAL MEDICINE

SCHOLARONE™
Manuscripts

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Analysis of age-sex and deprivation stratified trends in assault deaths in Scotland (1974-2015) to identify age, period or cohort effects

Jane Parkinson, Jon Minton, Gerry McCartney

Public Health Observatory, NHS Health Scotland, Meridian Court, 5 Cadogan Street, Glasgow, G2 6QE, UK

Correspondence to Dr Jane Parkinson Public Health Observatory, NHS Health Scotland, Meridian Court, 5 Cadogan Street, Glasgow, G2 6QE, UK, jane.parkinson@nhs.net, 07500 854571

Keywords assault, violence, excess mortality, age-period-cohort effects, Scotland

Word count 2322

ABSTRACT (292 words)

Objectives: Mortality rates in Scotland are higher, and health inequalities greater, than in the rest of Western and Central Europe. There was a marked divergence during the 1980s and 1990s in the Scottish rates partly due to rises in alcohol- and drug-related deaths, suicide and deaths by assault. This study examines whether age, period or cohort effects account for the trends in death by assault in Scotland and any sex or deprivation inequalities in these.

Design: We calculated crude and age-standardised mortality rates for deaths by assault for Scottish men and women from 1974 to 2015 for the population overall and for populations stratified by Carstairs area of deprivation. We examined age-sex stratified trends to identify obvious age-period-cohort effects.

Setting: Scotland.

Participants: Men and women whose registered death by the International Classification of Diseases was due to assault from 1974 to 2015 (n = 3936).

Results: Whereas age-standardised mortality rates from this cause fell gradually for females since 1974, for males they increased in the early 1990s and remained higher until around 2006, before falling. Death by assault was substantially more common amongst males aged around 15-50 years and in the most deprived areas. There was little change in the age groups most impacted over time, which made cohort effects unlikely. A period effect for the fifteen years until 2006, with a consistent age-sex-area deprivation patterning, was evident.

Conclusions: Mortality due to assault in Scotland is unequally felt, with young men living in the most deprived areas suffering the highest rates. There is a fifteen year

period effect up until 2006, impacting on young men as an age-period interaction, with no obvious cohort effects. Exploration of the demographics of criminological data may identify age, period or cohort effects amongst perpetrators of assault.

Strengths and limitations of this study

- This study uses a complete record of all deaths in Scotland occurring over a long time period (1974-2015)
- Deaths are carefully coded using the International Classification of Diseases and recorded as individual digital records which provides a robust dataset to examine
- There were insufficient deaths by assault to undertake more detailed visual analysis or statistical modelling and the conclusions are based on descriptive analyses of aggregated age-groups and periods
- Aggregating across periods to reduce fluctuations in the data means that such incidents that cause a noticeable increase in deaths by assault in a specific year can appear of prominence across a time period
- Our analysis focused on the victims rather than perpetrators of assaults who could display age, period or cohort effect, exploration of the demographics of criminological data (such as conviction rates by sex, age, and year) may be able to illuminate further.

INTRODUCTION

Around 1950 the rate of improvement in Scotland's mortality started to lag behind that of the rest of Britain and other Western European countries, and some areas experienced an increase in mortality rates in the 1980s.[1, 2] Scotland now has higher mortality rates and wider health inequalities than the rest of Western Europe.[1, 3] Since 1981 less of the higher mortality compared to England and Wales has been able to be explained by area deprivation.[4, 5] This excess mortality (i.e. after accounting for deprivation), slower rate of improvement in mortality and greater health inequalities has been attributed to higher mortality from alcohol- and drug-related deaths, violence (assault) and suicide (particularly in young adults) and higher mortality from heart disease, stroke and cancer throughout adulthood.[6, 7]

Using age, period, cohort (APC) analysis to seek to understand the reasons behind the trends in these health outcomes, we have previously shown age-period interactions in the rise and fall of alcohol-related deaths[8] and cohort effects and sex-area deprivation interactions in the recent trends in suicide and drug-related deaths.[9, 10] The latter cohort effects support an emerging hypothesis to explain the excess mortality in Scotland, namely that there is a greater vulnerability in Scotland to exposure to economic and social changes resulting from political changes of the 1980s.[7]

Although there are a number of existing epidemiological studies considering trends in deaths due to assault, none look for age, period and cohort effects.[11] This is important because cohort effects can remain hidden unless these are specifically sought.[12, 13]

In this paper we extend this exploration of APC patterns in external causes of death and the existing epidemiological analysis of deaths from assault in Scotland to consider whether age, period or cohort effects may be present in the trends in death due to assault since 1974 and whether there are inequalities by sex or deprivation.

METHODS

Data sources

Data on the number of deaths due to assault by sex, single year of age at death, year of registration of death and postcode of residence for Scotland from 1974-2015 were obtained from the National Records of Scotland (NRS) (n = 3936). Deaths were coded by International Classification of Diseases 8 (ICD 8) E960-E969 for 1974-1978 and by ICD9 E960-E969 for 1979-1999 for deaths where the underlying cause was homicide and injury purposely inflicted by other persons and by ICD10 X85-Y09 and Y87.1 for 2000 onward for deaths where the underlying cause was assault or sequelae of assault, collectively referred to in this paper as deaths due to assault. Deaths due to the Lockerbie bombing of December 1988, coded as assault by other specific explosive E9658 (n = 267), were subsequently excluded. Data manipulation was performed using IBM SPSS Statistics version 19 and Microsoft Excel 2013.

Analyses by deprivation were based on Carstairs area deprivation scores (calculated using data from the nearest census on the prevalence of male unskilled social class, housing overcrowding, unemployment and car ownership) for postcode sectors, which were then ranked and divided into fifths (quintiles, where quintile 1 = most deprived and quintile 5 = least deprived).[14] Carstairs look-up files were obtained from ISD and deaths assigned to a Carstairs deprivation category. Cases with no associated Carstairs scores (n = 217) were removed from the analyses by deprivation.

Mid-year population estimates for Scotland by sex and single year of age, from age 0 to 90+ years were obtained from NRS. These are produced as official statistics and certified by the independent UK Statistics Authority as 'National Statistics' and clear governance, robust methodological procedures and quality assurance processes exist to ensure data quality.[15, 16] Population data by Carstairs area deprivation, from age 0 to 85+ years, were obtained from Information Services Division Scotland (ISD) with interpolation between the censuses following robust methodological procedures. The age structure of the population data determined the upper age limit for analyses so analyses were restricted to those aged 0-90+ years, or aged 0-85+ years for the deprivation analysis. Subsequent to our analysis, a revision was made by NRS in their Scottish mid-year population estimates for 2002-2010, which affected the age distribution for those aged 81 years and above (see https://www.nrscotland.gov.uk/files//statistics/population-estimates/mid-year-corrections/correction-to-age-distribution-mid-year%20pop-estimates-2002-2010.pdf). Sensitivity analysis showed that this had no effect on our results.

Patient and Public Involvement statement

This study used de-identified secondary data. Patients were not involved in this study.

Descriptive analysis

We calculated age-standardised mortality rates for all ages from 1974 to 2015 by sex using the 2013 European Standard Population. For age effects analysis, data from 1974-1994 and data from 1995-2015 were separately combined for presentation of crude death rates by five year age groups (from 0-4 years to 90+ years) for age at death by sex. Further age effects investigation involved analysis of crude death rates by specified age groups for three year periods from 1974-76 to 2013-15.

For analysis by area deprivation, age-standardised mortality rates for all ages from 1974 to 2015 by sex and Carstairs quintile were calculated using the 2013 European Standard Population. Age effects investigation for males by area deprivation involved analysis of crude death rates by specified age groups for three year periods from 1974-76 to 2013-15.

We visually inspected trends to identify obvious age-period-cohort effects.

RESULTS

Trends over time

Age-standardised rates for assault deaths were higher amongst males than females for the entire period from 1974 to 2015 (Figure 1). Rates amongst males fell from 1974 to the mid-1980s, rose slightly until 1991, after which they increased rapidly and fluctuated at this higher level until 2006, and thereafter have steadily fallen. Rates for females in contrast have gradually fallen over the period.

[insert Figure 1 about here]

Age effects

Rates of deaths by assault are patterned by age for both males and females (Figure 2). Amongst males, rates were highest for those aged 20-24 years, falling steadily with increasing age until rising again amongst those over eighty. Between 1974-1994 and 1995-2015, the age profile for males did not change markedly, although higher rates extended across those aged 20 to 49 years in the later period and were lower for those aged 60+ years. There was some fluctuation amongst the oldest age groups over time. The age profile for females differed to that for males for both periods with an absence of a peak in rates for those aged 20 to 24 years and all rates except that for those aged 5-9 years were lower over the 1995-2015 period.

[insert Figure 2 about here]

The contribution of males aged 15-49 years to the increase in male mortality rate by assault from 1992-94 to the end of 2004-06 is clear from the age-stratified trend data (online supplementary Figure S1), with a greater contribution from those aged 15-29 years (Figure 3).

[insert Figure 3 about here]

Inequalities by area deprivation

Deaths by assault for males are very unequal by area deprivation, with the overall rise in mortality during the late 1980s and the fall in the late 2000s almost entirely due to a rise and fall in the most deprived areas (Figure 4 and supplementary Figure S2). There are also inequalities by area deprivation in deaths from assault amongst females, but these are much less than for males.

[insert Figure 4 about here]

The deprivation gradient for deaths by assault amongst males is largely a result of the distribution of deaths for those aged 15-49 years (Figure 5).

[insert Figure 5 about here]

DISCUSSION

Main results

Rates of death by assault are greater among males than females over the period 1974-2015. Death rates increased dramatically for males from the start of the 1990s and remained elevated until 2006, and have since fallen. Those for females remained low and gradually fell over the period. Males of around 15 to 50 years of age substantially contribute to the higher rates observed among males and young adult males especially to the period of elevated death rate from the mid-1980s. The age groups most impacted did not change markedly over time, making cohort effects unlikely. Deaths by assault are very unequal and the rise in rate of death for males between the start of the 1990s and the mid-2000s is clearly driven by deaths in the two most deprived quintiles. The results for males reflect a fifteen year age-period interaction effect evident for a specific sex-area deprivation group.

Strengths and weaknesses of the analysis

We used individual digital records that were introduced by NRS in 1974. These include deaths for the whole population, for which causes have been determined by medical practitioners and then carefully coded, following robust procedures,[17] thus providing a complete record of all deaths in Scotland over the time period and a robust and long time series to examine the potential for APC effects. Coding changes over the time series would have had no impact on deaths identified as being due to assault. Both ICD 8 and ICD 9 are comparably coded as E960-969 'Homicide and injury purposely inflicted by other persons' and analysis by NRS has shown that the change from ICD 9 to ICD 10 did not impact numbers.[18] Our deprivation analysis used Carstairs deprivation indices, which are widely used and allow for analysis by deprivation pre-1996. Based on the census they are therefore founded on robust underlying data but are limited by the availability of relevant census data and the size of the postcode sectors upon which they are based.[19]

There were insufficient deaths by assault to use Lexis surface plots of age-year specific rates by age in a single year or to undertake formal statistical modelling of the data stratified by APC, using Intrinsic Estimator (IE) regression modelling, which overcomes the mathematical co-dependence of APC effects that negates the use of simple regression models, as we have previously undertaken for suicide and alcohol- and drug-related deaths.[8-10] These methods require a level of disaggregation which would likely be disclosive, 'noisy' and too underpowered to clearly identify APC patterns and for IE modelling. As a result, the conclusions in relation to APC effects are based on descriptive analyses of aggregated age-groups and periods alone. A consequence of the small number of deaths is that incidents that cause a noticeable increase in deaths by assault in a specific year will be evident in the data and appear of prominence causing the trends to fluctuate. Aggregating across periods to reduce the fluctuations in the data however means that such incidents can appear of prominence across a time period rather than just a single year. Although both these are evident in our analysis, we do not feel that these consequences of dealing with small numbers affect our overall APC conclusions and the trends observed. While coded as deaths due to assault, we removed deaths resulting from the Lockerbie bombing of December 1988 (which involved an aircraft crash in Scotland from a overflying aeroplane in which a bomb exploded) as these were

unrelated to the deaths due to assault in Scotland that were the focus of this research and had a noticeable effect on the results.

Our analysis looks at mortality in deaths due to assault, and therefore the victims rather than the perpetrators of assaults. It may be that an APC analysis of perpetrators may be more likely to display cohort effects.

Comparison with other studies

Our results are consistent with and extend previous research demonstrating the most pronounced increase in death by assault for males aged 15-44 years in Scotland from 1980-2005, and the persistently higher rates for men and in more deprived areas.[11, 20] This is very similar to the socio-demographic patterning of penetrating injuries found across the UK.[21]

Male death rates by assault are dominated by deaths due to a sharp object, most notably a knife, and has accounted for around fifty percent of all homicides in the last ten years.[22] Increases in deaths due to sharp objects have been shown to have contributed to the increase in deaths by assault observed over the period 1980-2005 and will have largely contributed to the period effect we identified.[11, 23] The rate of homicides involving knives being especially high in Glasgow, a city with areas of high deprivation. Similar to our findings, the incident of assault-related sharp force injury (SFI) is also higher amongst younger people, males and those living in areas of social deprivation.[24] This incident rate has also been falling since 2009, most marked among younger age groups.[24]

The rise in mortality due to assault occurred at a similar time to the rise in alcohol- and drug-related mortality and suicide in Scotland, all of which have been attributed to the changing political and social conditions of the 1980s.[7] There has been some suggestion that the recent decline in deaths from assault as we observed may be due to ‘a public health approach’ to violence, knife crime and gang culture adopted by the violence reduction unit which was created by Strathclyde police in 2005 and later rolled out across Scotland.[25-27] Laws around the carrying of knives were also extended in 2006.[25] However, there is little evaluative evidence available to ascertain what, if any, contribution these initiatives had. Understanding the context of multiple deprivation, and the gendered environment in which violence occurs, and addressing these through a ‘maximum diversionary approach’, is evidenced as being effective at addressing (particularly youth) violence.[28, 29]

Implications and conclusions

Mortality due to assault is substantially more common amongst young men in deprived areas than for women, at older ages or for people living in less deprived areas. Mortality rates, and inequalities, increased markedly in the early 1990s and remained high until the mid-2000s before subsequently falling, but the age profile of victims changed little over time. There is therefore evidence of age and period effects, but little evidence of cohort effects, in deaths due to assault in Scotland. The 15 year period effect is likely to be due to similar factors that were behind the rise

and fall of alcohol-related mortality,[8] the causes of which relate to a vulnerable population encountering a changed political, economic and social situation from the early 1980s which created a period of high unemployment, high income inequality and disinvestment from deprived communities.[7]

Acknowledgements We would like to thank Julie Ramsay and Frank Dixon at NRS for the dataset and for advising on details of Scottish deaths due to assault statistics, and also David Readhead and Laura Kate Campbell at NHS National Services Scotland for assistance in providing data by deprivation groupings.

Contributors GM generated the initial idea for the study. Analyses of data were conducted by JP. JP interpreted the data and drafted the manuscript. Both JM and GM provided critical input into the interpretation of the data and intellectual content to the redrafting of the manuscript. All authors read and approved the final draft.

Ethics approval No ethical approval was required or sought for the analyses in this paper. The data for the research was obtained from an existing database containing details of Scottish deaths from 1974 held by the National Records of Scotland. All requirements specified for the use of this dataset by the National Records of Scotland were adhered to.

Funding This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing Interests None declared.

Data sharing statement The original data used for this study are owned by the NRS and can be obtained by researchers from them on request. No additional data are available.

REFERENCES

1 McCartney G, Walsh D, Whyte B, et al. Has Scotland always been the 'sick man' of Europe? An observational study from 1855 to 2006. *Eur J Public Health* 2010;22:756-760 doi:10.1136/jech-2014-204185 [published Online First: 12 September 2014].

2 Norman P, Boyle P, Exeter D, et al. Rising premature mortality in the UK's persistently deprived areas: Only a Scottish phenomenon? *Soc Sci Med* 2011;73:1575-1584 doi:10.1016/j.socscimed.2011.09.034 [published Online First: 13 October 2011].

3 Popham F, Boyle P. *Assessing socio-economic inequalities in mortality and other health outcomes at the Scottish national level: Final report.* Edinburgh: Scottish Collaboration for Public Health Research and Policy, 2011.

4 Hanlon P, Lawder R, Buchanan D, et al. Why is mortality higher in Scotland than in England & Wales? Decreasing influence of socioeconomic deprivation between 1981

and 2001 supports the existence of a 'Scottish effect'. *J Public Health (Oxf)* 2005;27:199-204 doi:10.1093/pubmed/fdi002 [published Online First: 17 March 2005].

5 Schofield L, Walsh D, Munoz-Arroyo R, et al. Dying younger in Scotland: Trends in mortality and deprivation relative to England and Wales,1981–2011. *Health Place* 2016;40:106-115 doi: 10.1016/j.healthplace.2016.05.007 [published Online First: 5 May 2016].

6 McCartney G, Collins C, Walsh D, et al. *Accounting for Scotland's excess mortality: towards a synthesis.* Glasgow: Glasgow Centre for Population Health, 2011.

7 Walsh D, McCartney G, Collins C, et al. *History, politics and vulnerability: explaining excess mortality in Scotland and Glasgow.* Glasgow: Glasgow Centre for Population Health, 2016.

8 McCartney G, Bouttell J, Craig N, et al. Explaining trends in alcohol-related harms in Scotland, 1991-2011 (I): the role of incomes, effects of socio-economic and political adversity and demographic change. *Public Health* 2016;132:13-23 doi: 10.1016/j.puhe.2015.12.013 [published Online First: 23 February 2016].

9 Parkinson J, Minton J, Lewsey J, et al. Recent cohort effects in suicide in Scotland: a legacy of the 1980s? *J Epidemiol Community Health* 2017;71:194-200 doi: 10.1136/jech-2016-207296 [published Online First: 18 July 2016].

10 Parkinson J, Minton J, Lewsey J, et al. Drug-related deaths in Scotland 1979–2013: evidence of a vulnerable cohort of young men living in deprived areas. *BMC Public Health* 2018;18:357-365 doi: 10.1186/s12889-018-5267-2 [published Online First: 27 March 2018].

11 Leyland AH, Dundas R. The social patterning of deaths due to assault in Scotland, 1980-2005: population-based study. *J Epidemiol Community Health* 2010;64:432-439 doi:10.1136/jech.2009.095018 [published Online First: 5 May 2010].

12 Minton J, Vanderbloemen L, Dorling D. Visualizing Europe's demographic scars with coplots and contour plots. *Int J Epidemiol* 2013;42:1164–1176 doi:10.1093/ije/dyt115 [published Online First: 30 August 2013].

13 Minton J, Shaw R, Green MA, et al. Visualising and quantifying 'excess deaths' in Scotland compared with the rest of the UK and the rest of Western Europe. *J Epidemiol Community Health* 2017;71:461-467 doi:10.1136/jech-2016-207379 [published Online First: 6 January 2017].

14 Carstairs V, Morris R. Deprivation: explaining differences in mortality between Scotland and England and Wales. *BMJ* 1989;299:886-9 doi: https://doi.org/10.1136/bmj.299.6704.886.

15 NRS. *Information on the quality assurance arrangements for administrative data used in population estimates.* Edinburgh: National Records Of Scotland, 2016.

16 NRS. *Mid-2018 Population Estimates for Scotland: Methodology Guide.* Edinburgh: National Records of Scotland, 2019.

17 NRS. Quality of National Records of Scotland (NRS) Data on Deaths. 2019 Available at: https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/deaths/deaths-background-information/quality-of-nrs-data-on-deaths. Accessed 2 May 2019.

18 General Register Office for Scotland. *Registrar General for Scotland Annual Report 2000.* Edinburgh: National Records of Scotland, 2001.

19 ISD Scotland. *Carstairs - Problems with the use of area classifications.* Edinburgh: ISD Scotland, 2013.

20 McGuffie AC, Graham CA, Beard D, et al. Scottish urban versus rural trauma outcome study. *J Trauma* 2005;59:632-638 doi:10.1097/01.ta.0000186543.47450.6f.

21 Whittaker G, Norton J, Densley J, et al. Epidemiology of penetrating injuries in the United Kingdom: A systematic review. *Int J Surg* 2017;41:65-69 doi:https://doi.org/10.1016/j.ijsu.2017.03.051 [published Online First:23 March 2017].

22 Scottish Government. *Homicide in Scotland 2017-18.* Edinburgh: Scottish Government, 2018.

23 Leyland AH. Homicides involving knives and other sharp objects in Scotland, 1981-2003. *J Public Health* 2006;28:145-147 doi:10.1093/pubmed/fdl004 [published Online First: 5 April 2005].

24 Goodall CA, MacFie F, Conway DI, et al. Assault–related sharp force injury among adults in Scotland 2001–2013: Incidence, socio-demographic determinants and relationship to violence reduction measures. *Aggress Violent Behav* 2018;in press doi:10.1016/j.avb.2018.10.002 [published Online First: 19 October 2018].

25 McCallum F. *Knife crime, SPICe Briefing.* Edinburgh: The Scottish Parliament, 2011.

26 Younge G, Barr C. *How Scotland reduced knife deaths among young people*. The Guardian, 2017.

27 Kmietowicz K. Glasgow gang members offered way out of violent lifestyle. *BMJ* 2008;337:a2972 doi:10.1136/bmj.a2972 [published Online first: 10 December 2008].

28 McAra L, McVie S. *Maximum diversion, minimum intervention: key messages from the Edinburgh Study of Youth Transitions and Crime. In Justice for Young People. The Howard League Research Medal.* 2013.

29 McAra L, McVie S. Understanding youth violence: The mediating effects of gender, poverty and vulnerability, *Journal of Criminal Justice* 2016;45:71-77 doi:10.1016/j.jcrimjus.2016.02.011 [published Online First: 19 February 2016].

FIGURE LEGENDS

Figure 1 Age-standardised rate of death by assault per 100,000 population per year in Scotland, 1974-2015, by sex.

Figure 2 Age distribution of crude rates of death by assault per 100,000 population per year in Scotland over periods 1974-1994 and 1995-2015 combined data, by sex.*
* These age profiles show general trends with age across two time periods 1974-1994 and 1995-2015 and will have been affected by any age-period-cohort effects occurring during those periods.

Figure 3 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years

Figure 4 Age-standardised rate of death by assault per 100,000 population per year in Scotland from 1974-2015, by sex and Carstairs quintile*
* Quintile 1 = most deprived and Quintile 5 = least deprived

Figure 5 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years by Carstairs quintile*
* Quintile 1 = most deprived and Quintile 5 = least deprived

ONLINE SUPPLEMENTARY FIGURE LEGENDS

Figure S1 Crude rates of death by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and age group

Figure S2 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015, by sex and Carstairs quintile*
* Quintile 1 = most deprived and Quintile 5 = least deprived

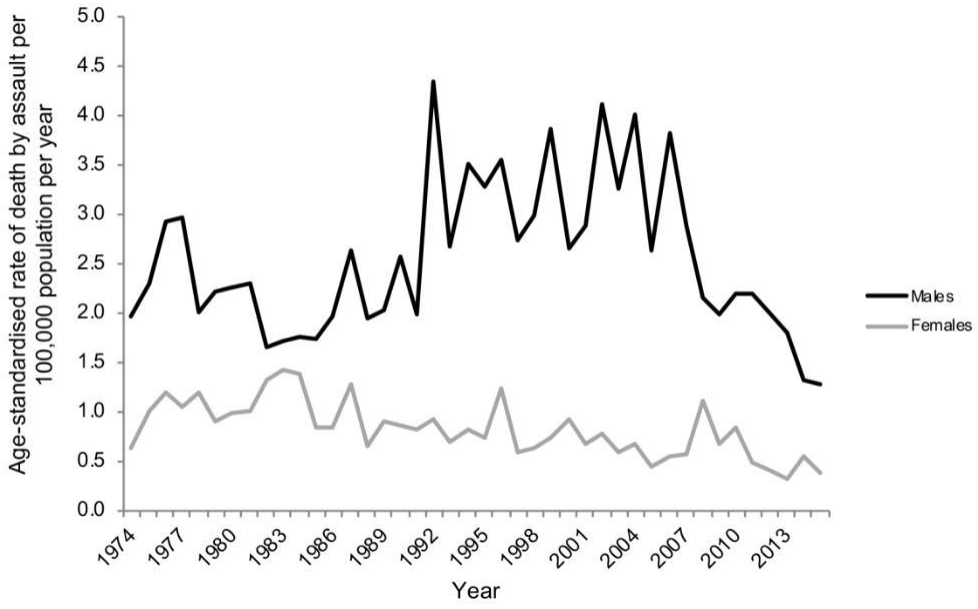


Figure 1 Age-standardised rate of death by assault per 100,000 population per year in Scotland, 1974-2015, by sex

150x95mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

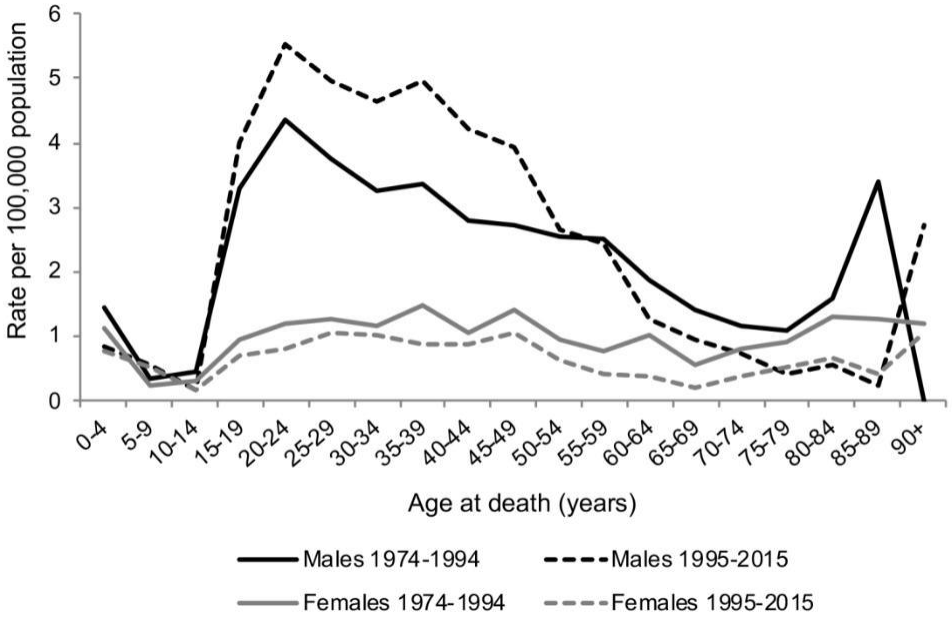


Figure 2 Age distribution of crude rates of death by assault per 100,000 population per year in Scotland over periods 1974-1994 and 1995-2015 combined data, by sex** These age profiles show general trends with age across two time periods 1974-1994 and 1995-2015 and will have been affected by any age-period-cohort effects occurring during those periods.

150x95mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

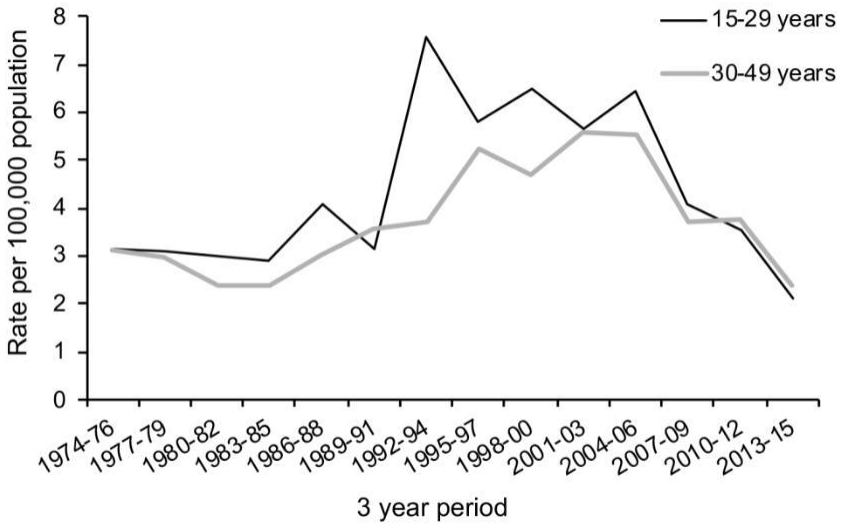


Figure 3 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years

150x95mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

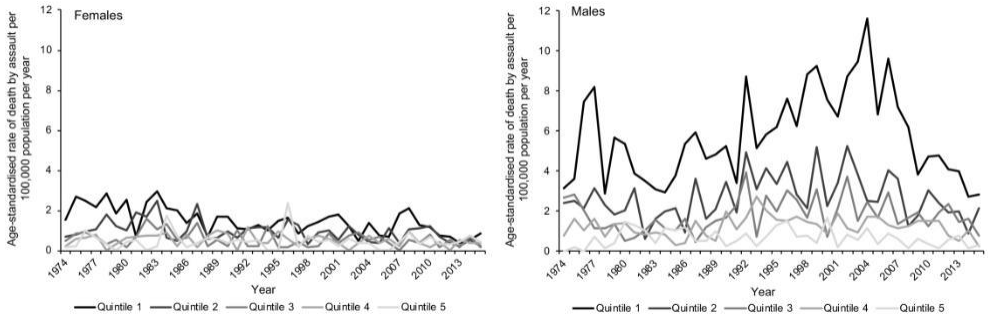


Figure 4 Age-standardised rate of death by assault per 100,000 population per year in Scotland from 1974-2015, by sex and Carstairs quintile** Quintile 1 = most deprived and Quintile 5 = least deprived

294x100mm (300 x 300 DPI)

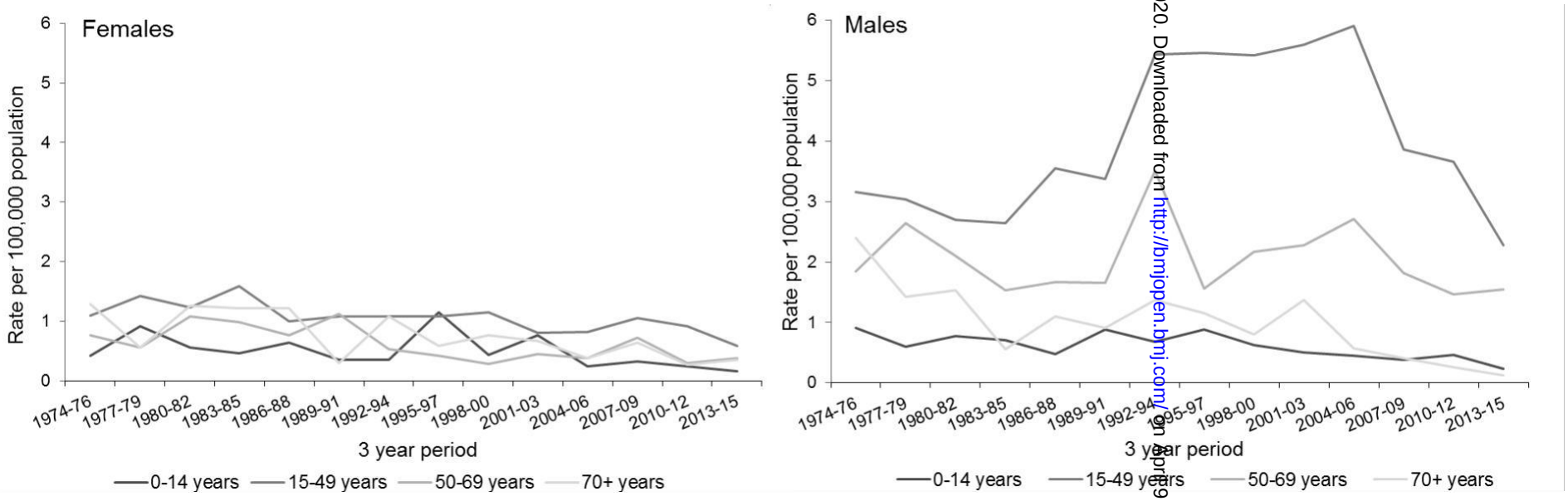
BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Supplementary Figure

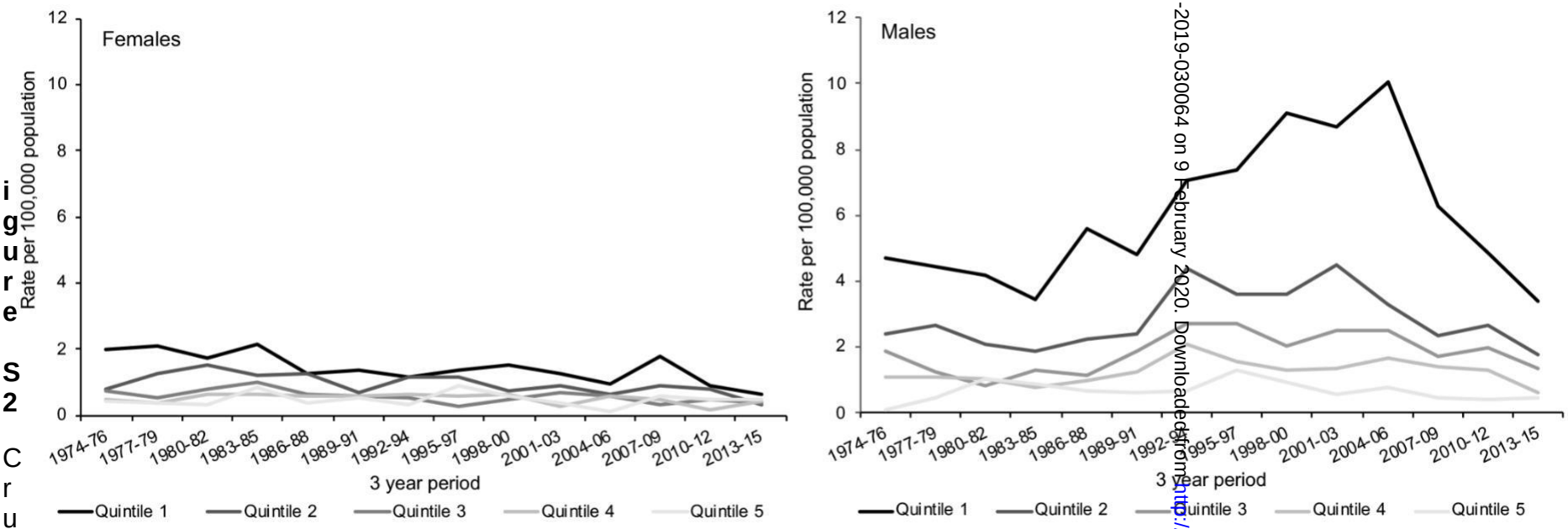
Figure S1 Crude rates of death by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and age group



36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Figure S2 Crude rates of death by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and Carstairs quintile*



*Quintile 1 = most deprived and Quintile 5 = least deprived

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	2
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	n/a
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	3
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	2-3
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	n/a
		(b) Indicate number of participants with missing data for each variable of interest	3

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Outcome data	15*	Report numbers of outcome events or summary measures	2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	3-4 – see figures also
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5
Discussion			
Key results	18	Summarise key results with reference to study objectives	4
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	4-5
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6
Generalisability	21	Discuss the generalisability (external validity) of the study results	5
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	6

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

Analysis of age-sex and deprivation stratified trends in assault deaths in Scotland (1974-2015) to identify age, period or cohort effects

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-030064.R2
Article Type:	Research
Date Submitted by the Author:	05- Jun-2019
Complete List of Authors:	Parkinson, Jane ; NHS Health Scotland, Public Health Observatory Minton, Jon; NHS Health Scotland, Public Health Observatory McCartney, Gerry; NHS Health Scotland, Public Health Observatory
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, SOCIAL MEDICINE

SCHOLARONE™
Manuscripts

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Analysis of age-sex and deprivation stratified trends in assault deaths in Scotland (1974-2015) to identify age, period or cohort effects

Jane Parkinson, Jon Minton, Gerry McCartney

Public Health Observatory, NHS Health Scotland, Meridian Court, 5 Cadogan Street, Glasgow, G2 6QE, UK

Correspondence to Dr Jane Parkinson Public Health Observatory, NHS Health Scotland, Meridian Court, 5 Cadogan Street, Glasgow, G2 6QE, UK, jane.parkinson@nhs.net, 07500 854571

Keywords assault, violence, excess mortality, age-period-cohort effects, Scotland

Word count 2742

ABSTRACT (298 words)

Objectives: Mortality rates in Scotland are higher, and health inequalities greater, than in the rest of Western and Central Europe. There was a marked divergence during the 1980s and 1990s in the Scottish rates partly due to rises in alcohol- and drug-related deaths, suicide and deaths by assault. This study examines whether age, period or cohort effects account for the trends in death by assault in Scotland and any sex or deprivation inequalities in these.

Design: We calculated crude and age-standardised mortality rates for deaths by assault for Scottish men and women from 1974 to 2015 for the population overall and for populations stratified by Carstairs area of deprivation. We examined age-sex stratified trends to identify obvious age-period-cohort effects and undertook intrinsic estimator regression modelling.

Setting: Scotland.

Participants: Men and women whose registered death by the International Classification of Diseases was due to assault from 1974 to 2015 (n = 3936).

Results: Whereas age-standardised mortality rates from this cause fell gradually for females since 1974, for males they increased in the early 1990s and remained higher until around 2006, before falling. Death by assault was substantially more common amongst males aged around 15-50 years and in the most deprived areas. There was little change in the age groups most impacted over time, which made cohort effects unlikely. A period effect for the fifteen years until 2006, with a consistent age-sex-area deprivation patterning, was evident.

Conclusions: Mortality due to assault in Scotland is unequally felt, with young men living in the most deprived areas suffering the highest rates. There is a fifteen year period effect up until 2006, impacting on young men as an age-period interaction, with no obvious cohort effects. Exploration of the demographics of criminological data may identify age, period or cohort effects amongst perpetrators of assault.

Strengths and limitations of this study

- This study uses a complete record of all deaths in Scotland occurring over a long time period (1974-2015)
- Deaths are carefully coded using the International Classification of Diseases and recorded as individual digital records which provides a robust dataset to examine
- There were insufficient deaths by assault to present more detailed visual analysis and the conclusions are based primarily on descriptive analyses of aggregated age-groups and periods
- Aggregating across periods to reduce fluctuations in the data means that such incidents that cause a noticeable increase in deaths by assault in a specific year can appear of prominence across a time period
- Our analysis focused on the victims rather than perpetrators of assaults who could display different age, period or cohort effects. Exploration of the demographics of criminological data (such as conviction rates by sex, age, and year) may be able to illuminate further.

INTRODUCTION

Around 1950 the rate of improvement in Scotland's mortality started to lag behind that of the rest of Britain and other Western European countries, and some areas experienced an increase in mortality rates in the 1980s.[1, 2] Scotland now has higher mortality rates and wider health inequalities than the rest of Western Europe.[1, 3] Since 1981 less of the higher mortality compared to England and Wales has been able to be explained by area deprivation.[4, 5] This excess mortality (i.e. after accounting for deprivation), slower rate of improvement in mortality and greater health inequalities has been attributed to higher mortality from alcohol- and drug-related deaths, violence (assault) and suicide (particularly in young adults) and higher mortality from heart disease, stroke and cancer throughout adulthood.[6, 7]

Using age, period, cohort (APC) analysis to seek to understand the reasons behind the trends in these health outcomes, we have previously shown age-period interactions in the rise and fall of alcohol-related deaths[8] and cohort effects and sex-area deprivation interactions in the recent trends in suicide and drug-related deaths.[9, 10] The latter cohort effects support an emerging hypothesis to explain the excess mortality in Scotland, namely that there is a greater vulnerability in Scotland to exposure to economic and social changes resulting from political changes of the 1980s.[7]

Although there are a number of existing epidemiological studies considering trends in deaths due to assault, none look for age, period and cohort effects.[11] This is important because cohort effects can remain hidden unless these are specifically sought.[12, 13]

In this paper we extend this exploration of APC patterns in external causes of death and the existing epidemiological analysis of deaths from assault in Scotland to consider whether age, period or cohort effects may be present in the trends in death due to assault since 1974 and whether there are inequalities by sex or deprivation.

METHODS

Data sources

Data on the number of deaths due to assault by sex, single year of age at death, year of registration of death and postcode of residence for Scotland from 1974-2015 were obtained from the National Records of Scotland (NRS) (n = 3936). Deaths were coded by International Classification of Diseases 8 (ICD 8) E960-E969 for 1974-1978 and by ICD9 E960-E969 for 1979-1999 for deaths where the underlying cause was homicide and injury purposely inflicted by other persons and by ICD10 X85-Y09 and Y87.1 for 2000 onward for deaths where the underlying cause was assault or sequelae of assault, collectively referred to in this paper as deaths due to assault. Deaths due to the Lockerbie bombing of December 1988, coded as assault by other specific explosive E9658 (n = 267), were subsequently excluded. Data manipulation was performed using IBM SPSS Statistics version 19 and Microsoft Excel 2013.

Analyses by deprivation were based on Carstairs area deprivation scores (calculated using data from the nearest census on the prevalence of male unskilled social class, housing overcrowding, unemployment and car ownership) for postcode sectors, which were then ranked and divided into fifths (quintiles, where quintile 1 = most deprived and quintile 5 = least deprived).[14] Carstairs look-up files were obtained from ISD and deaths assigned to a Carstairs deprivation category. Cases with no associated Carstairs scores (n = 217) were removed from the analyses by deprivation.

Mid-year population estimates for Scotland by sex and single year of age, from age 0 to 90+ years were obtained from NRS. These are produced as official statistics and certified by the independent UK Statistics Authority as 'National Statistics' and clear governance, robust methodological procedures and quality assurance processes exist to ensure data quality.[15, 16] Population data by Carstairs area deprivation, from age 0 to 85+ years, were obtained from Information Services Division Scotland (ISD) with interpolation between the censuses following robust methodological procedures. The age structure of the population data determined the upper age limit for analyses so analyses were restricted to those aged 0-90+ years, or aged 0-85+ years for the deprivation analysis. Subsequent to our analysis, a revision was made by NRS in their Scottish mid-year population estimates for 2002-2010, which affected the age distribution for those aged 81 years and above (see https://www.nrscotland.gov.uk/files//statistics/population-estimates/mid-year-corrections/correction-to-age-distribution-mid-year%20pop-estimates-2002-2010.pdf). Analysis involving repeating the analysis for Figures 1 and 2 with the revised population dataset showed that the revision in the population dataset had no effect on our results and conclusions drawn.

Patient and Public Involvement statement

This study used de-identified secondary data. Patients were not involved in this study.

Descriptive analysis

We calculated age-standardised mortality rates for all ages from 1974 to 2015 by sex using the 2013 European Standard Population. For age effects analysis, data from 1974-1994 and data from 1995-2015 were separately combined for presentation of crude death rates by five year age groups (from 0-4 years to 90+ years) for age at death by sex. Further age effects investigation involved analysis of crude death rates by specified age groups for three year periods from 1974-76 to 2013-15.

For analysis by area deprivation, age-standardised mortality rates for all ages from 1974 to 2015 by sex and Carstairs quintile were calculated using the 2013 European Standard Population. Age effects investigation for males by area deprivation involved analysis of crude death rates by specified age groups for three year periods from 1974-76 to 2013-15.

We visually inspected trends to identify obvious age-period-cohort effects.

Inferential analysis - Intrinsic estimator models

To model the independent APC effects, the intrinsic estimator (IE) command (apc_ie) in Stata version 13 (Stata Corp, College Station, Texas USA) was used for APC regression modelling.[17] Data were grouped into five-year age groups and five-year time periods (1974-2013) stratified by sex. The year for the synthetic cohort was calculated as being equal to the mean of a five year period minus the mean of a five year age group. Negative binomial models were used as the count data were over-dispersed. Best fit models were fitted separately for males (maximum likelihood model) and females (dispersion factor 0.065) to obtain a 1/degree of freedom deviance close to one.

RESULTS

Trends over time

Age-standardised rates for assault deaths were higher amongst males than females for the entire period from 1974 to 2015 (Figure 1). Rates amongst males fell from 1974 to the mid-1980s, rose slightly until 1991, after which they increased rapidly and fluctuated at this higher level until 2006, and thereafter have steadily fallen. Rates for females in contrast have gradually fallen over the period.

[insert Figure 1 about here]

Age effects

Rates of deaths by assault are patterned by age for both males and females (Figure 2). Amongst males, rates were highest for those aged 20-24 years, falling steadily with increasing age until rising again amongst those over eighty. Between 1974-1994 and 1995-2015, the age profile for males did not change markedly, although higher rates extended across those aged 20 to 49 years in the later period and were lower for those aged 60+ years. There was some fluctuation amongst the oldest age groups over time. The age profile for females differed to that for males for both periods with an absence of a peak in rates for those aged 20 to 24 years and all rates except that for those aged 5-9 years were lower over the 1995-2015 period.

[insert Figure 2 about here]

The contribution of males aged 15-49 years to the increase in male mortality rate by assault from 1992-94 to the end of 2004-06 is clear from the age-stratified trend data (online supplementary Figure S1), with a greater contribution from those aged 15-29 years (Figure 3).

[insert Figure 3 about here]

The IE regression analysis showed a clear age effect for both males and females, whereby males aged around 15-64 years and females around 24-49 years are at higher risk and those at younger and older ages are at lower risk (online supplementary Figure S2 and Appendix 1). There is also some suggestion that the

1990s to early 2000s was a period of relatively higher risk for males than other time periods, but this is small. Cohort effects are absent for females but for males birth cohorts born between around 1924 and 1954 are identified as being at relatively low risk and those born between around 1974 and 1989 at relatively high risk, however these cohort estimates need to be interpreted with caution, see discussion.

Inequalities by area deprivation

Deaths by assault for males are very unequal by area deprivation, with the overall rise in mortality during the late 1980s and the fall in the late 2000s almost entirely due to a rise and fall in the most deprived areas (Figure 4 and supplementary Figure S3). There are also inequalities by area deprivation in deaths from assault amongst females, but these are much less than for males.

[insert Figure 4 about here]

The deprivation gradient for deaths by assault amongst males is largely a result of the distribution of deaths for those aged 15-49 years (Figure 5).

[insert Figure 5 about here]

DISCUSSION

Main results

Rates of death by assault are greater among males than females over the period 1974-2015. Death rates increased dramatically for males from the start of the 1990s and remained elevated until 2006, and have since fallen. Those for females remained low and gradually fell over the period. Males of around 15 to 50 years of age substantially contribute to the higher rates observed among males and young adult males especially to the period of elevated death rate from the mid-1980s. The age groups most impacted did not change markedly over time, making cohort effects unlikely (see also online supplementary Figure 4). Deaths by assault are very unequal and the rise in rate of death for males between the start of the 1990s and the mid-2000s is clearly driven by deaths in the two most deprived quintiles. The results for males reflect a fifteen year age-period interaction effect evident for a specific sex-area deprivation group.

Strengths and weaknesses of the analysis

We used individual digital records that were introduced by NRS in 1974. These include deaths for the whole population, for which causes have been determined by medical practitioners and then carefully coded, following robust procedures,[18] thus providing a complete record of all deaths in Scotland over the time period and a robust and long time series to examine the potential for APC effects. Coding changes over the time series would have had no impact on deaths identified as being due to assault. Both ICD 8 and ICD 9 are comparably coded as E960-969 ‘Homicide and injury purposely inflicted by other persons’ and analysis by NRS has shown that the change from ICD 9 to ICD 10 did not impact numbers.[19] Our deprivation analysis used Carstairs deprivation indices, which are widely used and

allow for analysis by deprivation pre-1996. Based on the census they are therefore founded on robust underlying data but are limited by the availability of relevant census data and the size of the postcode sectors upon which they are based.[20]

A consequence of the small number of deaths is that incidents that cause a noticeable increase in deaths by assault in a specific year will be evident in the data and appear of prominence causing the trends to fluctuate. Aggregating across periods to reduce the fluctuations in the data however means that such incidents can appear of prominence across a time period rather than just a single year. Although both these are evident in our analysis, we do not feel that these consequences of dealing with small numbers affect our overall APC conclusions and the trends observed. While coded as deaths due to assault, we removed deaths resulting from the Lockerbie bombing of December 1988 (which involved an aircraft crash in Scotland from a overflying aeroplane in which a bomb exploded) as these were unrelated to the deaths due to assault in Scotland that were the focus of this research and had a noticeable effect on the results. The small number of deaths also means that there were insufficient deaths by assault to present Lexis surface plots of age-year specific rates by age in a single year as we have previously undertaken for suicide and alcohol- and drug-related deaths.[8-10] These methods require a level of disaggregation which would likely be disclosive, 'noisy' and too underpowered to clearly identify APC patterns.

Disentangling APC effects is problematic and while the IE is a newer approach to statistical estimation, which overcomes the mathematical co-dependence of APC effects that negates the use of simple regression models, it still has limitations.[10, 17] The cohort IE estimates especially need to be interpreted with caution because there are limited observations for the first and last cohorts, but also we have limited information for each birth cohort across their entire lifecourse. This can lead to age effects being misattributed by the IE model to a cohort effect. Given that the birth cohorts for males born between around 1924 and 1954 are identified as being at relatively low risk and those born between 1974 and around 1989 at relatively high risk, this could simply be because we observe those cohorts at the points in the lifecourse when they are at low and high risk respectively due to their age. It is therefore most likely that the age effects are most dominant, although there does seem to be a higher overall risk during the 1990s to early 2000s for the most impacted age groups. As a result, the conclusions in relation to APC effects are primarily based on the descriptive analyses of aggregated age-groups and periods.

Our analysis looks at mortality in deaths due to assault, and therefore the victims rather than the perpetrators of assaults. It may be that an APC analysis of perpetrators may be more likely to display cohort effects.

Comparison with other studies

Our results are consistent with and extend previous research demonstrating the most pronounced increase in death by assault for males aged 15-44 years in Scotland from 1980-2005, and the persistently higher rates for men and in more

deprived areas.[11, 21] This is very similar to the socio-demographic patterning of penetrating injuries found across the UK.[22]

Male death rates by assault are dominated by deaths due to a sharp object, most notably a knife, and has accounted for around fifty percent of all homicides in the last ten years.[23] Increases in deaths due to sharp objects have been shown to have contributed to the increase in deaths by assault observed over the period 1980-2005 and will have largely contributed to the period effect we identified.[11, 24] The rate of homicides involving knives being especially high in Glasgow, a city with areas of high deprivation. Similar to our findings, the incident of assault-related sharp force injury (SFI) is also higher amongst younger people, males and those living in areas of social deprivation.[25] This incident rate has also been falling since 2009, most marked among younger age groups.[25]

The rise in mortality due to assault occurred at a similar time to the rise in alcohol- and drug-related mortality and suicide in Scotland, all of which have been attributed to the changing political and social conditions of the 1980s.[7] There has been some suggestion that the recent decline in deaths from assault as we observed may be due to 'a public health approach' to violence, knife crime and gang culture adopted by the violence reduction unit which was created by Strathclyde police in 2005 and later rolled out across Scotland.[26-28] Laws around the carrying of knives were also extended in 2006.[26] However, there is little evaluative evidence available to ascertain what, if any, contribution these initiatives had. Understanding the context of multiple deprivation, and the gendered environment in which violence occurs, and addressing these through a 'maximum diversionary approach', is evidenced as being effective at addressing (particularly youth) violence.[29, 30]

Implications and conclusions

Mortality due to assault is substantially more common amongst young men in deprived areas than for women, at older ages or for people living in less deprived areas. Mortality rates, and inequalities, increased markedly in the early 1990s and remained high until the mid-2000s before subsequently falling, but the age profile of victims changed little over time. There is therefore evidence of age and period effects, but little evidence of cohort effects, in deaths due to assault in Scotland. The 15 year period effect is likely to be due to similar factors that were behind the rise and fall of alcohol-related mortality,[8] the causes of which relate to a vulnerable population encountering a changed political, economic and social situation from the early 1980s which created a period of high unemployment, high income inequality and disinvestment from deprived communities.[7]

Acknowledgements We would like to thank Julie Ramsay and Frank Dixon at NRS for the dataset and for advising on details of Scottish deaths due to assault statistics, and also David Readhead and Laura Kate Campbell at NHS National Services Scotland for assistance in providing data by deprivation groupings.

Contributors GM generated the initial idea for the study. Analyses of data were conducted by JP. JP interpreted the data and drafted the manuscript. Both JM and GM provided critical input into the interpretation of the data and intellectual content to the redrafting of the manuscript. All authors read and approved the final draft.

Ethics approval No ethical approval was required or sought for the analyses in this paper. The data for the research was obtained from an existing database containing details of Scottish deaths from 1974 held by the National Records of Scotland. All requirements specified for the use of this dataset by the National Records of Scotland were adhered to. The data are anonymised, and presented disaggregated only by age and year independently for each gender, rather than by both age and year in combination (as in a Lexis surface plot). The age and year categories used are also not disaggregated by single years/years of age. With this level of disaggregation the individuals cannot be de-identified, but the broader trends are still apparent.

Funding This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing Interests None declared.

Data sharing statement The original data used for this study are owned by the NRS and can be obtained by researchers from them on request. No additional data are available.

REFERENCES

1 McCartney G, Walsh D, Whyte B, et al. Has Scotland always been the 'sick man' of Europe? An observational study from 1855 to 2006. *Eur J Public Health* 2010;22:756-760 doi:10.1136/jech-2014-204185 [published Online First: 12 September 2014].

2 Norman P, Boyle P, Exeter D, et al. Rising premature mortality in the UK's persistently deprived areas: Only a Scottish phenomenon? *Soc Sci Med* 2011;73:1575-1584 doi:10.1016/j.socscimed.2011.09.034 [published Online First: 13 October 2011].

3 Popham F, Boyle P. *Assessing socio-economic inequalities in mortality and other health outcomes at the Scottish national level: Final report.* Edinburgh: Scottish Collaboration for Public Health Research and Policy, 2011.

4 Hanlon P, Lawder R, Buchanan D, et al. Why is mortality higher in Scotland than in England & Wales? Decreasing influence of socioeconomic deprivation between 1981 and 2001 supports the existence of a 'Scottish effect'. *J Public Health (Oxf)* 2005;27:199-204 doi:10.1093/pubmed/fdi002 [published Online First: 17 March 2005].

5 Schofield L, Walsh D, Munoz-Arroyo R, et al. Dying younger in Scotland: Trends in mortality and deprivation relative to England and Wales,1981–2011. *Health Place* 2016;40:106-115 doi: 10.1016/j.healthplace.2016.05.007 [published Online First: 5 May 2016].

6 McCartney G, Collins C, Walsh D, et al. *Accounting for Scotland's excess mortality: towards a synthesis.* Glasgow: Glasgow Centre for Population Health, 2011.

7 Walsh D, McCartney G, Collins C, et al. *History, politics and vulnerability: explaining excess mortality in Scotland and Glasgow.* Glasgow: Glasgow Centre for Population Health, 2016.

8 McCartney G, Bouttell J, Craig N, et al. Explaining trends in alcohol-related harms in Scotland, 1991-2011 (I): the role of incomes, effects of socio-economic and political adversity and demographic change. *Public Health* 2016;132:13-23 doi: 10.1016/j.puhe.2015.12.013 [published Online First: 23 February 2016].

9 Parkinson J, Minton J, Lewsey J, et al. Recent cohort effects in suicide in Scotland: a legacy of the 1980s? *J Epidemiol Community Health* 2017;71:194-200 doi: 10.1136/jech-2016-207296 [published Online First: 18 July 2016].

10 Parkinson J, Minton J, Lewsey J, et al. Drug-related deaths in Scotland 1979–2013: evidence of a vulnerable cohort of young men living in deprived areas. *BMC Public Health* 2018;18:357-365 doi: 10.1186/s12889-018-5267-2 [published Online First: 27 March 2018].

11 Leyland AH, Dundas R. The social patterning of deaths due to assault in Scotland, 1980-2005: population-based study. *J Epidemiol Community Health* 2010;64:432-439 doi:10.1136/jech.2009.095018 [published Online First: 5 May 2010].

12 Minton J, Vanderbloemen L, Dorling D. Visualizing Europe's demographic scars with coplots and contour plots. *Int J Epidemiol* 2013;42:1164–1176 doi:10.1093/ije/dyt115 [published Online First: 30 August 2013].

13 Minton J, Shaw R, Green MA, et al. Visualising and quantifying 'excess deaths' in Scotland compared with the rest of the UK and the rest of Western Europe. *J Epidemiol Community Health* 2017;71:461-467 doi:10.1136/jech-2016-207379 [published Online First: 6 January 2017].

14 Carstairs V, Morris R. Deprivation: explaining differences in mortality between Scotland and England and Wales. *BMJ* 1989;299:886-9 doi: https://doi.org/10.1136/bmj.299.6704.886.

15 NRS. *Information on the quality assurance arrangements for administrative data used in population estimates.* Edinburgh: National Records Of Scotland, 2016.

16 NRS. *Mid-2018 Population Estimates for Scotland: Methodology Guide.* Edinburgh: National Records of Scotland, 2019.

17 Yang Y, Schulhofer-Wohl S, Fu WJ, et al. The Intrinsic Estimator for Age-Period-Cohort Analysis: What It Is and How to Use It. *Am J Sociol* 2008;113(6):1697-736 doi: http://dx.doi.org/10.1086/587154.

18 NRS. Quality of National Records of Scotland (NRS) Data on Deaths. 2019 Available at: https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/deaths/deaths-background-information/quality-of-nrs-data-on-deaths. Accessed 2 May 2019.

19 General Register Office for Scotland. *Registrar General for Scotland Annual Report 2000.* Edinburgh: National Records of Scotland, 2001.

20 ISD Scotland. *Carstairs - Problems with the use of area classifications.* Edinburgh: ISD Scotland, 2013.

21 McGuffie AC, Graham CA, Beard D, et al. Scottish urban versus rural trauma outcome study. *J Trauma* 2005;59:632-638 doi:10.1097/01.ta.0000186543.47450.6f.

22 Whittaker G, Norton J, Densley J, et al. Epidemiology of penetrating injuries in the United Kingdom: A systematic review. *Int J Surg* 2017;41:65-69 doi:https://doi.org/10.1016/j.ijsu.2017.03.051 [published Online First:23 March 2017].

23 Scottish Government. *Homicide in Scotland 2017-18.* Edinburgh: Scottish Government, 2018.

24 Leyland AH. Homicides involving knives and other sharp objects in Scotland, 1981-2003. *J Public Health* 2006;28:145-147 doi:10.1093/pubmed/fdl004 [published Online First: 5 April 2005].

25 Goodall CA, MacFie F, Conway DI, et al. Assault–related sharp force injury among adults in Scotland 2001–2013: Incidence, socio-demographic determinants and relationship to violence reduction measures. *Aggress Violent Behav* 2018;in press doi:10.1016/j.avb.2018.10.002 [published Online First: 19 October 2018].

26 McCallum F. *Knife crime, SPICe Briefing.* Edinburgh: The Scottish Parliament, 2011.

27 Younge G, Barr C. *How Scotland reduced knife deaths among young people*. The Guardian, 2017.

28 Kmietowicz K. Glasgow gang members offered way out of violent lifestyle. *BMJ* 2008;337:a2972 doi:10.1136/bmj.a2972 [published Online first: 10 December 2008].

29 McAra L, McVie S. *Maximum diversion, minimum intervention: key messages from the Edinburgh Study of Youth Transitions and Crime. In Justice for Young People. The Howard League Research Medal.* 2013.

30 McAra L, McVie S. Understanding youth violence: The mediating effects of gender, poverty and vulnerability, *Journal of Criminal Justice* 2016;45:71-77 doi:10.1016/j.jcrimjus.2016.02.011 [published Online First: 19 February 2016].

FIGURE LEGENDS

Figure 1 Age-standardised rate of death by assault per 100,000 population per year in Scotland, 1974-2015, by sex.

Figure 2 Age distribution of crude rates of death by assault per 100,000 population per year in Scotland over periods 1974-1994 and 1995-2015 combined data, by sex.*
* These age profiles show general trends with age across two time periods 1974-1994 and 1995-2015 and will have been affected by any age-period-cohort effects occurring during those periods.

Figure 3 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years

Figure 4 Age-standardised rate of death by assault per 100,000 population per year in Scotland from 1974-2015, by sex and Carstairs quintile*
* Quintile 1 = most deprived and Quintile 5 = least deprived

Figure 5 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years by Carstairs quintile*
* Quintile 1 = most deprived and Quintile 5 = least deprived

ONLINE SUPPLEMENTARY FIGURE LEGENDS

Figure S1 Crude rates of death by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and age group

Figure S2 Intrinsic estimator coefficients and 95% confidence intervals for age, period and cohort effects for deaths by assault in Scotland by sex

Figure S3 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015, by sex and Carstairs quintile*
* Quintile 1 = most deprived and Quintile 5 = least deprived

Figure S4 Crude rates of death by assault per 100,000 population by ten year age group and five year period in Scotland from 1974-2013, by sex

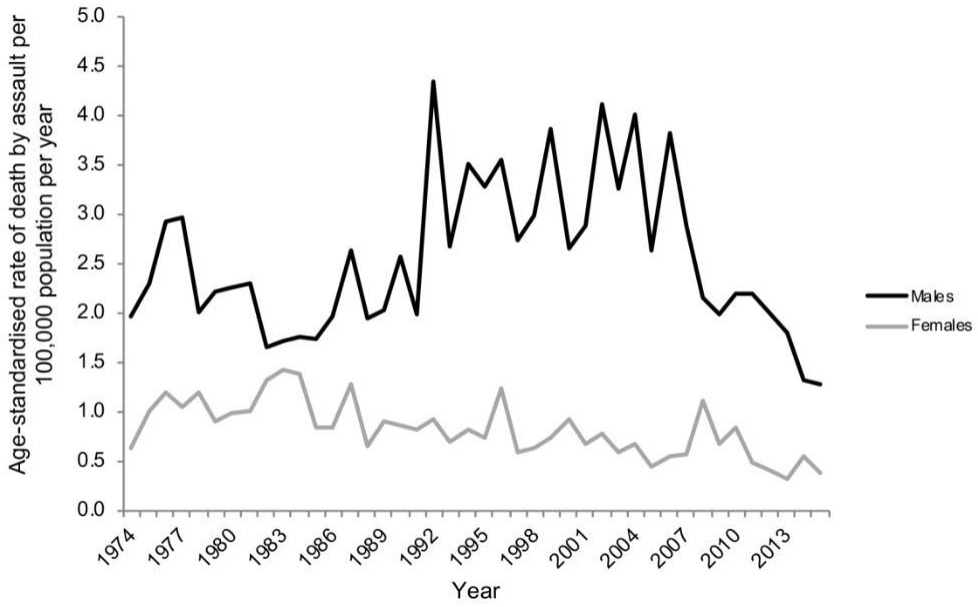


Figure 1 Age-standardised rate of death by assault per 100,000 population per year in Scotland, 1974-2015, by sex

150x95mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

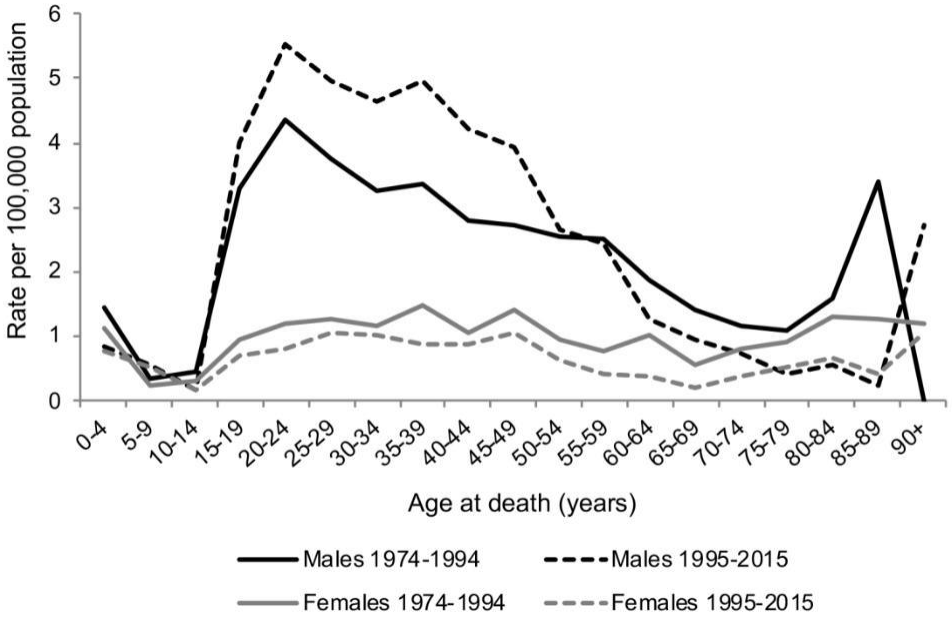


Figure 2 Age distribution of crude rates of death by assault per 100,000 population per year in Scotland over periods 1974-1994 and 1995-2015 combined data, by sex** These age profiles show general trends with age across two time periods 1974-1994 and 1995-2015 and will have been affected by any age-period-cohort effects occurring during those periods.

150x95mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

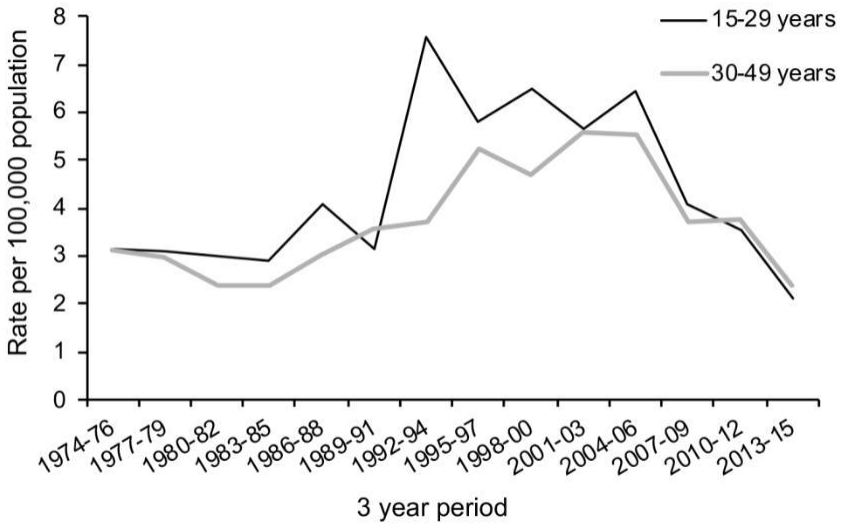


Figure 3 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years

150x95mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

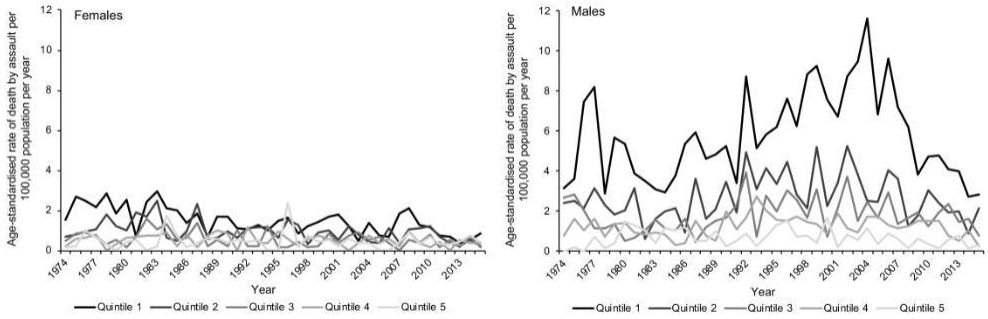


Figure 4 Age-standardised rate of death by assault per 100,000 population per year in Scotland from 1974-2015, by sex and Carstairs quintile** Quintile 1 = most deprived and Quintile 5 = least deprived

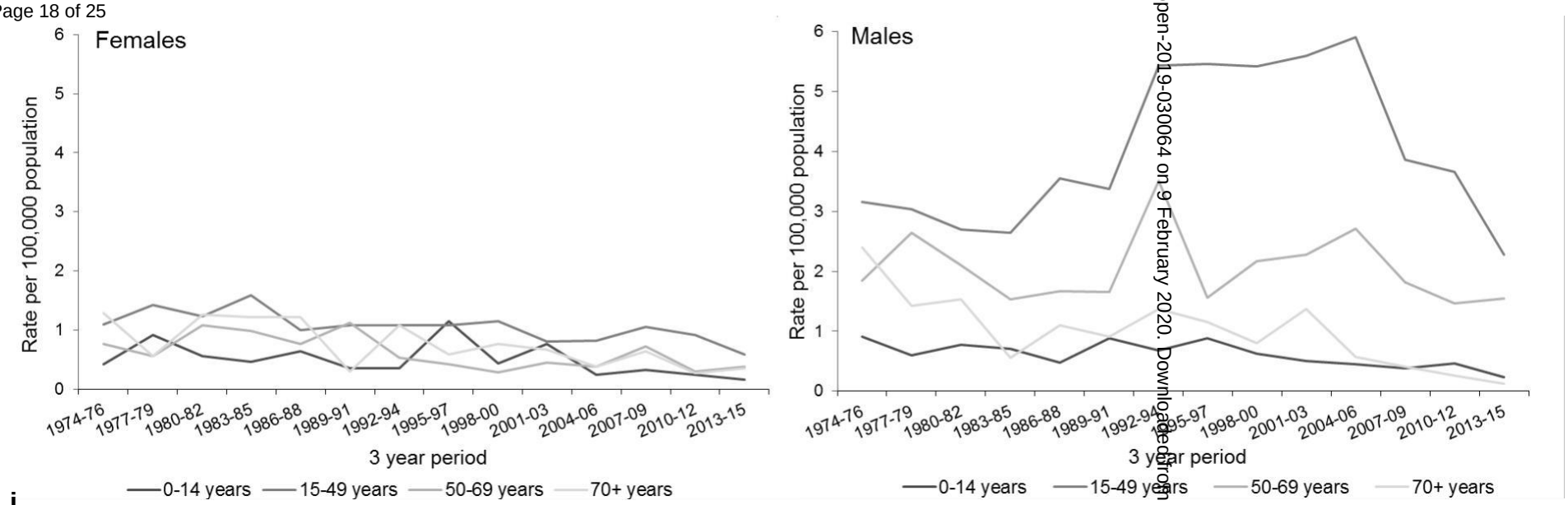
294x100mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

ath by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and age group

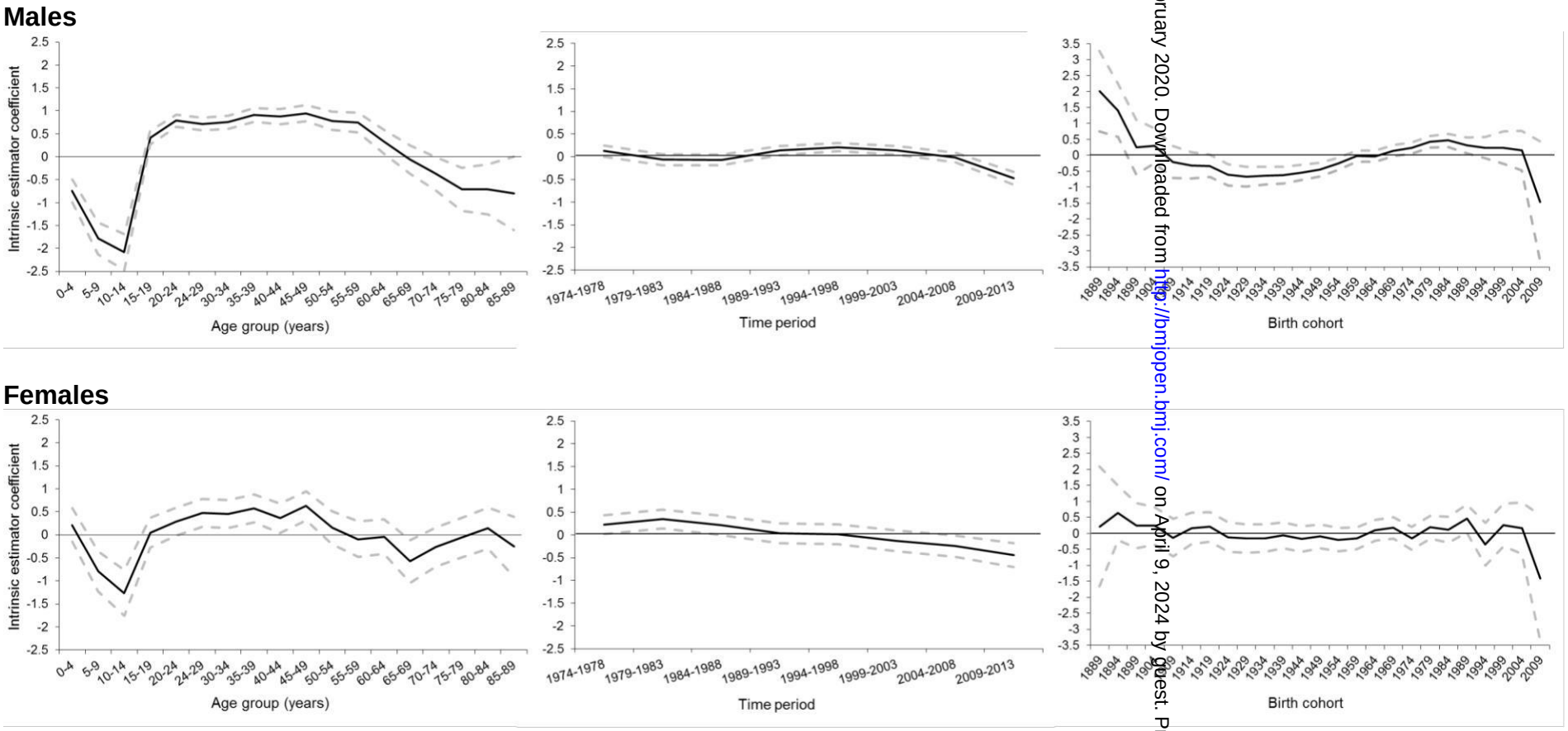


Supplementary Figure S1 Crude rates of death

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

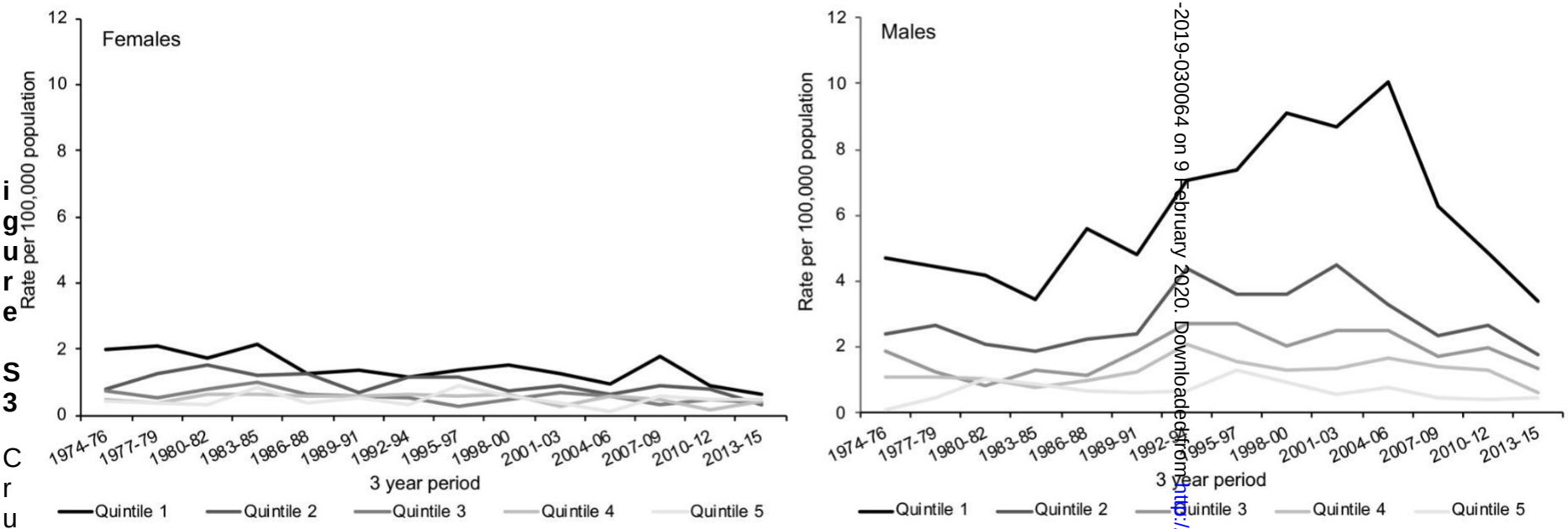
Figure S2 Intrinsic estimator coefficients and 95% confidence intervals for age, period and cohort effects for deaths by assault in Scotland by sex



36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Figure S3 Crude rates of death by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and Carstairs quintile*



*Quintile 1 = most deprived and Quintile 5 = least deprived

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Figure S4 Crude rates of death by assault per 100,000 population by ten year age group and five year period in Scotland from 1974-2013, by sex

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Appendix 1: Intrinsic estimator statistics

IE estimator coefficient statistics from the APC negative binomial models.

Table 1 Intrinsic estimator coefficient statistics for age, period and birth cohorts for deaths by assault in Scotland for females

numer	IE coeff	Std. Err.	z	P>z	95% CI Lower	95% CI Upper
Age (years)						
0-4	0.211	0.186	1.140	0.256	-0.153	0.576
5-9	-0.795	0.223	-3.560	0.000	-1.232	-0.358
10-14	-1.264	0.254	-4.980	0.000	-1.762	-0.767
15-19	0.048	0.167	0.290	0.773	-0.279	0.375
20-24	0.288	0.155	1.860	0.063	-0.016	0.593
24-29	0.476	0.152	3.120	0.002	0.177	0.774
30-34	0.451	0.156	2.890	0.004	0.146	0.756
35-39	0.579	0.155	3.740	0.000	0.275	0.883
40-44	0.360	0.165	2.180	0.029	0.036	0.685
45-49	0.633	0.160	3.970	0.000	0.320	0.946
50-54	0.152	0.183	0.830	0.406	-0.207	0.511
55-59	-0.095	0.196	-0.480	0.629	-0.479	0.289
60-64	-0.039	0.193	-0.200	0.838	-0.417	0.338
65-69	-0.577	0.236	-2.440	0.015	-1.040	-0.114
70-74	-0.263	0.218	-1.200	0.229	-0.691	0.165
75-79	-0.058	0.218	-0.270	0.790	-0.486	0.370
80-84	0.147	0.227	0.650	0.516	-0.297	0.592
85-89	-0.255	0.333	-0.770	0.443	-0.908	0.397
Period						
1974-1978	0.223	0.105	2.110	0.035	0.016	0.429
1979-1983	0.346	0.104	3.340	0.001	0.143	0.549
1984-1988	0.209	0.107	1.940	0.052	-0.002	0.419
1989-1993	0.032	0.111	0.290	0.771	-0.185	0.250
1994-1998	0.014	0.112	0.120	0.904	-0.206	0.233
1999-2003	-0.137	0.117	-1.170	0.242	-0.366	0.092
2004-2008	-0.246	0.120	-2.040	0.041	-0.482	-0.010
2009-2013	-0.440	0.133	-3.300	0.001	-0.702	-0.179
Cohort						
1889	0.217	0.960	0.230	0.821	-1.664	2.099
1894	0.638	0.431	1.480	0.139	-0.207	1.484
1899	0.240	0.362	0.660	0.508	-0.470	0.950
1904	0.236	0.299	0.790	0.430	-0.350	0.822
1909	-0.135	0.302	-0.450	0.654	-0.727	0.456
1914	0.157	0.252	0.620	0.534	-0.337	0.651
1919	0.202	0.234	0.870	0.386	-0.255	0.660
1924	-0.123	0.235	-0.530	0.599	-0.584	0.337
1929	-0.162	0.224	-0.720	0.469	-0.602	0.277
1934	-0.149	0.219	-0.680	0.496	-0.578	0.280
1939	-0.061	0.207	-0.300	0.768	-0.467	0.345
1944	-0.176	0.204	-0.870	0.387	-0.576	0.223
1949	-0.090	0.187	-0.480	0.630	-0.457	0.277
1954	-0.196	0.187	-1.050	0.293	-0.562	0.170
1959	-0.159	0.176	-0.900	0.367	-0.505	0.187
1964	0.097	0.169	0.570	0.567	-0.234	0.427
1969	0.172	0.170	1.010	0.313	-0.162	0.505
1974	-0.154	0.183	-0.840	0.400	-0.512	0.204
1979	0.192	0.184	1.050	0.295	-0.168	0.553
1984	0.116	0.208	0.550	0.579	-0.293	0.524
1989	0.463	0.222	2.080	0.037	0.028	0.899
1994	-0.339	0.337	-1.010	0.314	-0.998	0.321
1999	0.265	0.344	0.770	0.441	-0.409	0.939
2004	0.163	0.412	0.400	0.692	-0.644	0.971
2009	-1.413	1.012	-1.400	0.163	-3.397	0.571
_cons	-11.838	0.080	-148.390	0.000	-11.995	-11.682
ln(denom)	1	(exposure)				

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Table 2 Intrinsic estimator coefficient statistics for age, period and birth cohorts for deaths by assault in Scotland for males

numer	IE coeff	Std. Err.	z	P>z	95% CI Lower	95% CI Upper
Age (years)						
0-4	-0.746	0.128	-5.830	0.000	-0.997	-0.495
5-9	-1.781	0.177	-10.070	0.000	-2.128	-1.435
10-14	-2.079	0.199	-10.440	0.000	-2.470	-1.689
15-19	0.410	0.076	5.390	0.000	0.260	0.559
20-24	0.787	0.068	11.630	0.000	0.655	0.920
24-29	0.716	0.071	10.140	0.000	0.577	0.854
30-34	0.754	0.074	10.240	0.000	0.609	0.898
35-39	0.912	0.076	12.010	0.000	0.763	1.061
40-44	0.875	0.084	10.470	0.000	0.711	1.039
45-49	0.946	0.090	10.500	0.000	0.769	1.123
50-54	0.784	0.102	7.680	0.000	0.584	0.984
55-59	0.749	0.111	6.760	0.000	0.532	0.965
60-64	0.327	0.132	2.480	0.013	0.069	0.585
65-69	-0.061	0.158	-0.380	0.701	-0.369	0.248
70-74	-0.373	0.185	-2.010	0.044	-0.736	-0.010
75-79	-0.712	0.238	-2.990	0.003	-1.178	-0.246
80-84	-0.709	0.279	-2.540	0.011	-1.255	-0.163
85-89	-0.798	0.410	-1.950	0.052	-1.601	0.006
Period						
1974-1978	0.126	0.063	2.010	0.045	0.003	0.248
1979-1983	-0.064	0.065	-0.990	0.323	-0.191	0.063
1984-1988	-0.068	0.060	-1.130	0.260	-0.186	0.050
1989-1993	0.137	0.052	2.650	0.008	0.036	0.238
1994-1998	0.214	0.048	4.490	0.000	0.121	0.307
1999-2003	0.140	0.050	2.820	0.005	0.043	0.237
2004-2008	-0.015	0.055	-0.280	0.782	-0.124	0.093
2009-2013	-0.469	0.070	-6.720	0.000	-0.606	-0.332
Cohort						
1889	2.017	0.645	3.130	0.002	0.753	3.280
1894	1.405	0.427	3.290	0.001	0.569	2.242
1899	0.256	0.435	0.590	0.557	-0.598	1.109
1904	0.297	0.282	1.050	0.293	-0.256	0.850
1909	-0.212	0.253	-0.840	0.402	-0.708	0.283
1914	-0.315	0.212	-1.490	0.137	-0.730	0.100
1919	-0.335	0.179	-1.870	0.062	-0.686	0.017
1924	-0.613	0.168	-3.640	0.000	-0.943	-0.283
1929	-0.675	0.156	-4.310	0.000	-0.981	-0.368
1934	-0.640	0.144	-4.440	0.000	-0.923	-0.357
1939	-0.628	0.133	-4.710	0.000	-0.890	-0.367
1944	-0.538	0.121	-4.460	0.000	-0.774	-0.302
1949	-0.448	0.109	-4.110	0.000	-0.661	-0.234
1954	-0.266	0.099	-2.680	0.007	-0.460	-0.071
1959	-0.025	0.090	-0.280	0.777	-0.202	0.151
1964	-0.035	0.090	-0.390	0.693	-0.211	0.140
1969	0.144	0.088	1.630	0.104	-0.029	0.317
1974	0.229	0.090	2.530	0.011	0.052	0.406
1979	0.426	0.095	4.480	0.000	0.240	0.612
1984	0.467	0.104	4.500	0.000	0.263	0.670
1989	0.320	0.126	2.550	0.011	0.074	0.567
1994	0.240	0.172	1.400	0.162	-0.097	0.577
1999	0.241	0.262	0.920	0.358	-0.272	0.753
2004	0.150	0.317	0.470	0.635	-0.471	0.772
2009	-1.462	0.968	-1.510	0.131	-3.358	0.435
_cons	-10.846	0.062	-176.270	0.000	-10.967	-10.726
ln(denom)	1	(exposure)				

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	2
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	n/a
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	3
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	2-3
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	n/a
		(b) Indicate number of participants with missing data for each variable of interest	3

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Outcome data	15*	Report numbers of outcome events or summary measures	2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	3-4 – see figures also
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5
Discussion			
Key results	18	Summarise key results with reference to study objectives	4
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	4-5
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6
Generalisability	21	Discuss the generalisability (external validity) of the study results	5
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	6

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

Analysis of age-sex and deprivation stratified trends in assault deaths in Scotland (1974-2015) to identify age, period or cohort effects

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-030064.R3
Article Type:	Research
Date Submitted by the Author:	04- Jul-2019
Complete List of Authors:	Parkinson, Jane ; NHS Health Scotland, Public Health Observatory Minton, Jon; NHS Health Scotland, Public Health Observatory McCartney, Gerry; NHS Health Scotland, Public Health Observatory
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology
Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, SOCIAL MEDICINE

SCHOLARONE™
Manuscripts

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Analysis of age-sex and deprivation stratified trends in assault deaths in Scotland (1974-2015) to identify age, period or cohort effects

Jane Parkinson, Jon Minton, Gerry McCartney

Public Health Observatory, NHS Health Scotland, Meridian Court, 5 Cadogan Street, Glasgow, G2 6QE, UK

Correspondence to Dr Jane Parkinson Public Health Observatory, NHS Health Scotland, Meridian Court, 5 Cadogan Street, Glasgow, G2 6QE, UK, jane.parkinson@nhs.net, 07500 854571

Keywords assault, violence, excess mortality, age-period-cohort effects, Scotland

Word count 2437

ABSTRACT (292 words)

Objectives: Mortality rates in Scotland are higher, and health inequalities greater, than in the rest of Western and Central Europe. There was a marked divergence during the 1980s and 1990s in the Scottish rates partly due to rises in alcohol- and drug-related deaths, suicide and deaths by assault. This study examines whether age, period or cohort effects account for the trends in death by assault in Scotland and any sex or deprivation inequalities in these.

Design: We calculated crude and age-standardised mortality rates for deaths by assault for Scottish men and women from 1974 to 2015 for the population overall and for populations stratified by Carstairs area of deprivation. We examined age-sex stratified trends to identify obvious age-period-cohort effects.

Setting: Scotland.

Participants: Men and women whose registered death by the International Classification of Diseases was due to assault from 1974 to 2015 (n = 3936).

Results: Whereas age-standardised mortality rates from this cause fell gradually for females since 1974, for males they increased in the early 1990s and remained higher until around 2006, before falling. Death by assault was substantially more common amongst males aged around 15-50 years and in the most deprived areas. There was little change in the age groups most impacted over time, which made cohort effects unlikely. A period effect for the fifteen years until 2006, with a consistent age-sex-area deprivation patterning, was evident.

Conclusions: Mortality due to assault in Scotland is unequally felt, with young men living in the most deprived areas suffering the highest rates. There is a fifteen year

period effect up until 2006, impacting on young men as an age-period interaction, with no obvious cohort effects. Exploration of the demographics of criminological data may identify age, period or cohort effects amongst perpetrators of assault.

Strengths and limitations of this study

- This study uses a complete record of all deaths in Scotland occurring over a long time period (1974-2015)
- Deaths are carefully coded using the International Classification of Diseases and recorded as individual digital records which provides a robust dataset to examine
- There were insufficient deaths by assault to present more detailed visual analysis or to undertake detailed statistical modelling and the conclusions are based primarily on descriptive analyses of aggregated age-groups and periods
- Aggregating across periods to reduce fluctuations in the data means that such incidents that cause a noticeable increase in deaths by assault in a specific year can appear of prominence across a time period
- Our analysis focused on the victims rather than perpetrators of assaults who could display different age, period or cohort effects. Exploration of the demographics of criminological data (such as conviction rates by sex, age, and year) may be able to illuminate further.

INTRODUCTION

Around 1950 the rate of improvement in Scotland's mortality started to lag behind that of the rest of Britain and other Western European countries, and some areas experienced an increase in mortality rates in the 1980s.[1, 2] Scotland now has higher mortality rates and wider health inequalities than the rest of Western Europe.[1, 3] Since 1981 less of the higher mortality compared to England and Wales has been able to be explained by area deprivation.[4, 5] This excess mortality (i.e. after accounting for deprivation), slower rate of improvement in mortality and greater health inequalities has been attributed to higher mortality from alcohol- and drug-related deaths, violence (assault) and suicide (particularly in young adults) and higher mortality from heart disease, stroke and cancer throughout adulthood.[6, 7]

Using age, period, cohort (APC) analysis to seek to understand the reasons behind the trends in these health outcomes, we have previously shown age-period interactions in the rise and fall of alcohol-related deaths[8] and cohort effects and sex-area deprivation interactions in the recent trends in suicide and drug-related deaths.[9, 10] The latter cohort effects support an emerging hypothesis to explain the excess mortality in Scotland, namely that there is a greater vulnerability in Scotland to exposure to economic and social changes resulting from political changes of the 1980s.[7]

Although there are a number of existing epidemiological studies considering trends in deaths due to assault, none look for age, period and cohort effects.[11] This is important because cohort effects can remain hidden unless these are specifically sought.[12, 13]

In this paper we extend this exploration of APC patterns in external causes of death and the existing epidemiological analysis of deaths from assault in Scotland to consider whether age, period or cohort effects may be present in the trends in death due to assault since 1974 and whether there are inequalities by sex or deprivation.

METHODS

Data sources

Data on the number of deaths due to assault by sex, single year of age at death, year of registration of death and postcode of residence for Scotland from 1974-2015 were obtained from the National Records of Scotland (NRS) (n = 3936). Deaths were coded by International Classification of Diseases 8 (ICD 8) E960-E969 for 1974-1978 and by ICD9 E960-E969 for 1979-1999 for deaths where the underlying cause was homicide and injury purposely inflicted by other persons and by ICD10 X85-Y09 and Y87.1 for 2000 onward for deaths where the underlying cause was assault or sequelae of assault, collectively referred to in this paper as deaths due to assault. Deaths due to the Lockerbie bombing of December 1988, coded as assault by other specific explosive E9658 (n = 267), were subsequently excluded. Data manipulation was performed using IBM SPSS Statistics version 19 and Microsoft Excel 2013.

Analyses by deprivation were based on Carstairs area deprivation scores (calculated using data from the nearest census on the prevalence of male unskilled social class, housing overcrowding, unemployment and car ownership) for postcode sectors, which were then ranked and divided into fifths (quintiles, where quintile 1 = most deprived and quintile 5 = least deprived).[14] Carstairs look-up files were obtained from ISD and deaths assigned to a Carstairs deprivation category. Cases with no associated Carstairs scores (n = 217) were removed from the analyses by deprivation.

Mid-year population estimates for Scotland by sex and single year of age, from age 0 to 90+ years were obtained from NRS. These are produced as official statistics and certified by the independent UK Statistics Authority as 'National Statistics' and clear governance, robust methodological procedures and quality assurance processes exist to ensure data quality.[15, 16] Population data by Carstairs area deprivation, from age 0 to 85+ years, were obtained from Information Services Division Scotland (ISD) with interpolation between the censuses following robust methodological procedures. The age structure of the population data determined the upper age limit for analyses so analyses were restricted to those aged 0-90+ years, or aged 0-85+ years for the deprivation analysis. Subsequent to our analysis, a revision was made by NRS in their Scottish mid-year population estimates for 2002-2010, which affected the age distribution for those aged 81 years and above (see https://www.nrscotland.gov.uk/files//statistics/population-estimates/mid-year-corrections/correction-to-age-distribution-mid-year%20pop-estimates-2002-2010.pdf). Analysis involving repeating the analysis for Figures 1 and 2 with the revised population dataset showed that the revision in the population dataset had no effect on our results and conclusions drawn.

Patient and Public Involvement statement

This study used de-identified secondary data. Patients were not involved in this study.

Descriptive analysis

We calculated age-standardised mortality rates for all ages from 1974 to 2015 by sex using the 2013 European Standard Population. For age effects analysis, data from 1974-1994 and data from 1995-2015 were separately combined for presentation of crude death rates by five year age groups (from 0-4 years to 90+ years) for age at death by sex. Further age effects investigation involved analysis of crude death rates by specified age groups for three year periods from 1974-76 to 2013-15.

For analysis by area deprivation, age-standardised mortality rates for all ages from 1974 to 2015 by sex and Carstairs quintile were calculated using the 2013 European Standard Population. Age effects investigation for males by area deprivation involved analysis of crude death rates by specified age groups for three year periods from 1974-76 to 2013-15.

We visually inspected trends to identify obvious age-period-cohort effects.

RESULTS

Trends over time

Age-standardised rates for assault deaths were higher amongst males than females for the entire period from 1974 to 2015 (Figure 1). Rates amongst males fell from 1974 to the mid-1980s, rose slightly until 1991, after which they increased rapidly and fluctuated at this higher level until 2006, and thereafter have steadily fallen. Rates for females in contrast have gradually fallen over the period.

[insert Figure 1 about here]

Age effects

Rates of deaths by assault are patterned by age for both males and females (Figure 2). Amongst males, rates were highest for those aged 20-24 years, falling steadily with increasing age until rising again amongst those over eighty. Between 1974-1994 and 1995-2015, the age profile for males did not change markedly, although higher rates extended across those aged 20 to 49 years in the later period and were lower for those aged 60+ years. There was some fluctuation amongst the oldest age groups over time. The age profile for females differed to that for males for both periods with an absence of a peak in rates for those aged 20 to 24 years and all rates except that for those aged 5-9 years were lower over the 1995-2015 period.

[insert Figure 2 about here]

The contribution of males aged 15-49 years to the increase in male mortality rate by assault from 1992-94 to the end of 2004-06 is clear from the age-stratified trend data (online supplementary Figure S1), with a greater contribution from those aged 15-29 years (Figure 3).

[insert Figure 3 about here]

Inequalities by area deprivation

Deaths by assault for males are very unequal by area deprivation, with the overall rise in mortality during the late 1980s and the fall in the late 2000s almost entirely due to a rise and fall in the most deprived areas (Figure 4 and supplementary Figure S2). There are also inequalities by area deprivation in deaths from assault amongst females, but these are much less than for males.

[insert Figure 4 about here]

The deprivation gradient for deaths by assault amongst males is largely a result of the distribution of deaths for those aged 15-49 years (Figure 5).

[insert Figure 5 about here]

DISCUSSION

Main results

Rates of death by assault are greater among males than females over the period 1974-2015. Death rates increased dramatically for males from the start of the 1990s and remained elevated until 2006, and have since fallen. Those for females remained low and gradually fell over the period. Males of around 15 to 50 years of age substantially contribute to the higher rates observed among males and young adult males especially to the period of elevated death rate from the mid-1980s. The age groups most impacted did not change markedly over time, making cohort effects unlikely (see also online supplementary Figure S3). Deaths by assault are very unequal and the rise in rate of death for males between the start of the 1990s and the mid-2000s is clearly driven by deaths in the two most deprived quintiles. The results for males reflect a fifteen year age-period interaction effect evident for a specific sex-area deprivation group.

Strengths and weaknesses of the analysis

We used individual digital records that were introduced by NRS in 1974. These include deaths for the whole population, for which causes have been determined by medical practitioners and then carefully coded, following robust procedures,[17] thus providing a complete record of all deaths in Scotland over the time period and a robust and long time series to examine the potential for APC effects. Coding changes over the time series would have had no impact on deaths identified as being due to assault. Both ICD 8 and ICD 9 are comparably coded as E960-969 ‘Homicide and injury purposely inflicted by other persons’ and analysis by NRS has shown that the change from ICD 9 to ICD 10 did not impact numbers.[18] Our deprivation analysis used Carstairs deprivation indices, which are widely used and allow for analysis by deprivation pre-1996. Based on the census they are therefore founded on robust underlying data but are limited by the availability of relevant census data and the size of the postcode sectors upon which they are based.[19]

A consequence of the small number of deaths is that incidents that cause a noticeable increase in deaths by assault in a specific year will be evident in the data and appear of prominence causing the trends to fluctuate. Aggregating across periods to reduce the fluctuations in the data means that such incidents can appear of prominence across a time period rather than just a single year. While both of these are evident in our analysis, we do not feel that these consequences of dealing with small numbers affect our overall APC conclusions and the trends observed, although it does mean that there is a level of uncertainty around interpreting trends for specific individual ages. While coded as deaths due to assault, we removed deaths resulting from the Lockerbie bombing of December 1988 (which involved an aircraft crash in Scotland from a overflying aeroplane in which a bomb exploded) as these were unrelated to the deaths due to assault in Scotland that were the focus of this research and had a noticeable effect on the results. The small number of deaths also means that there were insufficient deaths by assault to present Lexis surface plots of age-year specific rates by age in a single year or to undertake formal statistical modelling of the data stratified by APC, using Intrinsic Estimator (IE)

regression modelling, which overcomes the mathematical co-dependence of APC effects that negates the use of simple regression models, as we have previously undertaken for suicide and alcohol- and drug-related deaths.[8-10] These methods require a level of disaggregation which would likely be disclosive, 'noisy' and too underpowered to clearly identify APC patterns and for IE modelling.

Additionally disentangling APC effects is problematic and while the IE modelling is a newer approach to statistical estimation, which overcomes the mathematical co-dependence of APC effects that negates the use of simple regression models, it still has limitations.[10, 20] For instance if used, cohort IE estimates especially would need to be interpreted with caution because there are limited observations for the first and last cohorts and also as we have limited information for each birth cohort across their entire lifecourse. This can lead to the age effects observed being misattributed by the IE model to a cohort effect. As a result, the conclusions in relation to APC effects are primarily based on the descriptive analyses of aggregated age-groups and periods.

Our analysis looks at mortality in deaths due to assault, and therefore the victims rather than the perpetrators of assaults. It may be that an APC analysis of perpetrators may be more likely to display cohort effects.

Comparison with other studies

Our results are consistent with and extend previous research demonstrating the most pronounced increase in death by assault for males aged 15-44 years in Scotland from 1980-2005, and the persistently higher rates for men and in more deprived areas.[11, 21] This is very similar to the socio-demographic patterning of penetrating injuries found across the UK.[22]

Male death rates by assault are dominated by deaths due to a sharp object, most notably a knife, and has accounted for around fifty percent of all homicides in the last ten years.[23] Increases in deaths due to sharp objects have been shown to have contributed to the increase in deaths by assault observed over the period 1980-2005 and will have largely contributed to the period effect we identified.[11, 24] The rate of homicides involving knives being especially high in Glasgow, a city with areas of high deprivation. Similar to our findings, the incident of assault-related sharp force injury (SFI) is also higher amongst younger people, males and those living in areas of social deprivation.[25] This incident rate has also been falling since 2009, most marked among younger age groups.[25]

The rise in mortality due to assault occurred at a similar time to the rise in alcohol- and drug-related mortality and suicide in Scotland, all of which have been attributed to the changing political and social conditions of the 1980s.[7] There has been some suggestion that the recent decline in deaths from assault as we observed may be due to 'a public health approach' to violence, knife crime and gang culture adopted by the violence reduction unit which was created by Strathclyde police in 2005 and later rolled out across Scotland.[26-28] Laws around the carrying of knives were also

extended in 2006.[26] However, there is little evaluative evidence available to ascertain what, if any, contribution these initiatives had. Understanding the context of multiple deprivation, and the gendered environment in which violence occurs, and addressing these through a 'maximum diversionary approach', is evidenced as being effective at addressing (particularly youth) violence.[29, 30]

Implications and conclusions

Mortality due to assault is substantially more common amongst young men in deprived areas than for women, at older ages or for people living in less deprived areas. Mortality rates, and inequalities, increased markedly in the early 1990s and remained high until the mid-2000s before subsequently falling, but the age profile of victims changed little over time. There is therefore evidence of age and period effects, but little evidence of cohort effects, in deaths due to assault in Scotland. The 15 year period effect is likely to be due to similar factors that were behind the rise and fall of alcohol-related mortality,[8] the causes of which relate to a vulnerable population encountering a changed political, economic and social situation from the early 1980s which created a period of high unemployment, high income inequality and disinvestment from deprived communities.[7]

Acknowledgements We would like to thank Julie Ramsay and Frank Dixon at NRS for the dataset and for advising on details of Scottish deaths due to assault statistics, and also David Readhead and Laura Kate Campbell at NHS National Services Scotland for assistance in providing data by deprivation groupings.

Contributors GM generated the initial idea for the study. Analyses of data were conducted by JP. JP interpreted the data and drafted the manuscript. Both JM and GM provided critical input into the interpretation of the data and intellectual content to the redrafting of the manuscript. All authors read and approved the final draft.

Ethics approval No ethical approval was required or sought for the analyses in this paper. The data for the research was obtained from an existing database containing details of Scottish deaths from 1974 held by the National Records of Scotland. All requirements specified for the use of this dataset by the National Records of Scotland were adhered to. The data are anonymised, and presented disaggregated only by age and year independently for each gender, rather than by both age and year in combination (as in a Lexis surface plot). The age and year categories used are also not disaggregated by single years/years of age. With this level of disaggregation the individuals cannot be de-identified, but the broader trends are still apparent.

Funding This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing Interests None declared.

Data sharing statement The original data used for this study are owned by the NRS and can be obtained by researchers from them on request. No additional data are available.

REFERENCES

1 McCartney G, Walsh D, Whyte B, et al. Has Scotland always been the 'sick man' of Europe? An observational study from 1855 to 2006. *Eur J Public Health* 2010;22:756-760 doi:10.1136/jech-2014-204185 [published Online First: 12 September 2014].

2 Norman P, Boyle P, Exeter D, et al. Rising premature mortality in the UK's persistently deprived areas: Only a Scottish phenomenon? *Soc Sci Med* 2011;73:1575-1584 doi:10.1016/j.socscimed.2011.09.034 [published Online First: 13 October 2011].

3 Popham F, Boyle P. *Assessing socio-economic inequalities in mortality and other health outcomes at the Scottish national level: Final report.* Edinburgh: Scottish Collaboration for Public Health Research and Policy, 2011.

4 Hanlon P, Lawder R, Buchanan D, et al. Why is mortality higher in Scotland than in England & Wales? Decreasing influence of socioeconomic deprivation between 1981 and 2001 supports the existence of a 'Scottish effect'. *J Public Health (Oxf)* 2005;27:199-204 doi:10.1093/pubmed/fdi002 [published Online First: 17 March 2005].

5 Schofield L, Walsh D, Munoz-Arroyo R, et al. Dying younger in Scotland: Trends in mortality and deprivation relative to England and Wales,1981–2011. *Health Place* 2016;40:106-115 doi: 10.1016/j.healthplace.2016.05.007 [published Online First: 5 May 2016].

6 McCartney G, Collins C, Walsh D, et al. *Accounting for Scotland's excess mortality: towards a synthesis.* Glasgow: Glasgow Centre for Population Health, 2011.

7 Walsh D, McCartney G, Collins C, et al. *History, politics and vulnerability: explaining excess mortality in Scotland and Glasgow.* Glasgow: Glasgow Centre for Population Health, 2016.

8 McCartney G, Bouttell J, Craig N, et al. Explaining trends in alcohol-related harms in Scotland, 1991-2011 (I): the role of incomes, effects of socio-economic and political adversity and demographic change. *Public Health* 2016;132:13-23 doi: 10.1016/j.puhe.2015.12.013 [published Online First: 23 February 2016].

9 Parkinson J, Minton J, Lewsey J, et al. Recent cohort effects in suicide in Scotland: a legacy of the 1980s? *J Epidemiol Community Health* 2017;71:194-200 doi: 10.1136/jech-2016-207296 [published Online First: 18 July 2016].

10 Parkinson J, Minton J, Lewsey J, et al. Drug-related deaths in Scotland 1979–2013: evidence of a vulnerable cohort of young men living in deprived areas. *BMC*

Public Health 2018;18:357-365 doi: 10.1186/s12889-018-5267-2 [published Online First: 27 March 2018].

11 Leyland AH, Dundas R. The social patterning of deaths due to assault in Scotland, 1980-2005: population-based study. *J Epidemiol Community Health* 2010;64:432-439 doi:10.1136/jech.2009.095018 [published Online First: 5 May 2010].

12 Minton J, Vanderbloemen L, Dorling D. Visualizing Europe's demographic scars with coplots and contour plots. *Int J Epidemiol* 2013;42:1164–1176 doi:10.1093/ije/dyt115 [published Online First: 30 August 2013].

13 Minton J, Shaw R, Green MA, et al. Visualising and quantifying 'excess deaths' in Scotland compared with the rest of the UK and the rest of Western Europe. *J Epidemiol Community Health* 2017;71:461-467 doi:10.1136/jech-2016-207379 [published Online First: 6 January 2017].

14 Carstairs V, Morris R. Deprivation: explaining differences in mortality between Scotland and England and Wales. *BMJ* 1989;299:886-9 doi: https://doi.org/10.1136/bmj.299.6704.886.

15 NRS. *Information on the quality assurance arrangements for administrative data used in population estimates.* Edinburgh: National Records Of Scotland, 2016.

16 NRS. *Mid-2018 Population Estimates for Scotland: Methodology Guide.* Edinburgh: National Records of Scotland, 2019.

17 NRS. Quality of National Records of Scotland (NRS) Data on Deaths. 2019 Available at: https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/deaths/deaths-background-information/quality-of-nrs-data-on-deaths. Accessed 2 May 2019.

18 General Register Office for Scotland. *Registrar General for Scotland Annual Report 2000.* Edinburgh: National Records of Scotland, 2001.

19 ISD Scotland. *Carstairs - Problems with the use of area classifications.* Edinburgh: ISD Scotland, 2013.

20 Yang Y, Schulhofer-Wohl S, Fu WJ, et al. The Intrinsic Estimator for Age-Period-Cohort Analysis: What It Is and How to Use It. *Am J Sociol* 2008;113(6):1697-736 doi: http://dx.doi.org/10.1086/587154.

21 McGuffie AC, Graham CA, Beard D, et al. Scottish urban versus rural trauma outcome study. *J Trauma* 2005;59:632-638 doi:10.1097/01.ta.0000186543.47450.6f.

22 Whittaker G, Norton J, Densley J, et al. Epidemiology of penetrating injuries in the United Kingdom: A systematic review. *Int J Surg* 2017;41:65-69 doi:https://doi.org/10.1016/j.ijsu.2017.03.051 [published Online First:23 March 2017].

23 Scottish Government. *Homicide in Scotland 2017-18.* Edinburgh: Scottish Government, 2018.

24 Leyland AH. Homicides involving knives and other sharp objects in Scotland, 1981-2003. *J Public Health* 2006;28:145-147 doi:10.1093/pubmed/fdl004 [published Online First: 5 April 2005].

25 Goodall CA, MacFie F, Conway DI, et al. Assault–related sharp force injury among adults in Scotland 2001–2013: Incidence, socio-demographic determinants and relationship to violence reduction measures. *Aggress Violent Behav* 2018;in press doi:10.1016/j.avb.2018.10.002 [published Online First: 19 October 2018].

26 McCallum F. *Knife crime, SPICe Briefing.* Edinburgh: The Scottish Parliament, 2011.

27 Younge G, Barr C. *How Scotland reduced knife deaths among young people*. The Guardian, 2017.

28 Kmietowicz K. Glasgow gang members offered way out of violent lifestyle. *BMJ* 2008;337:a2972 doi:10.1136/bmj.a2972 [published Online first: 10 December 2008].

29 McAra L, McVie S. *Maximum diversion, minimum intervention: key messages from the Edinburgh Study of Youth Transitions and Crime. In Justice for Young People. The Howard League Research Medal.* 2013.

30 McAra L, McVie S. Understanding youth violence: The mediating effects of gender, poverty and vulnerability, *Journal of Criminal Justice* 2016;45:71-77 doi:10.1016/j.jcrimjus.2016.02.011 [published Online First: 19 February 2016].

FIGURE LEGENDS

Figure 1 Age-standardised rate of death by assault per 100,000 population per year in Scotland, 1974-2015, by sex.

Figure 2 Age distribution of crude rates of death by assault per 100,000 population per year in Scotland over periods 1974-1994 and 1995-2015 combined data, by sex.*
* These age profiles show general trends with age across two time periods 1974-1994 and 1995-2015 and will have been affected by any age-period-cohort effects occurring during those periods.

Figure 3 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years

Figure 4 Age-standardised rate of death by assault per 100,000 population per year in Scotland from 1974-2015, by sex and Carstairs quintile*
* Quintile 1 = most deprived and Quintile 5 = least deprived

Figure 5 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years by Carstairs quintile*
* Quintile 1 = most deprived and Quintile 5 = least deprived

ONLINE SUPPLEMENTARY FIGURE LEGENDS

Figure S1 Crude rates of death by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and age group

Figure S2 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015, by sex and Carstairs quintile*
* Quintile 1 = most deprived and Quintile 5 = least deprived

Figure S3 Crude rates of death by assault per 100,000 population by ten year age group and five year period in Scotland from 1974-2013, by sex

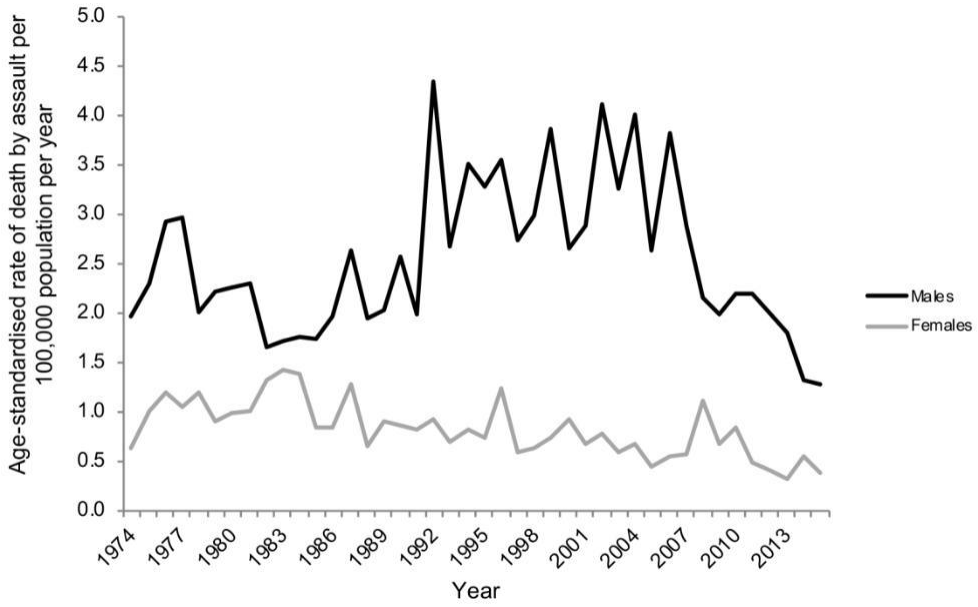


Figure 1 Age-standardised rate of death by assault per 100,000 population per year in Scotland, 1974-2015, by sex

150x95mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

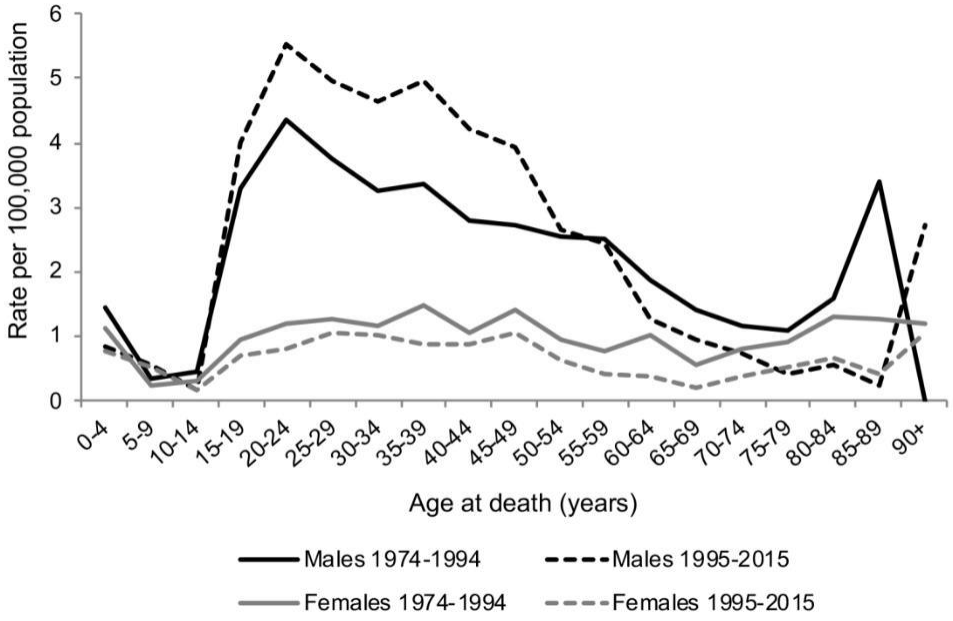


Figure 2 Age distribution of crude rates of death by assault per 100,000 population per year in Scotland over periods 1974-1994 and 1995-2015 combined data, by sex** These age profiles show general trends with age across two time periods 1974-1994 and 1995-2015 and will have been affected by any age-period-cohort effects occurring during those periods.

150x95mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

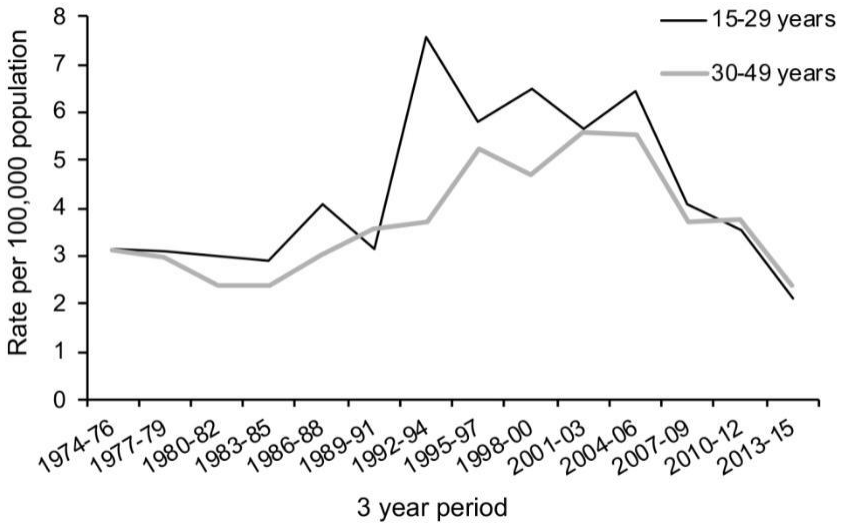


Figure 3 Crude rates of death by assault per 100,000 population per three year periods in Scotland from 1974-2015 for males aged 15-29 years and 30-49 years

150x95mm (300 x 300 DPI)

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

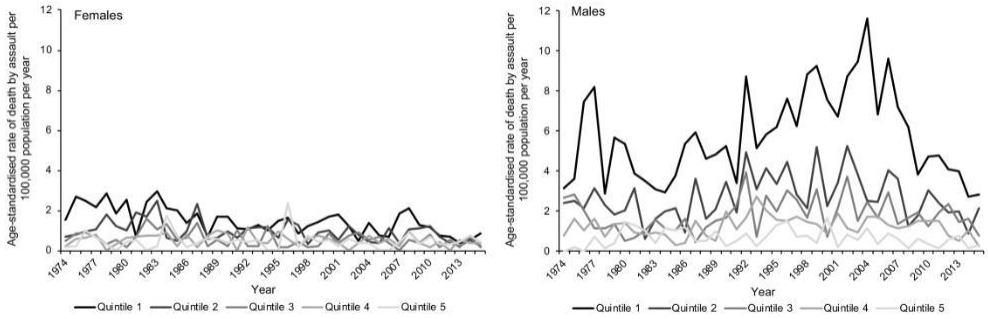


Figure 4 Age-standardised rate of death by assault per 100,000 population per year in Scotland from 1974-2015, by sex and Carstairs quintile** Quintile 1 = most deprived and Quintile 5 = least deprived

294x100mm (300 x 300 DPI)

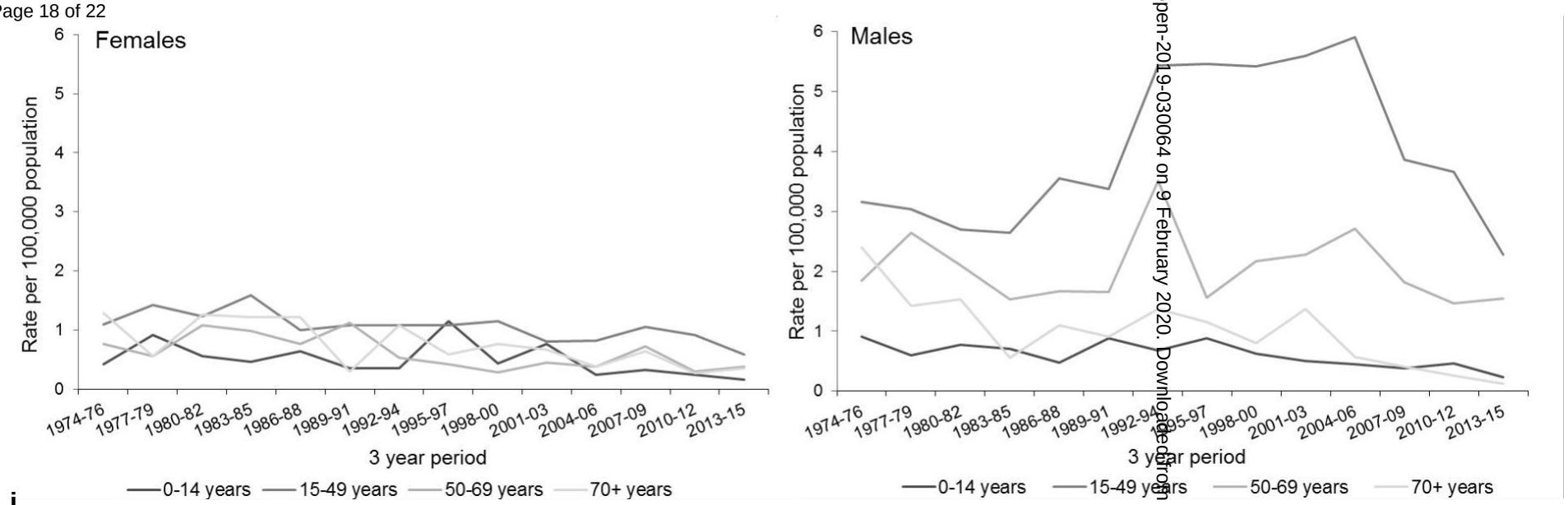
BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open: first published as 10.1136/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

ath by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and age group

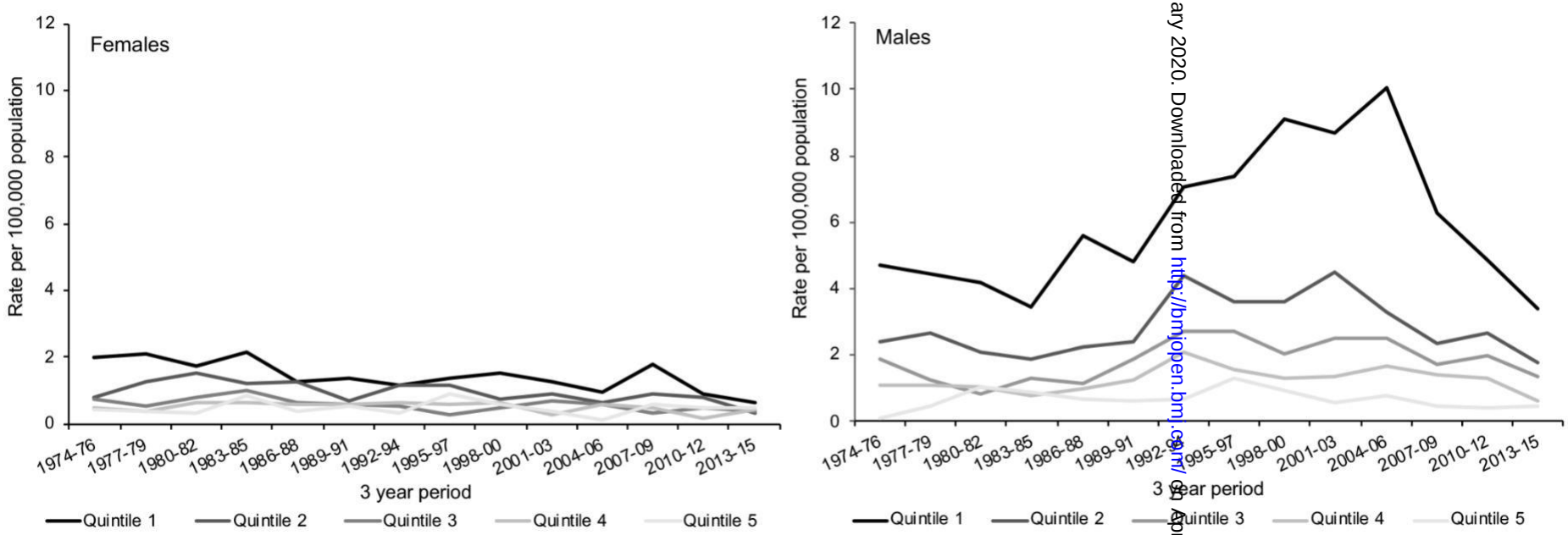


Supplementary Figure S1 Crude rates of death

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

36. bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Figure S2 Crude rates of death by assault per 100,000 population for three year periods in Scotland from 1974-2015, by sex and Carstairs quintile*

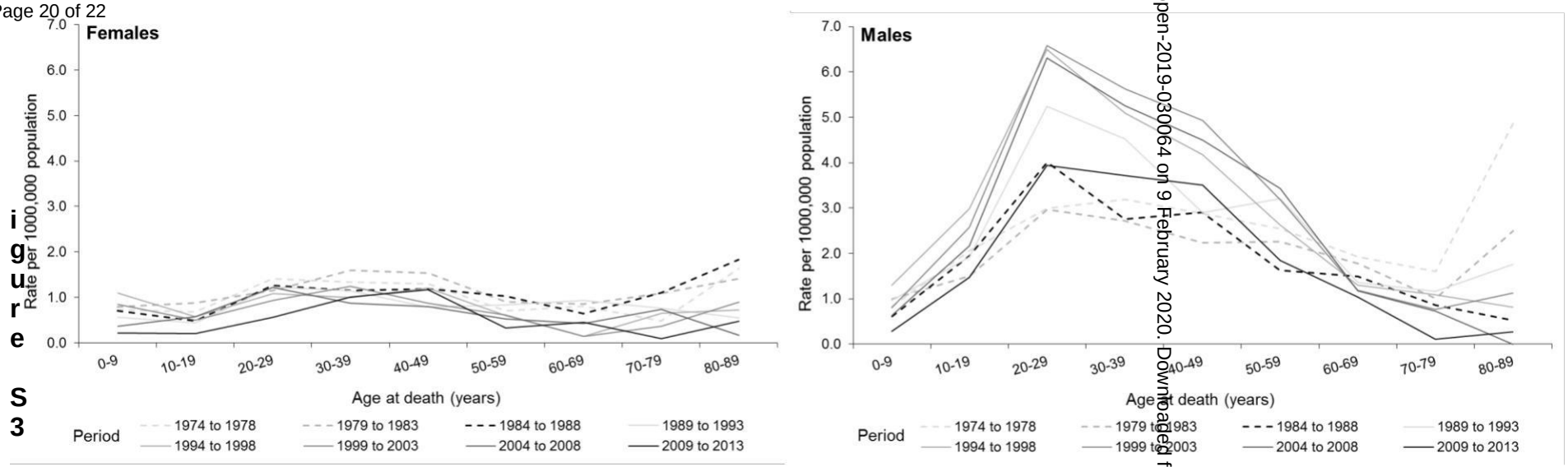


* Quintile 1 = most deprived and Quintile 5 = least deprived

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

Figure S3 Crude rates of death by assault per 100,000 population by ten year age group and five year period in Scotland from 1974-2013, by sex



For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

36/bmjopen-2019-030064 on 9 February 2020. Downloaded from http://bmjopen.bmj.com/ on April 9, 2024 by guest. Protected by copyright.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	2
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	n/a
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	3
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	2-3
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	n/a
		(b) Indicate number of participants with missing data for each variable of interest	3

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Outcome data	15*	Report numbers of outcome events or summary measures	2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	3-4 – see figures also
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5
Discussion			
Key results	18	Summarise key results with reference to study objectives	4
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	4-5
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6
Generalisability	21	Discuss the generalisability (external validity) of the study results	5
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	6

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml