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Preference-Based Assessments

An Intersectional Approach to Quantifying the Impact of Geographic Remoteness and Health Disparities on Quality-Adjusted Life Expectancy: Application to Australia

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ABSTRACT

Objectives: An intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA) is a novel method for exploring the interaction between sociodemographic characteristics that affect health outcomes. This study explores the interaction between geographic remoteness and socioeconomic status on health outcomes in Australia from an intersectional perspective.

Methods: Data from a cross-sectional survey were matched with data from the Australian Bureau of Statistics and the Australian Institute of Health and Welfare. To explore the effect of health-related quality of life on life expectancy, quality-adjusted life expectancy (QALE) was estimated through applying utility values derived from the EQ-5D-5L to life table data from the Australian Bureau of Statistics. The effect of geographic remoteness on QALE was quantified using multivariable linear regression. An intersectional MAIHDA was performed to explore differences in mean QALE across strata formed by intersections of age, sex, and Socioeconomic Indexes for Areas score.

Results: Based on multivariable linear modeling, QALE declined significantly with increasing remoteness (inner regional, −1.0 years [undiscounted]; remote/very remote, −3.3 years [undiscounted]) ($P < .001$). In contrast, life expectancy was only significantly different between participants in remote/very remote areas and major cities (β-coefficient, −2.4; 95% CI −4.4 to −0.4; $P = .016$). No intersectional interaction effects between strata on QALE were found in the MAIHDA.

Conclusions: QALE has considerable value as a metric for exploring disparities in health outcomes. Given that no intersectional interactions were identified, our findings support broad interventions that target the underlying social determinants of health appropriately reduce disparities versus interventions targeting intersectional interactions.

Keywords: health disparities, intersectionality, quality-adjusted life expectancy, rural health.

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Introduction

The impact of socioeconomic characteristics on behaviors that affect health outcomes is well established. Socioeconomic disadvantage is associated with a greater prevalence of risk factors for disease, including tobacco and alcohol use and overweight or obesity.[1-3] The relationship between disparate health outcomes and increasing geographic remoteness is well established in Australia. However, geographic remoteness alone does not adequately reflect the disparity in health outcomes observed among individuals residing in regional or remote areas, given that socioeconomic characteristics also vary with geographic remoteness.[4] For example, "neo-materialistic" determinants of health, including financial disadvantage, and psychosocial behaviors such as access to social support and cohesion may not be adequately captured using measures of geographic remoteness.[5] Finally, the extent to which geographic remoteness and socioeconomic disadvantage interact to affect health outcomes is poorly understood.[6,7]

Intersectional analysis has emerged as a novel method for understanding health disparities and has been recognized as a framework for facilitating health policy for improving health equity in Australia.[6,8,9] Intersectionality, in the context of social sciences, is a theoretical framework that explores the extent to which sociodemographic characteristics interact and overlap to drive health outcomes.[6,8] Under an intersectional approach, the effect of interactions between social strata may be considered additive or multiplicative. Additive effects suggest that interactions between sociodemographic characteristics and outcomes are uniform and layered, whereas multiplicative effects suggest that interactions may have amplifying or attenuating effects on outcomes.[6-8,10,11] For example, if the interaction between sex and socioeconomic status was determined to be additive, the impact of sex on mortality would be homogenous regardless of socioeconomic status.

In contrast, if multiplicative effects were identified, the effect of sex on mortality may be greater for participants with lower socioeconomic status.

Health-related quality of life (HRQoL) is a measure of a person's health status and captures physical and mental health domains. Generic multiattribute utility instruments (MAUIs) are used to derive utility values that reflect a person's health state. These lie on a scale anchored at 0 (representing dead) to 1 (representing full health), with values <0 representing states considered to be worse than death. A quality-adjusted life-year (QALY) incorporates quality of life and survival into a single measure; that is, a QALY reflects individual survival, adjusted for HRQoL, and is estimated through multiplying the duration of time spent in a particular health state by the utility score.[12] The EQ-5D is the most widely applied MAUI and is the instrument most often recommended by health technology assessment methods guides.[13] It measures HRQoL in terms of 5 dimensions, with either 3 (EQ-5D-3L) or 5 (EQ-5D-5L) response options, and is accompanied by value sets that allow for the estimation of a person's HRQoL through the application of a population-specific scoring algorithm to all health states described by the questionnaire.[14,15] In addition to informing HRQoL, the EQ-5D has been used to estimate quality-adjusted life expectancy (QALE).[16-18] Studies have highlighted the potential benefit of QALE (as distinguished from QALYs) in exploring the impact of disparities in health outcomes, as QALE incorporates HRQoL with life expectancy (LE) estimates and captures both fatal and nonfatal outcomes in a single measure of overall disease burden.[17,19]

In Australia, considerable disparities in health outcomes exist between individuals living in metropolitan and regional or remote areas.[4] Disparities in health outcomes for population groups increase with greater levels of geographic remoteness and socioeconomic disadvantage.[4] However, few studies have explored the disease burden attributed to disparities in the Australian context, and to date, no studies have examined the impact of social disadvantage, as measured by socioeconomic status, on QALE using an intersectional approach. This is despite equity being recognized as a key domain for assessing health systems performance based on the Australian Health Performance Framework, which was developed by the Australian government in collaboration with state and territorial governments to facilitate health systems improvement and policy development.[9,20] Therefore, this study aimed to (1) quantify the difference in QALE in Australia across different areas of geographic remoteness and (2) examine intersectionality and QALE along dimensions of age, sex, and socioeconomic disadvantage using cross-sectional survey data.

Methods

Study Design

A cross-sectional study was undertaken over a 2-month period (April 2022-June 2022) to collect EQ-5D-5L data within the community-dwelling Australian population setting.

Study Participants

A survey company (Stable Research) was engaged in recruiting study participants for an online survey conducted across Australia.[21] In determining the sample size, a total sample of 2000 participants achieved 80% power in detecting differences among mean utility values versus the alternative of equal means using an F-test with a 0.05 significance level. The sample was obtained through a quota process from the survey company's panel database using a nonprobability stratified proportional sampling opt-in approach. Participants were eligible to participate if they (1) were aged ≥ 18 years, (2) had sufficient English skills to complete the survey, and (3) had adequate access to the Internet. The survey was delivered via email and distributed through the ConfirmIt platform (Forsta, Oslo, Norway), with participants completing the survey online. Upon completion of the survey, the participant is notified of survey completion and reimbursed based on their specific panel agreements.[21] In particular, participants were reimbursed 250 points from panel survey completion. Points can be accumulated until they have earned 1000 (equivalent to Australian dollars [A$] 10), which may be redeemed for an e-gift voucher.

Key parameters collected as part of the online survey include participant age, gender, postcode, educational attainment, income, and self-reported health conditions. Standardized health measures were also collected, including HRQoL as measured using the EQ-5D-5L.[14,22]

Deriving QALE

Participant health status was measured using the EQ-5D-5L.[14,22] This was converted into utility scores by applying a recently-published value set for Australia to participants' EQ-5D-5L responses.[23] Participant LE by age and sex for general Australians was informed by life tables obtained from the Australian Bureau of Statistics (ABS). Given that LE varies by geographic remoteness, hazard ratios for mortality were sourced from the Australian Institute of Health and Welfare (AIHW)[4] to construct 4 life tables across 4 levels of geographic remoteness for Australians. Participant geographic status was informed through matching participant postcode data to geographic remoteness areas based on the Australian Statistical Geography Standard Remoteness Structure,[4,24] which is derived from the Accessibility/Remoteness Index of Australia Plus (ARIA+). Areas of geographic remoteness can be divided into 5 classes ("major cities," "inner regional," "outer regional," "remote," and "very remote") based on relative geographic access to "service centers," which are towns or localities with populations ≥1000 that deliver at least some basic level of health, education, or retail services.[24] For the purposes of our study, participants were classified as residing in "major cities," "inner regional," "outer regional," or "remote," with the number of participants residing in "very remote" areas collapsed into the "remote/very remote" group given that the remotest groups represents a small proportion (0.8%) of the Australian population.[4,24]

LE was then adjusted for HRQoL using the predicted utility scores for each of the age, sex, and remoteness level groups to estimate QALE through the Sullivan method.[23,25] QALE were estimated by assigning the respective utility weights to the years lived in each age interval using the life tables. In addition to undiscounted QALE estimates, annual discount rates of 3% and 5% were applied to estimate QALE as discounted values, in accordance with guidelines for the discounting of outcomes in health economic analyses across a variety of jurisdictions.[18,26]

Intersectionality Analysis

In the primary intersectional analysis, participant age group, sex, and Socioeconomic Indexes for Areas (SEIFA) scores were used to define intersectional strata. An intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA) was performed to explore the strata-specific average QALE and the degree of clustering of QALE within each stratum.[27,28]

Social Strata Dimensions

In the primary intersectional analysis, 3 dimensions of social identity (age, sex, and SEIFA scores) were used to construct 18 intersectional strata for MAIHDA (Table 1).

Studies using a MAIHDA approach to explore intersectionality partition age into broad strata to allow for distinguishing outcomes across socially meaningful age categories while ensuring equal distribution of sufficient participants across strata for analysis.[8,10] As such, participant age was partitioned into 3 groups (18-34, 35-54, and ≥55 years) to capture early, middle, and late adulthood with a fair distribution and sufficient participants across each stratum.[8,10] Although response options allowed for the capture of nonbinary or other-gendered categories, gender was recoded to a binary variable ("male" or "female") to allow for the estimation of sex-specific LE and, subsequently, sex-specific QALE. Henceforth, "sex" refers to self-reported male or female gender.

SEIFA scores are a composite index of relative social advantage and capture education, income, and geographic remoteness.[29] SEIFA is a product developed by ABS that ranks areas in Australia according to relative socioeconomic advantage and disadvantage.[29] Participant postcode data were matched to SEIFA scores based on the Index of Relative Socioeconomic Disadvantage.[4,29] SEIFA scores were divided into 3 groups for the purposes of the analyses. The first group comprised participants residing in the most disadvantaged areas (SEIFA quintiles 1-2), the second group comprised participants residing in midadvantaged areas (SEIFA quintile 3), and the third group comprised participants residing in the least disadvantaged areas (SEIFA quintiles 4-5).[29]

A secondary MAIHDA was performed using 5 dimensions of social identity (age, sex, education, income, and remoteness area) to explore potential effects that might not be captured through broad categorizations of social dimensions.[6,8] However, QALE was only estimable for 178 of 216 strata and the precision in the secondary analysis was reduced because of the small number of participants in each stratum.[7,8,11] As such, the results of this secondary MAIHDA are presented in Appendix Tables A1 and A2 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2023.08.013.

Statistical Analysis

Quantifying differences in QALE by geographic remoteness (multivariable linear regression analysis)

Multivariable linear regression was performed to explore differences in participants' QALE and LE across remoteness areas. First, univariable linear regression models were constructed across the following variables to identify potential confounders: age (18-34, 35-54, and ≥ 55 years), sex (male or female), level of education ("high school or below," "certificate/diploma," and "tertiary education"), household income levels ("< A$60 000 per year," "A$60 000-A$89 000 per year," or "≥ A$90 000 per year"), and the presence or absence of any ongoing medical conditions ("any" vs "no chronic health issues"). Variables found to have a significant impact ($P < .05$) on QALE through univariable linear regression were included in the final multivariable model to explore the impact of geographic remoteness on QALE.

Exploring intersectionality (MAIHDA)

An intersectional MAIHDA models 2-level hierarchical data, with individuals at level 1 nested within dimensions of social strata at level 2. The advantages of an intersectional MAIHDA as opposed to conventional fixed-effects (single-level) models to explore intersectionality between social strata have been described elsewhere.[6-8,10,11] In brief, these include model parsimony, simplicity in the interpretation of intersectional effects, and the automatic adjustment of estimated effects based on the observed stratum size that allows for a greater model precision.[6-8,10,11]

For the intersectional MAIHDA, null multilevel models were constructed to estimate the total variance in an outcome attributed to differences between intersectional strata. The null model comprised an intercept and the random effects component (the intersectional strata) of a multilevel model.[7,11,30] The magnitude of the variance partition coefficient (VPC) estimated using the null model is proportional to the extent to which the variance around an outcome may be attributed to differences across intersections. That is, a high VPC indicates that there are considerable differences in outcomes between intersectional strata, and similar outcomes within strata. Conversely, a low VPC estimated in the

Table 1. Social dimensions used in the MAIHDA.

Sex	Age group (years)	SEIFA quintile	Stratum number
Male	18-34	1-2 (most disadvantaged)	1
		3	2
		4-5 (most advantaged)	3
	35-54	1-2 (most disadvantaged)	4
		3	5
		4-5 (most advantaged)	6
	55+	1-2 (most disadvantaged)	7
		3	8
		4-5 (most advantaged)	9
Female	18-34	1-2 (most disadvantaged)	10
		3	11
		4-5 (most advantaged)	12
	35-54	1-2 (most disadvantaged)	13
		3	14
		4-5 (most advantaged)	15
	55+	1-2 (most disadvantaged)	16
		3	17
		4-5 (most advantaged)	18

MAIHDA indicates multilevel analysis of individual heterogeneity and discriminatory accuracy; SEIFA, Socioeconomic Indexes for Areas.

Table 2. Sociodemographic characteristics of the study participants.

Parameters	Study population (N = 2002)
Age, mean (SD)	48.4 (17.39)
Age group, n (%)	
18-29	338 (16.9)
30-39	403 (20.1)
40-49	306 (15.3)
50-59	324 (16.2)
60-69	348 (17.4)
70-79	241 (12.0)
80+	42 (2.1)
Sex, n (%)*	
Male	813 (40.6)
Female	1171 (58.5)
Remoteness level, n (%)	
Major cities	1248 (62.3)
Inner regional	505 (25.2)
Outer regional	198 (9.9)
Remote/very remote	34 (1.7)
Missing	17 (0.9)
Any chronic health issues†	1554 (77.6)
Education, n (%)	
High school or below	599 (29.9)
Certificate or diploma	638 (31.9)
Tertiary education	765 (38.2)
Income, n (%)	
<$60 000	719 (35.9)
$60 000-$89 000	328 (16.4)
$90 000	790 (39.5)
Other‡	165 (8.2)
SEIFA quintile, n (%)§	
1 (most disadvantaged)	363 (18.3)
2	373 (18.8)
3	390 (19.6)
4	346 (17.4)
5 (most advantaged)	514 (25.9)
Missing	16 (0.8)

SEIFA indicates Socioeconomic Indexes for Areas.
*18 participants identified as having nonbinary or other gender.
†Based on participant self-reported medical history.
‡165 participants preferred not to answer/did not know.
§SEIFA quintiles range from 1 (areas scoring in the lowest 20%) to 5 (areas scoring in the highest 20%).

null model suggests that health outcomes are similar between intersectional strata but are considerably different within each intersectional group.

Subsequently, each individual social dimension was added to the fixed-effects component of each multilevel model to construct a main effects MAIHDA model, allowing for the differentiation of additive effects from intersectional interaction effects. The magnitude of the VPC estimated from the main effects model (as opposed to the VPC estimated in the null model) is proportional to the degree of interaction between the variables used to define intersectional strata. A lower VPC indicates that intersectional differences are adequately explained by main effects, rather than the random effects of the multilevel model. For example, a VPC of 0% estimated in the main effects MAIHDA model suggests that any intersectional differences are additive and there are no intersectional multiplicative interaction effects.

All statistical analyses were conducted using Stata 17.0 software (StataCorp LP, College Station, TX). All MAIHDA models were estimated using the Bayesian Markov chain Monte Carlo method with noninformative priors and Gibbs sampling.[7,8,30] The burn-in length was 2500 iterations, and a total length of 10 000 was used.

Ethics

The study was approved by Deakin University Human Research Ethics Committee (reference number HEAG-H 100_2021).

Results

Study Cohort

The survey was distributed to 105 000 Australians on the survey company panel database via email. A total of 4583 participants commenced the survey, and of these, a total of 2002 participants completed the survey. The sociodemographic characteristics of surveyed participants are presented in Table 2. A comparison of the characteristics of surveyed participants with the adult (aged ≥18 years) Australian population is presented in Appendix Table B1 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2023.08.013.[4,31-34]

The surveyed cohort was largely female (59%), aged < 65 years, and residing in major cities or inner regional areas of Australia (87%). Overall, educational attainment was high with almost 70% of participants having at least a certificate- or diploma-level qualification and more than half of participants had reported an annual income of >$60 000. Participant SEIFA scores, which were matched to postcode data collected in the survey, were largely reflective of participant-reported educational attainment and income. Most participants had reported some form of ongoing medical condition (78%). Ultimately, with the exception of the presence of ongoing medical conditions, the characteristics of the surveyed sample are broadly representative of the sociodemographic profile of the Australian population based on data from the ABS and AIHW.[31,35]

Participant utility scores, by age, sex, geographic remoteness, and SEIFA quintile are presented in Appendix Table C1 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2023.08.013. In brief, participant utility scores were used in conjunction with life tables from the ABS to estimate QALE and LE from birth through the Sullivan method, stratified by sex and geographic remoteness (Appendix Table C2 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2023.08.013).[17,36]

Exploring the Difference in LE and QALE by Geographic Remoteness (Linear Regression Analyses)

The results of univariable and multivariable linear regression modeling for QALE (undiscounted) are presented in Table 3. Additional results of linear regression modeling for QALE (discounted) are presented in Appendix Tables D1 and D2 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2023.08.013.

Based on the results of univariable linear regression modeling, QALE was 2.7 years lower for participants living in inner regional areas (β-coefficient, −2.7; 95% CI −4.1 to −1.2; $P < .001$) than participants in major cities, but not significantly lower for participants in outer regional, remote, or very remote areas ($P > .05$ for both). QALE also declined significantly with increasing age, whereas significant increases in QALE were observed for female participants, participants reporting greater income levels or tertiary education, and participants without chronic health issues. After adjustment for key confounding variables in the multivariable analysis, QALE was significantly lower with increasing levels of remoteness, ranging from a reduction in QALE of 1.0 (inner regional) to 3.3 (remote/very remote) years.

As with QALE, participant remoteness (metropolitan vs inner regional), sex (female vs male), education (tertiary vs high school or below), income (≥ A$60 000 vs < A$60 000), and medical history (no current health issues vs any chronic health issues) were associated with greater LE in univariable modeling. In the multivariable regression model exploring the impact of geographic remoteness on LE, the only significant difference in LE was observed between participants in major cities and remote/very remote areas (β-coefficient, −2.4 95% CI −4.4 to −0.4; *P* = .016).

Intersectional Analysis (MAIHDA)

The results of the intersectional MAIHDA, including the VPCs (expressed as percentage) estimated for the null model and main effects models and regression coefficients (expressed as β-coefficients), are presented in Table 4.

Based on the VPC estimated for the null multilevel model for QALE, 88.8% of the total variance in QALE was attributed to between-stratum differences, with minimal within-stratum differences occurring. Similarly, a considerable proportion of the total variance in LE was attributed to between-stratum differences (null model VPC, 89.3%). The VPC estimated in the main effects interaction models were low (2.2% for QALE and 0.7% for LE) and declined considerably (88.8%-2.2% for QALE, 89.3%-0.7% for LE) from the null model to the multilevel main effects model. Therefore, most of between-stratum variance was attributed to the additive main effects of participant age group, sex, and SEIFA. There was minimal evidence of multiplicative intersectional effects on QALE.

The predicted results of participant QALE by the intersectional group are presented in Table 5.

Mean predicted QALE was considerably different between age and sex strata. For example, mean QALE was 46.8 years (95% CI 45.5-48.1) (undiscounted) for males aged 18 to 34 years and residing in areas of high disadvantage (SEIFA quintiles 1-2). In comparison, mean QALE was 49.3 years (95% CI 48.5-50.2) (undiscounted) for females in the same age and SEIFA strata and 34.8 (95% CI 33.3-36.3) (undiscounted) for older males (aged 35-54 years) in the same SEIFA strata. The mean predicted QALE did not vary considerably among different SEIFA strata.

Discussion

To the best of our knowledge, our study is the first to apply an intersectional MAIHDA approach to explore the impact of socioeconomic disparities and geographic remoteness on health outcomes in Australia. We found that increasing geographic remoteness is associated with decreasing QALE, whereas LE only decreased significantly for participants in remote/very remote regions. Although this may be attributed to limitations in sample

Table 3. Results of regression analyses on LE and QALE.

Parameter	LE				QALE			
	Univariable		Multivariable		Univariable		Multivariable	
	β-coefficient (95% CI)	*P* value	β-coefficient (95% CI)	*P* value	β-coefficient (95% CI)	*P* value	β-coefficient (95% CI)	*P* value
Remoteness area								
Major cities	REF		REF		REF		REF	
Inner regional	−2.5 (−4.1 to −0.8)	.005	−0.6 (−1.2 to 0.0)	.058	−2.7 (−4.1 to −1.2)	<.001	−1.0 (−1.5 to −0.4)	<.001
Outer regional	0.1 (−2.2 to 2.6)	.902	−0.4 (−1.3 to 0.4)	.345	−0.8 (−2.7 to 1.2)	.437	−1.1 (−1.8 to −0.3)	.001
Remote/very remote	2.4 (−3.2 to 8.0)	.419	−2.4 (−4.4 to −0.4)	.016	0.7 (−4.1 to 5.6)	.770	−3.3 (−5.2 to −1.4)	<.001
Age group								
18-34	REF		REF		REF		REF	
35-54	−16.3 (−17.0 to −15.7)	<.001	−15.9 (−16.5 to −15.2)	<.001	−13.9 (−14.4 to −13.4)	<.001	−13.6 (−14.1 to −13.1)	<.001
55+	−36.7 (−37.3 to −36.1)	<.001	−35.1 (−35.8 to −34.5)	<.001	−31.4 (−31.9 to −30.8)	<.001	−30.1 (−30.7 to −29.6)	<.001
Sex								
Male	REF		REF		REF		REF	
Female	8.1 (6.7-9.5)	<.001	4.3 (3.8-4.9)	<.001	6.0 (4.8-7.2)	<.001	2.8 (2.4-3.3)	<.001
Level of education								
High school or below	REF		REF		REF		REF	
Certificate/diploma	0.8 (−1.0 to 2.7)	.395	0.1 (−0.6 to 0.8)	.806	0.8 (−0.8 to 2.4)	.336	0.1 (−0.5 to 0.7)	.707
Tertiary	4.6 (2.8-6.4)	<.001	−0.4 (−1.1 to 0.3)	.244	4.4 (2.8-5.9)	<.001	−0.2 (−0.8 to 0.5)	.621
Income levels*								
<$60 000	REF		REF		REF		REF	
$60 0000-$89 000	4.3 (2.2-6.5)	<.001	0.3 (−0.5 to 1.1)	.426	3.8 (1.9-5.6)	<.001	0.2 (−0.5 to 0.9)	.592
≥$90 000	9.5 (7.9-11.1)	<.001	2.0 (1.3-2.6)	<.001	8.4 (7.1-9.7)	<.001	1.7 (1.1-2.2)	.001
Medical history								
Any chronic health issues	REF		REF		REF		REF	
No chronic health issues	8.5 (6.8-10.2)	<.001	1.0 (0.4-1.7)	<.001	7.5 (6.1-8.8)	<.001	0.9 (0.4-1.5)	.001

LE indicates life expectancy; QALE, quality-adjusted life expectancy; REF, reference.
*Income presented as 2022 A$.

size, in line with data from the AIHW,[4] participants were older in inner regional cities and younger in remote/very remote regions relative to participants in major cities. Given that age is a key determining factor of LE, the lack of statistically significant reductions to LE for participants in inner or outer regional areas may be due to the inherent limitation of LE in capturing health outcomes beyond mortality. Despite participants being younger, the greater risk of mortality (1.3 times higher vs major cities) likely contributed to the significant reduction in LE for participants residing in remote/very remote regions.[4] Notably, there was a more pronounced decline in QALE (−3.3 years for remote/very remote vs major cities) than LE (−2.4 years for remote/very remote vs major cities). As such, QALE is more sensitive to changes in HRQoL due to disparities in healthcare access for individuals residing in remote/very remote regions relative to health-adjusted LE or LE alone. Participant socioeconomic characteristics, including education and income levels, also significantly affected QALE and LE.

No evidence of multiplicative intersectional effects was identified in the MAIHDA intersectional analysis, with most of between-stratum variance being explained through additive effects of age, sex, and SEIFA score. This was broadly consistent with other MAIHDA, which found that most of the observed variance between strata was attributed to additive effects.[7,8,11] That is, based on our MAIHDA, the social dimensions (age, sex, and SEIFA) did not interact to amplify the predicted QALE. Hence, our findings suggest that interventions for improving QALE in disadvantaged areas would be most effectively implemented by addressing the broad, underlying socioeconomic determinants of health, as opposed to targeting any potential intersectional impacts attributed to age or sex.[8] In the context of health policy in Australia, such interventions may include the reform of funding structures for primary healthcare clinicians to ensure the adequate distribution of health services across areas of geographic remoteness.[37] Other broad public health interventions include improving access to educational attainment, targeting of modifiable risk factors such as tobacco consumption, and improving structural access to primary healthcare.[1] However, despite the lack of evidence for multiplicative effects in our analysis, it is important to acknowledge that a combined approach using both universal and targeted policies is warranted to better improve health equity.[37] Finally, it is worth noting that the intersections exhibited suboptimal discriminatory accuracy from the MAIHDA compared with the conventional main effects regression models. Most of the heterogeneity in QALE outcomes exist within rather than between intersectional strata, which is consistent with the overall findings emerging from MAIHDA of other outcomes,[8,10,38-40] and as noted earlier, the intersections constructed for the MAIHDA model do not differentiate participant QALE.

A study conducted in the UK[41] found that health disparities may be substantially greater when measured using QALE relative to LE or health-adjusted LE alone. As the EQ-5D-5L captures morbidity across physical and mental domains of health, health disparities may better be reflected in QALE; hence, the difference in QALE across the social strata is greater than that observed for LE. Therefore, our analyses may better quantify discrepancies in outcomes over time to provide an understanding of how health outcomes evolve with evolving socioeconomic characteristics. Notably, the gap in LE was wider than for QALE for females (vs males) and across age strata based on our regression analyses (Table 3). Other studies have identified instances of the difference in LE being greater than the difference QALE across strata (such as when comparing women and men in the UK and The Netherlands), which initiates discussion around the trade-off between longevity with and without morbidity.[36,42] Based on our findings, although the mortality burden (LE) among Australian females is lower relative to males, the smaller gain in QALE highlights the unmet need to address sex-specific contributors to morbidity. This is in line with studies conducted abroad; notably, financial hardship and inadequate management of chronic pain or

Table 4. Results of MAIHDA modeling.

Parameter	Outcome			
	LE (β-coefficient, 95% CI)	QALE (β-coefficient, 95% CI)		
		Undiscounted	3% discount rate	5% discount rate
Sex				
Male	REF	REF	REF	REF
Female	4.1 (3.4-4.8)	2.5 (1.6-3.4)	0.9 (0.3-1.4)	0.5 (0.1-0.9)
Age group				
Young (18-34 years)	REF	REF	REF	REF
Middle (35-54 years)	−16.0 (−16.8 to −15.1)	−13.6 (−14.6 to −12.6)	−12.1 (−12.8 to −11.4)	−8.9 (−9.4 to −8.4)
Old (55+)	−36.1 (−36.8 to −35.2)	−31.0 (−32.1 to −30.0)	−19.3 (−20.0 to −18.7)	−12.5 (−13.0 to −12.0)
SEIFA quintiles				
1-2	REF	REF	REF	REF
3	−0.0 (−0.9 to 0.8)	0.1 (−0.9 to 1.2)	−0.0 (−0.7 to 0.7)	−0.1 (−0.6 to 0.5)
4-5	0.1 (−0.6 to 0.9)	0.6 (−0.4 to 1.6)	−0.1 (−0.7 to 0.6)	−0.2 (−0.7 to 0.4)
Null model				
Between-stratum variance	255.2	184.5	76.6	31.7
Within-stratum variance	30.6	23.4	10.1	5.9
VPC (%)	89.30	88.75	88.39	84.4
Between-stratum variance	0.2	0.5	0.2	0.2
Within-stratum variance	30.6	23.4	10.1	5.9
VPC (%)	0.7	2.2	2.2	2.7

Note. VPC = Between-stratum variance / (between-stratum variance + within-stratum variance) × 100%.
LE indicates life expectancy; MAIHDA, multilevel analysis of individual heterogeneity and discriminatory accuracy; QALE, quality-adjusted life expectancy; REF, reference; SEIFA, Socioeconomic Indexes for Areas; VPC, variance partition coefficient.

Table 5. Results of participant QALE by intersectional group.

Stratum number	Stratum type	QALE (mean, 95% CI)		
		Undiscounted	3% discount rate	5% discount rate
1	YM1	46.8 (45.5-48.1)	21.6 (20.8-22.4)	13.2 (12.6-13.9)
2	YM2	46.5 (44.8-48.1)	21.0 (19.9-22.1)	12.7 (11.8-13.4)
3	YM3	47.0 (45.9-48.0)	20.2 (19.5-20.9)	11.8 (11.3-12.3)
4	MM1	33.3 (32.3-34.3)	9.5 (8.8-10.2)	4.3 (3.8-4.8)
5	MM2	34.8 (33.3-36.3)	10.3 (9.3-11.3)	4.7 (4.0-5.5)
6	MM3	34.6 (33.7-35.5)	9.7 (9.2-10.3)	4.3 (3.9-4.8)
7	OM1	15.0 (14.1-15.8)	2.2 (1.7-2.7)	0.6 (0.2-1.0)
8	OM2	15.2 (14.1-16.3)	2.2 (1.5-2.9)	0.6 (0.1-1.2)
9	OM3	16.3 (15.5-17.0)	2.4 (1.9-2.9)	0.7 (0.4-1.1)
10	YF1	49.3 (48.5-50.2)	22.9 (22.3-23.4)	14.0 (13.6-14.4)
11	YF2	49.1 (48.0-50.2)	22.4 (21.7-23.2)	13.6 (13.0-14.2)
12	YF3	50.1 (49.3-50.9)	22.9 (22.4-23.4)	14.0 (13.6-14.3)
13	MF1	35.0 (34.2-35.7)	9.8 (9.3-10.3)	4.4 (4.0-4.7)
14	MF2	35.2 (34.2-36.2)	9.9 (9.2-10.5)	4.4 (3.9-4.9)
15	MF3	35.5 (34.7-36.3)	9.9 (9.4-10.4)	4.4 (4.0-4.8)
16	OF1	19.6 (18.9-20.4)	3.1 (2.6-3.6)	1.0 (0.6-1.3)
17	OF2	18.9 (17.9-19.9)	2.9 (2.2-3.6)	0.9 (0.4-1.4)
18	OF3	18.7 (17.9-19.4)	2.9 (2.4-3.4)	0.9 (0.5-1.3)

MF1 indicates female, aged 35-54, SEIFA quintiles 1-2; MF2, female, aged 35-54, SEIFA quintile 3; MF3, female, aged 35-54, SEIFA quintiles 4-5; MM1, male, aged 35-54, SEIFA quintiles 1-2; MM2, male, aged 35-54, SEIFA quintile 3; MM3, male, aged 35-54, SEIFA quintiles 4-5; OF1, female, aged ≥ 55 years, SEIFA quintiles 1-2; OF2, female, aged ≥ 55 years, SEIFA quintile 3; OF3, female, aged ≥ 55 years, SEIFA quintiles 4-5; OM1, male, aged ≥ 55 years, SEIFA quintiles 1-2; OM2, male, aged ≥ 55 years, SEIFA quintile 3; OM3, male, aged ≥ 55 years, SEIFA quintiles 4-5; QALE, quality-adjusted life expectancy; SEIFA, Socioeconomic Indexes for Areas; YF1, female, aged 18-34, SEIFA quintiles 1-2; YF2, female, aged 18-34, SEIFA quintile 3; YF3, female, aged 18-34, SEIFA quintiles 4-5; YM1, male, aged 18-34, SEIFA quintiles 1-2; YM2, male, aged 18-34, SEIFA quintile 3; YM3, male, aged 18-34, SEIFA quintiles 4-5.

discomfort and anxiety or depressive symptoms have been identified as key factors for a lower gap in QALE between males and females.[17,36,43] Conversely, the greater reduction in LE with increasing age, relative to QALE, may highlight the need to address disparities in access to services to treat or prevent acute health events among aging populations.[17,36,43] Finally, the QALE gap by remoteness level was also wider than that for LE from the multivariable regression analysis, which suggested that disparities exist in LE and HRQoL. This finding is in accordance with previous studies conducted in the UK.[17,42] Ultimately, our study highlights the value of using both LE in conjunction with QALE as metrics for facilitating decision making and health policy that better addresses disparities in health outcomes.

Although there is no established willingness to pay threshold in Australia, a threshold of A$50 000 per QALY is used in determining the cost-effectiveness of new health technologies in Australia.[26] From our QALE data, the required number of QALYs gained to raise QALE in the most remote areas relative to metropolitan areas may be estimated through taking the overall population size in remote/very remote areas (493 386 persons in 2019) into account; that is, a total increase of 1.6 million QALYs would be required in 2019 (3.3 QALYs × 493 386) to reduce the gap in QALE.[44] Therefore, the QALE gap in Australia is worth A$165 000 per person (1.6 million QALYs × A$50 000 per QALY divided by 493 386) in the most remote areas. As such, our findings highlight the considerable cost consequences associated with ongoing disparities in health because of a combination of socioeconomic disadvantage and geographic remoteness in Australia.

Strengths and Limitations

Our study was based on survey data collected from a nationally representative cohort of participants to allow for the capture of differences in outcomes based on geographic remoteness. However, it was not without its limitations. First, the surveyed cohort was relatively small (N = 2002) despite being purposely drawn from regions across Australia. Hence, it is likely that our regression analyses were underpowered to detect differences in LE or QALE for participants residing in outer regional or remote/very remote areas. However, the proportional distribution of the Australian population residing in outer regional or remote/very remote areas is small (∼ 10% of the Australian population), and the under-representativeness of participants residing in these areas (and subsequent impacts on statistical analyses) is a limitation across cross-sectional studies which use Australian survey data.[45,46] Furthermore, to ensure adequate data in each stratum, the number of social dimensions in the primary MAIHDA were restricted to age, sex, and SEIFA quintiles with other characteristics, including race and nonbinary gender being omitted. Importantly, there are considerable disparities in health outcomes between indigenous and nonindigenous Australians that are attributed to socioeconomic disadvantage.[47] Furthermore, the geographic distribution of indigenous Australians varies, with the proportion of indigenous Australians increasing with increasing geographic remoteness.[47] However, it was not possible to explore the interaction between race and geographic remoteness on QALE using MAIHDA because of limitations in sample size and, correspondingly, the number of possible strata. Furthermore, the proportion of surveyed participants who were indigenous Australian was small (4.0%); as such, the inclusion of race in the MAIHDA model would not have been informative.[8,10] Additional justification for limiting our primary MAIHDA analysis to 18 strata was provided in our secondary analysis, which found a considerable number of missing strata (38 of 216 potential strata) and reduced statistical power (see Appendix Tables A1 and A2 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2023.08.013). Ultimately, a future study using a larger data set would allow for a more robust analysis of the impact of geographic remoteness on outcomes, as well as more granular analyses of intersectionality across more sociodemographic factors, including race and gender.

Second, our analyses were based on self-reported, cross-sectional data collected across Australia during the COVID-19 pandemic. As such, there is likely reporting bias in the use of self-reported income and educational and health status for our analyses. It was also not possible to explore the impact associated with transitioning between intersectional strata on QALE because of the cross-sectional nature of our data. Furthermore, a recently published Australian study found that HRQoL was significantly lower during the COVID-19 pandemic than prepandemic data.[48] Similarly, participant quality of life as estimated using the EQ-5D and therefore QALE would likely be considerably different in the period after the relaxation of public health measures for COVID-19, which limits the generalizability of our findings.[49,50] However, given that implementation of public health measures such as lockdowns varied across jurisdictions, it was not possible to discern the impact of such measures on HRQoL across socioeconomic or geographic strata with our data.[51]

Finally, negative utility values reflecting a health state worse than death may be elicited through MAUIs.[15,52] Hence, using QALE as a population health indicator could present a mathematical challenge because individuals with negative utility scores would have negative QALE and consequently have their LE subtracted from the population LE. This is the potential issue in using EQ-5D utility scores to measure QALE given that this may be methodologically controversial.

Conclusions

We found that increasing geographic remoteness had detrimental effects on QALE and, to a lesser extent, LE. Furthermore, disparities in socioeconomic status are more likely to be captured through QALE relative to LE or health-adjusted LE alone. Only additive effects were identified in our primary analysis, highlighting the need to address underlying social determinants of health as opposed to policies that target interactions between socioeconomic and geographic characteristics.

Author Disclosures

Drs Engel, Lubetkin, and Devlin are members of the EuroQol Group. No other disclosures were reported.

Supplemental Materials

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.jval.2023.08.013.

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REFERENCES

1. Adair T, Lopez AD. An egalitarian society? Widening inequalities in premature mortality from non-communicable diseases in Australia, 2006-16 [published correction appears in *Int J Epidemiol.* 2021;50(4):1403]. *Int J Epidemiol.* 2021;50(3):783–796.
2. Stevenson CE, Mannan H, Peeters A, et al. The effect of modifiable risk factors on geographic mortality differentials: a modelling study. *BMC Public Health.* 2012;12:79.
3. Welsh J, Bishop K, Booth H, et al. Inequalities in life expectancy in Australia according to education level: a whole-of-population record linkage study. *Int J Equity Health.* 2021;20(1):178.
4. Rural and remote health. Australian Institute of Health and Welfare. https://www.aihw.gov.au/reports/rural-remote-australians/rural-and-remote-health. Accessed November 14, 2022.
5. Singh A, Aitken Z, Baker E, Bentley R. Do financial hardship and social support mediate the effect of unaffordable housing on mental health? *Soc Psychiatry Psychiatr Epidemiol.* 2020;55(6):705–713.
6. Evans CR. Reintegrating contexts into quantitative intersectional analyses of health inequalities. *Health Place.* 2019;60:102214.
7. Evans CR, Erickson N. Intersectionality and depression in adolescence and early adulthood: a MAIHDA analysis of the national longitudinal study of adolescent to adult health, 1995-2008. *Soc Sci Med.* 2019;220:1–11.
8. Holman D, Salway S, Bell A. Mapping intersectional inequalities in biomarkers of healthy ageing and chronic disease in older English adults. *Sci Rep.* 2020;10(1):13522.
9. Flavel J, McKee M, Freeman T, et al. The need for improved Australian data on social determinants of health inequities. *Med J Aust.* 2022;216(8):388–391.

10. Evans CR, Williams DR, Onnela JP, Subramanian SV. A multilevel approach to modeling health inequalities at the intersection of multiple social identities. *Soc Sci Med*. 2018;203:64–73.
11. Zubizarreta D, Beccia AL, Trinh MH, Reynolds CA, Reisner SL, Charlton BM. Human papillomavirus vaccination disparities among U.S. college students: an intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA). *Soc Sci Med*. 2022;301:114871.
12. Whitehead SJ, Ali S. Health outcomes in economic evaluation: the QALY and utilities. *Br Med Bull*. 2010;96:5–21.
13. Kennedy-Martin M, Slaap B, Herdman M, et al. Which multi-attribute utility instruments are recommended for use in cost-utility analysis? A review of national health technology assessment (HTA) guidelines. *Eur J Health Econ*. 2020;21(8):1245–1257.
14. McCaffrey N, Kaambwa B, Currow DC, Ratcliffe J. Health-related quality of life measured using the EQ-5D-5L: South Australian population norms. *Health Qual Life Outcomes*. 2016;14(1):133.
15. Devlin N, Roudijk B, Ludwig K, eds. *Value Sets for EQ-5D-5L: A Compendium, Comparative Review & User Guide*. Cham, Switzerland: Springer; 2022.
16. Jia H, Zack MM, Thompson WW. State Quality-Adjusted Life Expectancy for U. S. adults from 1993 to 2008. *Qual Life Res*. 2011;20(6):853–863.
17. Love-Koh J, Asaria M, Cookson R, Griffin S. The social distribution of health: estimating quality-adjusted life expectancy in England. *Value Health*. 2015;18(5):655–662.
18. Palmer AJ, Campbell JA, de Graaff B, et al. Population norms for quality adjusted life years for the United States of America, China, the United Kingdom and Australia. *Health Econ*. 2021;30(8):1950–1977 [published correction appears in *Health Econ*. 2022;31(9):2090-2105].
19. Collins B. Results from a well-being survey in the north west of England: inequalities in EQ-5D-derived quality-adjusted life expectancy are mainly driven by pain and mental health. *Value Health*. 2017;20(1):174–177.
20. Health system overview. Australian Institute of Health and Welfare. https://www.aihw.gov.au/reports/australias-health/health-system-overview. Accessed March 29, 2023.
21. Stable Research. https://crnrstone.com.au/. Accessed December 9, 2022.
22. Herdman M, Gudex C, Lloyd A, et al. Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). *Qual Life Res*. 2011;20(10):1727–1736.
23. Norman R, Mulhern B, Lancsar E, et al. The use of a discrete choice experiment including both duration and dead for the development of an EQ-5D-5L value set for Australia. *Pharmacoeconomics*. 2023;41(4):427–438.
24. The Australian statistical geography standard (ASGS) - remoteness structure. Australian Bureau of Statistics. https://www.abs.gov.au/ausstats/abs@.nsf/mf/1270.0.55.005. Accessed September 19, 2022.
25. Sullivan DF. A single index of mortality and morbidity. *HSMHA Health Rep*. 1971;86(4):347–354.
26. The Pharmaceutical Benefits Advisory Committee (PBAC) Guidelines. Department of Health and Aged Care, The Australian Government. https://pbac.pbs.gov.au/information/about-the-guidelines.html. Accessed October 2, 2022.
27. Merlo J. Multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA) within an intersectional framework. *Soc Sci Med*. 2018;203:74–80.
28. Bell A, Holman D, Jones K. Using shrinkage in multilevel models to understand intersectionality: a simulation study and a guide for best practice. *Methodology*. 2019;15(2):88–96.
29. The Index of Relative Socio-economic Advantage and Disadvantage (IRSAD). Australian Bureau of Statistics. https://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa. Accessed September 19, 2022.
30. Ljungman H, Wemrell M, Khalaf K, Perez-Vicente R, Leckie G, Merlo J. Antidepressant use in Sweden: an intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA). *Scand J Public Health*. 2022;50(3):395–403.
31. Education and Work, Australia. Australian Bureau of Statistics. https://www.abs.gov.au/statistics/people/education/education-and-work-australia/latest-release. Accessed September 19, 2022.
32. Census of Population and Housing. Reflecting Australia - Stories From the Census, 2016. Australian Bureau of Statistics. https://www.abs.gov.au/ausstats/abs@.nsf/mf/2071.0. Accessed June 2, 2023.
33. National, State and Territory Population. Australian Bureau of Statistics. https://www.abs.gov.au/statistics/people/population/national-state-and-territory-population/latest-release. Accessed June 2, 2023.
34. 6.1 Profile of Indigenous Australians. Australian Institute of Health and Welfare. https://www.aihw.gov.au/getmedia/f29b7dd4-695a-4f9f-a508-ecdacc52beca/aihw-aus-221-chapter-6-1.pdf.aspx. Accessed June 2, 2023.
35. Chronic Conditions and Multimorbidity. Australian Institute of Health and Welfare. https://www.aihw.gov.au/reports/australias-health/chronic-conditions-and-multimorbidity. Accessed June 2, 2023.
36. Gheorghe M, Wubulihasimu P, Peters F, Nusselder W, Van Baal PH. Health inequalities in the Netherlands: trends in quality-adjusted life expectancy (QALE) by educational level. *Eur J Public Health*. 2016;26(5):794–799.
37. Fisher M, Harris P, Freeman T, et al. Implementing universal and targeted policies for health equity: lessons from Australia. *Int J Health Policy Manag*. 2022;11(10):2308–2318.
38. Axelsson Fisk S, Mulinari S, Wemrell M, Leckie G, Perez Vicente R, Merlo J. Chronic obstructive pulmonary disease in Sweden: an intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy [published correction appears in *SSM Popul Health*. 2020;12:100711]. *SSM Popul Health*. 2018;4:334–346.
39. Crimmins EM, Vasunilashorn SM. Chapter 3. Biodemography: adding biological insight into social, economic, and psychological models of population and individual health change with age. In: George LK, Ferraro KF, eds. *Handbook of Aging and the Social Sciences*. 8th ed. San Diego, CA: Academic Press; 2016.
40. Hernández-Yumar A, Wemrell M, Abásolo Alessón I, González López-Valcárcel B, Leckie G, Merlo J. Socioeconomic differences in body mass index in Spain: an intersectional multilevel analysis of individual heterogeneity and discriminatory accuracy. *PLoS One*. 2018;13(12):e0208624.
41. Collins B. Using a survey to estimate health expectancy and quality-adjusted life expectancy to assess inequalities in health and quality of life. *Value Health*. 2013;16(4):599–603.
42. McNamara S, Schneider PP, Love-Koh J, Doran T, Gutacker N. Quality-adjusted life expectancy norms for the English population. *Value Health*. 2023;26(2):163–169.
43. Love-Koh J, Schneider P, McNamara S, Doran T, Gutacker N. Decomposition of quality-adjusted life expectancy inequalities by mortality and health-related quality of life dimensions. *Pharmacoeconomics*. 2023;41(7):831–841.
44. Deaths, Australia. Australian Bureau of Statistics. https://www.abs.gov.au/statistics/people/population/deaths-australia/latest-release#:~:text=There%20were%20190%2C939%20registered%20deaths,increase%20of%2019%2C470%20since%202021. Accessed October 2, 2022.
45. Fisher JR, Tran TD, Hammarberg K, et al. Mental health of people in Australia in the first month of COVID-19 restrictions: a national survey. *Med J Aust*. 2020;213(10):458–464.
46. Armour M, Sinclair J, Chalmers KJ, Smith CA. Self-management strategies amongst Australian women with endometriosis: a national online survey. *BMC Complement Altern Med*. 2019;19(1):17.
47. Australian Burden of Disease Study. Impact and Causes of Illness and Death in Aboriginal and Torres Strait Islander People 2018. Australian Institute of Health and Welfare. https://www.aihw.gov.au/reports/burden-of-disease/illness-death-indigenous-2018/summary. Accessed March 15, 2022.
48. Mercieca-Bebber R, Campbell R, Fullerton DJ, et al. Health-related quality of life of Australians during the 2020 COVID-19 pandemic: a comparison with pre-pandemic data and factors associated with poor outcomes. *Qual Life Res*. 2023;32(2):339–355.
49. Social isolation and loneliness. Australian Institute of Health and Welfare. https://www.aihw.gov.au/reports/australias-welfare/social-isolation-and-loneliness. Accessed October 3, 2022.
50. Griffiths D, Sheehan L, Petrie D, van Vreden C, Whiteford P, Collie A. The health impacts of a 4-month long community-wide COVID-19 lockdown: findings from a prospective longitudinal study in the state of Victoria, Australia. *PLoS One*. 2022;17(4):e0266650.
51. The first year of COVID-19 in Australia: direct and indirect health effects. Australian Institute of Health and Welfare. https://www.aihw.gov.au/reports/burden-of-disease/the-first-year-of-covid-19-in-australia/summary. Accessed November 17, 2022.
52. Devlin NJ, Shah KK, Feng Y, Mulhern B, van Hout B. Valuing health-related quality of life: an EQ-5D-5L value set for England. *Health Econ*. 2018;27(1):7–22.