Public Health 217 (2023) 26-32

Contents lists available at ScienceDirect

Public Health

journal homepage: www.elsevier.com/locate/puhe

Original Research

How well does the Scottish Index of Multiple Deprivation identify income and employment deprived individuals across the urban-rural spectrum and between local authorities?



RSPH

G. McCartney ^{a, *}, R. Hoggett ^b

^a College of Social Sciences, University of Glasgow, 40 Bute Gardens, Glasgow, G12 8RT, UK
^b NHS Tayside Directorate of Public Health, King's Cross, Clepington Rd, Dundee, DD3 8EA, UK

ARTICLE INFO

Article history: Received 17 August 2022 Received in revised form 22 December 2022 Accepted 9 January 2023

Keywords: Scottish Index of Multiple Deprivation Rurality Income Employment

ABSTRACT

Background: Area-based indices of deprivation are used to identify populations at need, to inform service planning and policy, to rank populations for monitoring trends in inequalities, and to evaluate the impacts of interventions. There is scepticism of the utility of area deprivation indices in rural areas because of the spatial heterogeneity of their populations.

Objective: To compare the sensitivity of the Scottish Index of Multiple Deprivation (SIMD) for detecting income and employment deprived individuals by urban-rural classification and across local authorities. *Study design:* Descriptive analysis of cross-sectional data.

Methods: Data from the 2020 Scottish Index of Multiple Deprivation (SIMD) were used to calculate the number and percentage of income and employment deprived people missed within each of the six-fold urban-rural classification strata and each local authority using areas ranked by the national SIMD, within local authority rankings, and within urban-rural strata rankings, for deprivation thresholds between the 5% most deprived areas and the 30% most deprived areas. The Slope Index of Inequality (SII) and Relative Index of Inequality (RII) were calculated within local authorities and urban-rural classification strata to estimate the concentration of deprivation within ranked data zones.

Results: The number and percentage of income and employment deprived people is higher in urban than rural areas. However, using the national, local authority, and within urban-rural classification strata rankings of SIMD, and under all deprivation thresholds (from the 5%–30% most deprived areas), the percentage of income and employment deprived people missed by targeting the most deprived areas within urban-rural strata is higher in more remote and rural areas, and in island local authorities. The absolute number of income and employment deprived individuals is greater in urban areas across rankings and thresholds.

Conclusion: The SIMD misses a higher percentage of income and employment deprived people in remote, rural and island areas across deprivation thresholds and irrespective of whether national, local or within urban-rural classification strata are used. However, the absolute number of people missed is higher in urban areas.

© 2023 The Author(s). Published by Elsevier Ltd on behalf of The Royal Society for Public Health. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4. 0/).

Background

Socio-economic deprivation is an important determinant of population health.¹ Many countries have developed area-based indices of multiple deprivation to serve several purposes.² First, the indices can be used to identify populations with different needs for services or policy interventions based on their experience of deprivation.³ Second, the indices can be used to rank the population to monitor the extent of inequalities.^{4,5} Third, the indices can be used as a data source for evaluation and monitoring of policy interventions.⁶

Deprivation indices are constructed at small area level to make use of routinely available administrative data for standard geographies.² This facilitates regular updating of data and avoids the challenges of individual data linkage or the need to suppress small

* Corresponding author. E-mail address: Gerard.mccartney@glasgow.ac.uk (G. McCartney).

https://doi.org/10.1016/j.puhe.2023.01.009

0033-3506/© 2023 The Author(s). Published by Elsevier Ltd on behalf of The Royal Society for Public Health. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).



numbers to avoid inadvertent disclosure. A perceived limitation of area-based deprivation indices is the extent to which their sensitivity at identifying people in deprived circumstances varies according to how urban or rural the context is.⁷ This has led to some scepticism amongst service managers and planners about the utility of such deprivation indices in rural and island areas. This is not unique to rural areas given that most deprived individuals do not live in the most deprived areas,⁸ and the use of area-based deprivation scores to infer the characteristics of individuals or households falls foul of the ecological fallacy.⁹

The Scottish Government's official tool for identifying the concentration of deprivation across Scotland is the Scottish Index of Multiple Deprivation (SIMD). The SIMD is derived from a weighted score of data across seven domains (Income, Employment, Education, Health, Access to Services, Crime and Housing).¹⁰ The 'access to services' domain captures some aspects of rural deprivation, but the 'income' and 'employment' domains which make up the Income Employment Index (IEI), a sub-index of SIMD used to monitor health inequalities, does not. The experience of deprivation differs between urban and rural areas. In addition to service access issues, people living in rural areas may face higher costs (e.g. for fuel, transport and food), a lack of employment opportunities, and a reliance on part-time and seasonal work.¹¹

It has been suggested that SIMD, "tend[s] to privilege urban concentrations of deprivation to the detriment of deprived people in more rural areas",¹² on the basis that individuals experiencing deprivation may be more dispersed in rural areas, leading to greater heterogeneity in their populations.⁶

Given the perception that the commonly used area-based deprivation index (SIMD) in Scotland is not as sensitive for identifying deprived individuals in rural areas, this paper aims to compare the sensitivity of the SIMD in detecting income and employment deprived individuals between urban-rural categories and across local authorities.

Methods

The 2020 version of the SIMD data set was obtained from the Scottish Government for this analysis. The smallest unit of analysis for SIMD are data zones. There are 6796 data zones in Scotland (in the revision used for calculation of the 2020 SIMD) defined to follow natural and social boundaries where possible. The mean population size of a data zone is 778 people, the median 755, but with a range of 0-3847 reflecting that there are three data zones that have become completely depopulated since the definition of the data zone (due to the demolition of housing in those areas) and there are several areas whose population has grown substantially due to new house building since the last revision of boundaries.

The data set obtained had data for each data zone on: the SIMD ranking; number of individuals within each data zone classified as income deprived; the number of individuals within each data zone classified as employment deprived; the local authority; and the stratum of the six-fold urban-rural classification.^{13,14}

For Scotland overall, within each of the six-fold urban-rural categories, and within each local authority, data zones were ranked by the SIMD, and the cumulative numbers and percentages of income and employment deprived individuals calculated. The sensitivity and specificity of the SIMD was then assessed by calculating the percentage of income and employment deprived individuals for Scotland overall, within each urban-rural category, and within each local authority, captured below different deprivation thresholds (the 5%, 10%, 15%, 20%, 25% and 30% most deprived areas) and within categories (i.e. ranked fifths within Scotland, within each urban-rural category, and within each local

authority). In other words, the crude number, and % of the total number of income deprived individuals in Scotland, included within the most deprived 5% of areas, the most deprived 10% of areas, etc. were calculated. This was then repeated within each urban-rural strata, and within each deprivation fifth. As well as the total number and % captured within each of these, the reverse (the total number and % missed), were also calculated. The results were then tabulated and graphed to identify patterns.

The distribution of income deprived individuals across locally ranked data zones (within local authorities and urban-rural classification strata) was additionally explored through calculation of the Slope Index of Inequality (SII) and Relative Index of Inequality (RII) using weighted linear regressions as described by Pamuk.¹⁵

Results

Scotland-level deprivation strata

Although the majority of Scotland's population live in urban areas (71%), a significant minority live in remote (10%) and/or rural (17%) areas (Figure S1). Across the urban-rural classification system, the prevalence of income and employment deprivation is generally higher in urban than in remote or rural areas (Figure S2). Furthermore, the most deprived SIMD areas are heavily skewed towards urban areas, with 55.0% of the most deprived tenth of the population residing in 'Large Urban Areas', 38.8% in 'Other Urban Areas', 2.5% in 'Accessible Small Towns', 1.9% in 'Remote Small Towns', 1% in 'Accessible Rural' areas, and only 0.8% in 'Remote Rural' areas.

When Scottish areas are ranked by SIMD deprivation and divided by quintiles into fifths, 40% of income deprived individuals reside in the most deprived fifth, 27% in the second most deprived fifth, 18% in the middle fifth, 11% in the second least deprived fifth, and 5% in the least deprived fifth.

When the sensitivity of SIMD in detecting income deprivation is compared across the strata of the urban-rural classification system, clear differences can be seen (Fig. 1). Using the lowest ranked 20% of SIMD data zones across Scotland to identify people on low incomes, 55% of income deprived people are missed (and 45% of income deprived individuals are identified). However, fully 90% of lowincome individuals living within remote rural areas are missed using this approach, with a stepwise gradient down to 43% of lowincome individuals being missed in large urban areas. This gradient is seen across the urban-rural spectrum most clearly when a larger percentage of the most deprived SIMD data zones are included (e.g. when the 30% most deprived areas is used as the threshold).

Although the percentage of income deprived individuals missed by targeting deprived areas within remote and rural area strata is much higher than in urban areas irrespective of the deprivation threshold used, the absolute number of individuals missed is much higher in the urban areas because of the greater number of people in these areas and the overall higher prevalence (Fig. 2). The patterning and percentages are almost identical when employment deprivation is the outcome of interest instead of income deprivation (Figures S3 and S4).

Intra-local authority deprivation strata

The percentage of the population in each local authority area who are income deprived ranges from 5% in Shetland to 19% in Glasgow City (Figure S5). Using intra-local authority deprivation rankings to attempt to better identify income deprived individuals, the varying sensitivity of the SIMD measure can be seen. This ranking performs worst in the Orkney Islands, Shetland Islands, and Na-h-Eileanan Siar, with the most deprived fifth of locally ranked areas identifying only 24%, 29% and 25% of income



Fig. 1. Percentage of all low-income individuals missed within each of the six-fold urban-rural strata using a range of SIMD deprivation thresholds (from the 5% most deprived to the 30% most deprived).

deprived individuals within each local authority, respectively. In contrast, several relatively affluent local authorities (e.g. East Dunbartonshire and East Renfrewshire) have more sensitive local rankings, with 54% and 53% of income deprived individuals in East Dunbartonshire and East Renfrewshire, respectively, living in the locally defined most deprived fifth of locally ranked areas (Fig. 3). The sensitivity of the local rankings for these affluent local authorities are similar to that of the whole-Scotland SIMD ranking (in which 55% of income deprived people lived outside the most deprived fifth of Scottish areas, Fig. 1), but for all other areas the local rankings is less sensitive. Using the SII and RII to investigate the clustering of income deprivation in locally ranked data zones across the whole data zone distribution (i.e. not just using the 20% most deprived areas) shows that Na-h-Eileanan Siar has the flattest distributions using both absolute and relative measures

(Figures S6 and S7), meaning that income deprivation is distributed widely across SIMD ranked data zones within that local authority. Using the RII, there are a small number of local authorities which have substantially steeper gradients, representing greater spatial clustering of income deprivation and a lower overall prevalence (as the SII is then divided by a smaller number [the prevalence] to produce the RII), including East Dunbartonshire, East Renfrewshire, Aberdeenshire, City of Edinburgh, Aberdeen City and Stirling (Figure S7).

Intra-urban-rural classification strata

Ranking data zones within urban-rural classification strata is another potential means of better identifying people who are income deprived. Using this approach to ranking, the percentage of



Fig. 2. Number of all income deprived individuals missed within each of the six-fold urban-rural categories, using deprivation thresholds from 5% to 30% of most deprived SIMD-ranked data zones.

income deprived people who live in the most deprived 20% of areas within each urban-rural classification strata ranges from 45% in large urban areas to 35% in remote small towns and in remote rural areas (Fig. 4). When the distribution of income deprivation is measured using the SII, the concentration is greatest in large urban areas (Figure S8), but is greater in accessible rural areas using the RII (Figure S9).

Discussion

The prevalence of income and employment deprivation is higher in urban areas than in rural areas, although the prevalence in remote small towns is only slightly lower than in urban areas. The Scottish level SIMD ranking is more sensitive at detecting income and employment deprived people in urban areas than in rural areas, with 57% of income deprived people in large urban areas also living in the most deprived fifth of Scottish SIMD areas, compared to only 10% of the income deprived people living in remote rural areas. However, the absolute number of income and employment deprived people living in remote rural areas is much smaller, and so the number of people missed by the SIMD is higher in urban areas than rural areas at all deprivation thresholds.

When data zones are ranked by the SIMD *within* local authorities, the sensitivity for detecting income-deprived people is lowest



Fig. 3. The distribution of the income deprived individuals across intra-local authority deprivation rankings.

in the island local authorities, and highest in the more affluent urban local authorities such as East Dunbartonshire and East Renfrewshire. Finally, when data zones are ranked by the SIMD *within* urban-rural classification strata, the percentage of income deprived people who live in the most deprived 20% of areas within each urban-rural classification strata ranges from 45% in large urban areas to 35% in remote small towns and in remote rural areas. Although the sensitivity of all three rankings of SIMD (using Scottish rankings, within local authority rankings, and within urbanrural classification rankings) is lower in remote and rural areas and island local authorities, the number of income and employment deprived people missed remains greater in urban areas because of the higher prevalence and larger populations.

The key limitation in the approach taken in this paper is that the focus is on income and employment deprivation as an outcome. By definition, this misses the potentially compounding effects of rurality (e.g. higher costs, seasonal employment, etc.) on the experience of deprivation, and as a result may underestimate the limitations of SIMD in identifying deprivation in remote and rural areas. Income and employment deprivation within the SIMD are based on individuals being in receipt of income support or other benefits. There are studies that have suggested that a culture of self-reliance, or indeed stigma, may discourage individuals in rural areas from accessing income support to which they are entitled which could differentially underestimate the number of people actually income or employment deprived within rural areas compared to urban areas.¹⁶

Despite these limitations, this paper addresses a key question for policymakers in relation to the utility of SIMD in remote and rural areas in Scotland. Across all areas the sensitivity and specificity of SIMD in identifying income and employment deprived individuals is relatively low, and in percentage terms performs worse in remote and rural areas, and in island local authorities. However, the total number of people missed by SIMD at each threshold is much higher in urban areas. The implication is that the use of SIMD rankings, even within local strata or urban-rural strata, is a weak means of identifying people at high risk of income and employment deprivation (and likely other health and social problems), and this is worse in remote and rural areas. However, for resource allocation and identifying the degree of need across populations, more income and employment deprived people are missed in urban areas. Of course, rurality can be considered as an aspect of deprivation – especially in terms of the potentially greater difficulties in service access and through the range of higher costs faced by rural populations. Our results which consider the identification of income deprived individuals without accounting for these issues have to therefore be considered in that context.

Although much has been written about the limited ability of area-based deprivation measures to identify deprived individuals and households^{8,9,17} there is less known about whether the operation of this ecological fallacy varies across the urban-rural spectrum. Of those studies that have considered this question, and in contrast to this study, they find limited evidence to support a clear pattern in the sensitivity and specificity of deprivation measures across the urban-rural spectrum.¹⁸ There is a much more extensive literature on the relationship between rurality and health. For example, the likelihood of reporting a mental health condition was lower in rural (and especially island rural) areas, even after adjusting for markers of socio-economic position.¹⁸ However, for other diagnoses, such as prostate cancer, no relationship with rurality was identified across the UK.¹⁷

There are several implications from this study. First, there is a need for linkage between individual and household level socioeconomic position data and other data sets to address the issues identified here. Routine linkage of data from the Census, Her Majesty's Revenue and Customs (HMRC) and the Department for Work



orban-rular classification stratum

Fig. 4. The distribution of the income deprived individuals across intra-local authority deprivation rankings.

and Pensions (DWP), with other data sets (including health and mortality data sets) would be an obvious approach. Second, increasing the availability of data on wider aspects of deprivation (including differential costs, employment experiences, etc.) across areas, would allow for a much more nuanced understanding of the lived reality of deprivation between populations. Both of these would enhance the ability of service planners and policymakers at all levels to better assess the levels of need, and how to better target interventions. Service managers and policymakers working at local level should only use SIMD cautiously for assessing the needs of populations, and particularly in remote, rural and island areas. Place-based approaches to reducing inequalities are likely to have very limited impacts because of the wide spatial distribution of people across areas, and approaches that recognise socio-economic relationships between social groups^{19,20} rather than people classified by their place of residence may be more effective.

Conclusion

The sensitivity of SIMD for detecting income and employment deprived people is lower in remote and rural areas, and in island local authorities, no matter whether the Scottish ranking, within local authority ranking, or within urban-rural classification strata ranking, is used. Across deprivation thresholds and rankings derived at Scotland, local or within urban-rural strata, the percentage of local income and employment deprived people missed is greater in remote, rural and island areas, but the absolute number of people missed is higher in urban areas because the levels of deprivation are higher.

Author statements

Ethical approval

No ethical approval was sought for this study as it was restricted to the analysis of secondary data.

Funding

No funding was received for this study. GM is salaried by the University of Glasgow, RH is salaried by the NHS.

Competing interests

We declare that we have no competing interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2023.01.009.

References

- 1. Marmot M, Allen J, Goldblatt P, Herd E, Morrison J. Build back fairer: the COVID-19 marmot review. London: Health Foundation; 2020.
- Allik M, Leyland A, Travassos Ichihara MY, Dundas R. Creating small-area deprivation indices: a guide for stages and options. J Epidemiol Community Health 2020;74:20–5.
- Noble M, Wright G, Smith G, Dibben C. Measuring multiple deprivation at the small-area level. *Environ Plann: Econ Space* 2006;38(1):169–85. https://doi.org/ 10.1068/a37168.
- Frank J, Haw S. Best practice guidelines for monitoring socioeconomic inequalities in health status: lessons from Scotland. *Millbank Q* 2011;89(4): 658–93. https://doi.org/10.1111/j.1468-0009.2011.00646.x.
- 5. Long-term monitoring of health inequalities. March 2022 report. Edinburgh: Scottish Government; 2022.
- Greig A, El-Haram M, Horner M. Using deprivation indices in regeneration: does the response match the diagnosis? *Cities* 2010;27:476–82.
- Clelland D, Hill C. Deprivation, policy and rurality: the limitations and applications of area-based deprivation indices in Scotland. *Local Econ* 2019;**34**(1): 33–50.
- McLoone P. Targeting deprived areas within small areas in Scotland: population study. *BMJ* 2001;**323**(7309):374–5. https://doi.org/10.1136/ bmj.323.7309.374.
- **9.** Fieldhouse EA, Tye R. Deprived people or deprived places? Exploring the ecological fallacy in studies of deprivation with the Samples of Anonymised Records. *Environ Plann A* 1996;**28**:237–59.
- 10. Scottish Government. *Scottish index of multiple deprivation*. 2020. Available at: [https://www.gov.scot/collections/scottish-index-of-multiple-deprivation-2020/, [Accessed 23 August 2021].
- Scottish Government. SIMD rural deprivation evidence summary. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/ research-and-analysis/2017/02/scottish-index-of-multiple-deprivation-rural-

deprivation-evidence-and-case-studies/documents/rural-deprivation-anevidence-review/rural-deprivation-an-evidence-review/govscot% 3Adocument/rural%2Bdeprivation%2Bevidence%2Breview.pdf. [Accessed 23 August 2021].

- 12. McKendrick JH, Barclay C, Carr C, Clark A, Holles J, Perring E, et al. Our rural numbers are not enough: an independent position statement and recommendations to improve the identification of poverty, income inequality and deprivation in rural Scotland. Glasgow: Rural Poverty Indicators Action Learning Set; 2011.
- Scottish index of multiple deprivation 2020v2 data zones. Available at: [https://www.gov.scot/publications/scottish-index-of-multiple-deprivation-2020v2-data-zone-look-up/, [Accessed 23 August 2021].
- Scottish Government. Scottish index of multiple deprivation 2020v2 indicators. Available at: [https://www.gov.scot/publications/scottish-index-ofmultiple-deprivation-2020v2-indicator-data/, [Accessed 23 August 2021].
- Pamuk E. Social class inequality in mortality from 1921–1972 in England and Wales. Popul Stud 1985;39:17–31.
- Bailey N, Glen Bramley G, Gannon M. Urban and rural poverty in Scotland. Glasgow: University of Glasgow and Heriot Watt University; 2016.
- Smith L, Downing A, Norman P, Wright P, Hounsome L, Watson E, et al. Influence of deprivation and rurality on patient-reported outcomes of men living with and beyond prostate cancer diagnosis: a population-based study. *Cancer Epidemiol* 2020. https://doi.org/10.1016/j.canep.2020.101830.
- Halliday K, Clemens T, Dibben C. The island effect: spatial effects on mental wellbeing and residence on remote Scottish islands. Wellbeing Space Soc 2022;3:100098.
- McCartney G, Dickie E, Escobar O, Collins C. Using inequalities in power to operationalise fundamental causes theory and focus action to reduce health inequalities. Sociol Health Illness 2021;43(1):20–39. https://doi.org/10.1111/ 1467-9566.13181.
- Sayer A, McCartney G. Economic relationships and health inequalities: improving public health recommendations. *Publ Health* 2021;**199**:103–6. https://doi.org/10.1016/j.puhe.2021.08.017.