Measuring area-level disadvantage in Australia: development of a locally sensitive indicator

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Abstract

Background

In Australia, the Socio-Economic Indexes for Areas (SEIFA), which includes the Index of Relative Socioeconomic Disadvantage (IRSD), captures the socioeconomic characteristics of areas. Because SEIFA rankings are relative to the country or state, the decile categorisations may not reflect an area's socioeconomic standing relative to areas nearby.

Aims

The aim of the research was to explore whether IRSD rankings could be re-ranked to become locally sensitive.

Data and methods

Using existing SEIFA data to redistribute the membership of current decile IRSD groups, we tested three methods to re-rank all SA1 areas relative to the nearest areas capped at: (1) the nearest 99 neighbours, (2) a population threshold of 50,000 (3) a distance threshold of 10 km.

Results

The reclassification of SEIFA IRSD deciles was largest (up to 8 decile points of change) when comparing the nearest neighbour and population threshold local methods to current state-based rankings. Moreover, compared to using current national and state SEIFA IRSD rankings, the use of local rankings resulted in more evenly distributed deciles between cities, regional, and remote areas.

Conclusions

Because SEIFA IRSD rankings are used to allocate resources and health services, we encourage the combined use of a state and local ranking to refine areas considered the most disadvantaged.

Key words

Disadvantage; deprivation, neighbourhood; local; area-level; Australia.

1. Introduction

Using data from the 1981 UK Census, Townsend established that area-level circumstances are an important measure of deprivation independent of poverty or individual socioeconomic position (SEP) (Townsend 1987). Deprivation was defined as "…observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual, family or group belongs" (Townsend 1987 p. 125). Therefore, in comparison to individual level measures of socio-economic position such as income, education and occupation, area-based measures more commonly capture neighbourhood deprivation or disadvantage by aggregating social and material conditions of residential areas (e.g., % residents unemployed, % residents that own a car) into a single figure estimate. Such area-level socioeconomic conditions are often strongly associated with health outcomes both at the individual- and population-level, including long-term illness and mortality (Galobardes et al. 2004; Meijer 2013; King et al. 2006). These effects can accumulate over the life course, influencing an increased allostatic load (i.e., cumulative biological risk) and subsequently health status in adulthood (Cornaz et al. 2009; Gustafsson et al. 2014).

Following Townsend's pioneering work, contemporary area-level socioeconomic indicators are measured in a variety of ways including composite indexes derived from census (Atkinson et al. 2014; Department of the Environment, Transport and the Regions 2000; Norman et al. 2019; Townsend et al. 1988) or routinely collected administrative data (Exeter et al. 2017; Noble et al. 2006; Smith et al. 2015). In Australia, the Socio-Economic Indexes for Areas (SEIFA) are used to determine the relative socioeconomic characteristics of different areas in Australia (ABS 2011; ABS 2016b). This set of indexes is a product developed by the Australian Bureau of Statistics using data gathered in the five-yearly census. Broadly, to determine the collective socioeconomic characteristics of people living in an area, advantage and disadvantage are defined by people's access to social and material resources, including their ability to participate in society (ABS 2011).

Constrained by census questions, each of the four SEIFA indexes is a weighted combination of selected variables (see Data and Methods) measuring the aggregated attributes of the area's residents. Much of the methodological discussion in relation to such indexes in Australia and internationally relates to the choice of variables that make up each index or the size of the area-level unit being explored (Jordan et al. 2004). This latter issue is the well-recognised modifiable areal unit problem (MAUP) where the scale, or aggregation, one uses to analyse the information can produce different or distorted findings (Brunsdon & Comber 2020). Indexes can also be problematic for areas with very diverse neighbourhoods, such as the Australian Capital Territory (ACT). Indeed, the ACT Government has highlighted that SEIFA critically underestimates disadvantage in the ACT (ACT Government 2012) because in the ACT many disadvantaged households are adjacent to advantaged households (due to mixed tenure housing policy), which SEIFA does not capture because it averages across larger geographic areas (Tanton et al. 2015).

Many issues related to small-area measures of disadvantage have been discussed by Allik and colleagues (Allik et al. 2020). However, a largely unrecognised problem for Australia's SEIFA indexes and other international examples (Atkinson et al. 2014; Exeter et al. 2017; Townsend et al. 1988) is that the current rankings, and subsequent decile groups, are based on relative rankings across the whole country or within each individual state or territory. Therefore, indexes based on relative ranks within a country or state may not reflect an area's standing relative to its neighbours and nearby areas. Consequently, regional areas are ranked against both regional and urban areas (and vice versa) and regional areas with low-levels of disadvantage relative to other nearby areas cannot be distinguished because their level of deprivation is ranked relative to all other areas within the state or within the country.

The use of the decile groups (as recommended by the ABS (2011, 2016b)) makes it difficult to isolate the most disadvantaged areas relative to neighbouring areas and may misrepresent the levels of disadvantage present, especially in regional areas of Australia. The ABS recognise some of these limitations and note that users should be cautious when using the current SEIFA indexes for very remote areas of Australia (ABS 2011). The use of state-based relative rankings and resulting decile groups can also be problematic for localities bordering states or territories.

These limitations are important because place and health research relies on, and often assumes, locally sensitive measures of socioeconomic disadvantage. This is important to resolve as it is critical to employ suitable area-disadvantage indicators that are meaningful (Hugo 2007). Researchers and policy makers rely heavily on the SEIFA indexes to inform local and national policy development, to determine areas in need of funding and essential services, and to inform research examining relationships between area-level SEP and various social- and health-related outcomes (ABS 2011). Therefore, there are potentially major consequences to misinterpreting local socioeconomic disadvantage and misdirecting resources.

We direct interested readers to previous research that considers small area data zones (Allik et al. 2020; Noble et al. 2006; Zhao and Exeter 2016), and to researchers who are beginning to consider relative or local 'neighbouring disadvantage' within definitions of deprivation (Cox et al. 2007; Graif et al. 2016; Pearson et al. 2013; Zhang et al. 2011; Zhang et al. 2013). However, most relevant to our own concept is Rae's alternative approach to measuring neighbourhood deprivation within the United Kingdom (Rae 2009). Advocating an approach to better understand the relationships areas have with their wider neighbours, Rae developed a method to assess deprived areas as integrated neighbours rather than isolated entities. Despite its use in evidence-based policy development across England, the UK Index of Multiple Deprivation (IMD) lacked metrics specific to locally sensitive spatial dimensions. By calculating the mean value of IMD for three different levels of adjacent neighbourhoods, Rae developed a Nearest Neighbour IMD as an alternative method to interpret local level area deprivation.

Similarly, we contend that the current use of SEIFA rankings and the subsequent decile groups is limited for locally sensitive research questions and policy decisions. The shortcomings cannot be overcome through limiting and re-ranking areas within local government areas due to issues that would be introduced through edge-effects. Similar discussions have been had in Australia where the late Professor Graeme Hugo (Hugo 2007) previously advocated a move away from the traditionally employed administrative units in order to define more relevant spatial units when considering social, economic and environmental planning purposes. This work led to the restructuring of the statistical geography of Australia with the intention of using topography and built environments to homogenously group people with like characteristics. For example, in rural areas it is common for communities to form around the intersection of major roads and such a community should be kept together for analysis. In urban areas, a similar approach has been undertaken where topographic features such as roads and rivers can unite or divide an area – depending on the number of crossing points (bridges/traffic lights). To define the statistical geography, criteria were assigned by an expert panel with a weighting (high, medium or low) to facilitate the drawing of the spatial boundaries (ABS 2003; Eagleson et al. 2003). The intention of the restructured statistical geography based on Mesh Blocks (the smallest area defined by the ABS) was to allow flexibility (e.g., customised units) of data aggregation for the output of demographics and calculation of indexes by both researchers and policy makers. However, whilst broad land use characteristics, counts of dwellings and population have been published at the Mesh Block scale, SEIFA output remains confined to larger administration areas (e.g., SA1 or SA2).

Due to limited data availability on the Mesh Block scale, we explored whether SEIFA at the SA1 level could be re-ranked to become locally sensitive. Overall, research directly related to SEIFA indicators is remarkably scarce. By developing methods to re-rank the Index of Relative Socioeconomic Disadvantage (IRSD), we aimed to redistribute the membership of current decile groups to establish a locally sensitive indicator of relative disadvantage for Australia. In this proof-of-concept approach, to investigate whether existing SEIFA IRSD rankings could be redistributed to become locally sensitive, we explore three methods by re-ranking areas relative to:
(1) the nearest administrative (SA1) areas capped at the nearest 99 neighbours (nearest neighbour),
(2) the nearest areas capped at a population threshold of 50,000 (population threshold), and
(3) the nearest areas capped at a distance threshold of 10km (distance threshold).
Unlike the approach used by Rae (2009), our measure does not alter or recalculate the SEIFA scores allocated to areas, but simply re-ranks them. Ultimately our vision is for a local IRSD ranking to be tested, adapted, and adopted for wide use to inform relevant policy and research within Australia.

2. Data and methods

2.1 Description of current SEIFA IRSD rankings

The construction of the IRSD rankings have been outlined in detail elsewhere (ABS 2011, 2016b). Briefly, SEIFA scores are derived for almost all Statistical Area Level 1 (SA1) units across Australia (n=55,028), with a few excluded mainly due to issues such as low population size (ABS 2016a). SA1s are built from whole Mesh Blocks and are intended to remain relatively stable over time, although the boundaries are updated when there has been substantial population growth in given areas. SA1s are the smallest geographical unit for the release of SEIFA with an average population size of 400 residents (range 200 to 800 residents) (ABS 2016a). By nature of design, SA1s outside of cities are often smaller in population and larger in geographical coverage.

The 2016 version of the IRSD score for each SA1 is a weighted combination of 16 census-collected variables that indicate levels of social and material disadvantage at the SA1 level. Scores have been standardised to have a mean of 1,000 and a standard deviation of 100. For an area to receive a score of 1,000, all 16 indicators must be equal to the national average. With this score, SA1 areas are ranked on a continuum and then allocated to decile groups from 1 (most disadvantaged, i.e., a high proportion of relatively disadvantaged people in this area) to 10 (least disadvantaged). ABS recommend using these index rankings and deciles, rather than the numerical score. The rankings and decile groups are made available at a national level and at a state/territory level.

2.2 Methods to re-rank SEIFA IRSD

To achieve a more locally sensitive IRSD, membership of decile groupings was redistributed by re-ranking each SA1 across Australia according to the three methods described below (code currently available from authors upon request). To test our concept, we employed arbitrary cut off points for each method described below. It is important to note that each of these methods rely on first generating a geometric centroid for each SA1 polygon (ArcGIS – points forced to be inside polygon) and that the measures are not restricted to state borders (i.e., a neighbouring SA1 could be on the other side of the state boundary).

Method 1: Re-rank SA1s according to neighbours (nearest neighbour)

To explore whether existing SEIFA IRSD rankings (that are derived from nearly all SA1 units across Australia) could be re-ranked to become locally sensitive, this first method scored each SA1 against its 99 nearest neighbours (total of 100 inclusive of the SA1 that the nearest 99 was measured from). Once generated, the 99 nearest neighbours, i.e., 99 points in closest proximity, were identified using R and the ‘knearneigh’ function (R package ‘spdep’) and an origin-destination matrix was created. The scores for each SA1 were given a fixed rank based on how each SA1 scored in relation to its 99 nearest neighbours. This process resulted in the creation of new membership of decile groups relative to the SA1s nearest neighbours.

Method 2: Re-rank SA1s according to population (population threshold)

In Method 2, we constructed a nearest-neighbour matrix similar to Method 1, with a threshold of minimum 50,000 residents, rather than 99 neighbours. This was achieved using R and the ‘knn.index’ function of the ‘FNN’ package, by iteratively identifying nearest neighbouring areas and summing up corresponding population values, until the value of at least 50,000 was reached. The final SA1 neighbour added may cause the total to slightly exceed this threshold.

Method 3: Re-rank SA1s according to distance (distance threshold)

Nearest neighbours were identified within a distance of 10km measured from the centroid of the SA1 polygon. This was implemented through applying the ‘dnearneigh’ function (R package ‘spdep’), identifying neighbour points by Euclidean distance (10km). For this method, the minimum number of neighbouring areas was set at 30. This means that areas that have <30 SA1s within 10km are not included in this distance-based ranking.

Thus, updated decile groups are available at the national and state level (ABS generated) and the local level (generated using these three methods above). Comparisons of these decile groups were undertaken and graphs produced using Stata v16.1.

3. Results

We provide detail on the variations by state in the distribution of SA1s to decile groups according to the national, state and three local methods in Figure 1. Further details of the IRSD score breakdown within decile categories for each of the ranking methods is available from the authors on request.

Data presented in Figure 1 demonstrates subtle and sometimes large differences in the distribution of SA1s to decile groups depending on the ranking method used. Whilst at times the overall distribution seems to not have shifted a large amount, a more detailed look at the changes in Figure 2 illustrates the degree to which the decile membership of SA1s can shift when using the various local methods compared to the state-based decile groups using the state of Victoria as an example (possible range -9 to +9). For the nearest neighbour and population threshold methods some SA1s differed by up to 8 decile categories, indicating that their decile group would vary greatly depending on the use of state or local decile groups. For the distance threshold method, the differences at the tail ends of the distribution were not as great. National and state decile groups were also compared in the same way for Victoria (not presented) and it is clear that the distribution does not shift as meaningfully between state and national decile groupings, as it does between the state and the three local decile groups.

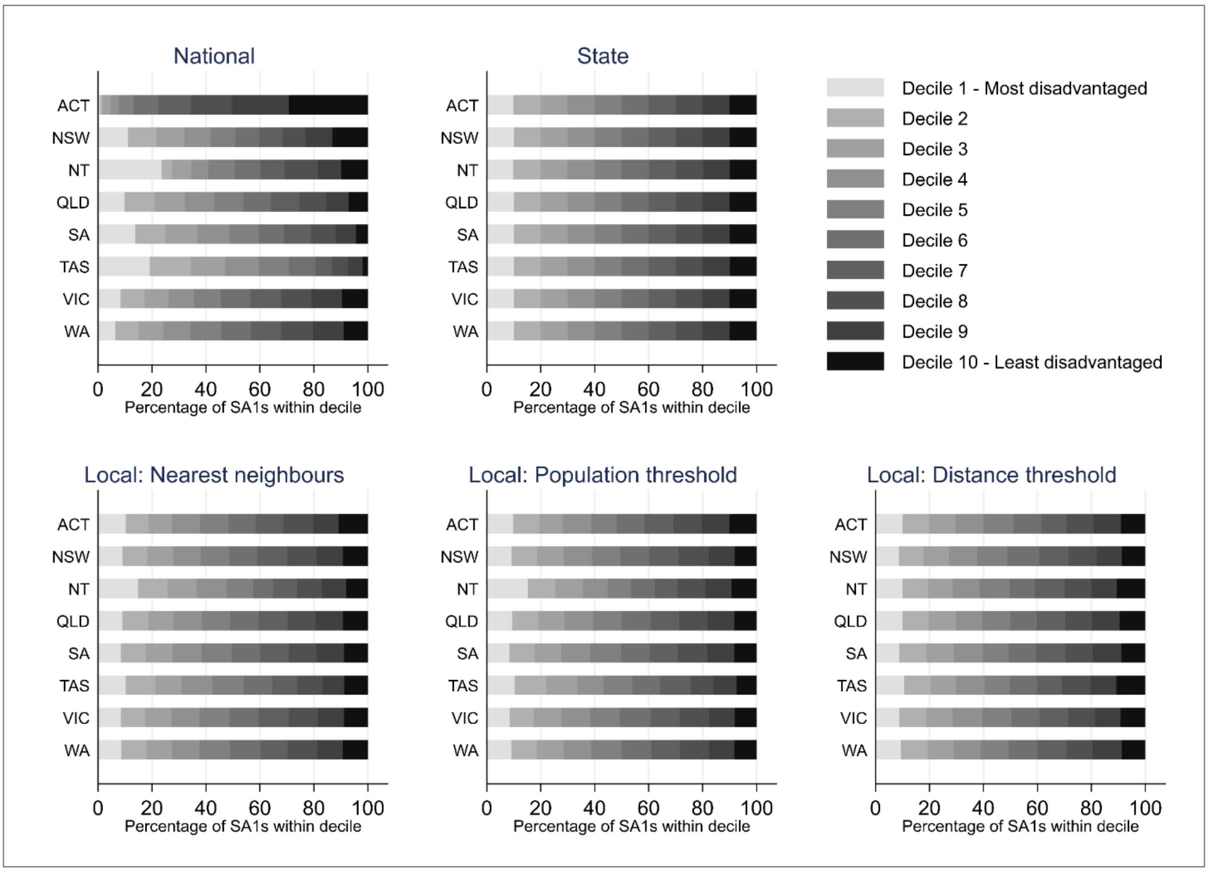

Figure 1: State-based differences in the percentage of SA1 in each decile of disadvantage using the national, state, and local ranking methods

Source: authors' calculations.

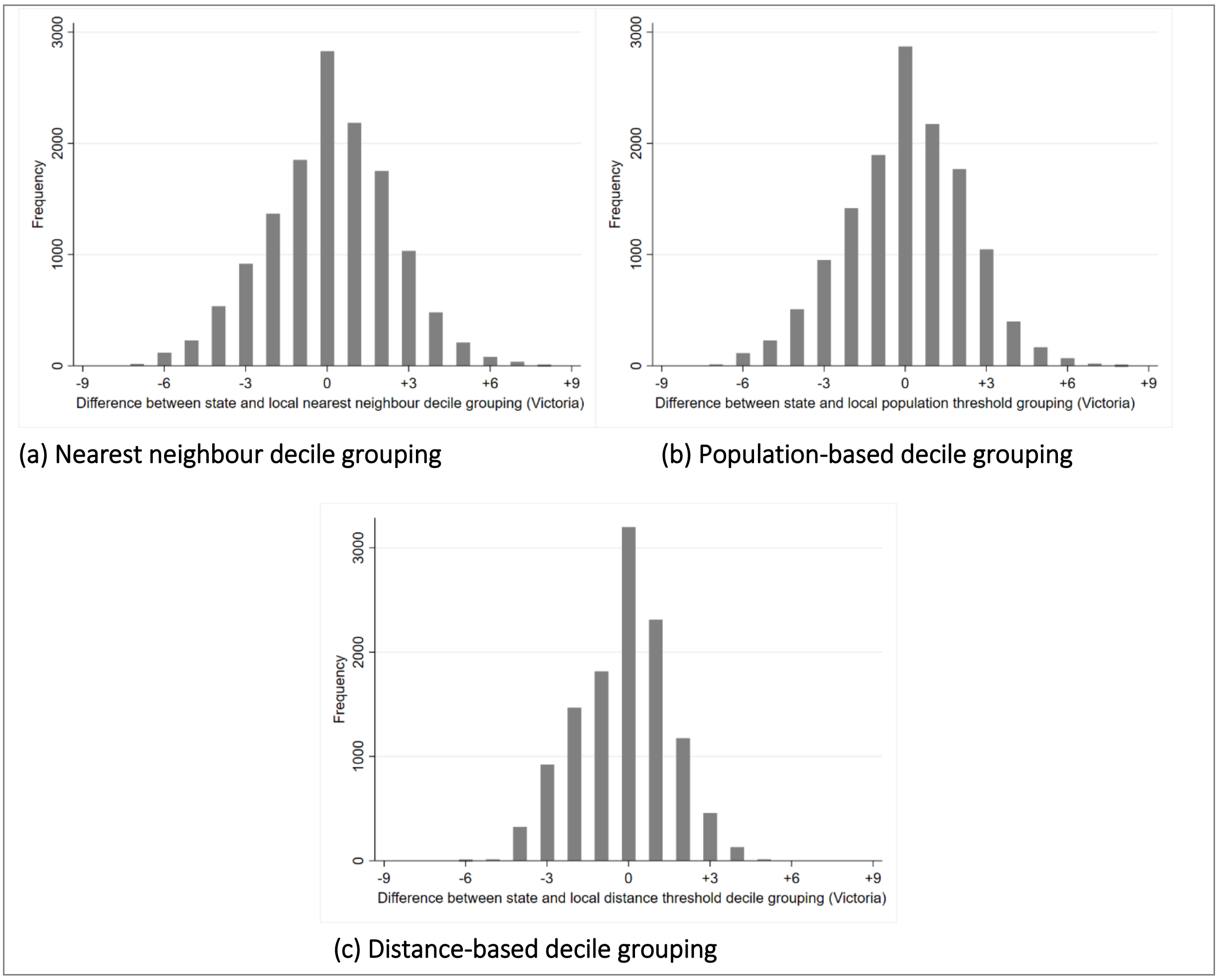

Figure 2: Distribution of shift in decile group membership between state decile groups and local decile groups within Victoria

Source: authors' calculations. *Note*: values represent how far a SA1 shifted in terms of decile group

Table 1 presents the percentage of each state's SA1s that were in both the state and local nearest neighbour most disadvantaged decile. The combined use of a state and local ranking is important for resource allocation purposes as it allows further refinement of areas considered the most disadvantaged. For SA1s in major city regions, excluding the ACT (82%), less than half of the SA1s categorised as most disadvantaged according to the state rankings were also in the local nearest neighbour most disadvantaged decile. These percentages were generally higher in inner regional and outer regional areas, but still suggested that between half and three quarters of the SA1s were in the most disadvantaged decile when combining both the state and nearest neighbour rankings compared to just the state-based ranking.

Table 1: Number and percentage of SA1s in state's most disadvantaged decile (Decile 1) that were also in the most disadvantaged decile (Decile 1) for the local nearest neighbour measure

	Major city			Inner regional			Outer regional		
State	No. of SA1s in State Decile 1	No. of SA1s in Nearest neighbour Decile 1	No. (%) of SA1s in State Decile 1 that are also in Nearest neighbour Decile 1	No. of SA1s in State Decile 1	No. of SA1s in Nearest neighbour Decile 1	No. (%) of SA1s in State Decile 1 that are also in Nearest neighbour Decile 1	No. of SA1s in State Decile 1	No. of SA1s in Nearest neighbour Decile 1	No. (%) of SA1s in State Decile 1 that are also in Nearest neighbour Decile 1
ACT	101	105	83 (82.2%)	0	0	0	-	-	-
NSW	1071	1090	501 (46.8%)	438	366	267 (61.0%)	219	127	118 (53.9%)
NT	-	-	-	-	-	-	2	32	2 (100%)
QLD	418	566	207 (49.5%)	385	213	183 (47.5%)	229	170	124 (54.1%)
SA	256	216	96 (37.5%)	33	64	24 (72.7%)	95	51	47 (49.5%)
TAS	-	-	-	94	89	64 (68.1%)	39	48	33 (84.6%)
VIC	889	811	319 (35.9%)	353	276	204 (57.8%)	119	72	68 (57.1%)
WA	307	339	141 (45.9%)	68	62	51 (75.0%)	79	44	44 (55.7%)

Source: authors' calculations

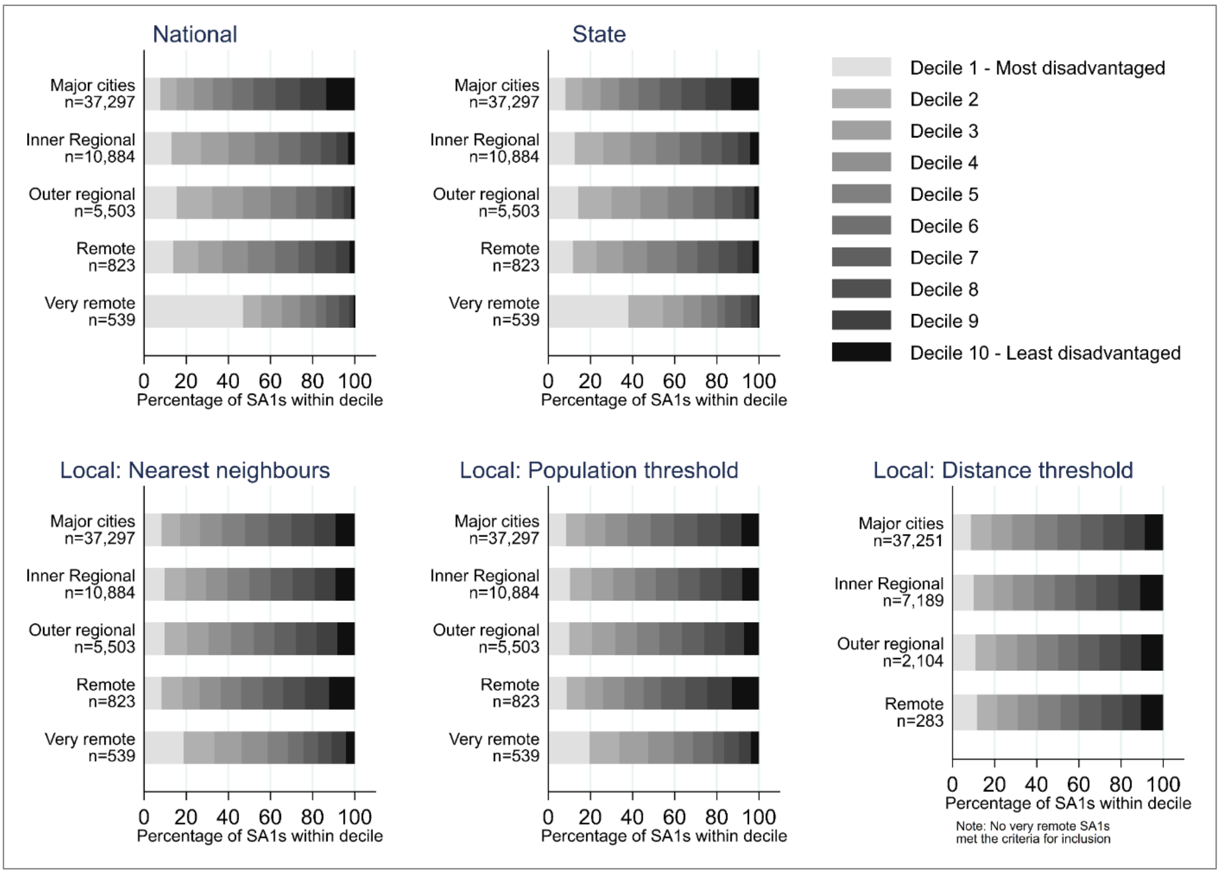

Figure 3: Remoteness area differences in the percentage of SA1s in each decile of disadvantage using the national, state, and local ranking methods

Source: authors' calculations.

Using the national and state rankings, over one third of major city SA1s are within deciles 8 to 10 (the least disadvantaged) whereas for inner regional, outer regional and remote areas over one third of SA1s are within deciles 1 to 3 (the most disadvantaged) (Figure 3). For each of these four areas, the distribution of SA1s within decile categories is more even when using the local ranking methods. We are cautious to make conclusions on the very remote SA1s given the unique characteristics of these areas. A visual example of the change in decile rankings for SA1s within and around the inner regional city of Bendigo in Victoria by comparing the national, state and local ranking methods is presented in Figure 4. This highlights a substantial reclassification of SA1 deciles using the local ranking methods in a single regional township and results presented earlier indicate this is likely to be replicated elsewhere.

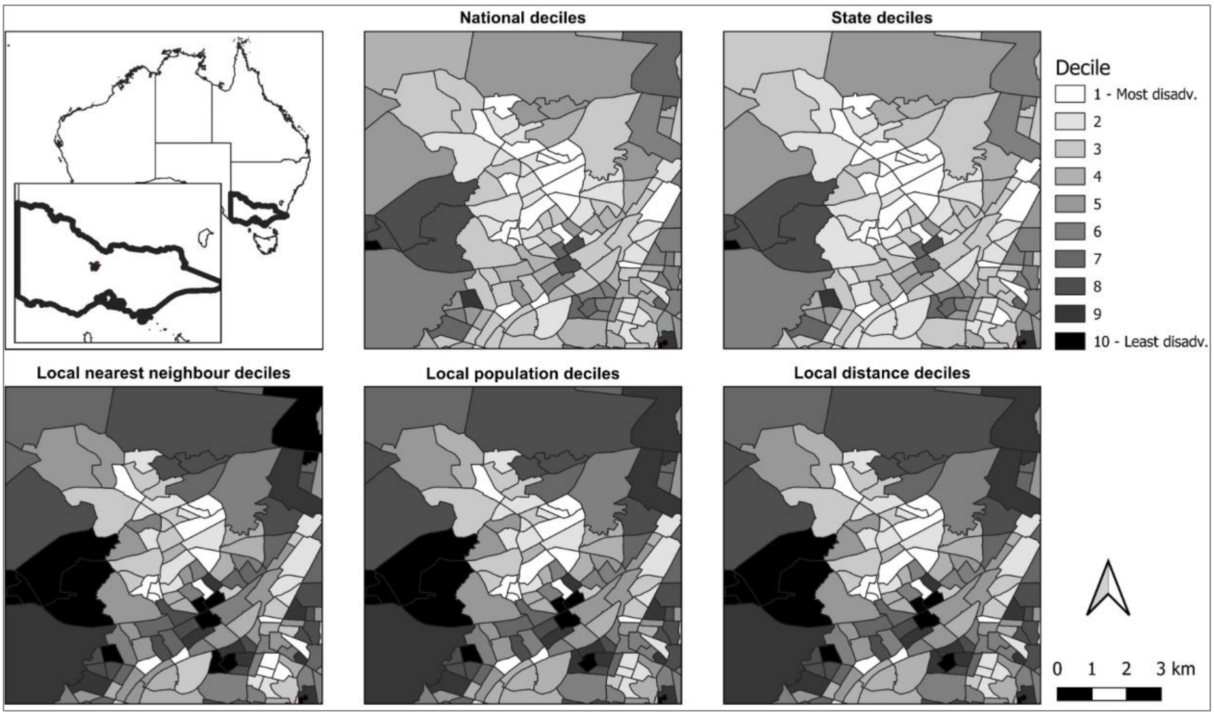

Figure 4: Comparison of the national, state, and local decile groupings around Bendigo (Victoria)
Source: authors' calculations.

4. Discussion

Area-based measures of disadvantage are critical for resource allocation, advocacy, and equitable planning (Salmond & Crampton 2012), and therefore it is imperative to accurately reflect relative levels of disadvantage. Current indicators of area-level disadvantage in Australia rank areas based on two separate geographic levels, national and state/territory. In this study we created a third, local, level for ranking the SEIFA disadvantage index and proposed three approaches to achieve this.

The methods we proposed in this research utilised existing SEIFA data and expanded upon current approaches to ranking areas to better capture relative disadvantage. We focused on Australian data since the large geographic area of Australia and distribution of the population across this large area makes this issue even more pertinent, particularly outside of major cities as demonstrated by our findings against the categories of remoteness. However, we also note that international measures of deprivation and disadvantage potentially suffer similar limitations (Allik et al. 2020; Braveman et al. 2005; Greco et al. 2019; Quick & Luan 2021) and whilst many ideas have been put forward to address these (mostly in relation to the creation of the composite indexes themselves), we believe our local ranking approach provides a unique contribution. Thus, as a proof of concept, we created three local ranking methods and reallocated the decile categorisation used in the SEIFA IRSD based on these new rankings. After this initial conceptualisation and validation work, we anticipate future research will further develop and refine the most appropriate local measure.

Our results highlight noticeable differences in the local rankings decile categories allocated to SA1s compared to that provided by national and state level rankings. Current SEIFA indicators may guide resource allocation, and with a high number of areas considered to have high levels of disadvantage under the state and national ranking system, it likely means that not all areas will be provided with the level of support required. By combining the state and local nearest neighbour ranking (as an example), a lower number of SA1s were considered most disadvantaged in comparison to using the state measure alone. Consequently, using this combination ranking may help to refine and identify priority areas with the greatest need of resource allocation. This may be particularly important in smaller regional local government areas where social support mechanisms may be underfunded, meaning that the prioritisation of resource allocation is critical (Parliament of Australia 2006).

We provide proof of concepts for three unique methods to rank area-level disadvantage at a local level in Australia. Unlike the currently available IRSD state decile groupings, our options for local groupings are less subject to edge-effects as they can cross state boundaries. Furthermore, we demonstrate that our methods improve the ability to distinguish areas of disadvantage relative to other nearby areas and populations, particularly outside of major cities.

We acknowledge that the methods and thresholds selected could be altered in a number of ways. Conclusions reached can depend on the input data and, similar to MAUP (Brunsdon & Comber 2020; Openshaw 1979; Openshaw 1984), the results of this study are specific to the methods and thresholds we used. To promote progress toward the development of more standardised methods for the measurement of local area-level disadvantage in Australia, we propose that research be undertaken to test alternative approaches. These could include further exploring the use of k-means clustering techniques to generate typology of deprivation classes that may be applied locally within urban and rural settings across Australia.

Based on our best judgement, we employed arbitrary cut off points for what constitutes a local neighbourhood (e.g., 99 neighbouring areas; areas within a 10km radius; nearest 50,000 population). All three methods were based on the distance to the centroid created for the nearest neighbour decile grouping, when in fact the road layout and presence of physical boundaries may create barriers between the SA1s. Using Mesh Blocks, it may have been possible to create an estimate of the population-weighted centroid which may alter results slightly for some of the more sparsely populated and therefore geographically larger SA1s in regional and remote areas. Additionally, because we set the minimum number of neighbouring areas at 30 for the distance-based decile groupings, we acknowledge that this method of re-ranking does not work as well in more sparsely populated areas and those near natural barriers such as coastlines.

In this study we use decile categorisation but do not address related problems. Categorisation of exposures measures can cause a wide range of issues (Lamb & White 2015) and, as recently highlighted by Allik et al. (2020), it is important to recognise that values near to the cut-off points between categories could easily belong to another category. This limitation means that caution is needed when using of decile categorisation as the deciding factor motivating a policy intervention.

5. Conclusions

The relationship between space and place is complex. While data collection systems and technology for processing data have evolved, we still need better ways to understand disadvantage and the process for equitable distribution of resources that help reduce the impact of socioeconomic disadvantage. The current methods demonstrate that relative levels of socioeconomic disadvantage at the national or state level differ to that at a local level. Because current rankings make it challenging to isolate disadvantaged areas relative to neighbouring areas, policy decisions relating to the distribution of health and other services may be misguided. As a first step to improve this limitation, we offer three methods to better measure local disadvantage throughout Australia and we encourage researchers to trial these in future research. Rather than replacing current SEIFA rankings, we envision these local ranking will complement existing national or state rankings.

Key messages

- Australia's area-based socioeconomic indexes (SEIFA) rank areas relative to country or state.
- To better reflect disadvantage relative to nearby areas, we developed local rankings.
- Results are presented for three newly developed local rankings for Australia.
- We encourage the combined use of a state and local rankings for resource allocation, to ensure that the most disadvantaged areas are not overlooked.

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