Area-level and individual-level socio-economic differences in health-related quality of life trajectories: Results from a 10-year longitudinal stroke study

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Background: We examined area-level (aSES) and individual-level (iSES) socio-economic status on trajectories of HRQoL to 10 years following stroke. *Methods:* Participants with strokes between 1/5/1996 and 30/4/1999 completed the Assessment of Quality of Life instrument (AQoL, range: -0.04 [worse than death] to 0 [death] to 1 [full health]) at ≥one of 3month, 6-month, 1-year, 2-year, 3-year, 4-year, 5-year, 7-year and 10-year interviews after stroke. Sociodemographic and health information were collected at baseline. We derived aSES from postcode using the Australian Socio-Economic Indexes For Area (2006) (categories: high, medium, low), and iSES from lifetime occupation (categories: non-manual, manual). Multivariable linear mixed effects modelling was used to estimate trajectories of HRQoL over 10 years, by aSES and iSES, adjusting for age, sex, cardiovascular disease, smoking, diabetes, stroke severity, stroke type, and the time influence on age and health conditions. *Results:* Of 1,686 participants enrolled, we excluded 239 with 'possible' stroke and 284 with missing iSES. Among the remaining 1,163 participants, 1,123 (96.6%) had AQoL assessed at ≥3 timepoints. In multivariable analysis, over time, people in the medium aSES group had mean 0.02 (95% CI -0.06, 0.02) greater reduction in AQoL score, and people in the low aSES group had mean 0.04 (95% CI, -0.07, -0.001) greater reduction, than those in the high aSES group. Manual workers had an average 0.04 (95% CI, -0.07, -0.01) greater reduction in AQoL score over time than non-manual workers. *Conclusions:* Over time, HRQoL declines in all people with stroke, declining most rapidly in lower SES groups.

Keywords: Area-level—Individual-level—Socio-economic status—Health-related quality of life—Longitudinal study

Introduction

After acute stroke, many people live with residual effects. Recent report suggested that the number of people lived with disabilities has nearly doubled [1]. Individuals' long-term changes in health-related quality of life (HRQoL) is a critical patient reported outcome and can provide important information for post stroke services planning. Prior studies on socioeconomic status (SES) and HRQoL post stroke have been mainly limited to cross-sectional designs [2–5]. Only a few longitudinal studies have examined the associations between SES and trajectories of QoL, and the follow-up time of most studies have been within one year and the repeated QoL assessment was less than four timepoints [6–8]. Only one study used insurance status as an SES indicator to examine the QoL

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trajectories up to five years after stroke [9]. Therefore, more studies are needed to better understand the patterns of different SES indicators on HRQoL changes over a long term after stroke.

SES can be measured by individual-level indicators, such as household income or occupation, and area-based measures, usually derived from indices reflecting economic resources averaged over small geographic areas [10], which reflect different aspects of SES. In the North-East Melbourne Stroke Incidence Study (NEMESIS), we found that the manual worker group had a lower HRQoL compared to the non-manual worker group at both 2 and 5 years [11,2]. In the present study, we aimed to use the NEMESIS dataset with 8 repeated HRQoL assessment to investigate both area-level socio-economic status (aSES) and life-long occupation as individual-level socio-economic status (iSES) on trajectories of HRQoL up to 10 years after stroke. The findings would hope to provide evidence for long-term rehabilitation services planning and evaluation.

Materials and methods

Participants

Participants were obtained from the NEMESIS with all having strokes between May 1, 1996 and April 30, 1999. Case ascertainment procedures have been detailed previously [12]. For this analysis we included all cases meeting the following criteria: any age, confirmed stroke, and complete details of their occupation. Possible stroke cases were excluded. The study was approved by ethics committee at all involved institutions. Informed consent was obtained before each interview.

Baseline assessment

Individuals' baseline information was obtained using multiple sources. Demographic data (age, sex, occupation and postcode), self-reported clinical data (hypertension, myocardial infarction and diabetes), discharge medications and self-reported smoking status (never, current, or ex-smoker) were obtained directly from participants or their proxies. Stroke subtype was obtained from neuroimaging and reports located in the medical record reports. Stroke severity, based on the National Institutes of Health Scale (NIHSS) [13], was obtained from either medical record or from direct assessment with a score, >7 denoting severe stroke. Presence of cardiovascular disease was defined as having hypertension or history of myocardial infarction. Diabetes was defined as known history or diagnosed on current presentation. We defined optimal discharge medications as prescribing a statin and an antihypertensive agent for ischaemic stroke, and antihypertensive agents for intracerebral haemorrhage.

Socioeconomic status

aSES was derived from the postcode of a subject's residential address, matched to the score of Index of Relative Socio-economic Advantage and Disadvantage (IRSAD), 2006 that was developed by the Australian Bureau of Statistics from the Socio-economic Indexes for Area (SEIFA) [14]. The IRSAD was derived from multiple measures, such as income and education, over small geographic areas collected from the national census. A high score indicates less disadvantage and greater advantage. We dichotomised the cut-off point by population distribution to approximately 30%, 40% and 30% to represent high, medium and low aSES groups. We defined aSES as high (≥1,125), medium (1,041 - 1,124), and low (≤ 1040) based on the IRSAD score. iSES was defined by an individual's occupation during their working life as manual or non-manual using the Australian Standard Classification of Occupation [15].

Follow-up and HRQoL assessment

Potential follow-up assessments were at 3 and 6 months, then 1, 2, 3, 4, 5, 7 and 10 years after stroke. Due to resource constraints, not all participants were approached to be followed-up at each time point. The questionnaires were completed by nurses during in-home visits with participants or their proxy.

Health-related quality of life was assessed using the Assessment of Quality of Life (AQoL) instrument, a valid and reliable instrument for use in people with stroke [16,17]. The AQoL comprises five domains of health-related quality of life: independent living, social relationship, physical senses, psychological well-being and illness [18]. The maximum score for each domain is 9. A higher overall score on each domain indicates poor quality of life. A weighted utility score was then calculated from each domain's unweighted health-related quality of life score except the illness domain. The AQoL utility score can range from 1 (full health state) to 0 (death-equivalent health states) to -0.04 (health states worse than death) [19]. To keep consistency with previous NEMESIS studies, we coded AQoL score 0 for those who had died at each point of assessment.

Statistical analyses

All statistical analyses were performed using R (version 4.1.2). For descriptive analyses, means and standard deviations (SD) were used for continuous variables, and frequencies and proportions for categorical variables. We described the baseline characteristics stratified by area-based and individual SES group. Group comparisons were calculated by using one-way ANOVA or t-test for continuous variables, and chi-squared test for categorical variables. Two-sided P-value <0.05 were considered statistically significant.

We used linear mixed effects modelling to estimate the trajectories of HRQoL over 10 years after stroke. First, we used a random intercept model with only individual variation as a random effect to test for clustering. If clustering was present, we proceeded to linear mixed effects model. The population mean trajectory over time was estimated by adding area-level or individual-level socio-economic group and time as fixed effects, extending to allow variation in individual specific trajectories. We used the literature to identify likely covariates to be included in the models. In the first model, we compared the trajectory in AQoL score over time in different socio-economic groups, with aSES and iSES examined in separate models, including socio-economic group and time variables as fixed effects. In the second model, we added quadratic effects of time, age and sex. In the final model, we also adjusted for other confounders including smoking status, history of CVD, severity of stroke, diabetes and stroke type. We also tested the interaction between time and aSES and iSES groups, and time and chronic health conditions. We compared models with interactions by time and non-linear associations using the D1 method which approximates the Wald test for imputed datasets. We reported the effect of differences in AQoL by aSES and iSES, with corresponding 95% confidence intervals.

We examined the pattern of missing data in both covariates and AQoL scores. We used multivariate imputation chained equations (MICE) technique to impute covariates only to minimise the potential bias and enhance the precision of estimates. In the models, we reported pooled effect from the 10 sets of imputation. Maximum likelihood estimation was used in linear mixed effect models to retain the subjects who had missing data at the point of assessment of AQoL. We conducted a sensitivity analysis comparing the complete case with multiple imputation analysis.

Results

A total of 1,686 cases were identified during the study period with 1,163 eligible for final analysis (Fig. 1).

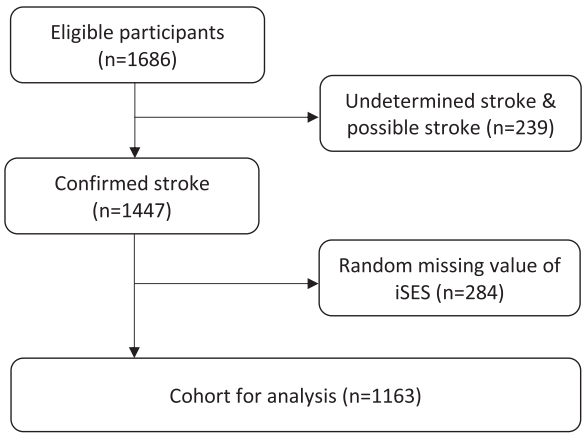

Fig. 1. *The flow chart of establishing study cohort.*

Missing data were minimal, ranged from 0.5% to 25.0%, and we only imputed five covariates: diabetes (0.5%), smoking (8.3%), CVD (0.9%), stroke severity (19.3%) and optimal discharge medication (25.0%). In this cohort, the mean age was 74 years, ranging from 23 to 103 years. People in higher aSES group were older. A large proportion of people in the low aSES group were smokers, manual workers, and had diabetes or CVD (Table 1). Stroke severity was similar by iSES or aSES. There were also large proportions of people with manual occupations who had CVD or were smokers (Supplement S1). Over the 10-year follow-up period, 71% people died (Supplement S2).

Pattern of HRQoL over time by aSES

In general, the proportion of people who completed the AQoL increased over time, largely because of the increasing proportion of people who died. Completion of the AQoL was least at the 6-month timepoint Overall HRQoL decreased in all aSES groups over time with some fluctuation (Table 2). The mean AQoL score was slightly greater (0.323) in the low aSES group compared with the high aSES groups (0.320) at 3 months after stroke. By 5 years, the average AQoL score of the low aSES group remained the largest, being 0.02 higher than the high aSES group. However, at 7 years after stroke, the mean AQoL score of the high aSES group was greater than the medium and low aSES groups. At the final timepoint (10 years), the score of the high aSES group remained the largest of the three groups.

Trajectories of HRQoL over time by aSES

The null model, using an individual's variation as a random effect, showed evidence of clustering ($p<0.0001$) so we proceeded to the liner mixed effect model. In model 1, pooled from 10 imputed data sets, the low aSES group had an average 0.02 (95% CI -0.03, 0.06) increase in AQoL score over time than the high aSES group, but this was not statistically different at conventional levels (Table 3). In model 2, which included quadratic time, age and sex variables, the mean AQoL scores of medium aSES group was reduced by 0.02 (95% CI -0.05, 0.02) and the low aSES group was reduced by 0.03 (95% CI -0.07, 0.01). In model 3, after adjusting for baseline CVD, smoking status, diabetes, stroke severity and stroke type, there was no magnitude change observed in medium group when compared with model 2. However, in the low aSES groups, there was a further average reduction in AQoL score. In model 4, after adjusting for the interaction between time and age, CVD, diabetes, stroke severity, the changes in the mean AQoL scores among groups were similar to model 3 with a slightly reduced AQoL score over time in the medium aSES group (-0.02 95% CI -0.05, 0.02) and a further reduction in the low aSES group (-0.04 95% CI -0.07, -0.001). No interaction was found between time and aSES groups (p = 0.71). In model 5, after adding optimal

Table 1. *Baseline characteristics of stroke patients by aSES.*

Variables	High aSES (n = 322)	Medium aSES (n = 493)	Low aSES (n = 348)	P- value	Total cases (n = 1163)	Missing N (%)
Age (year) mean (SD)	76 (13.0)	74 (13.0)	72 (14.1)	<0.001	1163	0 (0)
Sex n (%)				0.211		0 (0)
Female	168 (52.2)	237 (48.1)	158 (45.4)		563	0 (0)
Male	154 (47.8)	256 (51.9)	190 (54.6)		600	0 (0)
Smoker n (%)				0.001		97 (8)
Non-smoker	142 (44.1)	216 (43.8)	116 (33.3)		474	
Smoker	146 (45.3)	240 (48.7)	206 (59.2)		592	
iSES n (%)				<0.001		0 (0)
Non-manual	260 (80.7)	250 (50.7)	121 (34.8)		631	
Manual	62 (19.3)	243 (49.3)	227 (65.2)		532	
Diabetes n (%)				<0.001		6 (1)
No	278 (86.3)	398 (80.7)	257 (73.9)		933	
Yes	44 (13.7)	91 (18.5)	89 (25.6)		224	
CVD n (%)				0.028		10 (1)
No	143 (44.4)	171 (34.7)	129 (37.1)		443	
Yes	179 (55.6)	315 (63.9)	216 (62.1)		710	
Severe stroke n (%)				0.079		225 (19)
No	160 (49.7)	245 (49.7)	184 (52.9)		589	
Yes	117 (36.3)	141 (28.6)	91 (26.1)		349	
Stroke type n (%)				0.155		0 (0)
HS	63 (19.6)	100 (20.3)	53 (15.2)		216	
IS	259 (80.4)	393 (79.7)	295 (84.8)		947	
Optimal discharge medications n (%)				0.119		291 (25)
No	280 (87.0)	293 (59.4)	185 (53.2)		758	
Yes	32 (9.9)	46 (9.3)	36 (10.3)		114	
Death at time of assessment (year) n (%)				0.126		0 (0)
0.25	75 (23.3)	107 (21.7)	60 (17.2)		242	446 (38)
0.5	13 (4.0)	21 (4.3)	9 (2.6)		43	745 (64)
1	10 (3.1)	21 (4.3)	22 (6.3)		53	300 (26)
2	25 (7.8)	32 (6.5)	16 (4.6)		73	506 (43)
3	15 (4.7)	30 (6.1)	22 (6.3)		67	491 (42)
4	16 (5.0)	25 (5.1)	31 (8.9)		72	258 (22)
5	20 (6.2)	24 (4.9)	13 (3.7)		57	104 (9)
7	38 (11.8)	47 (9.5)	36 (10.3)		121	152 (13)
10	26 (8.1)	46 (9.3)	26 (7.5)		98	59 (5)

discharge medication, the results were almost identical to the results in model 4. Fig. 2 used the final model to predict HRQoL trajectories over 10 years. Sensitivity analyses without low follow-up rate, starting at 1 year follow-up, showed similar results, with average AQol score 0.02 lower in medium aSES group and 0.05 lower in low aSES group per year (p = 0.01). In complete cases analysis, the results were similar to the pooled effects using multiple imputation to replace missing data. However, in model 5, the associations were no longer significant (Supplement S3).

Pattern of HRQoL over time by iSES

In both nonmanual and manual occupation groups HRQoL reduced over the 10-year period. The mean AQoL scores of the nonmanual group were consistently larger than in the manual group at each time period (Table 3). The only exception to this was at 6 months, where more than one-thrid of cases had missing data on AQoL.

Trajectories of HRQoL over time by iSES

In the linear mixed effect model 1, the mean AQoL score of the manual group was 0.04 (95% CI -0.07, -0.003) less than the nonmanual group, with iSES and year as fixed effects, and accounting for individual variation (Table 4). In model 2, after adjusting for age and sex, there was 0.04 (95% CI -0.07, -0.01) greater reduction in the mean AQoL score than in the manual group over time. Similar results were obtained for models 3 (Table 4) and 4 (Fig. 3; Table 4). No interaction was found between time and iSES groups (p = 0.42). Sensitivity analysis starting at 1 year follow-up, also showed that similar result, with the low iSES had 0.03 reduction in AQol score per year

Table2. *Assessment of quality of life over time by area-level socio-economic group.*

Time-point of measurement	High aSES (n = 322)		Medium aSES (n = 493)		Low aSES (n = 348)	
	Missing value (Complete rate)	Mean (SD)	Missing value (Complete rate)	Mean (SD)	Missing value (Complete rate)	Mean (SD)
3-month	128 (60.2%)	0.320 (0.351)	195 (60.4%)	0.304 (0.353)	123 (64.7%)	0.323 (0.350)
6-month	231 (28.3%)	0.016 (0.093)	295 (40.2%)	0.133 (0.259)	219 (37.1%)	0.207 (0.308)
1-year	89 (72.4%)	0.293 (0.356)	125 (74.6%)	0.305 (0.356)	86 (75.3%)	0.293 (0.338)
2-year	117 (63.7%)	0.178 (0.311)	232 (52.9%)	0.150 (0.305)	157 (54.9%)	0.178 (0.293)
3-year	118 (63.4%)	0.169 (0.314)	219 (55.6%)	0.110 (0.257)	154 (55.7%)	0.154 (0.287)
4-year	54 (83.2%)	0.193 (0.315)	120 (75.7%)	0.176 (0.319)	84 (75.9%)	0.194 (0.312)
5-year	21 (93.5%)	0.196 (0.340)	49 (90.1%)	0.204 (0.334)	34 (90.2%)	0.216 (0.319)
7-year	16 (95.0%)	0.168 (0.329)	78 (84.2%)	0.139 (0.297)	58 (83.3%)	0.139 (0.293)
10-year	15 (95.3%)	0.127 (0.286)	25 (94.9%)	0.119 (0.276)	19 (94.5%)	0.123 (0.264)

Means were calculated without missing values.

(p = 0.02). Results were consistent in the complete case analysis (Supplement S3).

Discussion

In this large 10-year longitudinal study of people with stroke, we found that HRQoL reduced in all aSES groups over time, and that aSES was positively associated with HROoL trajectories over a 10-year period. A graded pattern was observed, with the medium aSES having a slightly moderate and the low aSES group having a more rapid, reduction in HRQoL compared to the high SES group. This finding was independent of age, sex, other chronic health conditions present at the time of stroke and stroke severity. A slightly more rapid decline in HRQoL in low aSES group every year following stroke requires attention because the longer the time following the stroke, the larger HRQoL difference may be seen among groups. Lower HRQoL may reflect individuals' poorer physical and mental health later in the life, and result in higher healthcare costs. This can further increase the burden of stroke. We also found that people who had manual occupations had an overall greater reduction in HRQoL over time than people who had non-manual occupations.

People living in areas of low aSES had a more rapid reduction in changing HRQoL than those living in more advantaged regions over 10 years following a stroke. In prior work living in disadvantaged neighbourhoods has been associated with poor functional recovery and quality of life independently from individual level socio-economic resources at 90 days after stroke [20]. Similarly, a higher neighbourhood socio-economic status has been significantly associated with better trajectories of physical health-related quality of life over 3 years [21]. aSES encompasses both the economic and social conditions of people living in that area, and usually includes household income, highest level of education, occupation,

Table 3. *The effect of health-related quality of life trajectories over time by aSES and iSES.*

Exposure	Model 1		Model 2*		Model 3†		Model 4‡		Model 5#	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
aSES										
High (reference)										
Medium	0.003	-0.04, 0.05	-0.02	-0.05, 0.02	-0.02	-0.05, 0.02	-0.02	-0.05, 0.02	-0.02	-0.06, 0.02
Low	0.02	-0.03, 0.06	-0.03	-0.07, 0.01	-0.04	-0.07, 0.00	-0.04	-0.07, -0.001	-0.04	-0.07,-0.001
iSES										
Nonmanual (reference)										
Manual	-0.04	-0.07, -0.003	-0.04	-0.07, -0.01	-0.04	-0.07, -0.01	-0.04	-0.07, -0.01	-0.04	-0.07, -0.01

aSES, area-level socio-economic status; iSES, individual-level socio-economic status; β, beta coefficient; CI, confidence interval.
Pooled analysis: we pooled results from 10 imputed data sets.
Complete cases: we analysed data without imputation
Model 1 included aSES /iSES and year as fixed effects, individual as a random effect.
Model 2* added the quadratic effect of time, age, sex to the analysis in model 1.
Model 3† added cardiovascular disease, diabetes, stroke severity, smoking status and stroke type as fixed effect to the analysis in model 2.
Model 4‡ added the time influence on age, cardiovascular disease, diabetes and stroke severity to the analysis in model 3.
Model 5# added optimal discharge medications to the analysis in model 4.

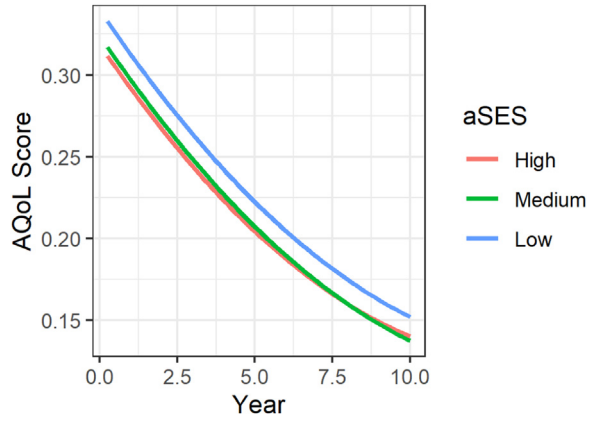

Fig. 2. *Predicted health-related quality of life (Assessment of Quality of Life Score) trajectories up to 10 years after stroke by area-level socio-economic status. The scores were predicted using model 4.*

unemployment and housing condition [14]. Because this metric is so broad, other factors that affect engagement and participation may also contribute. For instance, low social capital was found to be associated with poor family and friends support network and therefore hindered individual's community participation during his or her illness [22]. Thus, the lack of economic resources or availability of services or specialists may contribute to this poorer HRQoL in disadvantaged settings. Our findings can potentially be attributed to establish affordable long-term community-based support services in low socio-economic areas. People in low aSES group are less likely to attend rehabilitation services, perhaps due to the lack of private insurance or barriers travelling to facilities located elsewhere. Our evidence also provides insights to enhance the referral system to chronic disease management plan for ongoing multidisciplinary care and self-management support in primary health settings. One small longitudinal study supported that a greater community engagement has been associated with improved emotional well-being [23]. Interestingly, despite HRQoL reduced more sharply in lower aSES group, we also noted that the overall HRQoL scored larger in lower aSES group. Limited evidence suggested low aSES groups had better HRQoL. It is possible that people living in higher aSES areas had a higher baseline community engagement and higher perceived quality of life. The stroke event may therefore reduce their perception of HRQoL to a greater extent compared to other socioeconomic groups.

Studies using education as iSES indicator found that higher education level was not significantly associated with improved or but slightly worsening quality of life at 1 year after stroke [6–8]. In a five-year longitudinal study using insurance as an iSES indicator, the study found that after 3 years quality of life increased of in the group with Medicare/private insurance, and reduced in groups without insurance [9]. We used occupation as the indicator and found that manual workers had more rapid reduction in HRQoL compared to those with non-manual workers. aSES and iSES are usually correlated, but measuring aSES alone could mask the important individual factors that contribute to stroke survivors' HRQoL. Our findings suggest that the reduced HRQoL among stroke survivors who hold manual occupations persists, and potentially becomes even greater, over time.

There are a range of potential explanations for why an individual's occupation may influence HRQoL after stroke over time. A person's occupation partially reflects their educational attainment, employment status and income. Having access to less material resources may limit individuals access to services and supports beyond basic public health coverage, noting that free universal health care is available in Australia. Mechanisms underlying this connection between low iSES and HRQoL are complex and may be determined by an individual's choices, health behaviours and use of material resources to gain positive health outcomes. This requires individuals' knowledge in understanding their stroke, manage risk factors and medications, as well as the ability to navigating healthcare system. Patients receiving specific therapies, such as preventative medications, had a minimal impact on HRQoL trajectories among the groups, and our

Table 4. *Assessment of quality of life over time by individual-level socio-economic group.*

	Nonmanual (n = 631)		Manual (n = 532)	
Time-point of measurement	Missing value (Complete rate)	Mean (SD)	Missing value (Complete rate)	Mean (SD)
3 months	268 (57.5%)	0.319 (0.356)	178 (66.5%)	0.310 (0.346)
6 months	416 (34.1%)	0.116 (0.261)	329 (38.2%)	0.146 (0.257)
1 year	179 (71.6%)	0.319 (0.369)	121 (77.3%)	0.275 (0.327)
2 years	271 (57.1%)	0.186 (0.323)	235 (55.8%)	0.144 (0.276)
3 years	262 (58.5%)	0.159 (0.303)	229 (57.0%)	0.118 (0.260)
4 years	137 (78.3%)	0.206 (0.333)	121 (77.3%)	0.163 (0.291)
5 years	50 (92.1%)	0.227 (0.353)	54 (89.8%)	0.179 (0.300)
7 years	81 (87.2%)	0.168 (0.330)	71 (86.7%)	0.123 (0.273)
10 years	34 (94.6%)	0.139 (0.296)	25 (95.3%)	0.103 (0.248)

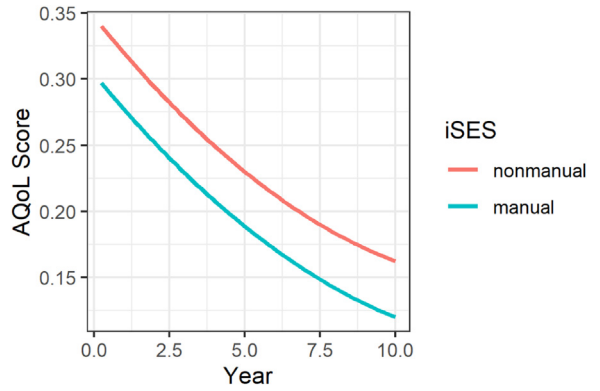

Fig. 3. *Predicted health-related quality of life (Assessment of Quality of Life Score) trajectories up to 10 years after stroke by individual-level socio-economic status (iSES). The scores were predicted using model 4.*

previous study indicated that individuals on discharge medications are likely to continue with these medications [24]. However, medium and low aSES groups had about 31% and 36% missing optimal discharge medications, respectively, compared to only 3.1% missing in high aSES group. This suggests that these individuals may not have started taking preventative medications at the time of discharge. Patient education on discharge medications and healthcare system factors, such as receiving discharge medications in time, should be considered during discharge planning. Our results were adjusted for risk factors and co-morbidities at the time of stroke, with differences still remaining, suggesting that other factors may contribute to these differences. For example, there are known links between lower socioeconomic status and lower levels of health literacy [25]. Given the link between iSES and health literacy, people with low iSES may have poorer adherence to medication, lesser attendance at primary care and have poorer lifestyle choices after stroke, than people with higher iSES, that may contribute to their reduction in quality of life.

The decline in HRQoL over time appears to be slower in those with high SES than those with low SES, irrespective of whether individual or area measures of SES are used. We note that aSES and iSES are highly correlated in our study, with individuals living in high aSES were more likely to be non-manual workers (81%). However, each indicator reflects different aspects of SES. aSES was obtained from Australian Census for the area reflecting community and individual resources. However, it may not fully reflect the true SES at individual level. In contrast, while iSES might directly or indirectly reflect individuals' income and education, it may incorrectly classify those who are unemployed, women, or those who are retired [10].

Strengths and limitation

Given the large sample size and lengthy follow-up period, our study is the largest prospective longitudinal study of the associations between SES and HRQoL trajectories after stroke. The large prospective community-based study design and 10-year follow-up with 8 repeated HRQoL assessment during the follow-up period enabled us to increase the precision of estimates on the HRQoL over an extended period. Additionally, we explored both aSES and iSES on the HRQoL trajectories, enabling us to assess these two separate aspects of socio-economic status.

However, a few limitations exist in our study. The use of patients' postcodes to link to the IRSAD score may not adequately distinguish between areas of diverse resources within the defined areas shared by the same postcode. Because our study was conducted in the North-East Melbourne region, the population in this region could be homogenous. This is somewhat evident from the distribution of the IRSAD score that was higher than the state-level average, although the aSES ranged from 915 to 1174, showing a relatively wide diversity of aSES in this metropolitan region. Secondly, an individual's occupation was measured as a major "lifetime" occupation, so it was not possible to account for potential changes in iSES over time. Therefore, it is unclear whether individuals' occupations had changed following their stroke, and factors that could be important if the stroke affected their ability to obtain the services required to monitor their health. The relation between iSES and well-being can be bidirectional whereby a person's health influences their occupation. In addition, baseline information on depression and disability or independence in activities in daily living was not available for this study, and these can be the potential confounders in our study. Furthermore, as some questionnaires were completed by proxies, it might be challenging to obtain subjective measure on HRQoL from stroke survivors and in repeated measures. Stroke caregiver burden has been found to correlate with their perception of their QoL [26], therefore, HRQoL of stroke survivors obtained from their proxies are likely to be underestimated. Finally, the dataset used in this study is old, although the follow-up is to 2009, and some clinical practice may have changed since then. However, according to the National Stroke Audit Acute Service reports, in most regions the clinical practices have been only slightly improved [27,28]. What is important when modelling these associations is whether the change in HRQoL after stroke associated with SES has changed over time. Unfortunately, there are no studies where trends in SES differences in HRQoL over time have been examined to address this issue. However, studies of time trends in SES differences in other stroke-related outcomes, such as incidence [29,30] and risk factors [31], suggest that SES differences in these outcomes after stroke have widened. Therefore, it is likely that our results are an underestimate of the differences in HRQoL after stroke by SES. Also, a study with 10 years of follow-up will naturally have baseline data that is already at least 10 years old. More contemporary studies with

repeat assessments of HRQoL and SES after stroke are needed to confirm our findings. It is unlike that the pattern of SES and HRQoL from our findings would have been changed today.

This prospective longitudinal study provided evidence that low SES groups had a slightly more rapid reduction in HRQoL over time after stroke than higher SES groups. Support services targeting disadvantaged areas and vulnerable populations may promote positive changes in stroke survivors' lives to enable them to maintain their HRQoL during stroke recovery.

Author Contributions

S.L.G. and H.P. conceptualized the study. Y.A.S. conducted analytical plan, performed data analysis and drafted the manuscript. M.J. assisted with data analysis and interpretation. A.G.T. was the principal investigator of the NEMESIS leading its conception and data acquisition. S.L.G., H.P., M.J. and A.G.T. assisted with interpretation of data, reviewed and edited the manuscript. All authors read and approved the final version of the report.

Data Availability Statement

This study was conducted at a time prior to these data availability criteria, so we do not have approval from ethics committees to share data

Declaration of Competing Interest

We declare that we have no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jstrokecerebrovasdis.2023.107188.

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