Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Socioeconomic Disparities in Health-related Quality of Life following Respiratory Post- Acute Infection Syndrome: Findings from Virus Watch - a prospective community cohort study

Wing Lam Erica Fong
University College London
Sarah Beale
sarah.beale@ucl.ac.uk

University College London
Vincent Grigori Nguyen
University College London
Jana Kovar
University College London
Andrew C Hayward
University College London
Ibrahim Abubakar
University College London
Sander MJ Kuijk
Maastricht University Medical Centre
Robert W Aldridge
University of Washington

Research Article

Keywords: Post-acute infection syndrome, health inequalities, deprivation, health-related quality of life, EQ-5D

Posted Date: April 19th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9294879/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: No competing interests reported.

Abstract

Purpose: Persistent symptoms following an acute respiratory infection, termed respiratory post-acute infection syndrome (PAIS), can reduce health-related quality of life (HRQoL). Socioeconomic deprivation is associated with poorer HRQoL in the general population and among individuals with chronic conditions, but its role in respiratory PAIS remains unclear. Using data from the Virus Watch study, we assessed whether HRQoL associated with respiratory PAIS varied by deprivation.

Methods: HRQOL was assessed using the EuroQol 5-dimension, 5-level (EQ-5D-5L) with the England Value Set to generate disutility scores (1 minus the EQ-5D-5L utility value) for participants with and without respiratory PAIS. A two-part model assessed the association between deprivation and HRQoL, stratified by respiratory PAIS status. Logistic regression estimated the odds of HRQoL loss (disutility > 0), followed by linear regression with robust standard errors on disutility scores. EQ-VAS scores were analysed separately using linear regression with robust standard errors.

Results: 16,418 participants completed the EQ-5D-5L, of whom 1,084 (6.6%) had respiratory PAIS. Living in the most deprived areas was consistently associated with poorer HRQoL, including a higher likelihood of reporting HRQoL loss (no PAIS aOR: 1.57 [95% Confidence Interval (CI): 1.34-1.85]; PAIS: 2.10 [0.83-5.32]), greater disutility (no PAIS adjusted coefficient: 0.067 [0.053-0.081]; PAIS: 0.094 [0.043-0.144]), and a lower EQ-VAS score (no PAIS adjusted coefficient: 4.55 [3.23, 5.88]; PAIS: 8.00 3.28, 12.70]), compared with living in the least deprived regions. Across deprivation levels, participants with respiratory PAIS had higher predicted mean disutility scores (without vs. with PAIS range: 0.18-0.25 vs. 0.20-0.29) and lower predicted mean EQ-VAS scores (without vs. with PAIS range: 72.4-77.0 vs. 64.4-72.4) than those without PAIS.

Conclusion: Our findings indicate that respiratory PAIS has an additive negative impact on HRQoL. Existing health inequalities may be further exacerbated, as reduced HRQoL can have long-term socioeconomic consequences. Preventing infection, early detection of respiratory PAIS, and integrated care pathways addressing respiratory symptoms alongside pain and mental health are essential, particularly in deprived communities where the burden is greatest.

Introduction

Acute respiratory tract infections represent a major global health burden, contributing substantially to morbidity and mortality [1]. While many individuals recover fully, a proportion of patients experience persistent or new symptoms following the acute infection [2]. These ongoing symptoms, collectively referred to as respiratory post-acute infection syndrome (respiratory PAIS) in this paper, can lead to long-term disability and substantially impair patients' health-related quality of life (HRQoL) [3]. Respiratory PAIS has been under-recognised due to its non-specific symptom presentation and the lack of standardised diagnostic criteria. However, the emergence of post-COVID-19 condition (PCC) has increased awareness of respiratory PAIS as a wider phenomenon following respiratory infections. Despite this, it remains poorly supported in most health systems, leaving affected individuals with limited access to appropriate care [2].

Individuals with respiratory PAIS have been found to experience reduced HRQoL. A cohort study in the United Kingdom (UK) found that participants with PCC had a lower mean EuroQol 5-dimension, 5-level (EQ-5D-5L) score than those without PCC, corresponding to a loss of 0.37 quality-adjusted life-months due to PCC. Self-reported PCC was associated with worse EQ-5D-5L utility scores than conditions including heart failure, multiple sclerosis and end-stage renal disease [4]. Additionally, evidence from long-term follow-up studies of community-acquired pneumonia, Severe Acute Respiratory Syndrome, and Legionella pneumophila infections also shows persistent reductions in both physical and social domains of HRQoL, as measured by instruments such as the Medical Outcomes Study Short Form 36-Item, EQ-5D, and Quality Adjusted Life Years [5–8]. Most HRQoL-related studies have focused on post-hospitalisation cohorts, and little is known about the long-term effects of respiratory PAIS on HRQoL within the general population.

The burden of impaired HRQoL from respiratory PAIS may not be evenly distributed, with early evidence suggesting that deprivation could increase the risk of developing respiratory PAIS and have a greater impact on health and daily living. People living in more deprived areas typically experience worse overall health and lower HRQoL than those who are less deprived [9], a pattern consistently observed in conditions such as cardiovascular disease, diabetes, and stroke [10–12]. Similar inequalities are likely to exist for respiratory PAIS, although evidence remains limited and largely focused on PCC. A recent study by Carlile et al. showed

that individuals with lower annual income reported greater HRQoL loss [4], whereas unemployment status was associated with impairments in the mobility and self-care domains [13]. Furthermore, in a previous analysis of the Virus Watch cohort in England and Wales, we found that individuals living in more deprived areas were more likely to experience functional limitations from PCC than those living in the least deprived areas [14]. Taken together, these findings suggest that social inequalities may exacerbate the impacts of respiratory PAIS on HRQoL. Understanding deprivation-related inequalities in this context is essential for informing equitable policy responses and guiding targeted rehabilitation and support services for those most affected. Using data from Virus Watch, a prospective community cohort in England and Wales, we therefore aimed to assess whether HRQoL associated with respiratory PAIS varies across levels of deprivation.

Materials and Methods

Study design and participants

Virus Watch is a large prospective community cohort study conducted from June 2020 to March 2025 to examine the transmission and impact of COVID-19 in England and Wales, with 58,497 participants enrolled by March 2022. Participants self-selected into the study, with eligibility limited to households with internet access and a lead household member proficient in reading English, although consent forms were available in multiple languages. Participants completed weekly online surveys on COVID-19 symptoms, testing, and vaccination, along with occasional in-depth questionnaires on COVID-19-related topics such as behavioural practices, healthcare access and long-term symptoms. Furthermore, the Virus Watch cohort was linked to Hospital Episode Statistics Admitted Patient Care, which contains details of all admissions at NHS hospitals in England and to private or charitable hospitals funded by the NHS [15]. The full study design and methodology are described elsewhere [16, 17].

Participants in this analysis were a subset of the Virus Watch study cohort. They were included if they 1) were aged 16 years or above, 2) registered with an English postcode, and 3) had never been hospitalised for/with COVID-19 or other respiratory infections. We restricted analyses to participants aged 16 years or more, as the EQ-5D-Y instrument used for younger individuals is not directly comparable to the EQ-5D-5L used in adults. Hospitalised individuals were also excluded to prevent misclassifying cases of post-intensive-care or post-sepsis syndromes as respiratory PAIS [18].

Exposure

Socioeconomic deprivation

Socioeconomic deprivation was measured using quintiles of the Index of Multiple Deprivation [19]. IMD is calculated for small local areas in England and typically covers seven dimensions of deprivation: crime, employment, education, income, health, living environment, and barriers to housing and services. These areas are ranked from most to least deprived relative to others and categorised into five quintiles. The 1st quintile represents the most deprived areas, and the 5th quintile represents the least deprived. We recalculated the IMD quintile measure by excluding the health domain from the ranking score, following the methodology described by Adams and White [20]. We used this as the exposure variable, since including the health domain may introduce endogeneity bias. The IMD classification for each participant was determined based on their self-reported residential postcode in the baseline survey, which was linked to the May 2020 Office for National Statistics (ONS) Postcode Lookup dataset [19]. For this analysis, the 5th quintile was the reference category.

Respiratory PAIS status

Participants were identified to have an acute respiratory infection if they reported at least one acute respiratory symptom, including fever, feeling feverish, chills, cough (dry or productive), runny or blocked nose, white or green phlegm, sneezing, sore throat, or change/loss of smell or taste, through weekly symptom surveys [21]. Reports of fever, feeling feverish, or chills accompanied only by gastrointestinal symptoms (diarrhoea or vomiting) were not classified as respiratory infections. SARS-CoV-2 infections were identified from weekly surveys reporting positive polymerase chain reaction or lateral flow test results, or from linked national hospital and community testing data.

Respiratory PAIS status was then determined using six surveys on long-term symptoms conducted over four years (February 2021, May 2021, March 2022, March 2023, October 2023, April 2024, November 2024). In each long-term symptom survey, participants reported the development of any new symptoms lasting at least four weeks since the last survey (or since February 2020 for the first two long-term symptom surveys), irrespective of whether the symptoms were attributable to COVID-19/PCC, the onset dates of their three most severe symptoms, and whether they were ongoing or resolved. Symptom duration was calculated from symptom onset to survey completion (for ongoing symptoms) or reported resolution date. Individuals were classified as having respiratory PAIS if they reported any acute respiratory symptoms, including fever, feeling feverish, chills, change or loss of smell or taste, dry/wet cough, white/green phlegm, runny nose, blocked nose, sneezing, and sore throat, within three months of long-term symptom onset, with at least one symptom persisting for two months or more and unexplained by an alternative diagnosis, or any persistent symptoms within three months of a confirmed SARS-CoV-2 infection, with at least one symptom lasting two months or more and unexplained by an alternative diagnosis [22].

Outcomes

The EQ-5D-5L questionnaire was administered online four times over two years (March 2023, October 2023, April 2024, November 2024). The questionnaire assesses five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. There are five possible responses to indicate the severity of each dimension: level 1: no problems, level 2: slight problems, level 3: moderate problems, level 4: severe problems, and level 5: unable to/extreme problems [23]. EQ-5D utility scores were calculated using the EuroQol mapping function with the England-specific value set, which ranges from − 0.285 to 1 [24]. A score of 1 represents full health, 0 represents a health state equivalent to being dead, and negative values represent states considered worse than death [25].

Disutility was calculated as one minus the EQ-5D-5L utility score, which indicates the lost quality of life from perfect health. The first outcome was the probability that disutility exceeded zero, indicating a less-than-perfect health state, and higher values imply greater loss of quality of life. The second outcome was the absolute disutility score, which ranged from 0 to 1.285.

The EQ-5D-5L questionnaire also contains a visual analogue scale (EQ-VAS), in which respondents rate their overall health at the time of assessment from 0 (‘the worst health you can imagine’) to 100 (‘the best health you can imagine’) [23]. The third outcome was the EQ-VAS score.

Covariates

The covariates were age group at the time of EQ-5D-5L survey completion (16–44, 45–64, 65 + years), sex assigned at birth (male and female), ethnicity, migration status, number of comorbidities and time since persistent symptom onset. Ethnic minority status was self-reported and grouped as White British or ethnic minority, with the ethnic minority category including individuals identifying as White Irish, White Other, mixed, South Asian, other Asian, Black, or other were categorised as ethnic minorities [26]. Migration status was derived from self-reported country of birth, with participants born outside the UK classified as migrants. Those who did not report their country of birth were classified as ‘Missing’. The number of comorbidities was determined through self-report in the baseline and occasional surveys, and was categorised as 0 to 4 or more (see list of comorbidities in Supplementary Table 1). Time since persistent symptom onset was calculated as the difference between the date of the earliest completed EQ-5D survey after the start of persistent symptoms and the reported date of respiratory infection.

Statistical Analysis

Baseline demographic and clinical characteristics were summarised using descriptive statistics. We also presented the distribution of responses for each EQ-5D dimension across IMD quintiles, stratified by respiratory PAIS status, using stacked bar graphs.

Since EQ-5D-5L disutility scores are bounded and a large proportion of participants reported full health, we applied a two-part modelling strategy to evaluate the association between socioeconomic deprivation and HRQoL [27]. For all analyses, IMD was entered as the exposure, and each was stratified by respiratory PAIS status. In the first part, we estimated the probability of reporting any disutility (disutility > 0; indicating loss of HRQoL) using logistic regression. In the second part, we fitted a linear regression with robust standard errors on absolute disutility scores. We also conducted a sensitivity analysis in which the linear

regression was restricted to participants who reported any HRQoL loss to separately assess the association of socioeconomic deprivation with the severity of HRQoL loss, conditional on loss. Separately, EQ-VAS scores were modelled using linear regression with robust standard errors.

All regression models were adjusted for age at EQ-5D survey completion, sex, ethnic minority status, migration status, and number of comorbidities. In models restricted to participants with respiratory PAIS, we also adjusted for the number of days since symptom onset, reflecting the potential influence of illness duration on HRQoL. Reference categories are as follows in parentheses for each categorical variable: IMD quintile (IMD 5 - least deprived), age (65+), sex (female), ethnic minority status (White British), migration status (UK born), and number of comorbidities (0).

Results were presented as odds ratios and predicted probabilities for reporting any disutility, and those from the linear regression models were presented as regression coefficients and estimated marginal means derived for both the absolute disutility and EQ-VAS scores. Both odds/regression coefficients were presented to allow comparisons within groups between IMD quintiles, while predicted probabilities/estimated marginal means were presented to allow comparisons across groups at different deprivation levels.

Results

Table 1 reports the sociodemographic and clinical characteristics of the analysis cohorts. Our study cohort tended to be older, female, White British, UK-born and residing in less deprived areas.

Table 1
Demographic and clinical characteristics of the analysis cohort by respiratory PAIS status.

Characteristic	No Respiratory PAIS N = 15,334	Respiratory PAIS N = 1,084
Age group		
16–44	1,179 (7.7%)	37 (3.4%)
45–64	4,783 (31%)	366 (34%)
65+	9,372 (61%)	681 (63%)
Sex (at birth)		
Male	6,789 (44%)	336 (31%)
Female	8,545 (56%)	748 (69%)
IMD Quintile (excluding health domain)		
1 (most deprived)	1,033 (6.7%)	86 (7.9%)
2	2,005 (13%)	159 (15%)
3	3,179 (21%)	232 (21%)
4	3,879 (25%)	284 (26%)
5 (least deprived)	4,530 (30%)	281 (26%)
Missing	708 (4.6%)	42 (3.9%)
Migration status		
UK Born	10,385 (68%)	718 (66%)
Not UK-born	953 (6.2%)	60 (5.5%)
Missing	3,996 (26%)	306 (28%)
Ethnic minority status		
White British	13,696 (89%)	989 (91%)
Ethnic minority	1,305 (8.5%)	76 (7.0%)
Missing/Prefer not to say	333 (2.2%)	19 (1.8%)
Number of comorbidities		
0	4,844 (32%)	249 (25%)
1	4,428 (29%)	321 (32%)
2	2,757 (18%)	232 (19%)
3	1,497 (4.8%)	126 (11%)
4+	1,295 (3.7%)	122 (11%)
Missing	513 (3.3%)	24 (2.2%)
Days since onset of respiratory PAIS	-	185 (134, 247)

[1]n (%); Median (Q1, Q3)

EQ-5D-5L Dimension scores

Figure 1 presents the breakdown of the reported severity of problems for each dimension by respiratory PAIS status and IMD quintile. Across both 'Respiratory PAIS' and 'No Respiratory PAIS' groups, participants in the most deprived quintile (IMD 1) consistently reported the highest proportion of problems (ranging from slight to extreme) across all five EQ-5D dimensions, whereas participants in the least deprived quintile (IMD 5) reported the lowest proportion. For example, the difference in the proportion of problems reported between IMD 1 and IMD 5 ranged from 13% (IMD 1 vs 5: 47% vs 60%) in mobility to 23% (36% vs 59%) in anxiety/depression within the respiratory PAIS group. Overall, the 'Respiratory PAIS' group also had a lower proportion of participants with no problems across all dimensions, regardless of IMD quintile, compared with the 'No Respiratory PAIS' group.

The majority of reported problems were slight or moderate, while the proportion of severe and extreme problems was limited across all groups, IMD quintiles, and dimensions. Extreme problems were generally below 2.5% across all quintiles and groups, with the exception being 4% of participants in IMD 1 within the respiratory PAIS group who reported extreme problems with anxiety/depression.

Within the 'No Respiratory PAIS' group, self-care similarly was the dimension least frequently affected, with proportions reporting any level of problem ranging from 7% in IMD 5 to 21% in IMD 1. By contrast, pain/discomfort was the domain with the highest burden, with 53% of participants in IMD 5 and 63% in IMD 1 reporting at least some level of problem. Among participants with respiratory PAIS, we observed a similar pattern. The linear increase across deprivation levels observed in the 'No Respiratory PAIS' group was less consistent in this group in certain dimensions. For self-care, a markedly higher proportion of participants in IMD 1 reported problems compared with those in IMD 2–5 (IMD 1: 34% vs. IMD 2–5: 12–14%). A similar pattern was also observed for anxiety/depression (IMD 1: 66% vs. IMD 2–5: 44–48%).

EQ-5D-5L disutility: Two-part model

Among participants without respiratory PAIS, those living in the most, 2nd, and 3rd most deprived quintiles had increased odds of reporting a loss of HRQoL compared to those in the least deprived quintile (Fig. 2A; Supplementary Table 2). Specifically, the greatest odds ratio for reporting a loss of HRQoL was observed in those from the most deprived quintile, with a 1.57 [95% Confidence Interval (CI): 1.34–1.85] increase in odds of reporting a loss of HRQoL compared to those in the least deprived quintile. Among individuals with respiratory PAIS, the point estimate indicated greater odds of reporting HRQoL loss among those in IMD 1 than those in IMD 5 (OR: 2.10 [0.83–5.32]), but the confidence intervals were wide (Fig. 2A; Supplementary Table 3).

When comparing predicted probabilities, participants without respiratory PAIS consistently had a lower likelihood of reporting any HRQoL loss than those with respiratory PAIS across all levels of deprivation (Fig. 2B; Supplementary Table 4–5). In both groups, we observed a general increase in the probability of reporting HRQoL loss with increasing deprivation, although this pattern was less pronounced in the respiratory PAIS group.

In evaluating the absolute disutility score in the group without respiratory PAIS, we found strong evidence of a higher mean disutility score (indicating greater HRQoL loss) among individuals in IMD 1–3 compared to those in IMD 5 (Fig. 2C; Supplementary Table 2). The greatest disparity was between the most and least deprived quintiles, with those in IMD 1 exhibiting a 0.067 (0.053–0.081) higher mean disutility score than those in IMD 5. Among participants with respiratory PAIS, a similar pattern was observed, with those in the most deprived areas having a mean disutility score 0.094 higher (0.043–0.14) than those in the least deprived quintile, after adjusting for all covariates (Fig. 2C; Supplementary Table 3).

The predicted mean disutility scores for participants without respiratory PAIS were consistently lower across all deprivation levels compared to those with respiratory PAIS (Fig. 2D; Supplementary Table 4–5). The most notable difference was in IMD 1, where those with respiratory PAIS had a predicted mean disutility score 0.089 higher than those without, indicating poorer HRQoL in this group (Supplementary Table 4–5).

Sensitivity analysis excluding participants with full health displayed similar socioeconomic gradients in both respiratory PAIS and non-PAIS groups, with overall higher predicted mean disutility. Among individuals without respiratory PAIS, predicted mean disutility ranged from 0.18 (0.17–0.19) in IMD 1 to 0.25 (0.23–0.27) in IMD 5. For those with respiratory PAIS, values ranged from 0.20 (0.19–0.22) in IMD 1 to 0.29 (0.25–0.34) in IMD 5 (Supplementary Tables 6–7).

EQ-VAS

Individuals without respiratory PAIS in IMD 1 and 2 had a 4.55 (3.23, 5.88) and 2.56 (1.63, 3.49) lower mean EQVAS score, respectively, than those in IMD 5 after adjustment for covariates (Fig. 3A; Supplementary Table 8). Among those with respiratory PAIS, the disparity was larger; those in IMD 1 scored 8.00 (3.28, 12.7) points lower on the EQVAS than their counterparts in IMD 5. Furthermore, the predicted average EQVAS scores were consistently higher among participants without respiratory PAIS than those with across deprivation levels (No Respiratory PAIS range vs. Respiratory PAIS range: 72.4–77.0 vs. 64.4–72.4) (Fig. 3B; Supplementary Table 9).

Discussion

Summary of findings

In this study, we found clear evidence of a social gradient in HRQoL, with more deprived individuals consistently reporting poorer HRQoL. Among participants without respiratory PAIS, those in the most deprived quintile (IMD 1) were more likely to report HRQoL loss and had a mean disutility score 0.067 (0.053–0.081) higher than those in the least deprived quintile. For participants with respiratory PAIS, the disparity was 0.094 (0.043–0.14). Both exceed the 0.063 minimally important difference defined for EQ-5D-5L utility scores for England, highlighting the clinical relevance of these differences [28]. HRQoL was also lower among individuals experiencing respiratory PAIS than among those without PAIS, across all deprivation levels. We also observed similar patterns for EQ-VAS, with both deprivation and respiratory PAIS having a substantial and additive negative impact on HRQoL.

Our findings corroborated existing literature demonstrating that greater deprivation is associated with poorer HRQoL in both the general population and among individuals with chronic conditions [29–31]. In the non-PAIS group, our results align with prior studies, reporting a socioeconomic gradient in EQ-5D-5L scores, with increasing deprivation associated with lower HRQoL [29, 30]. Among populations living with chronic conditions, higher levels of education and income, indicators of deprivation, have been identified as strong predictors of better HRQoL across a range of conditions [31]. The lower HRQoL observed among individuals with respiratory PAIS in our analysis is also consistent with evidence from a UK cohort study. People with PCC were reported to be nearly five times more likely to report HRQoL loss than those without. Specifically, the study identified increased pain/discomfort and anxiety/depression among people with PCC, findings in line with our results across all deprivation levels [4]. Other studies have similarly demonstrated lower physical and mental HRQoL among individuals with PCC [32–34].

The higher prevalence of problems in the pain/discomfort and anxiety/depression domains of the EQ-5D-5L highlights the multifaceted impact of respiratory PAIS on HRQoL. Pain and mental health are closely interrelated, with persistent pain contributing to anxiety and depression, and vice versa, creating compounding effects on overall well-being and functional capacity [35, 36]. Although guidelines recommend a multidisciplinary approach to PCC rehabilitation, there is a lack of holistic and consistent support in current care pathways, with mental health often under-addressed [37–39]. The combination of respiratory PAIS and deprivation may exacerbate existing inequalities as deprived populations experience higher baseline levels of chronic pain and financial hardship, which has also been shown to increase both vulnerability to and perception of pain, compared to those less deprived [40, 41]. This likely contributes not only to greater loss of HRQoL but also to long-term socioeconomic impacts, including reduced ability to work and an increased risk of social exclusion. Our findings highlight the need for integrated care pathways that go beyond managing respiratory symptoms, incorporating pain management and mental health support, especially in deprived communities where the burden is likely to be greatest.

Our findings also have important implications for the winter peaks in respiratory illness. In England, emergency hospital admission rates for influenza, COVID-19, and bacterial pneumonia have consistently been higher for those living in more deprived areas compared to those in the least deprived areas [42, 43]. Differential vaccine uptake is likely to have exacerbated this burden, with more deprived areas consistently reporting lower vaccine uptakes for a range of respiratory infections, including influenza, RSV and COVID-19 [44–46]. People in deprived areas already face barriers to accessing healthcare, including difficulties securing appointments for primary care or specialist services, and these challenges are likely to intensify during periods of high winter demand [47, 48]. Higher exposure to infections, poorer healthcare access, and a greater burden of respiratory PAIS among deprived populations would not only increase the strain on healthcare services but also heighten long-term health inequalities.

Policy responses should prioritise prevention and equitable access to care. This includes improving vaccine uptake for respiratory infections among the more deprived communities and reducing occupational and environmental exposure to respiratory viruses among high-risk groups. To ensure timely access to treatment and rehabilitation services, primary and community care services in deprived areas may require additional resources to manage increased demand during respiratory infection surges or future pandemics. Early identification and a holistic approach to managing persistent symptoms by incorporating pain and mental health support alongside respiratory care are also essential to minimise loss of HRQoL and long-term socioeconomic impacts.

Strengths and limitations

While evidence on the HRQoL impacts of PCC is growing, little is known about the effects of other respiratory PAIS. By examining HRQoL outcomes across deprivation levels among individuals with and without respiratory PAIS, our study provides novel evidence on the role of socioeconomic inequalities in shaping long-term health outcomes. Using the validated EQ-5D-5L in our analysis allows direct comparisons with other studies and strengthens the relevance to policy and practice. Furthermore, drawing on community-based cohort data allowed us to assess the quality-of-life impacts of respiratory PAIS beyond hospital or specialist services, generating a more comprehensive picture of the burden of respiratory PAIS, including those who may not present to healthcare services.

However, this study had several limitations. The generalisability of our findings may be limited by the underrepresentation of individuals from more deprived areas in the Virus Watch cohort. This was likely due to language barriers, limited internet access, and economic circumstances, which may also subsequently reduce statistical power. We used IMD as an area-level measure of deprivation, which may not accurately reflect individual socioeconomic position. Individual-level indicators should be used in future studies. The cross-sectional design of this study precludes causal inference, as baseline HRQoL prior to the onset of respiratory PAIS was not collected. However, our findings are consistent with a greater health burden among more deprived groups and those with PCC [49]. Furthermore, our sample of individuals with respiratory PAIS was insufficient to explore interactions between deprivation and other socioeconomic variables, such as ethnicity and migration status, limiting our ability to assess how these intersecting variables may influence HRQoL outcomes.

Since testing for non-COVID-19 respiratory pathogens was not conducted as part of the Virus Watch study, we were unable to differentiate between different types of respiratory PAIS. This limitation means that our estimated association between deprivation and HRQoL reflects an average effect across heterogeneous respiratory infections rather than infection-specific effects, which warrant further exploration. As a result, we were unable to adequately adjust for vaccination status, as data on vaccines for respiratory infections other than COVID-19 were not collected. Furthermore, some individuals with respiratory PAIS may not have been identified due to recall bias, undetected asymptomatic infections, or inconsistent reporting to the weekly symptom surveys, potentially resulting in under-ascertainment of cases and an underestimation of HRQoL impacts.

Conclusion

The current study demonstrated that socioeconomic gradients in HRQoL persist among individuals following post-acute respiratory illness, with respiratory PAIS having an additive negative impact. This underscores the need for equitable uptake of respiratory infection vaccines and integrated care pathways that address respiratory symptoms, pain and mental health to prevent downstream consequences of poorer HRQoL, such as worsening health or disrupted employment, and subsequently widen health inequalities. These findings are particularly relevant given the expected winter surges in respiratory infections and the broader need for pandemic preparedness, where ensuring equitable access to care and support is critical.

Abbreviations

COVID-19 – Coronavirus-2019

EQ-5D-5L – EuroQol 5-Dimension 5-Level

EQVAS – EuroQol Visual Analogue Scale

HRQoL – Health-related quality of life

IMD – Index of Multiple Deprivation

ONS – Office for National Statistics

PAIS – Post-acute infection syndrome

PCC – Post-COVID-19 condition

Declarations

Ethics statement

Virus Watch was approved by the Hampstead NHS Health Research Authority Ethics Committee: 20/HRA/2320, and conformed to the ethical standards set out in the Declaration of Helsinki. Participants provided informed consent for all aspects of the study.

Availability of data and materials

We aim to share aggregate data from this project on our website and via a "Findings so far" section on our website - https://ucl-virus-watch.net/. We will also share individual-level record data via a research data-sharing service, such as the Office for National Statistics Secure Research Service. In sharing the data, we will work within the principles set out in the UKRI Guidance on best practice in the management of research data. Access to use of the data whilst research is being conducted will be managed by the Chief Investigators (AH and RA) in accordance with the principles set out in the UKRI guidance on best practice in the management of research data.

Competing Interests

We declare no competing interests.

Funding

This work was supported by the Medical Research Council [Grant Ref: MC_PC 19070] awarded to UCL on 30 March 2020 and the Medical Research Council [Grant Ref: MR/V028375/1] awarded on 17 August 2020. The study also received $15,000 of advertising credit from Facebook to support a pilot social media recruitment campaign on 18th August 2020. This study was supported by the Wellcome Trust through a Wellcome Clinical Research Career Development Fellowship to RWA [206602].

From 1 May 2022, Virus Watch received funding from the European Union (Project: 101046314). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency (HaDEA). Neither the European Union nor the granting authority can be held responsible for them. From 28 November 2024, SB also received funding from the National Institute for Health Research University College London Hospital Biomedical Research Centre [BRC1261/PPI/SB/104990] to support patient and public involvement and engagement work on PCC. The views expressed are those of the author(s) and not necessarily any of the funders.

Authors' Contributors

Conceptualisation (WLEF, SB, SvK, RA), Data curation (WLEF, SB, VN), Formal Analysis (WLEF), Funding acquisition (RA, AH, IA), Methodology (WLEF, SB, SvK, RA), Project administration (JK), Software (VN), Supervision (SB, SvK, RA), Visualisation (WLEF), Writing – original draft (WLEF), Writing – reviewing and editing (all)

Acknowledgements

We would like to thank all the members of the END-VoC Long COVID advisory group, which includes individuals with post-COVID-19 condition, carers of individuals with post-COVID-19 condition, primary and secondary care clinicians, and politicians, for their input on the conceptualisation of this study. We would also like to thank all Virus Watch study participants for their time, effort, and continued contributions. Their participation enabled us to better understand how post-COVID-19 condition differentially affects quality of life across populations in the community.

References

1. World Health Organization. (2024, August 24). *The top 10 causes of death*. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death
2. The Lancet Infectious Diseases. (2024). Post-acute infection sequelae in focus. *The Lancet Infectious Diseases*, *24*(3), 217. https://doi.org/10.1016/S1473-3099(24)00085-9
3. Weckler, B. C., Kutzinski, M., Vogelmeier, C. F., & Schmeck, B. (2025). Multiorgan sequelae following non-COVID-19 respiratory infections: a review. *Infection*, *53*(4), 1259–1272. https://doi.org/10.1007/S15010-025-02519-7/METRICS
4. Carlile, O., Briggs, A., Henderson, A. D., Butler-Cole, B. F. C., Tazare, J., Tomlinson, L. A., Marks, M., Jit, M., Lin, L. Y., Bates, C., Parry, J., Bacon, S. C. J., Dillingham, I., Dennison, W. A., Costello, R. E., Walker, A. J., Hulme, W., Goldacre, B., Mehrkar, A., … Eggo, R. M. (2024). Impact of long COVID on health-related quality-of-life: an OpenSAFELY population cohort study using patient-reported outcome measures (OpenPROMPT). *The Lancet Regional Health - Europe*, *40*, 100908. https://doi.org/10.1016/j.lanepe.2024.100908
5. Mangen, M. J. J., Huijts, S. M., Bonten, M. J. M., & de Wit, G. A. (2017). The impact of community-acquired pneumonia on the health-related quality-of-life in elderly. *BMC Infectious Diseases*, *17*(1), 1–9. https://doi.org/10.1186/S12879-017-2302-3/TABLES/4
6. Tansey, C. M., Louie, M., Loeb, M., Gold, W. L., Muller, M. P., De Jager, J. A., Cameron, J. I., Tomlinson, G., Mazzulli, T., Walmsley, S. L., Rachlis, A. R., Mederski, B. D., Silverman, M., Shainhouse, Z., Ephtimios, I. E., Avendano, M., Downey, J., Styra, R., Yamamura, D., … Herridge, M. S. (2007). One-Year Outcomes and Health Care Utilization in Survivors of Severe Acute Respiratory Syndrome. *Archives of Internal Medicine*, *167*(12), 1312–1320. https://doi.org/10.1001/ARCHINTE.167.12.1312
7. Hui, D. S., Joynt, G. M., Wong, K. T., Gomersall, C. D., Li, T. S., Antonio, G., Ko, F. W., Chan, M. C., Chan, D. P., Tong, M. W., Rainer, T. H., Ahuja, A. T., Cockram, C. S., & Sung, J. J. Y. (2005). Impact of severe acute respiratory syndrome (SARS) on pulmonary function, functional capacity and quality of life in a cohort of survivors. *Thorax*, *60*(5), 401–409. https://doi.org/10.1136/THX.2004.030205
8. Lettinga, K. D., Verbon, A., Nieuwkerk, P. T., Jonkers, R. E., Gersons, B. P. R., Prins, J. M., & Speelman, P. (2002). Health-related quality of life and posttraumatic stress disorder among survivors of an outbreak of legionnaires disease. *Clinical Infectious Diseases*, *35*(1), 11–17. https://doi.org/10.1086/340738,
9. Kashem, T., Al Sayah, F., Tawiah, A., Ohinmaa, A., & Johnson, J. A. (2019). The relationship between individual-level deprivation and health-related quality of life. *Health and Quality of Life Outcomes 2019 17:1*, *17*(1), 176-. https://doi.org/10.1186/S12955-019-1243-5
10. Füller, D., Andresen-Bundus, H., Pagonas, N., Jaehn, P., Ukena, C., Gödde, K., Holmberg, C., Ritter, O., & Sasko, B. (2025). Adverse socioeconomic factors are associated with a widening gap in one-year health-related quality of life after acute myocardial infarction. *Scientific Reports*, *15*(1), 1–10. https://doi.org/10.1038/S41598-025-04604-1;SUBJMETA=1538,459,478,692,700,784;KWRD=DISEASE+PREVENTION,HEALTH+POLICY,PUBLIC+HEALTH,QUALITY+OF+LIFE
11. Meisters, R., Albers, J., Sezer, B., de Galan, B. E., Eussen, S. J. P. M., Stehouwer, C. D. A., Schram, M. T., van Greevenbroek, M. M. J., Wesselius, A., Koster, A., & Bosma, H. (2024). Socioeconomic inequalities in health-related functioning among people with type 2 Diabetes: longitudinal analyses in the Maastricht Study. *BMC Public Health*, *24*(1), 1–10. https://doi.org/10.1186/S12889-023-17553-Z/FIGURES/3
12. Sun, Y. A., Kalpakavadi, S., Prior, S., Thrift, A. G., Waddingham, S., Phan, H., & Gall, S. L. (2023). Socioeconomic status and health-related quality of life after stroke: a systematic review and meta-analysis. *Health and Quality of Life Outcomes*, *21*(1), 1–15. https://doi.org/10.1186/S12955-023-02194-Y/TABLES/4
13. Pham, A., Smith, J., Card, K. G., Byers, K. A., & Khor, E. (2024). Exploring social determinants of health and their impacts on self-reported quality of life in long COVID-19 patients. *Scientific Reports*, *14*(1). https://doi.org/10.1038/S41598-024-81275-4,
14. Lam, W., Fong, E., Beale, S., Nguyen, V. G., Kovar, J., Yavlinsky, A., Hayward, A. C., Abubakar, I., Van Kuijk, S. M. J., & Aldridge, R. W. (2026). Post-COVID-19 condition and disparities in daily functional activities in England: a retrospective analysis of data from the Virus Watch community cohort. *The Lancet Primary Care*, *0*(0), 100093. https://doi.org/10.1016/J.LANPRC.2025.100093

15. Herbert, A., Wijlaars, L., Zylbersztejn, A., Cromwell, D., & Hardelid, P. (2017). Data Resource Profile: Hospital Episode Statistics Admitted Patient Care (HES APC). *International Journal of Epidemiology*, *46*(4), 1093–1093i. https://doi.org/10.1093/ije/dyx015
16. Byrne, T., Kovar, J., Beale, S., Braithwaite, I., Fragaszy, E., Fong, W. L. E., Geismar, C., Hoskins, S., Navaratnam, A. M. D., Nguyen, V., Patel, P., Shrotri, M., Yavlinsky, A., Hardelid, P., Wijlaars, L., Nastouli, E., Spyer, M., Aryee, A., Cox, I., … Aldridge, R. W. (2023). Cohort Profile: Virus Watch—understanding community incidence, symptom profiles and transmission of COVID-19 in relation to population movement and behaviour. *International Journal of Epidemiology*, *52*(5), e263–e272. https://doi.org/10.1093/ije/dyad087
17. Hayward, A., Fragaszy, E., Kovar, J., Nguyen, V., Beale, S., Byrne, T., Aryee, A., Hardelid, P., Wijlaars, L., Fong, W. L. E., Geismar, C., Patel, P., Shrotri, M., Navaratnam, A. M. D., Nastouli, E., Spyer, M., Killingley, B., Cox, I., Lampos, V., … Aldridge, R. W. (2021). Risk factors, symptom reporting, healthcare-seeking behaviour and adherence to public health guidance: protocol for Virus Watch, a prospective community cohort study. *BMJ Open*, *11*(6), e048042. https://doi.org/10.1136/bmjopen-2020-048042
18. Fleischmann-Struzek, C., Joost, F. E. A., Pletz, M. W., Weiß, B., Paul, N., Ely, E. W., Reinhart, K., & Rose, N. (2024). How are Long-Covid, Post-Sepsis-Syndrome and Post-Intensive-Care-Syndrome related? A conceptional approach based on the current research literature. *Critical Care*, *28*(1), 1–8. https://doi.org/10.1186/S13054-024-05076-X/FIGURES/3
19. Ministry of Housing Communities & Local Government. (2019). *The English Indices of Deprivation 2019. File 1: index of multiple deprivation*. https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019
20. Adams, J., & White, M. (2006). Removing the health domain from the Index of Multiple Deprivation 2004—effect on measured inequalities in census measure of health. *Journal of Public Health*, *28*(4), 379–383. https://doi.org/10.1093/PUBMED/FDL061
21. National Health Service. (2024, December). *Respiratory tract infections (RTIs)*. National Health Service. https://www.nhs.uk/conditions/respiratory-tract-infection/
22. World Health Organiszation. (2022). *Post COVID-19 condition (Long COVID)*. https://www.who.int/europe/news-room/fact-sheets/item/post-covid-19-condition
23. Devlin, N., Pickard, S., & Busschbach, J. (2022). Chapter 1: The Development of the EQ-5D-5L and its Value Sets. In *Value Sets for EQ-5D-5L: A Compendium, Comparative Review & User Guide* (pp. 1–12). Springer. https://doi.org/10.1007/978-3-030-89289-0_1
24. Devlin, N. J., Shah, K. K., Feng, Y., Mulhern, B., & van Hout, B. (2018). Valuing health-related quality of life: An EQ-5D-5L value set for England. *Health Economics*, *27*(1), 7–22. https://doi.org/10.1002/HEC.3564
25. Rowen, D., Mukuria, C., Bray, N., Carlton, J., Cooper, S., Longworth, L., Meads, D., O'Neill, C., & Yang, Y. (2023). UK Valuation of EQ-5D-5L, a Generic Measure of Health-Related Quality of Life: A Study Protocol. *Value in Health*, *26*(11), 1625–1635. https://doi.org/10.1016/j.jval.2023.08.005
26. Office for National Statistics. (n.d.). *People and places: Ethnicity and race*. Retrieved July 4, 2025, from https://service-manual.ons.gov.uk/content/language/ethnicity-and-race
27. Ramos-Goñi, J. M., Pinto-Prades, J. L., Oppe, M., Cabasés, J. M., Serrano-Aguilar, P., & Rivero-Arias, O. (2014). Valuation and Modeling of EQ-5D-5L Health States Using a Hybrid Approach. *Medical Care*, *55*(7), e51. https://doi.org/10.1097/MLR.0000000000000283
28. McClure, N. S., Sayah, F. Al, Xie, F., Luo, N., & Johnson, J. A. (2017). Instrument-Defined Estimates of the Minimally Important Difference for EQ-5D-5L Index Scores. *Value in Health*, *20*(4), 644–650. https://doi.org/10.1016/J.JVAL.2016.11.015
29. Schneider, P., Love-Koh, J., McNamara, S., Doran, T., & Gutacker, N. (2022). Socioeconomic inequalities in HRQoL in England: an age-sex stratified analysis. *Health and Quality of Life Outcomes*, *20*(1), 121. https://doi.org/10.1186/S12955-022-02024-7
30. Maheswaran, H., Kupek, E., & Petrou, S. (2015). Self-reported health and socio-economic inequalities in England, 1996–2009: Repeated national cross-sectional study. *Social Science & Medicine*, *136–137*, 135–146. https://doi.org/10.1016/J.SOCSCIMED.2015.05.026
31. Kangas, T., Milis, S. L., Vanthomme, K., & Vandenheede, H. (2025). The social determinants of health-related quality of life among people with chronic disease: a systematic literature review. *Quality of Life Research*, *34*(9), 2501–2511. https://doi.org/10.1007/S11136-025-03976-1/TABLES/3

32. O' Mahony, L., Buwalda, T., Blair, M., Forde, B., Lunjani, N., Ambikan, A., Neogi, U., Barrett, P., Geary, E., O'Connor, N., Dineen, J., Clarke, G., Kelleher, E., Horgan, M., Jackson, A., & Sadlier, C. (2022). Impact of Long COVID on health and quality of life. *HRB Open Research*, *5*, 31. https://doi.org/10.12688/HRBOPENRES.13516.1
33. Rodrigues, A. N., Paranhos, A. C. M., da Silva, L. C. M., Xavier, S. S., Silva, C. C., da Silva, R., de Vasconcelos, L. A., Peixoto, I. V. P., Panzetti, T. M. N., Tavares, P. R., Reis, C. de S., Launé, B. F., Palácios, V. R. da C. M., Vasconcelos, P. F. da C., Quaresma, J. A. S., & Falcão, L. F. M. (2024). Effect of long COVID-19 syndrome on health-related quality of life: a cross-sectional study. *Frontiers in Psychology*, *15*, 1394068. https://doi.org/10.3389/FPSYG.2024.1394068/BIBTEX
34. Yagi, K., Kondo, M., Terai, H., Asakura, T., Kimura, R., Takemura, R., Tanaka, H., Ohgino, K., Masaki, K., Namkoong, H., Chubachi, S., Miyata, J., Kawada, I., Kaido, T., Mashimo, S., Kobayashi, K., Hirano, T., Lee, H., Sugihara, K., … Fukunaga, K. (2025). Impact of long COVID on the health-related quality of life of Japanese patients: A prospective nationwide cohort study. *Respiratory Investigation*, *63*(4), 610–616. https://doi.org/10.1016/J.RESINV.2025.05.001
35. Aaron, R. V., Ravyts, S. G., Carnahan, N. D., Bhattiprolu, K., Harte, N., McCaulley, C. C., Vitalicia, L., Rogers, A. B., Wegener, S. T., & Dudeney, J. (2025). Prevalence of Depression and Anxiety Among Adults With Chronic Pain: A Systematic Review and Meta-Analysis. *JAMA Network Open*, *8*(3), e250268. https://doi.org/10.1001/JAMANETWORKOPEN.2025.0268
36. Davies, K. A., Silman, A. J., Macfarlane, G. J., Nicholl, B. I., Dickens, C., Morriss, R., Ray, D., & McBeth, J. (2009). The association between neighbourhood socio-economic status and the onset of chronic widespread pain: Results from the EPIFUND study. *European Journal of Pain*, *13*(6), 635–640. https://doi.org/10.1016/J.EJPAIN.2008.07.003
37. Fang, C., Baz, S. A., Sheard, L., & Carpentieri, J. D. (2024). "They seemed to be like cogs working in different directions": a longitudinal qualitative study on Long COVID healthcare services in the United Kingdom from a person-centred lens. *BMC Health Services Research*, *24*(1), 406. https://doi.org/10.1186/S12913-024-10891-7
38. Miller, A., Song, N., Sivan, M., Chowdhury, R., & Burke, M. R. (2024). Identifying the needs of people with long COVID: a qualitative study in the UK. *BMJ Open*, *14*(6), e082728. https://doi.org/10.1136/BMJOPEN-2023-082728
39. National Institute for Health and Care Excellence. (2020). COVID-19 rapid guideline: managing the long-term effects of COVID-19. In *National Institute for Health and Care Excellence*. NICE.
40. Arthritis Research UK. (2017). *Musculoskeletal Conditions and Multimorbidity*.
41. Rios, R., & Zautra, A. J. (2011). Socioeconomic Disparities in Pain: The Role of Economic Hardship and Daily Financial Worry. *Health Psychology*, *30*(1), 58–66. https://doi.org/10.1037/A0022025
42. UK Health Security Agency. (2023). *COVID-19 and flu: inequalities in emergency hospital admission rates - GOV.UK*. UK Health Security Agency. https://www.gov.uk/government/publications/covid-19-and-flu-inequalities-in-emergency-hospital-admission-rates
43. UK Health Security Agency. (2025). *Health inequalities in health protection report 2025*.
44. UK Health Security Agency. (2026). *RSV vaccine coverage report in older adults in England: October 2025 - GOV.UK*. UK Health Security Agency. https://www.gov.uk/government/publications/rsv-older-adults-vaccination-coverage-in-england/rsv-vaccine-coverage-report-in-older-adults-in-england-october-2025
45. Dolby, T., Finning, K., Baker, A., Fowler-Dowd, L., Khunti, K., Razieh, C., Yates, T., & Nafilyan, V. (2022). Monitoring sociodemographic inequality in COVID-19 vaccination uptake in England: a national linked data study. *J Epidemiol Community Health*, *76*(7), 646–652. https://doi.org/10.1136/JECH-2021-218415
46. UK Health Security Agency. (2025). *Seasonal influenza vaccine uptake in GP patients in England: winter season 2024 to 2025 - GOV.UK*. UK Health Security Agency. https://www.gov.uk/government/statistics/seasonal-influenza-vaccine-uptake-in-gp-patients-winter-season-2024-to-2025/seasonal-influenza-vaccine-uptake-in-gp-patients-in-england-winter-season-2024-to-2025#results-of-influenza-vaccine-uptake-for-gp-patients
47. UK Health Security Agency. (n.d.). *Place-based approaches for reducing health inequalities: annexes*. 2021. Retrieved January 30, 2026, from https://www.gov.uk/government/publications/health-inequalities-place-based-approaches-to-reduce-inequalities/place-based-approaches-for-reducing-health-inequalities-annexes
48. The King's Fund. (2024). *Poverty Taking A Heavy Toll On NHS Services*. The King's Fund. https://www.kingsfund.org.uk/insight-and-analysis/press-releases/poverty-health-nhs-services

49. Collins, B., Humphrys, M., Orford, R., Ford, R., & Charles, J. (2023). P107 Health-related quality of life in long covid (post-COVID-19 syndrome) service users in Wales is much worse than the general population. *J Epidemiol Community Health*, *77*(Suppl 1), A102–A102. https://doi.org/10.1136/JECH-2023-SSMABSTRACTS.211

Figures

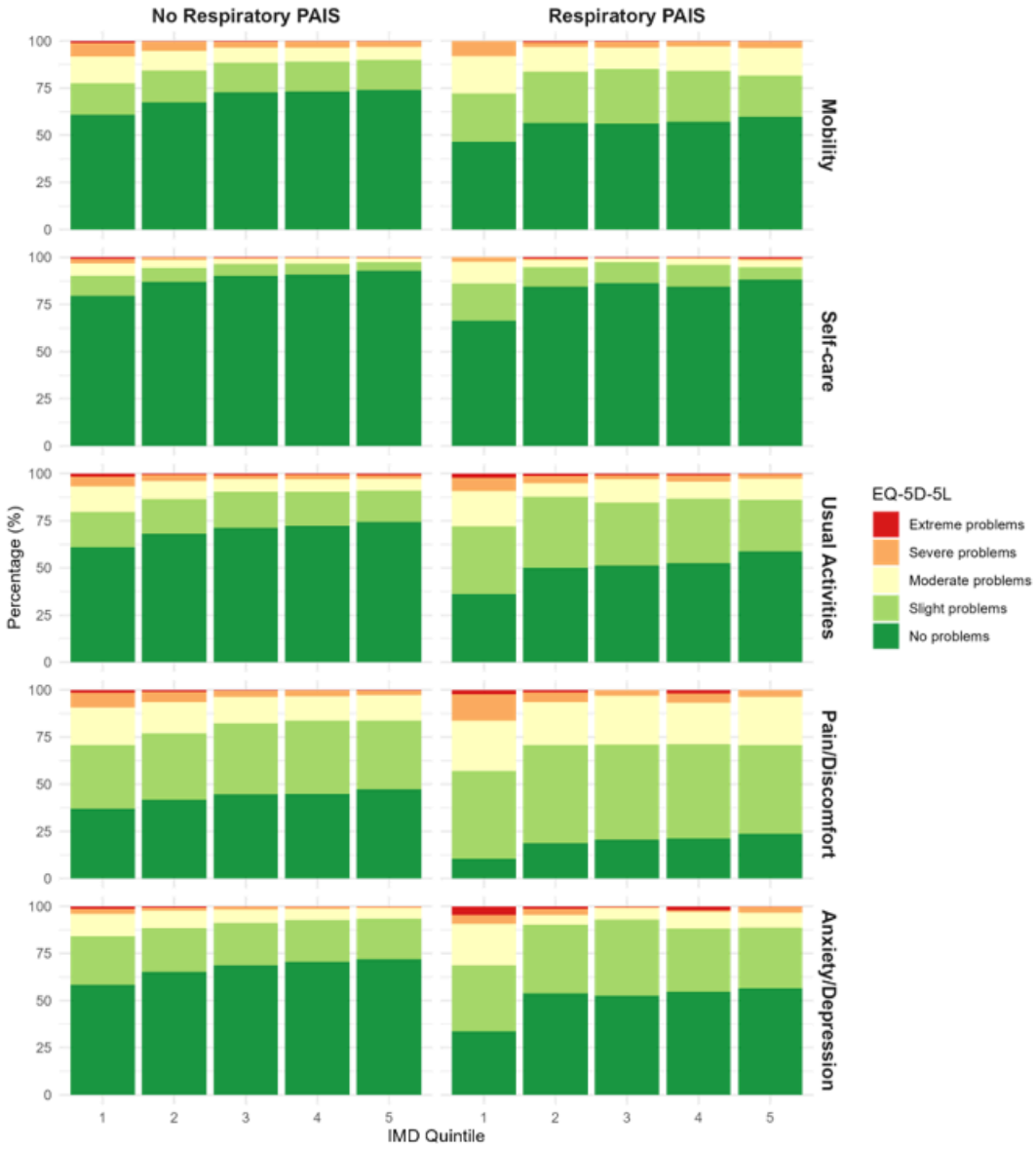


Figure 1

Proportions of reporting severity of problems of the five EQ-5D-5L dimensions, by IMD Quintile and respiratory PAIS status.

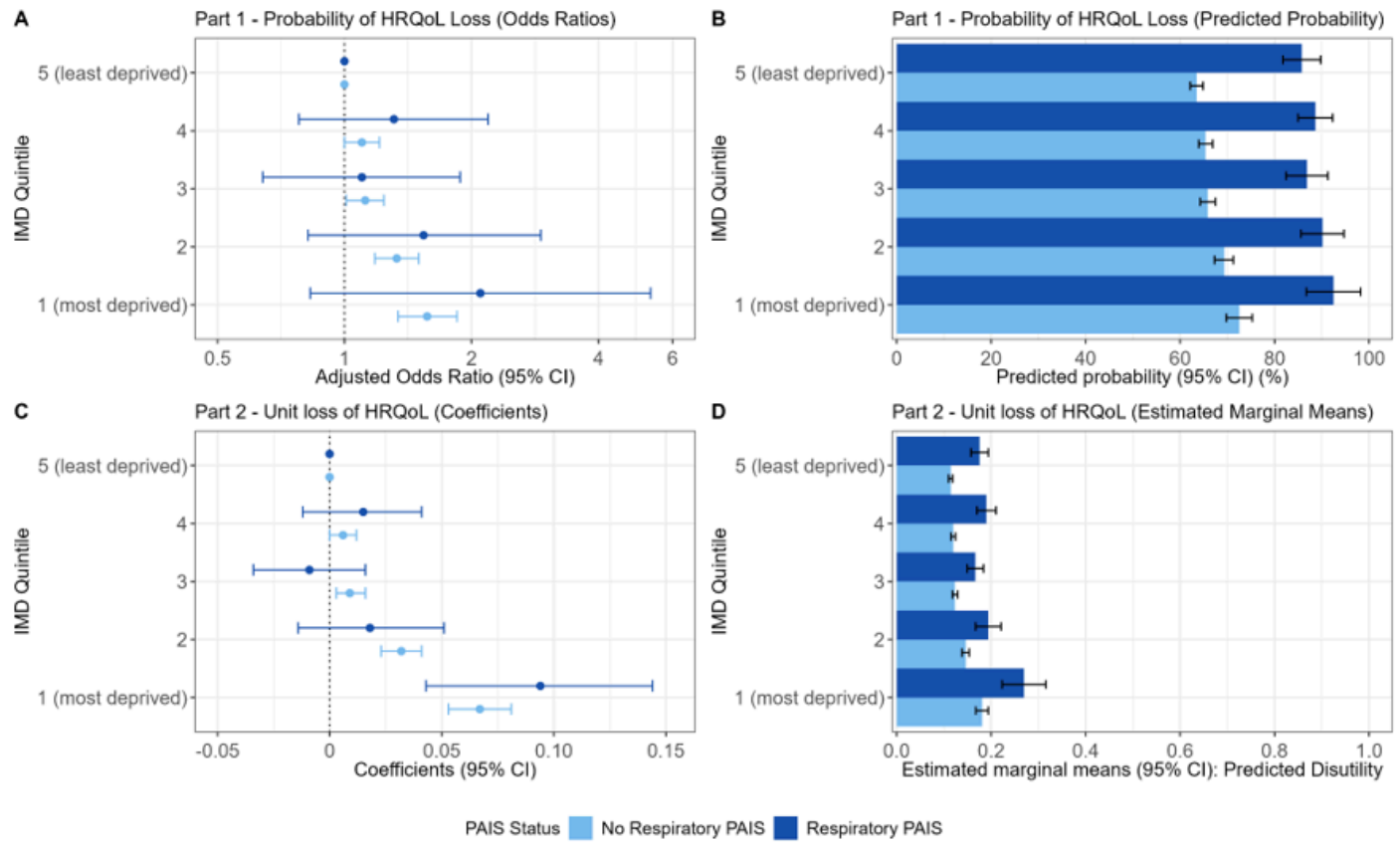


Figure 2

EQ-5D-5L disutility two-part model outputs by respiratory PAIS status. A) Odds ratio for the probability of reporting disutility > 0 in the first part of the two-part model; B) Predicted probability of reporting disutility > 0; C) Regression coefficients for the second part of the model, interpreted as the unit increase in EQ-5D-5L disutility score (greater HRQoL loss) compared to IMD 5 (least deprived); D) Predicted mean EQ-5D-5L disutility score, higher disutility indicates greater HRQoL loss.

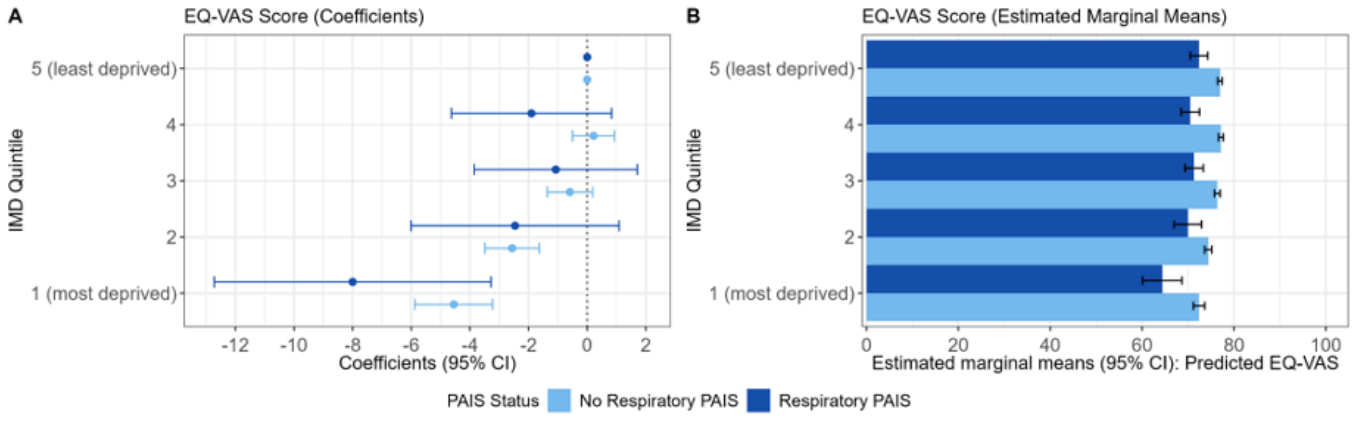


Figure 3

EQ-VAS disutility model output by respiratory PAIS status. A) Regression coefficients for the model assessing the association between IMD quintile and EQ-VAS score, interpreted as the unit increase in EQ-VAS score (greater self-perceived health) compared to IMD 5 (least deprived); B) Predicted mean EQ-VAS score.