Author/s:
Le, HND;Mensah, F;Eadie, P;McKean, C;Sciberras, E;Bavin, EL;Reilly, S;Gold, L

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Health-related quality of life of children with low language from early childhood to adolescence: results from an Australian longitudinal population-based study

Running head: HRQoL in children with low language

Ha N.D Le,[1,2] Fiona Mensah,[2,3,4] Patricia Eadie,[5] Cristina McKean,[2,6,9] Emma Sciberras,[2,3,7] Edith L.Bavin,[8,2] Sheena Reilly,[2,3,9] and Lisa Gold[1,2]

[1]Deakin Health Economics, School of Health and Social Development, Deakin University, Geelong, VIC, Australia; [2]Murdoch Children's Research Institute, Melbourne, VIC, Australia; [3]Department of Pediatrics, University of Melbourne, Melbourne, VIC, Australia; [4]Royal Children's Hospital, Parkville, Melbourne, VIC, Australia; [5]Melbourne Graduate School of Education, University of Melbourne, Melbourne, VIC, Australia; [6]Speech and Language Sciences, School of Education, Communication and Language Sciences, Newcastle University, Newcastle upon Tyne, UK; [7]School of Psychology, Deakin University, Geelong, VIC, Australia; [8]School of Psychology and Public Health, La Trobe University, Melbourne, VIC, Australia; [9]Menzies Health Institute Queensland, Griffith University, Gold Coast, QLD, Australia

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Background: Low language abilities are known to be associated with significant adverse long-term outcomes. However, associations between low language and health-related quality of life (HRQoL) are unclear. We aimed to (1) examine the association between low language and HRQoL from 4-13 years, and (2) classify the children's trajectories of HRQoL and language and examine the association between language and HRQoL trajectories. **Methods:** Data were from an Australian community-based cohort of children. HRQoL was measured at ages 4-13 years using

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the parent-reported Pediatric Quality of Life Inventory 4.0. Language was assessed using the Clinical Evaluation of Language Fundamentals (CELF)-Preschool 2nd edition at 4 years and the CELF-4th edition at 5, 7 and 11 years. Multivariable linear regression and mixed effect modelling were used to estimate cross-sectional and longitudinal associations between low language and HRQoL from 4-13 years. A joint group-based trajectory model was used to characterize associations between HRQoL and language trajectories over childhood. **Results:** Children with low language had substantially lower HRQoL than children with typical language from 4-13 years. Higher language scores were associated with better HRQoL, particularly in social and school functioning. Three HRQoL trajectories were identified: stable-high (51% of children), reduced with slow decline (40%) and low with rapid decline (9%). Children with low language were less likely to follow a stable-high HRQoL trajectory (40%) while 26% and 34% followed the reduced with slow decline and low with rapid decline trajectories respectively. **Conclusions:** Children with low language experienced reduced HRQoL from 4-13 years. More than half had declining trajectories in HRQoL highlighting the need to monitor these children over time. Interventions should not only aim to improve children's language ability but also address the wider functional impacts of low language. **Keywords:** HRQoL; children; low language.

Introduction

Between 7 and 17% of children have low language attainment (Reilly et al., 2010, Norbury et al., 2016, Tomblin et al., 1997) with higher prevalence in studies defining low language (LL) as performance falling below a specific cut-point on a single standardised test (1.25 standard deviation below the population mean) (McKean et al., 2017a) and lower in those requiring low scores across a number of tests (Norbury et al., 2016, Tomblin et al., 1997). This study examines children with LL meeting the former, more inclusive criteria, including children with Language Disorder where there may be a recognized aetiology and Developmental Language Disorder (DLD) where the aetiology is unknown (Bishop et al., 2016). While the links between LL and higher risk of mental health, social and academic difficulties are well-established (Schoon et al., 2010, Beitchman et al., 2001, Conti-Ramsden and Botting, 2008), the relationship between LL and individuals' experiences of broader wellbeing and participation is less clear. Recent developments in the field suggest a closer examination of these constructs. First, changes to terminology and diagnostic criteria have been advocated (Bishop et al., 2016). DLD refers to children who have "language problems enduring into middle childhood and beyond, with a significant impact on everyday social interactions or educational progress" and that "lead to significant functional impairments unlikely to resolve without specialist help" (p. 1070, (Bishop et al., 2016)). This focus on 'functioning' brings with it the need to further our understanding of these associations and of methods to characterize and quantify the construct in children with LL. Second, epidemiological studies have demonstrated that even in children as young as four, any language difficulties present are very likely to persist (McKean et al., 2017b). Evidence from these studies have refocused the emphasis of school-age interventions from 'curing' language difficulties to reducing their associated negative consequences. This shift has occurred alongside a growing recognition that many individuals living with chronic conditions perceive improvements in their wellbeing and participation outcomes as more meaningful and valuable than improvements in their underlying impairment (Fellinghauer et al., 2012). Such a perception has been shown for children with DLD and their families (Lyons and Roulstone, 2018, Roulstone et al., 2012).

We also do not have the necessary understanding of the associations between LL and poorer broader social, communicative and educational functioning over the developmental course

for services to plan and deliver preventative interventions to reduce the risk of such difficulties emerging. Children with LL are reported to experience limitations in participation in play and academic performance (Nicola and Watter, 2018), although which children with LL experience or may go on to experience such difficulties is unknown. Of concern is whether children with LL who appear to be functioning well at one point in their development develop functional difficulties later. Incorporating the identification and prevention of poor outcomes in wellbeing and participation into practice is a priority, and yet these issues have not been thoroughly investigated to date.

Health-related quality of life (HRQoL) is a multidimensional construct encompassing physical, mental and social facets of life (Bullinger, 2002). Given its utility in guiding patient treatment and designing population health interventions, HRQoL is increasingly being used as an outcome measure in clinical trials and in patient care (Sung et al., 2010). Here we describe the HRQoL trajectories in a large sample of children with LL to examine the constructs of wellbeing and participation in this group.

Two recent systematic reviews report inconsistent findings regarding the association between LL and reduced overall HRQoL (Feeney et al., 2012, Le et al., 2020). Le et al. (2020) reported that 7 out of 12 included studies found that LL was associated with poorer overall HRQoL or specific aspects of HRQoL including physical, emotional, social and school domains (Flapper and Schoemaker, 2013, McKean et al., 2017a). Variations in HRQoL measures used, and heterogeneity in study cohorts (e.g. varied age groups from birth to adolescents), or study design (e.g. community-based vs. case-control) or methodologies (e.g. LL definition) contribute to the variation in results (Le et al., 2020). Furthermore, most studies to date have relied on cross-sectional analyses. For example, one recent longitudinal community study examining cross-sectional associations between LL and HRQoL from 4 to 9 years (Eadie et al., 2018) found poorer HRQoL in children with LL than their peers with typical language at 9 years only, and that differences in HRQoL were not associated with LL severity. However, cross-sectional studies provide limited evidence about how and when associations between LL and HRQoL emerge. Further research is warranted to disentangle these mixed findings, in particular with longitudinal studies to better understand the progression of HRQoL over time amongst children experiencing LL.

Subgroups in language trajectories were recently explored longitudinally in a population study from 4-11 years. McKean et al. (2017b) found 3 language trajectories: stable (94% of children), low-decreasing (4%) and low-improving (2%). Exploring HRQoL trajectories from 4-13 years, Vella et al. (2015) found 4 trajectories: healthy (85% of children), high risk (8%), rebound (5%), and recovery (2%). However, little is known about how child language is associated with HRQoL trajectories.

We aim to use the Australian population-based cohort, the Early Language in Victoria Study (ELVS), from early childhood to adolescence to:

(1) examine the association between LL and children's HRQoL, and
(2) classify the trajectories of HRQoL and language children followed and examine the association between the language and HRQoL trajectories.

Methods

Sample, participants and setting

The ELVS is a prospective, cohort of 1910 children born in metropolitan Melbourne, Victoria, Australia (Reilly et al., 2017). Details of the sample, participants, and data collection were reported elsewhere (Reilly et al., 2017). Briefly, families were recruited at the routine 8-month well-child visit, across six local government areas in metropolitan Melbourne, Australia. The study comprises 11 waves with data collected at child age 8 months (wave 1), yearly from child ages 1-7 years (waves 2-8) and then every two years from child ages 9-13 years (waves 9-11). The analyses in this paper involve children and their parents at child ages 4-13 years.

Ethics

Ethical approval was obtained from The Royal Children's Hospital (Melbourne), La Trobe University and Deakin University. All participating parents provided written and informed consent.

Measures

Language status. Face-to-face assessments were undertaken to determine children's oral language ability. At 4 years the Clinical Evaluation of Language Fundamentals-Preschool 2nd, Australian Standardisation (CELF-P2) (Wiig et al., 2006) was administered and at ages 5, 7, and 11 years, the Clinical Evaluation of Language Fundamentals-4th Edition, Australian Standardization (CELF-4) (Semel et al., 2006). The CELF produces standardized scales, each with a mean of 100 and a standard deviation (SD) of 15, for receptive, expressive and composite or core language scores.

Low language definition. LL was defined as a standard score ≤ 1.25 standard deviations below the population mean on the CELF-4 or CELF-P2 core scores (i.e.. ≤ 81 for either measures) at one or more of the 4 time points. This aligned with cut-off points from previous studies to allow for comparison with previous work within the ELVS cohort (Reilly et al., 2014, Reilly et al., 2010, McKean et al., 2017a) and other studies (Tomblin et al., 1997, Beitchman et al., 2001).

Health-related quality of life. Children's HRQoL was measured using the PedsQL generic core scale 4.0. Parent-proxy versions of the PedsQL corresponding to the children's ages were used; the 2-4 year old version at 4 years; the 5-7 year old version for 5-7 years; the 8-12 year old version for 8-11 years; and the 13-18 year old version for 13 years. The PedsQL generic core scale 4.0 comprises four domains: physical, emotional, social and school functioning (Varni et al., 2003). Combining all items generates a summary HRQoL score (scale 0 to 100), with higher scores indicating better HRQoL (Varni, 2014). The PedsQL has demonstrated a high level of internal and external reliability (Cronbach's alpha coefficients ≥0.9 for both child-self report and parent-proxy report) (Varni et al., 2003).

Child and family characteristics. Information about child and family characteristics were collected (see Table S1). Child temperament was measured at 3 years using the Short Temperament Scale for Children reactivity scale (Sanson et al., 1994). Maternal mental health was measured using the Kessler K6 screening scale (Kessler et al., 2003) from 5-9 years. Mother's receptive vocabulary was measured using the 44-item Mill Hill vocabulary scale at

child age 1 year (Raven, 1997). Socio-economic status was determined by the census-derived Socio-economic Indexes for Areas (SEIFA) disadvantage score based on the family's home postcode (Australian Bureau of Statistics, 2009).

These characteristics were specified a priori based on the literature (Vella et al., 2015, Feeney et al., 2017, van Agt et al., 2010) and used as confounders in both the multivariable linear regression and mixed effect models. As we were interested in the association of child HRQoL and LL regardless of aetiology, we did not intend to delineate the effects of LL from cognitive abilities or other comorbidities by including these factors as confounders.

Statistical analyses

Data were analysed using Stata version 15.0 (College Station, TX) (StataCorp., 2015). Baseline characteristics of the initial ELVS cohort and the sample with complete HRQoL data at each time point (4-13 years) are described.

(Aim 1) Multivariable linear regression was used to explore the cross-sectional associations between overall HRQoL and child language at each time point. Although the HRQoL data were relatively skewed, estimation was robust given that the normality assumption is not required in a large sample (Fitzmaurice et al., 2012). Potential confounders were adjusted for throughout all of the analyses (described in Table S1).

Longitudinal associations between LL, HRQoL and each HRQoL domain from 4-13 years were examined using mixed effects models (Howard, 2008). Models were specified including child language ability as continuous and binary variables. Thus models estimated the mean differences (with 95% confidence intervals) in HRQoL/HRQoL domains between children with and without LL (classified at each time point so that this can vary over the period of 4-13 years). Similarly, mean differences in HRQoL/HRQoL domains according to the continuous measure of language over time were estimated. Models accounted for correlation structure arising from repeated outcome measurements within individual children over time, and utilized all available data (Howard, 2008). Choice of the mixed model structure was determined visually using plots of

HRQoL over time for children with LL versus typical language identified at each time point (Figure S1).

(Aims 2) Trajectories of HRQoL/language over time and association between each trajectory group of the two outcomes were explored using a joint group-based trajectory model, which utilises a multinomial modeling strategy. The joint group-based model for developmental trajectories identifies groups of children with a similar pattern of scores over the time period who may be considered to be following similar trajectories (Nagin and Odgers, 2010). This model was used to examine the associations between the developmental trajectories of the two outcomes: HRQoL and child language. Maximum likelihood was used for the estimation of the model parameters. The censored normal distribution was applied in both models. Five group-based trajectories models were fitted with the number of groups increasing from 1 to 5, with each group having different parameters (i.e. linear, or quadratic trend). Final model choice, the three-group trajectories model, was based on model goodness of fit (Table S2) and interpretability, which takes into account variation among groups and size of group.

Results

Baseline characteristics of the analytic samples (N ranged from 707 to 1482) at each time point were comparable to the initial sample, although from age 5 years the analytic samples were less socio-economically disadvantaged compared to baseline (Table 1). At 4 years, 11% of the sample had LL relative to their peers with the proportion fluctuating at later ages: 8%, 10% and 5% at 5, 7 and 11 years respectively. HRQoL decreased slightly over time (Table 2).

Association between LL and HRQoL from 4-13 years

Multivariable regression analysis considering potential confounders estimated that children with LL had significantly lower HRQoL across all time points compared to children with typical

language. Notably, the adjusted mean difference in HRQoL between children with and without LL from 6-13 years was larger than the minimum clinically important difference of the PedsQL (i.e. 4.5 points) (Varni et al., 2003).

The mixed effect models were conducted twice: once using continuous language score and once using LL/typical language status as a random effect. Examining the longitudinal association between LL and HRQoL from 4-13 years with language status as a binary predictor, and accounting for potential confounders, children with LL experienced significantly lower HRQoL than children with typical language (mean difference -2.3, 95% CI -3.9 to -0.6) (Table 3). When considering language score as a continuous predictor, the model estimated that an increase of one in the core language standard score was associated with an increase of 0.07 point in the PedsQL summary score (95% CI 0.04 to 0.1), with increases particularly in the social and school domains (Table 3).

Trajectories of HRQoL and language

The joint-trajectory analyses produced both HRQoL and language trajectories. For HRQoL, three HRQoL trajectories were identified: (1) stable-high (51% of children), (2) reduced with slow decline (40%) and (3) low with rapid decline (9%) groups (Figure 1). The stable-high group had high HRQoL scores (mean = 90) at 4 and remained high to 11 years; the reduced-slow decline had relatively low HRQoL scores at 4 years (mean = 81) and these worsened slowly over time; and the low-rapid decline had particularly low scores at 4 and which worsened rapidly up to 11 years (Table S3). Compared to the low-rapid-decline HRQoL group, children in the stable-high and reduced-slow-decline groups had significantly higher HRQoL across all time points.

Three language trajectories were identified: high (37.8% of children), middle (50.8%) and low language score (11.4%) (Table S4 and Figure S2).

Association between language and HRQoL trajectories

Amongst children in the low language score trajectory, 40 to 67% had LL at one or more time points, 40% were in the stable-high HRQoL group with 36% and 24% in the reduced-slow-decline and low-rapid-decline groups (Figure 2). Conversely, just a small proportion of children with middle (7%) or high language scores (4%) were in the low-rapid-decline HRQoL trajectory.

Discussion

Within a large population-based study, we found that children with LL had significantly lower HRQoL than children with typical language from 4-13 years. Higher language scores were associated with better HRQoL, particularly in the social and school domains. Of the children in the low language group, less than half were in the stable-high HRQoL trajectory with the remainder in the reduced-slow-decline and low-rapid-decline HRQoL groups.

By confirming the association between LL and poorer HRQoL from 4-13 years, these findings help clarify the variability identified in two recent systematic reviews (Feeney et al., 2012, Le et al., 2020). Our findings align with those of other studies that have used the PedsQL as a HRQoL measure (Feeney et al., 2017, McKean et al., 2017a, Nicola and Watter, 2015, Nicola and Watter, 2018). The association between LL and lower HRQoL at 9 years and a decline in HRQoL between 4 and 9 years were similar to a recent study that also drew on the ELVS cohort (Eadie et al., 2018). However, Eadie et al. (2018) did not find this association at 4 or 7 years, which might be explained by the exclusion of children with comorbid difficulties and/or to their criteria for LL (i.e. LL at *both* 4 and 7 years rather than, as in the current study at only one time point). Broader inclusion criteria were used to categorize LL (i.e. LL with or without co-morbid conditions, and at one or more of the 4 time points) as our aim was to investigate the association between child HRQoL and language difficulties, regardless of etiology.

The fluctuation of LL prevalence from 4-11 years may be due to the use of cut-points and measurement error around the cut-points, the 'catch-up growth' of children who speak languages other than English (McKean et al., 2017b), the support provided when children start school, and/or the attrition of the sample. Poor HRQoL in children from middle primary to transition to secondary

school (i.e., from 8-11 years in Australia) aligns with behavioral, social and emotional changes of the pre-teens years (e.g. early hormonal changes related to puberty) (The Centre for Adolescent Health, 2018). Adolescence has been acknowledged as a crucial period of cognitive, psychosocial and emotional transformations (Hines, 2007) and for children with LL, this might also increase social problems (e.g. difficulties in peer relations) (St Clair et al., 2011).

The association between LL and the social or school domains reflects the nature of the condition itself, e.g. LL is likely to impact more in some areas than others. For example, LL at age 7 years has been associated with concurrent literacy and behavioral difficulties and limitations in psychosocial and school functioning (McKean et al., 2017a). In line with these associations, findings from qualitative studies have highlighted the difficulties encountered by children with LL in forming and maintaining peer relationships or being able to complete tasks independently and make their own decisions at school (Markham and Dean, 2009, Markham et al., 2009).

Children in the stable-high HRQoL trajectory had HRQoL scores that are comparable to the PedsQL population mean (i.e. 87.4) (Varni et al., 2007). Children in the reduced-slow-decline (54%) and low-rapid-decline (87%) HRQoL groups had HRQoL at 4 years of similar magnitude to children with minor chronic conditions (e.g. attention deficit hyperactivity disorder (ADHD) using the International Classification of Diseases, 9th revision-based system that classifies children into categories based on healthcare claim and encounter data within one-year period (Huang et al., 2009)). Of significant concern are children in the low-rapid-decline HRQoL trajectory, a majority of whose HRQoL at 4 years were comparable to children with major chronic conditions (e.g. cystic fibrosis or cancer) (Huang et al., 2009). These children may have other behavioral or medical conditions co-morbid with LL (e.g. ADHD or autism) (McKean et al., 2017b).

The strengths of our study include the use of a large community-based sample from a longitudinal study with repeated outcome measures over 9 years. Using clinically validated language measures, longitudinal mixed model analyses accounted for the correlation of repeated measures over time, and longitudinal group-based trajectories analyses identified profiles of children's HRQoL from 4-13 years. Limitations include the use of parent-proxy report on HRQoL. Empirical research showed that parents generally rated their children higher in physical, social and school functioning than did the children themselves (Nicola and Watter, 2018). As the self-

report versions of the PedsQL are not appropriate for children younger than 8 years, parent-proxy report was the available alternative.

Findings from this study have relevant clinical and policy implications. The reduced HRQoL in children with LL from 4-13 years highlights a need to monitor these children over time. While children may appear to be functioning well at an earlier time point, their difficulties may become more apparent as they develop. Identifying children with LL would enable access to early intervention and relevant support for these children. These findings could also assist clinicians and public health policy-makers with decisions about efficient resources allocation (e.g. planning services for these children who may require additional support). Given that school and social functioning are particularly affected, a cross-agency endeavor involving education and community services and groups (e.g. sport groups) is needed to address the needs of children with LL. Furthermore, associations between language scores and HRQoL were present across the distribution of language abilities. The promotion of robust language development for all children, not just those with the lowest language abilities, would therefore seem an important public health priority. Future research also needs to identify the additional contributing factors to lower HRQoL in children with LL to support the design of preventative interventions.

Conclusions

Low language was associated with poorer HRQoL from early childhood to adolescence (4-13 years). While 40% of children in the low language score group were in the stable-high HRQoL trajectory, 60% followed the reduced-slow-decline and low-rapid-decline trajectories. This evidence has implications for both identification and interventions. The functional impacts of LL must be monitored over time and interventions for children with LL should address these broader functional impacts in addition to their underlying language difficulties. Research should also consider which factors contribute to lower HRQoL in children with LL.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Table S1. Description of variables used in the analyses.

Table S2. Goodness-of-fit indices used to identify number of groups in joint-trajectory model.

Table S3. Overall HRQoL scores of children in each HRQoL trajectory from 4-13 years.

Table S4. Standard language core scores of children in each language trajectory from 4-13 years.

Figure S1. HRQoL in children with and without low language from 4 to 13 years in the analytic sample.

Figure S2. Trajectories of core language standard scores in ELVS children from 4 to 13 years.

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Correspondence

Ha N.D Le, Deakin Health Economics, Deakin University, 221 Burwood Hwy, Burwood, VIC, 3025, Australia; Email: ha.le@deakin.edu.au

Key points

- Low language has significant adverse outcomes. Association between low language and poorer health-related quality of life (HRQoL) is not clear.
- Low language was associated with reduced HRQoL from 4-13 years. Three HRQoL trajectories were identified: stable-high (51% of children), reduced-slow-decline (40%) and low-rapid-decline HRQoL (9%). Only 40% of the children in the low language score group followed the stable-high HRQoL trajectory.
- Identification and management of low language could improve HRQoL. Interventions aiming to improve language difficulties should address the wider functional impacts of low language, not just the underlying language difficulties. Research should consider factors contributing to lower HRQoL in children with low language.

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Table 1: Baseline characteristics of the ELVS cohort retained at each time point and the analytic samples from 4 to 13 years

Characteristics	Time point	Whole Sample (N=1910)	4 years (N = 1482)	5 years (N =888)	6 years (N=897)	7 years (N=1073)	9 years (N=1014)	11 years (N=811)	13 years (N=707)
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Child gender, girl	8m	945 (49.5)	710 (49.1)	469 (50.0)	455 (50.8)	462 (50.9)	515 (51.0)	425 (54.8)	369 (52.2)
Number of siblings	8m								
No sibling		889 (46.7)	690 (47.9)	451 (48.2)	433 (48.4)	428 (47.2)	476 (47.3)	374 (48.3)	337 (47.9)
One sibling		718 (37.7)	528 (36.6)	338 (36.1)	316 (35.4)	329 (36.3)	371 (36.8)	280 (36.2)	256 (36.4)
>=2 siblings		297 (15.6)	223 (15.5)	147 (15.7)	145 (16.2)	149 (16.5)	160 (15.9)	120 (15.5)	111 (15.8)
Language spoken at home - English	8m	1799 (94.2)	1388 (96.1)	909 (96.8)	870 (97.1)	884 (97.4)	979 (96.9)	757 (97.5)	690 (97.6)
Partner (yes)	1 year	1830 (92.9)	1393 (96.4)	914 (97.3)	872 (97.3)	884 (97.4)	977 (96.7)	757 (97.6)	689 (97.5)
Health care card access (yes)	8m	110 (12.9)	99 (12.9)	85 (12.9)	80 (12.2)	83 (12.5)	89 (12.2)	93 (12.2)	80 (11.8)
SEIFA of postcode	1 year								
1st quintile (least disadvantaged)		740 (38.7)	572 (39.6)	394 (42.0)	374 (41.8)	381 (42.0)	425 (42.1)	334 (43.0)	303 (42.9)
2nd quintile		445 (23.3)	344 (23.8)	230 (24.5)	219 (24.5)	224 (24.7)	250 (24.8)	193 (24.9)	176 (24.9)
3rd quintile		324 (17.0)	257 (17.8)	162 (17.2)	152 (17.0)	152 (16.8)	163 (16.2)	124 (16.0)	116 (16.4)
4th quintile		147 (7.7)	104 (7.2)	64 (6.8)	64 (7.2)	61 (6.7)	69 (6.8)	54 (7.0)	47 (6.7)

5th quintile (most disadvantaged)	254 (13.3)	169 (11.7)	89 (9.5)	86 (9.6)	89 (9.8)	102 (10.1)	71 (9.1)	65 (9.1)

SEIFA quintiles were calculated from 2011 Victorian SEIFA data (Australian Bureau of Statistics). The first quintile represents the least disadvantaged one-fifth of the Victorian population and the fifth represents the most disadvantaged one-fifth of the Victorian population. N ranged from 769 to 1482 (4 and 5 years), from 654 to 896 (6 years), from 663 to 908 (7 years), from 732 to 1010 (8 years), from 764 to 776 (9 and 11 years), from 677 to 707 (13 years) due to missing data.

Table 2: HRQoL in children with and without low language from 4 to 13 years (multivariable regression model)

Time point	Whole analytic sample		Typical language		Low language		Unadjusted analyses		Adjusted analyses	
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	Mean difference	95% CI	Mean difference	95% CI
4 years	1,482	85.1 (9.2)	1,322	85.3 (8.8)	160	83.4 (11.7)	**-2.0**	(-3.5,-0.5)	**-1.7**	(-3.3, -0.03)
5 years	888	83.4 (9.8)	818	83.7 (9.7)	70	79.8 (10.9)	**-3.7**	(-6.1, -1.3)	**-2.6**	(-5.1, -0.06)
6 years	897	84.5 (9.9)	826	84.8 (9.6)	71	80.2 (12.4)	**-4.6**	(-7.0,-2.2)	**-4.6**	(-7.1, -2.1)
7 years	1073	83.5 (10.4)	964	84.1 (9.9)	109	78.5 (13.4)	**-5.6**	(-7.7,-3.6)	**-5.5**	(-7.8, -3.2)
9 years	1014	82.5 (12.5)	919	83.4 (11.8)	95	73.7 (15.9)	**-9.7**	(-12.3,-7.1)	**-10.4**	(-13.3, -7.6)
11 years	811	80.8 (12.9)	767	81.3 (12.4)	44	71.6 (16.7)	**-9.7**	(-13.6,-5.9)	**-8.6**	(-12.8, -4.4)
13 years	707	78.9 (14.0)	674	79.4 (13.7)	33	69.6 (17.3)	**-9.8**	(-9.5,-1.8)	**-10.9**	(-14.6, -4.9)

SD: Standard deviation

Mean difference: difference in mean HRQoL summary scores between children with and without LL at a given time point.

Analyses adjusted for child gender, number of siblings (4 and 11 years), child temperament (3 years), language spoken to child (4 and 5 years), maternal education (4, 5 and 11 years), maternal stress (4-8 years), maternal vocabulary ability (1 year), having a partner (4, 5, 6, 11 and 13 years), socioeconomic status (1 year), healthcare card access (4, 11 and 13 years), and parental warmth (7 years) for the analyses at 7, 9, 11 and 13 years.

Statistically significant mean in bold.

Table 3: HRQoL in children with and without low language from 4 to 13 years (mixed effect model)

Language ability	Overall HRQoL	Physical functioning	Emotional functioning	Social functioning	School functioning
	Mean difference (95% CI)	Mean difference (95% CI)	Mean difference (95% CI)	Mean difference (95% CI)	Mean difference (95% CI)
Language scores as binary, typical language as reference[a]					
Low language	**-2.3** (-3.9, -0.6)	-2.1 (-4.3, 0.01)	-0.5 (-2.6, 1.7)	**-4.4** (-6.9, -2.0)	**-5.6** (-7.9, -3.2)
Language scores as continuous variable[b]					
Core language standard score	**0.07** (0.04, 0.1)	0.02 (-0.02, 0.06)	**0.07** (-0.02, 0.1)	**0.2** (0.1, 0.2)	**0.2** (0.15, 0.24)

[a]N ranged from 2817 to 3032 observations including 870 to 873 clusters in individual.

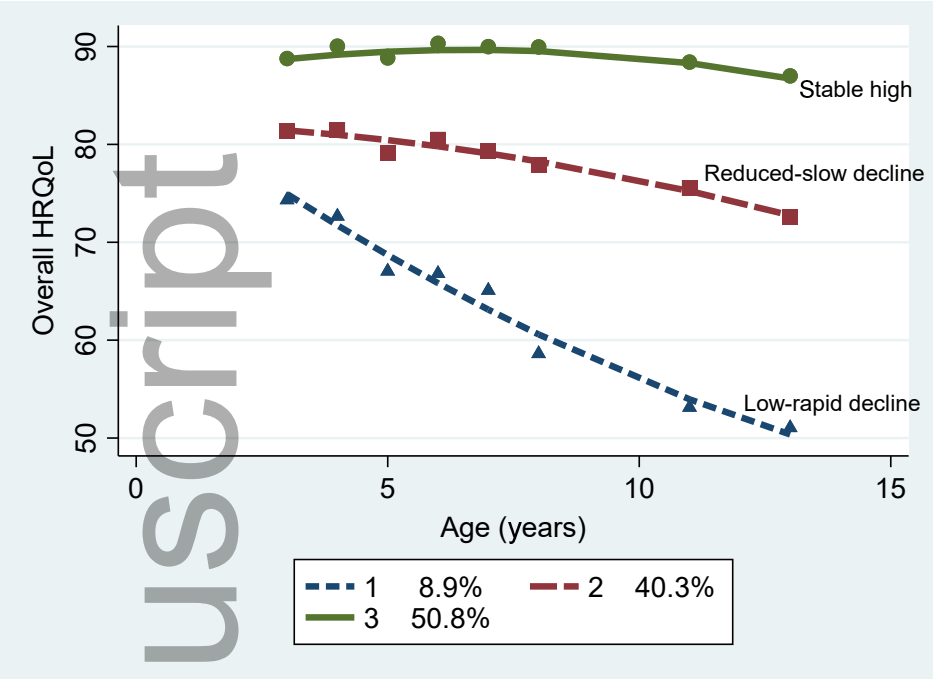
[b]N ranged from 2351 to 2528 observations including 717 to 718 clusters in individual.

[a]Mean difference: difference in mean HRQoL scores between children with and without low language. Language status (typical/low language) was modelled as a random effect with random intercept and random slope being modelled to represent within child variability in repeated measures.

[b]Mean difference: mean difference in HRQoL scores according to the continuous language scores. Language score (continuous) was modelled as a random effect, with random intercept and random slope being modelled to represent within child variability in repeated measures.

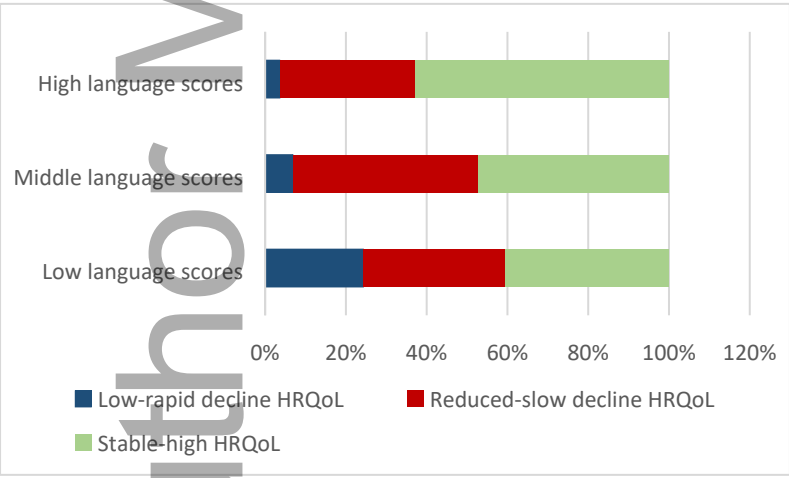
Analyses adjusted for child gender, number of siblings (4 years), child temperament (3 years), language spoken to child (4 years), maternal education (4 years), maternal stress (4 years), maternal vocabulary (1 year), having a partner (4 years), socioeconomic status (1 year), healthcare card access (4 years), and parental warmth (7 years). Statistically significant mean in bold**.**

Figure 1: Overall HRQoL trajectories from 4 to 13 years in the ELVS sample



N=1911 observations. 274 excluded due to missing data or having no trajectory. 1637 observations used in the trajectory model.

Figure 2: HRQoL by language scores from the trajectory analysis



Low language scores: mean scores <80, n=296

Middle language scores: mean scores from 81 to 100, n=1117

High language scores: mean scores >100, n=498