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Application of the Australian Bureau of Statistics Socio-Economic Indexes for Areas in cardiovascular disease research: a scoping review identifying implications for research

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ABSTRACT

Objective. To scope how the Australian Bureau of Statistics Socio-Economic Indexes for Areas (SEIFA) has been applied to measure socio-economic status (SES) in peer-reviewed cardiovascular disease (CVD) research. **Methods.** The Joanna Briggs Institute's scoping review methodology was used. **Results.** The search retrieved 2788 unique citations, and 49 studies were included. Studies were heterogeneous in their approach to analysis using SEIFA. Not all studies provided information as to what version was used and how SEIFA was applied in analysis. Spatial unit of analysis varied between studies, with participant postcode most frequently applied. Study quality varied. **Conclusions.** The use of SEIFA in Australian CVD peer-reviewed research is widespread, with variations in the application of SEIFA to measure SES as an exposure. There is a need to improve the reporting of how SEIFA is applied in the methods sections of research papers for greater transparency and to ensure accurate interpretation of CVD research.

Keywords: Australia, Australian Bureau of Statistics, cardiovascular disease, health policy, SEIFA, social determinants of health, socio-economic factor, Socio-Economic Indexes for Areas, scoping review.

Introduction

Socio-economic status (SES) is important to understand the relationship between chronic disease and risk factors. Globally, the association of SES and the risk of multimorbidity, non-communicable disease, frailty and disability is well established.[1,2] Cardiovascular disease (CVD) is one of the most prominent causes of death globally, with 17.9 million people estimated to have died from CVD in 2019,[3] which increased to 20.5 million people in 2021.[4] A socio-economic gradient is well established for CVD morbidity and mortality outcomes, and it includes lower levels of educational attainment, income level and employment status.[5,6] For example, residing in a disadvantaged neighbourhood has been associated with a higher incidence of coronary heart disease[5] and a higher risk of CVD.[7] In Australia, national data indicate that mortality rates associated with CVD are higher in populations residing in the lowest socio-economic areas compared with populations residing in the highest socio-economic areas.[8]

CVD research examining and understanding the role of SES is central to developing targeted preventative interventions, and informing health service planning and policy. Research has generally applied two approaches to classifying SES in health research.[9,10] These include classification at an individual level using income, education or occupation data; and at an area level using a range of existing socio-economic information.[10] In Australian health research undertaken with specific communities (Aboriginal and Torres Strait Islander peoples), individual-level approaches have been preferred by researchers to ensure that findings are more relevant to the research setting.[9] For analysis of population-level data, area-level approaches are more commonly applied in a defined geographical area.[11] The annual reporting of Australian health data (such as the Australian Institute of Health and Welfare Australia's Health Report) uses the Socio-Economic Indexes for Areas (SEIFA) Index of Relative Socio-Economic Disadvantage (IRSD) as an area-level measure to report on socio-economic characteristics of health risk factors, chronic disease, mortality and morbidity.[10] Further information is provided in Supplementary File S1.

General guidance from the Australian Bureau of Statistics (ABS) around applying SEIFA states that the indexes indicate the average socio-economic characteristics of populations in an area, and are best interpreted as ordinal measures.[12–14] Researchers have critiqued the use of SEIFA as a composite measure in health research because it does not account for the heterogeneity of individual indicators of SES in a geographical area.[15] International scholars have supported the use of area-level approaches using spatial measures of CVD risk and socio-economic disadvantage, to implement targeted public health interventions to communities at higher risk for CVDs.[5] Examining how SEIFA has been applied in CVD research and at what spatial unit, is important to identify any opportunities to improve the consistency in application. To our knowledge, a review of Australian CVD peer-reviewed research examining the application of SEIFA, has not been conducted, indicating a research gap. No similar proposed reviews were identified.

The review question was:

How has the ABS SEIFA been applied to examine SES in peer-reviewed CVD research undertaken in Australia?

Objectives included:

1. To scope the application of the ABS SEIFA to examine SES as an exposure measure in peer-reviewed CVD research; and
2. To examine at what spatial unit SEIFA has been applied in peer-reviewed CVD research.

Methods

The Joanna Briggs Institute's (JBI) scoping review methodology was used.[16] The Preferred Reporting Items for Systematic Reviews and Meta-analysis extension for Scoping Reviews (PRISMA-ScR)[17] checklist was reported against (Supplementary File S2). Methods were specified in advance (Open Science Framework https://doi.org/10.17605/OSF.IO/M9WD7). The JBI three-step search process guided the development of the search strategy.[18] Searches were developed for databases: Ovid MEDLINE, CINAHL Complete (EBSCOhost), APA PsycInfo (EBSCOhost), and Embase (Elsevier) (Supplementary File S3). Google Scholar was also searched using keywords.

Inclusion and exclusion criteria

Studies were screened according to the inclusion and exclusion criteria (Table 1). Peer-reviewed CVD research in which SES was examined as a primary or secondary exposure measure using the ABS SEIFA indexes, was included. Searches were limited from 1 January 2013 to capture research published since the release of SEIFA 2011 (March 2013).

Study selection and data extraction

Citations were imported into Covidence (Veritas Health Innovation, Melbourne, Australia). Titles and abstracts were screened independently by two reviewers. Full text review and data extraction was then undertaken. Findings were synthesised using a descriptive approach.[16] A quality assessment of included studies was undertaken using the JBI critical appraisal tools. To our knowledge, no validated quality assessment tool currently exists for ecological studies, therefore the JBI critical appraisal tool for analytical cross-sectional studies was applied where appropriate (an approach used by other reviews examining ecological studies).[20]

Ethics

Ethics approval was not required for this review of the literature.

Results

Of the 95 citations eligible for full text screening, 49 studies were included. No additional citations were identified through a review of references (Fig. 1). Reasons for excluding studies are provided in Supplementary File S4. A narrative synthesis of studies and implications of studies is presented in Supplementary File S5.

Characteristics of included studies

Of the 49 included studies (Table 2), 10 studies had a national focus and two studies focused on populations residing in two or more Australian states or territories. The remaining studies had a geographical focus at a state or territory level: the highest proportion focused on populations in Victoria ($n = 12$), followed by Queensland ($n = 10$), Tasmania ($n = 5$), New South Wales ($n = 4$), Western Australia ($n = 3$), South Australia ($n = 2$) and Australian Capital Territory ($n = 1$).

Study design varied and included ecological studies using data linkage methods ($n = 22$: $n = 10$ study design not specified, $n = 5$ cohort study, $n = 5$ cross-sectional study, $n = 1$ time series and spatial analysis, $n = 1$ panel study), cohort studies using data linkage methods ($n = 19$) or analysis of trial datasets ($n = 1$), cross-sectional studies using screening ($n = 1$) or data linkage and/or surveys ($n = 4$), an economic modelling study using data linkage ($n = 1$), and a case study ($n = 1$).

The included studies cited 78 data sources. These included existing state or territory databases ($n = 32$; e.g.

Table 1. Inclusion and exclusion criteria.

	Inclusion criteria	Exclusion criteria
Population	Australian populations with CVD. Cardiovascular diseases were classified using the International Classification of Diseases (11 – diseases of the circulatory system)[19] and defined as disorders of the heart and blood vessels, and included coronary heart disease, hypertension, cerebrovascular disease, congenital heart disease, rheumatic heart disease, peripheral arterial disease, deep vein thrombosis and pulmonary embolism.[3]	Non-Australian populations, Australian populations without CVD.
Concept	Peer-reviewed experimental or observational research, including, but not limited to, cross-sectional studies, cohort studies, randomised controlled trials, which used the ABS SEIFA indexes[12] to examine SES as a primary or secondary exposure measure.	Editorials, protocols, opinion-based pieces, and non-peer-reviewed literature (e.g. government reports) and research using non-ABS measures of SES and studies that examine SES as a confounder, not an exposure.
Context	Studies published in English since 1 January 2013 to capture studies published since the release of SEIFA 2011.	Studies published prior to 1 January 2013

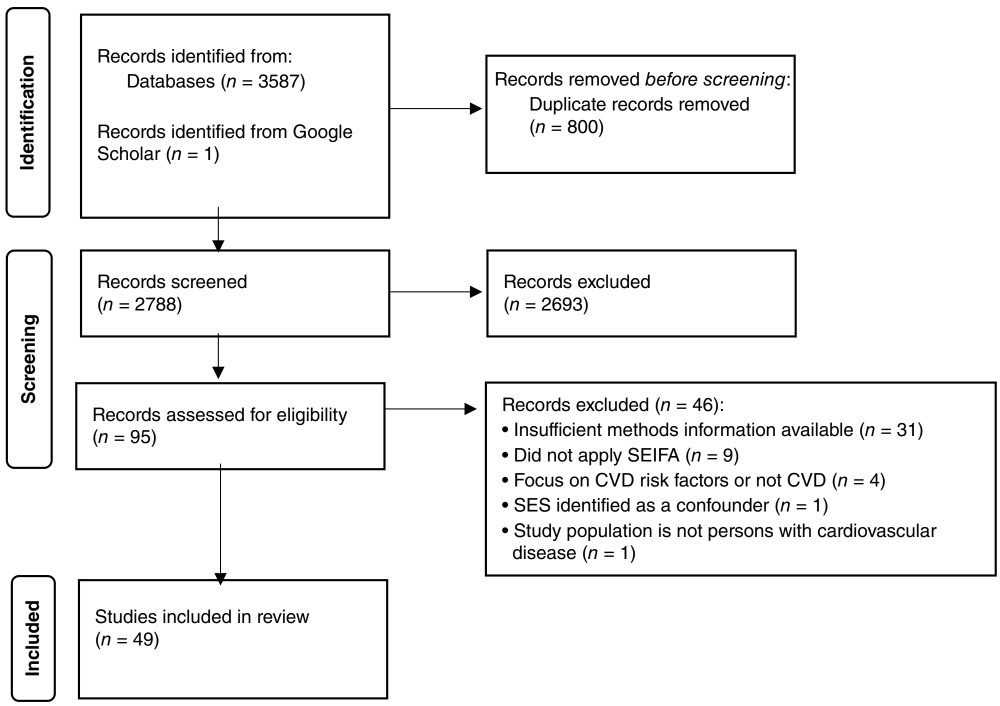

Fig. 1. PRISMA flow diagram. From Page *et al.*[21]

Victorian Admitted Episodes Dataset, Tasmanian Death Registry), national databases ($n = 19$; e.g. Australian Pharmaceutical Benefits Scheme database), research and/or quality improvement databases ($n = 22$; e.g. Medicine Insight database), health service databases ($n = 4$; e.g. hospital specific), and other administrative databases not otherwise named ($n = 1$).

Application of Socio-Economic Indexes for Areas indexes

All of the studies cited the use of SEIFA in the methods section (Table 3). One study did not cite which SEIFA version (year of release) or SEIFA index was applied,[69] 13 studies did not report which specific SEIFA index was used but reported the SEIFA version applied, and two studies did not report which version was used. Studies that reported the version and index applied most frequently, used the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) 2011.

Of the included studies, seven studies used a direct approach that involved assigning SEIFA scores or deciles to study populations for analysis. Most studies ($n = 41$) applied an indirect approach, which involved collapsing SEIFA scores or deciles into further categories, including quintiles, quartiles and tertiles. One study did not report how SEIFA was applied.[69]

Table 2. Characteristics of included studies.

Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
Adair and Lopez (2021)[22]	Australia	To assess whether mortality inequalities among specific non-communicable diseases in Australians aged 35–74 years, widened during 2006–2016 (2006–2016)	Ecological study (data linkage)	Premature mortality (SES; remoteness)	Not reported for CVD	No	CVD mortality inequalities were mostly wider than for all non-communicable diseases. The Q1:Q5 premature mortality ratio was 2.28 for male participants and 2.67 for female participants.	Due to different versions of SES measured using IRSAD for 2006–2010 (SLA) and 2011–2016 (SA2), an analysis of long-term trends was not possible.	Widening inequalities in premature mortality rates attributed to non-communicable disease, including CVD, is a public health issue requiring immediate policy responses with a focus on socio-economic disadvantage.
Astley *et al.* (2020)[23]	South Australia	To determine the impact of cardiac rehabilitation attendance on cardiovascular re-admission, morbidity, and mortality between 2013 and 2015 (2013–2015)	Retrospective cohort study (data linkage)	Re-admissions; morbidity; mortality (SES)	49,909 eligible patient separations	No	Of 49,909 eligible separations, 30.2% were referred to cardiac rehabilitation with an attendance rate of 28.4%. Referred/declined patients were older, more likely to be female, with more heart failure and arrhythmia admissions and higher socio-economic disadvantage (median IRSAD: 950.1 vs 960.4, $P < 0.001$).	Given that administrative datasets were used, data may be incomplete with the risk of systematic bias in reporting of outcomes.	System and program considerations for future cardiac rehabilitation programs are identified.

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Table 2. (*Continued*)

Citation	State/Territory/Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
Atkins *et al.* (2013)[24]	Western Australia	To characterise admissions for an atherothrombotic event in the major arterial territories in men and women aged 35–84 years to tertiary, non-tertiary metropolitan, and rural hospitals in Western Australia during 2007 (2007)	Retrospective cohort study (data linkage)	Sociodemographic features; clinical features; hospital type (SES)	11,670 index admissions	No	Comparisons of socio-economic disadvantage identified that for those admitted to rural hospitals, more than one-third were in the most disadvantaged quintile, compared with one-fifth admitted to any metropolitan hospital.	Given that administrative datasets were used, analysis was limited by the variables requested. Furthermore, given that SEIFA scores were based on the residential address on hospital admission, this could potentially overestimate or underestimate the level of disadvantage if the address was not the usual location for the person.	Due to these significant differences, findings have implications for atherothrombotic healthcare provision and the generalisation of research findings from studies conducted exclusively in the tertiary metropolitan hospitals.
Baker *et al.* (2017)[25]	New South Wales	To present a method for comparing temporal trends in disease outcomes between multiple diseases and examine the effect of residual shared latent factors over time after adjusting for known factors (2001–2006)	Case study (Bayesian spatiotemporal method)	Hospitalisation rates	13,866 cases (coronary artery disease); 6401 cases (chronic obstructive pulmonary disease); 5150 cases (chronic heart failure); 4869 cases (type 2 diabetes mellitus); 804 cases (hypertension)	No	It was identified that the choice of model depends upon the application. SES was substantively associated with hospitalisation rates, which differed for each disease.	Socio-economic information was available only for 1 year of the study. Information regarding other factors was not available at a spatial or temporal level.	Selecting the appropriate joint disease model enables the examination of temporal patterns and spatial factors for each disease.

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Table 2. (*Continued*)

Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
Biswas *et al.* (2019)[26]	Victoria	To examine whether there is an association between SES and baseline risk profile, clinical outcomes and use of secondary prevention therapy in patients undergoing PCI for ST-elevated myocardial infarction (2005–2015)	Prospective cohort study (data linkage)	Major adverse cardiovascular events; 12-month mortality; 30-day mortality, and 30-day major adverse cardiovascular events; secondary prevention medications; smoking status; post-PCI (SES)	5665 patients	No	Patients residing in a lower socio-economic area were more likely to have diabetes mellitus, be smokers, and present to a non-PCI-capable hospital (all $P \leq 0.01$). The median time to reperfusion was slightly higher in lower SES groups (211 [144–337] vs 193 [145–285] min, $P < 0.001$). Twelve months following PCI, lower SES patients had higher rates of ongoing smoking and lower use of guideline-recommended secondary prevention therapy (both $P < 0.01$). Despite these differences, SES group was not found to be an independent predictor of 12-month major adverse cardiovascular events.	As a registry-based study, all possible confounders were unable to be accounted for. Individual SES was not accounted for, rather based on the patient's residential area. Other factors not included in the IRSD score, may also affect patient health, and were not accounted for.	There were baseline differences in lower SES patients who had more comorbidities and slightly longer reperfusion times, however, clinical outcomes following a PCI were similar across SES groups.

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Table 2. (*Continued*)

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Busija *et al.* (2013)[27]	Victoria	To estimate the proportion of stroke patients who take part in clinical research studies and to compare demographic and clinical profiles of research participants and non-participants (2004–2011)	Cross-sectional study (administrative dataset)	Participation in clinical research (patient characteristics; re-admissions; SES)	5235 patients	No	10.7% of patients took part in at least one of the 33 clinical research studies during the study period. High SES (OR = 0.74, 95% CI: 0.59–0.93) were associated with lower odds of research participation.	Patients included were from a single metropolitan teaching hospital.	Stroke patients who take part in clinical research are not representative of the 'typical' patient admitted to a stroke unit, which has implications for interpretation of research findings reported in stroke literature.
Carter *et al.* (2019)[28]	Australia	To project the long-term impacts of Australian CVD deaths in 2003 on labour force participation and the present value of lifetime income forgone (2003)	Economic modelling study (data linkage)	Labour force participation; present value of lifetime income forgone (SES)	18,450 premature deaths	No	Premature deaths due to CVD in 2003 accounted for 51,659 working years and $A2.69 billion in present value of lifetime income forgone when modelled to 2030 (95%CI: $2.63–$2.75 billion). Deaths occurring in individuals residing in the most socio-economically disadvantaged areas at the time of death had a disproportionately large impact on the total present value of lifetime income loss.	SEIFA index used as a proxy for an individual's SES.	The magnitude of costs identified indicates the need for investments in effective healthcare interventions to provide positive economic returns.

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Table 2. (*Continued*)

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Cheng *et al.* (2020)[29]	Queensland	To examine short-term effects of winter temperature on the risk of myocardial infarction and explore spatial associations of winter hospitalisations with temperature and SES (2005–2015)	Ecological study using time series and spatial analysis (data linkage)	Myocardial infarction hospitalisation; daily temperature (SES)	4978 hospitalisations	No	At the city level, each 1°C drop in temperature below a threshold of 15.6°C was associated with an RR of 1.016 (95%CI: 1.008–1.024) for myocardial infarction hospitalisations on the same day. Winter myocardial infarction incidence rates varied spatially in Brisbane, with a higher incidence rate in areas with lower socio-economic levels (RR: 0.900, 95%CI: 0.886–0.914 for each decile increase in IRSAD).	Study was undertaken in one metropolitan centre, limiting generalisability of findings. A stratified analysis of patient disease history was not undertaken.	Findings support that short-term winter temperature drops were associated with an elevated risk of myocardial infarction hospitalisations in a subtropical region with a mild winter, and the need for particular attention for persons residing in socio-economically disadvantaged areas.
Chew *et al.* (2016)[30]	Australia	To explore geographic, socio-economic, health service and disease indicators associated with variation in angiography rates across Australia (2011)	Ecological study (data linkage)	Rates of acute coronary syndrome, angiography, revascularisation, and mortality (SES; health workforce indicators; rurality)	Not reported	No (Aboriginal and Torres Strait Islander status included as a variable)	Socio-economic disadvantage and remoteness were correlated with disease burden, acute coronary syndrome incidence and mortality, but not with angiography rate.	A linear relationship between variables was assumed. A small sample was used.	Variation in rates of coronary angiography, not related to clinical need, occurs across Australia.

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Close *et al.* (2014)[31]	New South Wales	To investigate the relationship between heart failure outcomes and SES (1998–2002)	Ecological study (data linkage)	Hospitalisation rates; mortality rates (SES)	Not reported	No	Rates of heart failure hospitalisations per local government area were inversely correlated with level of SES.	Study population from a single metropolitan centre, therefore findings may be limited in generalisability.	Higher rates of heart failure hospitalisations were identified for persons residing in areas that were socio-economically disadvantaged and indicate the need for targeted strategies.
Dawson *et al.* (2022)[32]	Victoria	To assess whether there are disparities in incidence rates, care, and outcomes for patients with chest pain attended by emergency medical services according to SES (2015–2019)	Cohort study (data linkage)	Clinical outcomes; quality of care (SES)	240,466 patients	No (Aboriginal and Torres Strait Islander status included as a variable)	Age-standardised incidence of chest pain was higher for patients residing in lower SES areas (lowest SES quintile 1595 vs highest SES quintile 760 per 100,000 person-years; $P < 0.001$). Patients of lower SES were less likely to attend metropolitan, private, or revascularisation-capable hospitals and had greater comorbidities. In multivariable models adjusted for clinical characteristics and final diagnosis, lower SES quintiles	A proportion of ambulance cases could not be linked to hospital admissions and SES data were not available for all patients. Individual SES was not examined.	Lower SES was associated with a higher incidence of chest pain presentations to emergency and differences in care and outcomes, which indicate socio-economic disparities.

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							were associated with increased mortality risks and re-admission.		
Gutman *et al.* (2019)[33]	Victoria	To determine whether traditional markers of disadvantage [female sex, low SES (SES), and remoteness] are associated with lower prescription of evidence-based therapy and higher mortality in patients with moderate–severe heart failure with reduced ejection fraction (2005–2016)	Cohort study (trial dataset)	Mortality; evidence-based therapy delivery (SES; remoteness)	452 patients	No	No difference in overall survival based on sex (HR = 1.19, 95%CI: 0.74–1.92) was identified. Higher SES or inner-city residence did not have an overall survival benefit.	Analysis of an observational trial therefore subject to confounders.	Delivery of care and likelihood of death were comparable between the sexes, SES groups, and persons residing in rural vs metropolitan areas.
Hanigan *et al.* (2017)[34]	Australian Capital Territory	To explore the impact of the scale of spatial aggregation when describing the spatial distribution of selected hospital admissions for CVD and examine associations of socio-economic disadvantage (2011–2013)	Ecological study (data linkage)	Hospitalisation (SES)	1365 admissions (myocardial infarction); 10,441 (CVD)	No	Relationships observed differed between the two types of spatial units. SA1-level exposure–response curve for rates against the disadvantage index extended in a linear fashion above the midrange level, whereas the SA2 level suggested a curvilinear form	Limitations of not being able to analyse individual-level data given the use of administrative datasets.	Results support findings from other research that identified that disadvantage increases the risk of CVD. The scale of analysis does influence the understanding of geographical patterns of socio-economic

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							with no evidence that rates increased with higher disadvantage beyond the midrange.		disadvantage and CVD morbidity.
Hastings *et al.* (2022)[35]	Australia	To project new-onset CVD and related health economic outcomes in Australia by SES from 2021 to 2030 (2011–2012, 2017–2018 and 2020).	Retrospective cohort and prospective population economic modelling (data linkage)	New-onset cardiovascular events; SES	3299 participants	No	Modelling showed that 8.4% of people in the most disadvantaged quintile were at high risk of CVD, compared with 3.7% in the least disadvantaged quintile.	Use of administrative datasets may not reflect current distribution of cardiovascular risk and use of an area-based measurement of SES.	There is a need to implement primary prevention interventions to reduce cardiovascular health inequity
Huynh *et al.* (2018)[36]	Tasmania	To determine whether regional markers of SES were associated with days at home after discharge from hospital (2009–2012)	Ecological cohort study (data linkage)	Days at home; 30- and 90-day re-admission; mortality; re-admissions; days to first re-admission (SES; rurality)	1391 patients	No	Included patients had a median of 352 days at home [IQR, 167–361]. All four SES indexes (i.e. IRSAD, IRSD, IEO, IER) and the remoteness index ($P < 0.001$) were adversely associated with days at home, independent of other clinical and non-clinical factors.	Use of administrative dataset and possibility of missing data, data only from public hospitals, and did not account for individual measures of SES.	Residential SES is associated with adverse outcomes in heart failure patients and requires targeted strategies.
Hyun *et al.* (2018)[37]	Australia	To examine the influence of SES on in-hospital care, and clinical	Cohort study (data linkage)	In-hospital care; clinical events (SES)	9238 patients	No	Following adjustments for patient characteristics,	Based on observational data of which the follow-up data	Gaps in delivery of care do not differ according to a patient's SES.

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		events for patients presenting with an acute coronary syndrome to public hospitals in Australia (2009)					there were no differences in the odds of receiving coronary angiogram, revascularisation, prescription of recommended medication, or referral to cardiac rehabilitation across SES groups (P = 0.06, 0.69, 0.89 and 0.79, respectively). The most disadvantaged group were 37% more likely to have a major adverse cardiovascular event than the least disadvantaged group (OR (95%CI): 1.37 (1.1–1.71), P = 0.02) driven by incidence of in-hospital heart failure.	were self-reported. SES measure did not capture individual SES.	The likelihood of death is also comparable between SES groups.
Jacobs *et al.* (2018)[38]	Australia	To assess the extent to which SES contributes to geographic disparity in CVD mortality (2009–2012)	Ecological study (data linkage)	CVD mortality (SES; rurality)	180,530 deaths	No	After allowing for the mediating effect of SES, female participants living in inner regional areas and male participants living	Possible that results may be influenced by misclassification of cause of death in administrative datasets, and use of an area-level	SES explained a substantial proportion of the association between where a person resides and CVD mortality rates;

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Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
							in remote/very remote areas had the greatest CVD mortality rates (mortality rate ratio (MMR): 1.12, 95%CI: 1.07–1.17; MRR: 1.15, 95%CI: 1.05–1.25, respectively) compared with those in major cities.	measure of SES makes it difficult to account for other confounding factors.	however, remoteness has an effect above and beyond SES for subpopulations. Focusing on both socio-economic disadvantage and accessibility to reduce CVD mortality in regional and remote Australia is imperative.
Jahan *et al.* (2022)[39]	Australia	To examine the care of patients with comorbid coronary heart disease and depression in general practice and explore the use of antidepressants by sociodemographic variables (2011–2018)	Cohort study (administrative dataset)	Antidepressant use (SES)	880,900 medical records	No	Among male participants with newly recorded coronary heart disease and depression, antidepressant prescribing was more frequent in major cities or inner regional areas (~81%) than in outer/remote Australia (66.6%; 95%CI: 52.8–80.4%). No effect of SES.	Reliance on an administrative dataset.	Differences in prescribing were identified across geographic locations and need to be considered.
Justo *et al.* (2017)[40]	Queensland	To investigate paediatric cardiac surgical outcomes in the Australian Aboriginal and Torres Strait	Cohort study (administrative dataset)	Cardiac surgical outcomes (SES)	123 Aboriginal and Torres Strait Islander peoples; 1405 non-Aboriginal and	Yes	52.7% (62) of Aboriginal and Torres Strait Islander peoples were in the lowest third of the socio-	Referral bias cannot be excluded. Statistical power may be limited because the	The Aboriginal and Torres Strait Islander population had a higher 6-year mortality. This

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		Islander peoples (2006–2014)			Torres Strait Islander peoples		economic index compared with 28.2% (456) of non-Aboriginal and Torres Strait Islander peoples ($P \leq 0.001$). No difference was noted between the groups in 30-day mortality.	Aboriginal and Torres Strait Islander peoples cohort represented a small proportion of the total population.	apparent relationship is explained by increased patient complexity, which may reflect negative social and environmental factors.
Kang *et al.* (2021)[41]	Queensland	To examine differences in disease burden between Aboriginal and Torres Strait Islander peoples and to evaluate the care of individuals living in rural and remote – rather than urban – locations (1997–2017.	Ecological cohort study (administrative dataset)	Rheumatic heart disease incidence, hospitalisations, and surgery (SES; rurality)	622 Aboriginal and Torres Strait Islander peoples; 64 non-Aboriginal and Torres Strait Islander peoples	Yes	An inverse correlation between an area's SEIFA score and its rheumatic heart disease prevalence (rho = -0.77, $P = 0.005$) was identified.	The use of the SEIFA score may explain why there was greater correlation between the SEIFA score and the prevalence of rheumatic heart disease in different communities than the clinical endpoints in individual patients.	The burden of rheumatic heart disease remains high and is dis-proportionately experienced by socio-economically disadvantaged Aboriginal and Torres Strait Islander peoples.
Kawai *et al.* (2022)[42]	Victoria	To explore regional trends in transient ischaemic attack hotspots using spatial regression followed by spatiotemporal analysis (2001–2011)	Ecological study (data linkage)	Transient ischaemic attack incidence (SES; rurality)	Not reported	No	Choropleth maps showed higher standardised transient ischaemic attack ratios in North-west rural region.	Individual-level data were not used, rather an aggregate count for each local government area, which can make findings susceptible to ecological inference fallacy.	A statistically significant spatial component to transient ischaemic attack rate over regional areas was identified but no temporal changes or yearly trends were supported.

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Table 2. (*Continued*)

Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
Korda *et al.* (2016)[43]	New South Wales	To quantify socio-economic variation in rates of primary and secondary CVD events in mid-age and older Australians (2006–2009)	Retrospective cohort study (data linkage)	Major CVD event (socio-economic position; rurality)	266,684 participants	No	For primary and secondary events, incidence increased with decreasing education. For area-level disadvantage, CVD gradients were weak and non-significant in persons over 64 years of age.	Administrative data may not have captured all CVD events and there was reliance on some self-reported data.	Individual-level data are important for quantifying socio-economic variation in CVD incidence.
Mariajoseph *et al.* (2022)[44]	Australia	To examine whether low SES may affect aneurysmal subarachnoid haemorrhage incidence and outcomes (2008–2018)	Ecological cross-sectional study (data linkage)	Incidence; clinical recovery (rurality; SES)	7,209 cases	No	3591 low-SES patients (49.8%) were identified. Average crude incidence of aneurysmal subarachnoid haemorrhage was persistently higher among the SES disadvantaged (6.6 cases per 100,000 person-years, 95%CI: 6.3–6.8), compared to the SES advantaged group (4.1 cases per 100,000 person-years, 95%CI: 4.0–4.2) ($P < 0.0001$).	Use of administrative data and use of an area-level measure of SES.	Aneurysmal subarachnoid haemorrhage occurs more frequently in low-SES communities.
Mather *et al.* (2014)[45]	New South Wales	To examine variation in the magnitude of socio-economic	Ecological cross-sectional study (data linkage)	Annual household income; highest education obtained (SES)	205,709 participants	No	The relative index of inequality was largest for income and smallest for	Access to data on other markers of individual SES (i.e. wealth) was not	Socio-economic inequality varies substantially according to the

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Table 2. (*Continued*)

Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
		inequalities in health and age-related variations in inequalities, according to the SES measure used (2006–2008)					SEIFA; they were generally largest in the youngest age group and smallest in the oldest group.	possible. Sensitivity on individual vs area measures of SES will be dependent on precision of measurement and level of aggregation (e.g. at which level SEIFA scores were assigned).	type of SES measure used and age (individual vs area). Researchers and policy makers should be aware of the extent to which SEIFA-based estimates underestimate the magnitude of health inequality compared with individual-level measures, especially in younger age groups.
Mnatzaganian *et al.* (2018)[46]	Victoria	To inspect socio-economic gradients in admission to a CCU or an ICU for adult patients presenting with non-traumatic chest pain in three acute-care public hospitals in Victoria, Australia (2009–2013).	Ecological panel study (administrative data)	Admissions (SES)	53,177 patients	No	A dose–response effect of socio-economic disadvantage and admission to CCU or ICU was identified, with risk of admission increasing as SES declined. Patients from the lowest SES locations were 27% more likely to be admitted to these units compared with those coming from the least disadvantaged	Use of administrative dataset with limited available data and no use of individual SES measures.	A dose–response effect was identified for socio-economic gradients in admissions to CCU and ICU, supporting increased cardiovascular morbidity as socio-economic disadvantage increases.

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Table 2. (*Continued*)

Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
							locations, $P < 0.001$.		
Mnatzaganian *et al.* (2021)[47]	Australia	To investigate whether disparities in the management of CHD exist based on socio-economic indicators and remoteness of patient's residence (2016–2018).	Cross-sectional study (administrative dataset)	Secondary prevention prescriptions; risk factors; treatment targets (SES; rurality)	137,408 patients	No (Aboriginal and Torres Strait Islander peoples status noted)	Compared with patients from the highest SES fifth, those from the lowest SES fifth were 8% more likely to be prescribed more medications for secondary prevention (incidence rate ratio (95%CI): 1.08 (1.04–1.12)) but 4% less likely to achieve treatment targets (incidence rate ratio: 0.96 (95%CI: 0.95–0.98)).	Results may not be representative of population and information may be missing.	Despite being more likely to be prescribed medications for secondary prevention, those who are most socio-economically disadvantaged are less likely to achieve treatment targets.
Morton *et al.* (2022)[48]	Victoria	To evaluate treatment disparities for myocardial infarction, as well as 1-year re-admission and mortality rates following myocardial infarction, by diabetes status, sex and socio-economic disadvantage (2012–2017).	Cohort study (data linkage)	Treatment disparities; 1-year re-admission; mortality rates (SES; diabetes)	43,272 people	No	Male participants and people residing in more disadvantaged areas were at increased risk of re-admission and mortality following myocardial infarction.	Use of administrative datasets and potential for missing information and use of an area-level measure as a proxy for individual SES.	Inequalities attributed to socio-economic disadvantage are likely to continue without adaptations of policy.

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Table 2. (*Continued*)

Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
Morton *et al.* (2022)[49]	Victoria	To quantify 1-year re-admission and mortality rates following ischaemic stroke, and variation by diabetes status, sex, and socio-economic disadvantage (2012–2017).	Cohort study (data linkage)	One-year re-admission rates; mortality rates (SES; diabetes status)	25,421 people	No	No relationship between socio-economic disadvantage and risk of cardiovascular or ischaemic stroke re-admission were identified, while 1-year mortality risk did increase with increasing socio-economic disadvantage (HR for most vs least disadvantaged quintile: 1.15 [95%CI: 1.03–1.27]; *P* trend = 0.006), and all-cause re-admission risk decreased (sub-HR: 0.94 [95%CI: 0.90–0.99]; *P* trend = 0.001).	Use of administrative datasets and potential for missing information.	A high risk of re-admissions following ischaemic stroke was identified.
Nembhard *et al.* (2016)[50]	Western Australia	To describe survival into adulthood for Aboriginal and Torres Strait Islander children and non-Aboriginal and Torres Strait Islander children with selected congenital heart defects and determine	Cohort study (data linkage)	Mortality; 5- and 25-year survival (SES; rurality)	4339 infants	Yes	Aboriginal and Torres Strait Islander children had lower survival rates than non-Aboriginal and Torres Strait Islander children for all congenital heart defects.	Possible underestimation of mortality because did not use the Australian National Death Index.	Long-term survival was lower for Aboriginal and Torres Strait Islander children with congenital heart defects. Increased risk may be due to SES and environmental factors.

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Table 2. (*Continued*)

Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
		whether Aboriginal and Torres Strait Islander children experience increased risk of mortality (1980–2010).							
Nghiem *et al.* (2022)[51]	Queensland	To present the baseline characteristics of index cardiovascular hospitalisations between first time and recurrent admissions (2010–2015).	Cohort study (data linkage)	Admission types; Charlson comorbidity index; hospital characteristics (SES)	132,343 hospitalisations	No (Aboriginal and Torres Strait Islander peoples status noted)	SEIFA quintiles were evenly distributed for recurrent admissions, whereas higher quintiles were overrepresented for first time admissions.	Only follows those with a cardiovascular hospitalisation during 2010.	Demonstrates that linked health data is a useful tool to examine factors mediating with CVD progression.
Nichols *et al.* (2021)[52]	Tasmania	To understand early (<24 h post ictus) and late (up to 12 months) survival post aneurysmal subarachnoid haemorrhage with a focus on rurality and SES (2010–2014).	Ecological cohort study (data linkage)	Aneurysmal subarachnoid haemorrhage-related death (SES; rurality)	237 cases	No	12-month mortality was 52.3% with 54.0% of these deaths occurring within 24 h post-ictus. In univariable analysis of 12-month survival, outcome was not influenced by SES, but rural geographical location was associated with a non-significant increase in death.	Use of an administrative dataset with limited variables and missing data.	Survival to 12 months was not related to geographical location or SES.
Nichols *et al.* (2018)[53]	Tasmania	To define a new baseline of the incidence and	Ecological cohort study (data linkage)	Incidence (SES; rurality)	237 persons	No	A significant association between area-	Use of an area-level measure of SES may have	A high incidence of aneurysmal subarachnoid

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Table 2. (*Continued*)

Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
		temporal trends of aneurysmal subarachnoid haemorrhage within an Australian population (2010–2014).					level socio-economic disadvantage and incidence was identified, with the rate of aneurysmal subarachnoid haemorrhage in disadvantaged geographical areas being 1.40-fold higher than that in advantaged areas (95%CI: 1.11–1.82; $P = 0.012$).	underestimated findings and subject to ecological fallacy.	haemorrhage was identified with socio-economic variations. Addressing this is imperative for improving disease prevention and management.
Nichols *et al.* (2020)[54]	Tasmania	To examine the effect of geographical location, SES, and inter-hospital transfer on time to treatment following an aneurysmal subarachnoid haemorrhage (2010–2014).	Ecological cohort study (data linkage)	Time to treatment (rurality; SES; inter-hospital transfer time)	205 cases	No	The median (IQR) time to intervention was 13.78 (6.48–20.63) h. Socio-economic disadvantage was associated with a 1.52-fold increase in the time to hospital ($P < 0.05$) and a 1.76-fold increase in time to neurosurgical admission ($P < 0.05$).	Findings may not be generalisable to other healthcare systems.	Time to treatment was negatively influenced by socio-economic disadvantage, geographical location, and inter-hospital transfers, which requires attention.
Pemberton *et al.* (2019)[55]	Queensland	To describe temporal trends in incidence of pre-hospital outcomes from adult out-of-hospital cardiac	Cohort study (data linkage)	Resuscitation status (rurality; SES)	30,541 cases	No	Crude incidence significantly increased over time for No-Resus and Sustained-return of	Confounders not accounted for, and use of residential postcode to	Factors to be addressed include being of middle age, more rural location, and lower SES.

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Table 2. (*Continued*)

Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
		arrest attended by Queensland Ambulance Service paramedics (2012–2014).					spontaneous circulation, and significantly decreased for No-return of spontaneous circulation. These trends were reflected in major cities, inner and outer regional areas. The incidence of out-of-hospital cardiac arrest increased in areas categorised as lower relative advantage.	estimate SES and remoteness.	
Pemberton *et al.* (2019)[56]	Queensland	To describe incidence in pre-hospital outcomes of adult out-of-hospital cardiac arrest of presumed cardiac aetiology, attended by QAS paramedics (2012–2014).	Cohort study (data linkage)	Resuscitation status (rurality; SES)	30,560 cases	No	Incidence was significantly greater in male than in female participants and incrementally increased with age. An inverse association between incidence and SES was identified (SEIFA 1 and 2: 81.34 per 100,000 [95%CI :79.28–83.40]; SEIFA 9 and 10: 61.57 per 100,000 [95%CI: 59.67–63.46]).	Confounders not accounted for, and use of residential postcode to estimate SES and remoteness.	Prevention and management strategies for out-of-hospital cardiac arrests are required for lower socio-economic groups.
Pemberton *et al.* (2021)[57]	Queensland	To describe annual incidence and temporal trends	Cohort study (data linkage)	Survival (SES; rurality)	4393 cases	No	Incidence of total admitted events, survival 30–364	Confounders not accounted for, and use of	Prevention and management strategies for

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Table 2. (*Continued*)

Citation	State/Territory/Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
		(2002–2014) in incidence of long-term outcomes of adult out-of-hospital cardiac arrest of presumed cardiac aetiology attended by QAS paramedics (2012–2014).					days, and survival 365+ days, increased over time; no trends were observed for survival <30 days.	residential postcode to estimate SES and remoteness.	out-of-hospital cardiac arrests are required for lower socio-economic groups.
Rachele *et al.* (2016)[58]	Queensland	To examine associations between neighbourhood socio-economic disadvantage and self-reported type 2 diabetes and heart disease (2007).	Cross-sectional study (survey and data linkage)	Self-reported type 2 diabetes, heart disease and comorbidity (SES)	10,620 participants	No	Compared with the most advantaged neighbourhoods, residents of the most-disadvantaged neighbourhoods were more likely to report type 2 diabetes, heart disease, and comorbidity. This weakened after adjustment for individual-level socio-economic position but remained statistically significant for type 2 diabetes and comorbidity.	The study had a 31.5% survey non-response rate, higher among persons residing in lower socio-economic areas, which may underestimate findings.	There is a need to establish why persons residing in disadvantaged areas are more likely to have heart disease and type 2 diabetes independent of their individual socio-economic position.
Ramkumar *et al.* (2019)[59]	Tasmania	To investigate whether IRSAD, IEO and IER were associated with	Cohort study (administrative dataset)	Proportion of new-onset atrial fibrillation (SES)	379 participants (atrial fibrillation $n = 50$; sinus rhythm $n = 329$)	No	Persons with atrial fibrillation ($n = 50$, 13%) were more likely to be male	Potential for population selection bias owing to	Area SES was associated with the risk of incident atrial

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Table 2. (*Continued*)

Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
		incident atrial fibrillation, independent of risk factors and cardiac function (not reported).					(64% vs 42%, $P = 0.003$). Areas with lower SES (IAD (assumed to be SEIFA 2011 IRSAD) and IEO) had a higher risk of incident atrial fibrillation.	recruitment through media outlets and a small sample.	fibrillation, independent of clinical risk, indicating that additional resources may be required for people residing in these areas.
Randall *et al.* (2016)[60]	Western Australia	To investigate acute myocardial infarction incidence in Australia in more detail, including both hospitalisations and out of hospital deaths in the Western Australian population (1993–2012).	Ecological study (data linkage)	Incidence of myocardial infarction (rurality; SES)	97,638 cases	No	Myocardial infarction incidence decreased in Western Australia from 1993 to 2012 by 1.2% per year (95%CI: -1.7 to -0.8). There was a large effect of SES, with those from the lowest quintile having a 68% higher acute myocardial infarction incidence than those from the highest socio-economic quintile.	Diagnostic process for acute myocardial infarction changed, which may mediate with results.	Focus on sub-populations is required for the primary care prevention of acute myocardial infarction.
Roberts *et al.* (2015)[61]	Queensland, Northern Territory and Western Australia	To compare regional differences in the prevalence of rheumatic heart disease detected by echocardio-graphic screening in high-risk	Cross-sectional study (screening)	Rheumatic heart disease prevalence (SES)	3946 participants	Yes	Prevalence of rheumatic heart disease differed between regions. Evaluation of socio-economic data suggests that the Top End group was the most	Selection bias may contribute to differences in prevalence.	Prevalence of rheumatic heart disease in and Torres Strait Islander children residing in remote settings is significant. Regional

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Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
		Aboriginal and Torres Strait Islander children (2008–2010).					disadvantaged in our study population.		variations in prevalence were observed and need to be considered.
Robins *et al.* (2017)[62]	Victoria	To investigate the differences in hypertensive disease hospitalisations across rural and urban Victoria, and to determine predicting variables (2010–2015).	Ecological study (data linkage)	Hypertensive disease hospitalisations (SES)	11,205 admissions	No (Aboriginal and Torres Strait Islander peoples status noted)	Hospitalisation rates were consistently higher in rural areas than in urban areas, and rural residents on average stayed in hospital for longer. Significant predictor variables for hypertensive disease hospitalisation included various indicators of socio-economic disadvantage, GPs per 1000 population and GP attendance per 1000 population.	Limited variables available for analysis in administrative datasets.	Hypertensive disease hospitalisation is increasing in Victoria, with rates in rural areas exceeding that of urban areas. Further research is required.
Roseleur *et al.* (2021)[63]	Australia	To investigate the prevalence of diagnosed hypertension in Australian general practice and explore whether hypertension control is influenced by sociodemographic characteristics,	Cross-sectional study (administrative dataset)	Hypertension control (SES)	1,198,199 patients	No	Blood pressure control was lower in female participants (54.1%) than in male participants (55.7%) and in the oldest age group (52.0%), but there were no differences by SES.	Potential for missing information in administrative datasets.	Prevalence of hypertension varied by sociodemo-graphic, but there were no differences in assessment or control of hypertension by SES.

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Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
		duration since diagnosis, or prescription of antihypertensive medications (2017).							
Saghapour *et al.* (2021)[64]	Queensland	To examine the total effect of neighbourhood disadvantage on CVD to address the limitations of previous research by examining the indirect effects of neighbourhood disadvantage on CVD (2007–2016).	Cohort study (data linkage)	Self-reported CVD (neighbourhood disadvantage)	11,035 participants	No	The incidence of CVD was found to be significantly higher in the most disadvantaged neighbourhoods (OR 1.50; HR 1.29) compared with the least disadvantaged. Physical activity was a significant mediator of this.	Use of self-reported CVD.	Further research is required around the social and built environment, physical activity, and CVD.
Shi *et al.* (2014)[65]	Victoria	To examine the clinical profile, early outcomes and late survival of patients presenting for coronary surgery, to identify whether rurality and SES were predictors of early and late outcome (2001–2009).	Ecological study (data linkage)	Coronary surgery outcomes (rurality; SES)	14,150 patients	No	Patients from socio-economically-disadvantaged areas had a greater burden of cardiovascular risk factors including diabetes, obesity and current smoking. Thirty-day mortality (disadvantaged 1.6% vs advantaged 1.6%, $P > 0.99$) was similar between groups as was late survival (7 years: $83 \pm 0.9\%$ vs	SES assigned by postcodes and limitation of retrospective study design.	Targeted strategies to promote early recognition and referral of patients with coronary disease are required for those residing in areas characterised by socio-economic disadvantage.

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Citation	State/Territory/Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
							84 ± 1.0%, $P = 0.79$). Propensity analysis did not show SES or rurality to be associated with late outcomes.		
Smurthwaite and Bagheri (2017)[66]	South Australia	To determine the geographic variation of obesity, CVD and type 2 diabetes, using general practice clinical data (2010–2014).	Ecological cross-sectional study (data linkage)	Prevalence of obesity, CVD and type 2 diabetes (SES)	20,594 patients	No	Spatial distribution of obesity, CVD, and type 2 diabetes varied across geographical areas. An inverse relationship was observed between area-level prevalence of CVD, obesity, and type 2 diabetes with SES.	Potential for selection bias in use of general practice records and potential for lack of generalisability.	Further research is required around community profiles and disease distribution.
Straney *et al.* (2016)[67]	Victoria	To identify population-based demographic and health factors associated with (1) high incidence and (2) low bystander CPR, and to examine the contribution of these factors to the variation seen across Victoria (2011–2013).	Ecological cross-sectional study (data linkage)	Rates of out-of-hospital cardiac arrest; bystander cardiac pulmonary resuscitation (LGA; SES)	15,830 cardiac arrests	No	Incidence rates varied across the state between 41.9 and 104.0 cases/100,000 population. The proportion of the population over 65, SES, smoking prevalence and education level were significant predictors of incidence in the multivariable model, explaining 93.9% of the variation in	Study population may not be representative of people at risk, therefore incidence rate may be overestimated.	Characteristics identified will be useful in targeting regions for interventions.

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Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
							incidence between LGAs.		
Tideman *et al.* (2013)[68]	South Australia and Victoria	To understand causes of geographical CVD mortality disparities (2004–2006).	Ecological cross-sectional study (data linkage)	Age group-specific measures of absolute CVD risk; mortality rates (SES; rurality)	1563 Greater Green Triangle participants; 3036 North West Adelaide Study participants	No (Aboriginal and Torres Strait Islander peoples status noted)	Few significant differences in CVD risk between the study regions were identified, with absolute CVD risk ranging from approximately 5% to 30% in the 35–39 and 70–74 age groups, respectively. Lower measures of SES were associated with worse cardiovascular outcomes regardless of geographic location.	Study populations not necessarily representative.	Further research is required around the determinants of CVD and targeted strategies.
Xu *et al.* (2021)[69]	Queensland	To assess the effects of extreme temperatures on hospitalisations and post-discharge deaths for stroke in individuals with and without pre-existing hyperlipidaemia, and examine whether individual- and community-level	Ecological cohort study (data linkage)	Hospitalisations; post-discharge deaths for stroke (SES; greenspace)	11,469 cases	No	People living in suburbs with the lowest socio-economic advantage level or the lowest economic resources level were most vulnerable to the effects of heat and cold on hospitalisations for stroke.	Area-level SES used as a proxy for individual SES.	Need for targeted interventions for individuals with hyperlipidaemia to reduce heat-related stroke burden, especially for those residing in socio-economic areas characterised by disadvantage.

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Citation	State/Territory/ Australia	Research aim (study period)	Study design type (methods)	Outcome measure(s) (exposure measure(s))	Participant sample	Aboriginal and Torres Strait Islander peoples focus (Yes/No)	Findings	Study limitations	Implications
		characteristics modified the temperature–-stroke relationship (2005–2013).							
Yiallourou *et al.* (2022)[70]	Victoria	To compared age-adjusted all-cause and CVD mortality for women registered for fertility treatment who received it, compared with those who did not (1975–2014).	Cohort study (data linkage)	Standardised mortality rates for all-cause and CVD mortality stratified by area-level socio-economic disadvantage	44,149 women	No	All-cause and CVD mortality was lower for the study participant when compared to the general female population. The standardised mortality rate was lowest for both groups in the fifth IRSD quantile (least disadvantaged)	CVD risk was not assessed and SEIFA used as a proxy.	Fertility treatment does not increase long-term all-cause of CVD mortality risk.

CCU, coronary care unit; CHD, coronary heart disease; CPR, cardiopulmonary resuscitation; GP, general practitioner; HR, Hazard Ratio; ICU, intensive care unit; IEO, Index of Education and Occupation; IER, Index of Economic Resources; IRSAD, Index of Relative Socio-Economic Advantage and Disadvantage; IRSD, Index of Relative Socio-Economic Disadvantage; LGA, local government area; PCI, percutaneous coronary intervention; QAS, Queensland Ambulance Service; RR, relative risk; SA1/2, statistical area level 1/2; SLA, statistical local area.

Table 3. Application of SEIFA.

Citation	SEIFA indexes (raw scores or deciles)	Spatial unit	How SEIFA was applied in methods and results
Adair and Lopez (2021)[22]	IRSAD 2006 for deaths registered in 2006–2010 IRSAD 2011 for deaths registered in 2011–2017	SLA for deaths registered in 2006–2010 SA2 for deaths registered in 2011–2017	Indirect: Australian Cause of Death Unit Record File place of usual residence was linked to IRSAD. Inequalities were assessed by area socio-economic quintile (Q1 lowest SES to Q5 highest SES).
Astley *et al.* (2020)[23]	IRSAD 2016	Not reported	Direct: Used linkage key identifiers held separately from any personal demographic information to determine IRSAD score. Presented for each cohort (not referred, referred/declined, and attended) as an IRSAD median score with interquartile range.
Atkins *et al.* (2013)[24]	SEIFA 2006 (index used not reported)	If available, collection district. If not available, SLA or LGA (non-ABS structure)	Indirect: A SEIFA score was assigned by the data linkage program at index admission using residential address at hospital admission. For analysis, deciles were grouped into quintiles at the Collection District level (available for 89% of the sample, or SLA level or LGA (11%).
Baker *et al.* (2017)[25]	IRSAD 2001 IRSD 2001 IEO 2001 IER 2001	SLA	Indirect: Data were obtained from the 2001 versions specific to each of the 21 SAs of resident included in the study. Raw scores for each index were split into quartiles for analysis.
Biswas *et al.* (2019)[26]	IRSD 2011	Postcodes	Indirect: Patients' residential postcode was used to assign an IRSD decile, which were merged into quintiles for analysis with Q1 as patients with the lowest SES, and Q5 as patients with the highest SES.
Busija *et al.* (2013)[27]	IRSAD 2006 IRSD 2006 IEO 2006 IER 2006	Postcodes	Indirect: Assigned using participant postcode, and classified into tertiles for analysis (low SES, middle SES, and high SES). Not reported whether SEIFA raw scores or deciles were used.
Carter *et al.* (2019)[28]	SEIFA 2011 (index used not reported)	Not reported	Indirect: Area of usual residence (undefined) converted to a SEIFA quintile.
Cheng *et al.* (2020)[29]	IRSAD 2011	Postal areas	Indirect: Deciles for postal areas were obtained from IRSAD 2011 and grouped into quintiles for analysis.
Chew *et al.*(2016)[30]	SEIFA 2011 (index used not reported)	Not reported	Indirect: Not reported. Mean SEIFA raw score and standard deviation presented in analysis by geographical area (metropolitan, regional, and rural). Not stated how geographical areas were classified.
Close *et al.* (2014)[31]	IRSD 2001	LGA	Direct: Outcomes by LGA were correlated with SEIFA Index of Disadvantage scores.
Dawson *et al.* (2022)[32]	IRSD 2016	Postcodes	Indirect: Scores were divided into quintiles and allocated for postcodes.
Gutman *et al.* (2019)[33]	IRSAD 2011	Not reported	Indirect: Patient residential address was used to determine IRSAD quintiles.
Hanigan *et al.* (2017)[34]	IRSD 2011	SA1	Indirect: The SA1 and SA2 of residence was used to assign an area-level measure of socio-economic disadvantage using the IRSD. Original data were standardised to *Z*-scores because SA1 values are known to have a national mean of 1000 and standard deviation of 100. Given that the principal components used to construct the index are arbitrary with respect to their sign (positive or negative), the index was rescaled to improve intuitive interpretation. More-disadvantaged areas were assigned positive scores, and less-disadvantage areas, negative scores.

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Table 3. (*Continued*)

Citation	SEIFA indexes (raw scores or deciles)	Spatial unit	How SEIFA was applied in methods and results
Hastings *et al.* (2022)[35]	SEIFA 2011 (index used not reported)	Not reported	Indirect: SEIFA deciles were grouped in quintiles, defining five socio-economic levels (SE 1–SE 5). The model population was profiled on the latest available demographic data for the Australian population in 2020 divided into five quintiles, each representing a socio-economic quintile, with SE 1 being the lowest socio-economic quintile (most disadvantaged) and SE 5 being the highest quintile (least disadvantaged).
Huynh *et al.* (2018)[36]	IRSAD 2011 IRSD 2011 IER 2011 IEO 2011	Not reported	Indirect: Patient's residential address was used to determine SES using the four indexes of SEIFA. Grouped into tertiles for analysis by index used.
Hyun *et al.* (2018)[37]	IRSD 2011	Postal areas	Indirect: Patient's postcode of usual residence was matched with the IRSD postcode. IRSD deciles were further stratified into four groups, where group 1 includes 20% of the lowest SES areas and group 4 includes 40% of the highest SES areas.
Jacobs *et al.* (2018)[38]	IRSAD 2011	SA2	Indirect: IRSAD scores for each SA2 were obtained. Sex-specific proportions of SA2s were tabulated by remoteness and IRSAD category (quintiles). To improve clarity of maps, data were aggregated to an SA3 level (an SA3 is composed of multiple SA2s, with populations ranging from 30,000 to 130,000), and death rates were then calculated and age-standardised in the same manner as at the SA2 level.
Jahan *et al.* (2022)[39]	IRSAD 2016	Not reported	Indirect: Used IRSAD quintiles and assigned to patients. Not reported explicitly how this occurred, but the authors refer to IRSAD quintiles based on postcodes in the methods section.
Justo *et al.* (2017)[40]	SEIFA 2011 (index used not reported)	Postcodes	Indirect: The SES of the usual residence of children was assessed at the postcode level and were presented as tertiles in the results section.
Kang *et al.* (2021)[41]	SEIFA 2011 (index used not reported)	Not reported	Direct: Used SEIFA (index not reported) scores. Area level not reported.
Kawai *et al.* (2022)[42]	IRSAD (year not reported)	LGA	Direct: Decile assigned according to the IRSAD in each LGA.
Korda *et al.* (2016)[43]	IRSD 2006	Postcodes	Indirect: IRSD was categorised into population-based quintiles and assigned to individuals using their postcode of residence.
Mariajoseph *et al.* (2022)[44]	SEIFA 2016 (index used not reported	Not reported	Indirect: Quintiles collapsed into two categories: socio-economic advantage was defined to encompass middle and high socio-economic groups (quintile 3, 4, 5), while socio-economic disadvantage was limited to quintiles 1 and 2.
Mather *et al.* (2014)[45]	IRSD 2006	Postcodes	Indirect: IRSD was based on postcode of residence and categorised into population-based quintiles using cut-off scores from the 2006 Australian Census.
Mnatzaganian *et al.* (2018)[46]	SEIFA 2011 (index used not reported)	Postcodes	Indirect: Individual's residential postcode was used to assign a SEIFA score. The SEIFA was further used to calculate a Relative Index of Inequality (RII), which is a regression-derived index summarising the magnitude of socio-economic disadvantage while taking into account the sample size and the relative disadvantage experienced by each individual. The estimated RII was further introduced as quintiles categorised according to the score's distribution in the sample.
Mnatzaganian *et al.* (2021)[47]	IRSD 2016	Postcodes	Indirect: Patients' most recent residential addresses were used because these were recorded in the last patient–GP encounter during the 2-year study period. The SEIFA-IRSD deciles were categorised into five groups.

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Table 3. (*Continued*)

Citation	SEIFA indexes (raw scores or deciles)	Spatial unit	How SEIFA was applied in methods and results
Morton *et al.* (2022)[48]	IRSD 2016	Postcodes	Indirect: IRSD was assigned based on the individual's last known postcode. IRSD was classified into quintiles, where a higher IRSD indicates a lower proportion of disadvantaged people in an area.
Morton *et al.* (2022)[49]	IRSD 2016	Postcodes	Indirect: IRSD was assigned based on the individual's last known postcode. IRSD was classified into quintiles, where a higher IRSD indicates a lower proportion of disadvantaged people in an area.
Nembhard *et al.* (2016)[50]	IRSD 1996, 2011 and 2006	Collection district	Indirect: Obtained maternal community-level social class information by linking to the SEIFA collection district-level data using maternal household postcode at the time of delivery.
Nghiem *et al.* (2022)[51]	SEIFA 2011 – index used not reported	Postcodes	Indirect: Used quintiles to represent socio-economic advantage of a region using postcode data.
Nichols *et al.* (2021)[52]	IRSAD 2011	SA2	Indirect: Assigned from geocoded residential street addresses using SA2 data. Deciles were dichotomised with scores of less than or equal to 3 representing disadvantage.
Nichols *et al.* (2018)[53]	SEIFA 2011 (index used not reported)	SA2	Indirect: Assigned using participant's geocoded residential street address at the time of the haemorrhage. Data were available at SA2. To assess the association between socio-economic disadvantage and incidence, the SEIFA deciles were analysed both on a linear basis across the deciles and dichotomously (split at the 3rd decile).
Nichols *et al.* (2020)[54]	SEIFA 2011 (index used not reported)	SA2	Indirect: Applied using participant's geocoded residential street address at the time of the haemorrhage. SEIFA deciles measuring socio-economic advantage/disadvantage were dichotomised (score ≤ 3 = disadvantaged).
Pemberton *et al.* (2019)[55]	IRSAD 2011	SA2	Indirect: Determined using residential postcode. Analysis presented as quintiles.
Pemberton *et al.* (2019)[56]	IRSAD 2011	SA2	Indirect: Determined using residential postcode. Analysis presented as quintiles.
Pemberton *et al.* (2021)[57]	IRSAD 2011	SA2	Indirect: Determined using residential postcode. Analysis presented as quintiles.
Rachele *et al.* (2016)[58]	IRSD 2006	Collection district	Indirect: Neighbourhood socio-economic disadvantage was derived using a weighted linear regression, using scores from the ABS IRSD from each of the previous six censuses from 1986 to 2011. Derived socio-economic scores from each of the HABITAT neighbourhoods were then quantised as percentiles, relative to all of Brisbane. The 200 HABITAT neighbourhoods were then grouped into quintiles with Q1 denoting the 20% least disadvantaged areas relative to the whole of Brisbane and Q5 the most disadvantaged 20%.
Ramkumar *et al.* (2019)[59]	IAD 2011 (assumed to be SEIFA 2011 IRSAD) IER 2011 IEO 2011	Postcodes	Indirect: Indexes applied using participants' postcode. Reported using deciles.
Randall *et al.* (2016)[60]	SEIFA 2001 2006 and 2011 (index used not reported)	Not reported	Indirect: Index was classified into quintiles.
Roberts *et al.* (2015)[61]	IRSD 2011 IRSAD 2011	Not reported	Indirect: Information about school attendance and the Aboriginal and Torres Strait Islander peoples status of enrolled students, as well as Index of Community Socio-Educational Advantage (ICSEA 10) scores were obtained for each participating school from the Australian Government's MySchool website. SEIFA scores were obtained for each participating community from the ABS 2011 census data and presented as mean and median scores.

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Table 3. (*Continued*)

Citation	SEIFA indexes (raw scores or deciles)	Spatial unit	How SEIFA was applied in methods and results
Robins *et al.* (2017)[62]	IRSD (year not reported) IER (year not reported) IEO (year not reported)	LGA	Direct: Data sourced according to LGAs. Not clear how indexes were applied in results.
Roseleur *et al.* (2021)[63]	IRSAD 2011	Not reported	Indirect: Not clear how SEIFA was applied. Presented in IRSAD quintiles in results.
Saghapour *et al.* (2021)[64]	IRSD 2011	Collection districts	Indirect: Each of the 200 neighbourhoods was assigned a socio-economic score using the IRSD. The derived IRSD scores for the HABITAT neighbourhoods were then grouped into quintiles, with Q5 denoting the 20% least disadvantaged areas relative to the whole of Brisbane and Q1 denoting the 20% most disadvantaged areas.
Shi *et al.* (2014)[65]	IRSAD 2011	Postcodes	Indirect: Determined by linking patient residential postcode to the IRSAD from the ABS. To enable a sizeable group for statistical comparison, the deciles of socio-economic disadvantage were collapsed into quintiles. In the socio-economic analysis, outcomes were compared between the quintiles of most and least socio-economic disadvantage.
Smurthwaite and Bagheri (2017)[66]	SEIFA 2011 (index used not reported)	SA1	Indirect: SES was classified into tertiles based on ABS SEIFA data, including low socio-economic, moderate socio-economic, and high socio-economic regions.
Straney *et al.* (2016)[67]	IRSAD 2011	LGA	Direct: Scores were assigned for each LGA.
Tideman *et al.* (2013)[68]	IRSD 2006	SLA	Direct: The distribution of IRSD scores between the two groups was compared and the relationship between IRSD and CVD mortality rates were explored.
Xu *et al.* (2021)[69]	SEIFA (year and index not reported)	Not reported	Not reported.
Yiallourou *et al.* (2022)[70]	IRSD 2016	Postcodes	Indirect: Standardised mortality ratios were stratified by IRSD quintiles.

HABITAT, How Areas in Brisbane Influence healTh And acTivity project; LGA, local government area; SA1/2, statistical area level 1/2; SLA, statistical local area.

Studies varied in the spatial unit applied for analysis. Of the studies, 22 applied a non-ABS spatial unit for analysis (n = 16 applied SEIFA using postal areas (POAs) or postcodes (terms used interchangeably, noting that SEIFA is available only for POA); n = 4 used local government area (LGA); n = 2 used statistical local area), 14 used an ABS spatial unit for analysis (n = 2 statistical area level 1 (SA1); n = 7 SA2; n = 1 multiple statistical area levels; n = 4 collection district), and 13 studies did not report what the spatial unit of analysis was. One study analysed data using multiple spatial units (SA1 and SA2), and identified that analysis at a finer spatial resolution supported a stronger association between SES as an exposure and the outcome of interest (i.e. rates of CVD).[34] Another study examined the association between temperature and myocardial infarction hospitalisations in a metropolitan centre using postal area levels (non-ABS structure) rather than the finest spatial resolution available for SEIFA (i.e. SA1).[29]

Quality assessment and study limitations

The quality of studies varied. A common limitation of cross-sectional and cohort studies was that confounders were not identified or adjusted for (Tables 4, 5 and 6).

Other limitations included the constraints of analysing administrative datasets (e.g. missing data, set data points),[23,34,37] which included the inability to use address-level data due to privacy issues, or lack of availability to geocode to a smaller spatial unit[42] or inability to confirm whether the address was current,[24] and caveats of using an area-based approach as a proxy for individual SES (e.g. ecological fallacy, unable to account for individual confounders, underestimates inequality),[26,28,37,38,42,45,48] particularly for studies including Aboriginal and Torres Strait Islander peoples.[50] A longitudinal study cited the limitation of using SEIFA as a proxy measure for SES over time, which required multiple versions of SEIFA to be used.[22]

Table 4. Quality assessment of cross-sectional studies.

Citation	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with the confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?
Adair and Lopez (2021)[22]	Y	Y	Y	Y	N	N	Y	Y
Busija *et al.* (2013)[27]	Y	Y	Y	Y	Y	Y	Y	Y
Chew *et al.*(2016)[30]	Y	Y	Y	Y	Y	Y	Y	Y
Hanigan *et al.* (2017)[34]	Y	Y	Y	Y	Y	Y	Y	Y
Jacobs *et al.* (2018)[38]	Y	Y	Y	Y	N	N	Y	Y
Kawai *et al.* (2022)[42]	Y	Y	Y	Y	Y	Y	Y	Y
Mariajoseph *et al.* (2022)[44]	Y	Y	Y	Y	Y	Y	Y	Y
Mather *et al.* (2014)[45]	Y	Y	Y	Y	N	N	Y	Y
Mnatzaganian *et al.* (2021)[47]	Y	Y	Y	Y	Y	Y	Y	Y
Rachele *et al.* (2016)[58]	Y	Y	Y	Y	Y	Y	Y	Y
Randall *et al.* (2016)[60]	Y	Y	Y	Y	N	N	Y	Y
Roberts *et al.* (2015)[61]	Y	Y	Y	Y	N	N	Y	Y
Robins *et al.* (2017)[62]	Y	Y	Y	Y	Y	Y	Y	Y
Roseleur *et al.* (2021)[63]	Y	Y	Y	Y	N	N	Y	Y
Smurthwaite and Bagheri (2017)[66]	Y	Y	Y	Y	N	N	Y	Y
Straney *et al.* (2016)[67]	Y	Y	Y	Y	N	N	Y	Y
Tideman *et al.* (2013)[68]	Y	Y	Y	Y	N	N	Y	Y

N, no; NA, not applicable; Y, yes.

Table 5. Quality assessment of cohort studies.

Citation	Were the two groups similar and recruited from the same population?	Were the exposures measured similarly to assign people to both exposed and unexposed groups?	Was the exposure measured in a valid and reliable way?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Were the outcomes measured in a valid and reliable way?	Was the follow up time reported and sufficient to be long enough for outcomes to occur?	Was follow up complete, and if not, were the reasons for loss to follow up described and explored?	Were strategies to address incomplete follow up used?	Was appropriate statistical analysis used?
Astley *et al.* (2020)[23]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Atkins *et al.* (2013)[24]	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y
Biswas *et al.* (2019)[26]	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	Y
Carter *et al.* (2019)[28]	NA	NA	Y	N	N	N	Y	Y	Y	NA	Y
Cheng *et al.* (2020)[29]	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
Close *et al.* (2014)[31]	NA	NA	Y	N	N	Y	Y	Y	Y	Y	Y
Dawson *et al.* (2022)[32]	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
Gutman *et al.* (2019)[33]	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hastings *et al.* (2022)[35]	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
Huynh *et al.* (2018)[36]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hyun *et al.* (2018)[37]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Jahan *et al.* (2022)[39]	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Justo *et al.* (2017)[40]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

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Table 5. (*Continued*)

Citation	Were the two groups similar and recruited from the same population?	Were the exposures measured similarly to assign people to both exposed and unexposed groups?	Was the exposure measured in a valid and reliable way?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Were the outcomes measured in a valid and reliable way?	Was the follow up time reported and sufficient to be long enough for outcomes to occur?	Was follow up complete, and if not, were the reasons for loss to follow up described and explored?	Were strategies to address incomplete follow up used?	Was appropriate statistical analysis used?
Kang *et al.* (2021)[41]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Korda *et al.* (2016)[43]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Mnatzaganian *et al.* (2018)[46]	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
Morton *et al.* (2022)[48]	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
Morton *et al.* (2022)[49]	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nembhard *et al.* (2016)[50]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nghiem *et al.* (2022)[51]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Nichols *et al.* (2021)[52]	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nichols *et al.* (2018)[53]	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nichols *et al.* (2020)[54]	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pemberton *et al.* (2019)[55]	NA	NA	Y	N	N	Y	Y	Y	Y	Y	Y
Pemberton *et al.* (2019)[56]	NA	NA	Y	Y	N	Y	Y	Y	Y	Y	Y
Pemberton *et al.* (2021)[57]	NA	NA	Y	N	N	Y	Y	Y	Y	Y	Y

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Table 5. (*Continued*)

Citation	Were the two groups similar and recruited from the same population?	Were the exposures measured similarly to assign people to both exposed and unexposed groups?	Was the exposure measured in a valid and reliable way?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Were the outcomes measured in a valid and reliable way?	Was the follow up time reported and sufficient to be long enough for outcomes to occur?	Was follow up complete, and if not, were the reasons for loss to follow up described and explored?	Were strategies to address incomplete follow up used?	Was appropriate statistical analysis used?
Ramkumar *et al.* (2019)[59]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Saghapour *et al.* (2021)[64]	NA	NA	Y	N	N	Y	Y	Y	Y	Y	Y
Shi *et al.* (2014)[65]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Xu *et al.* (2021)[69]	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Yiallourou *et al.* (2022)[70]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y

N, no; NA, not applicable; Y, yes.

Table 6. Quality assessment of case study.

Citation	Were there clear criteria for inclusion in the case series?	Was the condition measured in a standard, reliable way for all participants included in the case series?	Were valid methods used for identification of the condition for all participants included in the case series?	Did the case series have consecutive inclusion of participants?	Was there clear reporting of the demographics of the participants in the study?	Was there clear reporting of clinical information of the participants?	Were the outcomes or follow up results of cases clearly reported?	Was there clear reporting of the presenting site (s)/clinic(s) demographic information?	Was statistical analysis appropriate?
Baker *et al.* (2017)[25]	Y	Y	Y	N	N	N	Y	N	Y

N, no; Y, yes.

Discussion

The application of the ABS SEIFA indexes in Australian peer-reviewed CVD research to measure SES as an exposure has been widespread since 2013. Variations in the application of the SEIFA indexes were identified. It was not always clear which of the four SEIFA indexes (IRSAD, IRSD, Index of Education and Occupation, and Index of Economic Resources) were applied, how they were applied, and at what spatial unit. It is likely that the terms 'postcode' and 'POA' have been used interchangeably in included studies. These findings are important because how SEIFA is applied affects study outcomes (e.g. due to modifiable areal unit problem; MAUP), which has implications for the generalisability of CVD research in Australia.

Findings expand on the established complexity of measuring SES as an exposure, and quantifying the relationship between SES and health outcomes.[2,5,71] Internationally, there has been much discussion around measuring SES, with the strengths and limitations of individual measures (e.g. educational attainment) discussed at length[71–73] and compared with area-level measures of SES.[74] In Australia, population health research identified that socio-economic inequality varied according to how SES was measured, with a SEIFA-based approach found to underestimate inequality when compared with the use of individual-level measures.[45]

What is clear is that there is no single measure of SES that is appropriate for all study designs, disease groups, settings and countries. The application of area-level measures is useful when individual-level data are not available and for the understanding of potential areas in need of population-level interventions. In CVD research it has been identified that a single measure of SES is unlikely to be sufficient to predict CVD risk or outcomes due to regional differences in SES, changes in individual measures of SES across the lifespan, and the complex interplay of factors known to contribute to CVD risks.[5,38] The application of the SEIFA indexes as a composite area-level measure of SES in CVD research remains important.

There are some key issues identified in studies that should be considered by researchers. First, although SEIFA indexes have been applied as a proxy for individual SES in CVD research, there are limitations to this because the indexes do not account for individual measures of SES,[75] confounders, or diversity in a geographical region.[76] A second consideration is that SEIFA indexes are constructed after each 5-yearly national census, making indexes cross-sectional only. Due to this, SEIFA indexes cannot be applied to populations outside of Australia. Given that each version of SEIFA is different (e.g. between SEIFA 2006 and SEIFA 2011, the smallest spatial unit changed from collection districts to SA1), longitudinal application is problematic because versions are not comparable. Studies applying SEIFA are also subject to spatial bias, specifically the ecological fallacy of assuming SES homogeneity in a region when applying an area-level approach, which is more problematic for sparsely populated regions (e.g. rural areas)[77] and the MAUP (i.e. effects of applying different spatial units to analysis).[78]

Given the tendency for studies to assign a SEIFA decile or score based on postcode or POA (an approximation for postcodes),[79] and categorise into tertiles, quartiles or quintiles for analysis, it is important to consider what constitutes appropriate application. Supported by the ABS aligning with the release of SEIFA 2021,[13] it is appropriate to use SEIFA as an area-level measure to describe the characteristics of a study cohort in a defined geographical region. If used as a proxy for individual SES, it is important to interpret findings correctly and identify the limitations of this approach.[75] If individual-level measures of SES are available as variables, it is recommended to analyse these and compare findings to that of area-level SES; a recommendation supported internationally.[80]

It is also necessary to apply the version of SEIFA that corresponds to the study period and consider multiple versions for longitudinal studies. It is also recommended to opt for the smallest spatial unit available[34] to mitigate bias attributed to the ecological fallacy (e.g. avoid postcodes or large areas, particularly for rural studies) and geocode the participant addresses into the smallest spatial unit (e.g. SA1, noting that the purpose of SA2 units is to represent a community that interacts together socially and economically).[81–83] This may not be possible due to the use of administrative datasets (a widely cited limitation).[84,85] There are other appropriate applications of SEIFA, such as application for the prospective sampling of study populations for area-level SES representativeness.[86,87]

A clear and transparent explanation and justification should be provided in the methods section (or as a Supplementary File) as to which SEIFA version and index was applied, how it was applied (direct or indirect), at what spatial unit it was applied, and whether the spatial unit was an ABS or non-ABS unit. Presenting data prior to collapsing into categories for analysis[88] and providing information as to which data sources were analysed, is also recommended. Future efforts should examine the appropriateness of SEIFA as an area-level composite measure for specific populations, the implications of application from a policy perspective, and opportunities for other approaches to spatial modelling that account for a finer spatial resolution.[89]

Limitations

The scope of this review was limited to peer-reviewed literature. An analysis of grey literature, including evaluation reports, government documents, theses and policy documents would be of value to examine consistency in application beyond the peer-reviewed literature. Although the focus of this review was CVD, it is probable that the findings will be of relevance to researchers examining other highly prevalent non-communicable diseases, which is an area requiring further investigation. There is a possibility that not all Australian CVD research was retrieved due to publication bias.

Conclusion

The use of SEIFA in Australian CVD peer-reviewed research has been widespread with variations in the application to measure SES as an exposure. There is a need to improve the reporting of how SEIFA is applied in the methods sections of research for greater transparency. This is important to ensure that the application is consistent and the research findings are generalisable, so that they can accurately inform population-level interventions and investment to address the burden of CVD.

Consent for publication

Not applicable.

Supplementary material

Supplementary material is available online.

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