



Prevalence of swallow, communication, voice and cognitive compromise following hospitalisation for COVID-19: the PHOSP-COVID analysis

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ABSTRACT

Objective Identify prevalence of self-reported swallow, communication, voice and cognitive compromise following hospitalisation for COVID-19.

Design Multicentre prospective observational cohort study using questionnaire data at visit 1 (2–7 months post discharge) and visit 2 (10–14 months post discharge) from hospitalised patients in the UK. Lasso logistic regression analysis was undertaken to identify associations.

Setting 64 UK acute hospital Trusts.

Participants Adults aged >18 years, discharged from an admissions unit or ward at a UK hospital with COVID-19.

Main outcome measures Self-reported swallow, communication, voice and cognitive compromise.

Results Compromised swallowing post intensive care unit (post-ICU) admission was reported in 20% (188/955); 60% with swallow problems received invasive mechanical ventilation and were more likely to have undergone proning ($p=0.039$). Voice problems were reported in 34% (319/946) post-ICU admission who were more likely to have received invasive ($p<0.001$) or non-invasive ventilation ($p=0.001$) and to have been proned ($p<0.001$). Communication compromise was reported in 23% (527/2275) univariable analysis identified associations with younger age ($p<0.001$), female sex ($p<0.001$), social deprivation ($p<0.001$) and being a healthcare worker ($p=0.010$). Cognitive issues were reported by 70% (1598/2275), consistent at both visits, at visit 1 respondents were more likely to have higher baseline comorbidities and at visit 2 were associated with greater social deprivation ($p<0.001$).

Conclusion Swallow, communication, voice and cognitive problems were prevalent post hospitalisation for COVID-19,

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ COVID-19 is a multisystem disease with primary and potentially long-lasting impacts on respiratory function, musculoskeletal, gastrointestinal, circulatory, cardiac and nervous systems.
- ⇒ We do not yet know what the impact on swallow, communication, voice and cognition are post hospitalisation, so we explored what longer-term functional problems people experienced.

WHAT THIS STUDY ADDS

- ⇒ We now know that swallow, communication, voice and cognitive problems are prevalent post hospitalisation for COVID-19 and were commonly associated with being younger, female and living in socially deprived areas.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ This study tells us a significant number of people are experiencing swallow communication voice and cognitive issues, and they are likely to require support and effective rehabilitation to improve their function.
- ⇒ Future research and phenotype determination need to capture swallow, communication, voice and cognition subtypes, using detailed assessments and measurements of these important symptoms so we can improve outcomes.



alongside whole system compromise including reduced mobility and overall health scores. Research and testing of rehabilitation interventions are required at pace to explore these issues.

INTRODUCTION

SARS-CoV-2 has complex and multifaceted effects and results in the multisystem disease COVID-19. The primary impact of the virus and its variants are on respiratory function; however musculoskeletal, gastrointestinal, circulatory, cardiac and nervous systems can also be compromised.^{1–4} Many experience symptoms persisting beyond 4 weeks from initial presentation, irrespective of severity of acute illness (long COVID).⁵ Our analysis explores data from PHOSP-COVID,⁶ which collected holistic clinical information from a large cohort of patients hospitalised with COVID-19 across the UK to determine chronic health sequelae. To date, there are no population-based studies on the prevalence of self-reported swallowing, communication, voice and cognitive problems post-COVID-19.

Swallowing problems and COVID-19

Causes of swallow compromise following COVID-19 are multifactorial. For those intubated and ventilated in hospital, iatrogenic injury to the larynx and upper airway frequently impacts on anatomy fundamental to safe and effective swallowing.⁷ Numerous patients who were not ventilated also experienced swallowing problems⁸ associated with respiratory compromise, neurological issues, encephalopathies and pre-existing comorbidities.^{9–10} Respiration and swallowing occur in synchrony via neural mechanisms. Consequently, when breathing is impacted by disease or respiratory support,¹¹ destabilisation of the breathe-swallow pattern can result in aspiration (food and/or drink passing below the level of the vocal cords and into the trachea).¹¹ This can cause a range of consequences from coughing and choking during eating and drinking to pneumonia and death.¹²

Communication and cognitive difficulties in COVID-19

Communication compromise may arise from a range of aetiologies associated with numerous pathologies.¹³ Word finding difficulties post COVID-19 have been described,¹⁴ potentially due to encephalopathies and associated dysexecutive syndromes. However no studies have prospectively investigated this symptom, its severity or recovery trajectory. Alongside communication issues, 'brain fog'^{6 15} and neurocognitive problems¹⁶ have been reported.¹⁵ People may experience language deficits (dysphasia), or a conglomerate of symptoms involving language production and processing, and concurrent cognitive challenges which simultaneously impact on memory, perception, attention and reasoning. These cognitive processes are core components of successful communicative interactions and language use.¹⁷ These

problems can be insidious and physically difficult for the individual to describe due to the nature of compromised language function.¹⁸

Voice and COVID-19

Voice changes (dysphonia) have been identified in both the acute presentation of the virus in hospitalised patients¹⁹; and in up to 43% of non-hospitalised patients.²⁰ Laryngeal injury including vocal fold palsy can be a consequence of intubation and postviral infection,²¹ along with alteration to the physiology of the larynx and upper airway causing voice changes. Voice and vocal competence are fundamental to communication, and essential for individuals to work and function effectively in society.²² Significant distress has been reported as an effect of an inability to communicate.²³ Impaired voice competence is an immediate and long-term risk to individual function, quality of life and ability to return to work, therefore a socioeconomic burden to the UK workforce.²⁴

Clinical questions

1. What is the prevalence of swallow, voice, communication and cognitive problems after discharge from hospital following COVID-19?
2. What were the associations with individual characteristics in those who experienced these issues?

METHODS

Methods, analysis and results are reported in line with Strengthening the Reporting of Observational Studies in Epidemiology guidelines.²⁵ Prevalence of swallow, voice, communication and cognitive problems are reported, this is the proportion of the population included in the PHOSP data collection at and during particular time points, who self-reported these particular functional compromise.²⁶

Data source

Data from PHOSP-COVID⁶ that recruited adult patients discharged from a ward or admissions unit at 64 UK hospital Trusts, with confirmed diagnosis of COVID-19 were analysed to explore swallow communication, voice and cognitive symptoms. Participants were asked to complete two research visits; between 2–7 (visit 1) and 10–14 months (visit 2) post discharge, visits outside this timeframe were excluded (± 14 days). Outcomes of interest were all derived from questionnaire responses completed at research visits. A number of participants were unable to attend their first visit but attended the second and therefore respondents included in the cohort at visit 2 may not have been in the visit 1 cohort (figure 1).

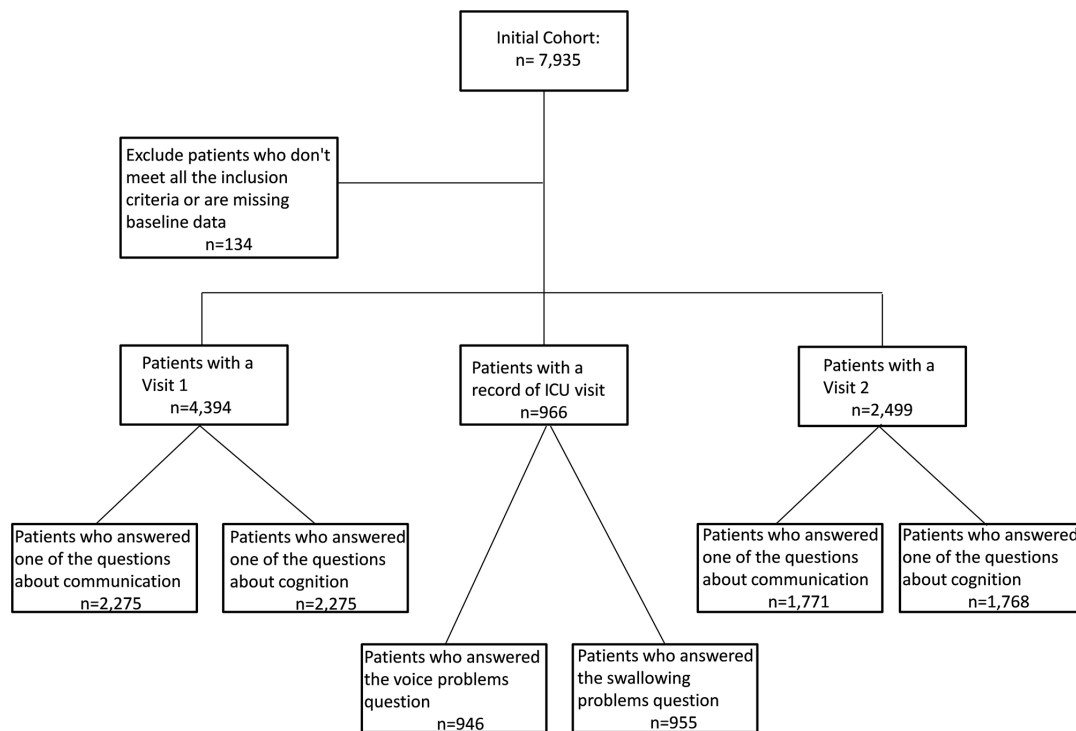


Figure 1 Flow chart. ICU, intensive care unit.

Variables

Six outcomes of interest were self-reported communication issues and cognitive issues at visits 1 and 2, and self-reported voice and swallow problems during an intensive care unit (ICU) stay at some point in the index admission. Only people treated in ICU were asked whether they had voice or swallow problems. We defined someone as having a communication issue at either visit if they answered ‘yes’/‘yes—some difficulty’/‘yes—a lot of difficulty’ or ‘cannot do at all’ to “Using your usual (customary) language, do you have difficulty communicating, for example, understanding or being understood” or if they answered ‘yes’ to having ‘difficulty with communication’ within the last 7 days. Cognitive symptoms were identified if the respondent stated they had at least one of the following within the last 7 days; ‘confusion or fuzzy head’, ‘difficulty with concentration’, ‘short-term memory loss’, ‘physical slowing down’ or ‘slowing down in your thinking’. Swallowing and voice data were only collected from respondents who stated they had been admitted to ICU and answered ‘yes’ to either CRF question 3 “Are you having difficulties eating, drinking or swallowing such as coughing, choking or avoiding any food or drinks?” or the Patient Symptom Questionnaire (PSQ) “Have you or your family noticed any changes to your voice such as difficulty being heard, altered quality of the voice, your voice tiring by the end of the day or an inability to alter the pitch of your voice?” Any comorbidities listed as ‘other’ were reviewed individually and categorised, ensuring comprehensive data were included. Number of comorbidities were calculated as a count and treated as a continuous variable. Respondents’ body mass

indices (BMI) were not collected at baseline but were collected at each of the follow-up visits.

Outcome measures

Relationships between six outcome variables and factors from the baseline visit were investigated, with further outcomes from questionnaires at both visits 1 and 2. We used the EQ-5D-5L²⁷ health-related quality-of-life questionnaire, the Medical Research Council (MRC) Dyspnoea Scale,²⁸ Dyspnoea 12,²⁹ the Post-traumatic Checklist for DSM-5 (PCL-5), a 20-item questionnaire which assesses the requirements for a Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) diagnosis of post-traumatic stress disorder (PTSD) (overall score was categorised into 0–32 unlikely to have PTSD, and 33–80 indicative of probable PTSD) as per guidance,³⁰ the Montreal Cognitive Assessment (MoCA) assessment of cognition, visuospatial abilities, short-term memory, attention, working memory, language and orientation³¹ presenting a summary of the overall score, categorised as per published guidance³¹ into normal (>25), mild (18–25) and moderate or severe cognitive impairment (<18), and finally the Rockwood Clinical Frailty (RCF) score,³² a clinical measure of frailty from 1 (very fit) to 9 (terminally ill). We categorised the RCF into 1–4 (fit to vulnerable) and 5+ (mildly frail to terminally ill).

Explanatory variables: age and ethnicity were grouped and distributed. Respondents’ postcodes were linked to Indices of Multiple Deprivation (IMD)³³ to provide an estimate of deprivation. We detailed ranked quintiles of IMD, 1 being most, 5 being least deprived.³³

All levels of respiratory support during index admission were captured, with a combined variable relating to the WHO clinical progression scale. WHO respiratory support classification was 'class 7–9' for extracorporeal membrane oxygenation (ECMO), renal replacement therapy (RRT) or invasive mechanical ventilation (IMV), 'class 6' for high flow nasal O₂ (HFN), bi-level non-invasive ventilation (NIV), continuous positive airway pressure (CPAP), 'class 5' for supplemental O₂ and 'class 4' if the patient received none of these interventions.

Statistical methods

Respondents missing age, sex and gender were excluded from analysis. Categorical variables are reported as counts and percentages; continuous variables are presented as medians with IQRs. Univariable analysis of categorical variables was undertaken using either χ^2 test or Fisher's exact test for small numbers, for continuous variables the Kruskal-Wallis test was used. Only completed data have been included for the summaries of the in-hospital, pre-hospital and outcomes. Although included in our protocol, after reviewing data for maximal inspiratory pressure and maximal expiratory pressure, handgrip and quadriceps strength and chest X-ray findings, we decided not to investigate these further due to incomplete data. P values <0.05 were considered statistically significant.

Before multivariable analyses were undertaken, a subset of variables were chosen to be included based on clinical knowledge. From the demographics section, we chose to exclude healthcare worker status and shielding status, the only COVID-19 symptoms included were cough, fever, headache confusion or other symptoms relating to ear, nose or throat problems, all comorbidities, new diagnoses, pre-admission medications and respiratory support were included. We only included antibiotic therapy, systemic steroids, therapeutic dose anticoagulation and RRT as these were treatment options available for the whole time period. For respondents included in the study, we included unknown categories for missing data in the baseline demographics in the multivariable analysis. For any pre-hospital or in-hospital variables included in the multivariable analysis, we included an unknown category.

We undertook lasso logistic regression with the binary outcomes of swallow, communication, voice or cognitive problems as the dependent variable for variable selection. We investigated a number of techniques including cross validation with 10 folds, adaptive lasso and elasticnet and chose the solution with the best out of sample model goodness of fit. We required age at admission and sex be included in the final models given their contextual importance.³⁴ As a sensitivity analysis, we performed a complete-case analysis.

RESULTS

Overall, 7935 participants were included in the study, n=134 were excluded as they did not meet the inclusion

criteria or had missing data. N=4394 had visit 1 data, n=966 had an intensive care unit visit and n=2499 had a visit 2 (see [figure 1](#)). Swallow, communication, voice and cognitive problems were prevalent and persisted over time from visit 1 to visit 2 (see [tables 1 and 2](#)). Swallow problems were reported in 20% (188/955) and voice problems in 34% (319/946) of those admitted to ICU. Of the whole cohort, communication issues were reported by 23.2% (527/2275) at visit 1 which remained at 22.5% (399/1771) at visit 2. Cognitive problems were more highly prevalent and reported by 70.2% (1598/2275) at visit 1, and remained at 69.6% (1231/1768) at visit 2.

Swallow problems

Only participants who had been treated in ICU could report swallow problems. Important clinical features included the following: they were more likely to have undergone IMV (p<0.001), to have been prone (p=0.039) ([table 3](#)), to be younger (p=0.001) and female (p=0.041) ([table 1](#)). Significant physiological comorbidities associated with swallow problems were asthma (26% vs 16%, p=0.002) and gastro-oesophageal reflux disease (15% vs 8%, p=0.002) ([table 4](#)). There did not appear to be any difference in ethnicity, education, deprivation, healthcare worker or shielding status prior to admission.

Respondents with swallow problems spent longer in hospital (median length of stay: 24 vs 16 days) and were more likely to report worsening mobility (p<0.001), self-care (p<0.001), usual activities (p=0.005), pain or discomfort (p=0.006) and have lower health score (p<0.001) ([table 5](#)). They had a higher overall score on the Dyspnoea 12 (p<0.001), and on physical and affective subdomains (p<0.001), had a higher PCL-5 (PTSD) overall score (p<0.001) and were more likely to be clinically frail according to the RCF (p<0.001) ([table 5](#)). Swallow problems were only collected at one time point so it is not possible to determine how long these problems persisted. Variables included in the final model chosen by cross-validation are detailed in online supplemental data 1.1.

Voice problems

Over a third of eligible respondents reported voice problems (319/946, 34%) during their admission. There were no demographic differences between participants with and without voice problems ([table 1](#)); however, they were more likely to have asthma (23% vs 15%, p=0.003) to have received CPAP (59% vs 47%, p=0.001), NIV (16% vs 10%, p=0.021) and almost twice as likely to have received IMV (65% vs 36%) ([table 3](#)). These are important associations which identify relationships between perceived voice problems and respiratory compromise. They were also more likely to receive antibiotics (93% vs 86%), to have been prone (54% vs 35%) and to have a new diagnosis of renal failure requiring dialysis (12% vs 7%). They were more likely to state one of their COVID-19 symptoms was

Table 1 Demographics of patients who answered questions about voice and swallow problems during their index admission

		ICU swallow problems			ICU voice problems		
		No	Yes	P value	No	Yes	P value
Age at admission (years)	N (%)	767 (80.3%)	188 (19.7%)		627 (66.3%)	319 (33.7%)	
	Median* (IQR)	60 (51–67)	57 (51–64.5)	0.001	60 (51–68)	59 (52–64)	0.071
	Under 40	48 (6.3%)	14 (7.4%)	0.026	47 (7.5%)	14 (4.4%)	0.012
	40–49	105 (13.7%)	26 (13.8%)		79 (12.6%)	50 (15.7%)	
	50–59	216 (28.2%)	73 (38.8%)		177 (28.2%)	106 (33.2%)	
	60–69	260 (33.9%)	53 (28.2%)		203 (32.4%)	110 (34.5%)	
	70–79	138 (18.0%)	22 (11.7%)		121 (19.3%)	39 (12.2%)	
Sex	Female	219 (28.6%)	68 (36.2%)	0.041	187 (29.8%)	97 (30.4%)	0.853
	Male	548 (71.4%)	120 (63.8%)		440 (70.2%)	222 (69.6%)	
Ethnicity	White	548 (71.4%)	127 (67.6%)	0.102	446 (71.1%)	223 (69.9%)	0.915
	South Asian	79 (10.3%)	27 (14.4%)		67 (10.7%)	39 (12.2%)	
	Black	75 (9.8%)	12 (6.4%)		57 (9.1%)	28 (8.8%)	
	Other†	65 (8.5%)	22 (11.7%)		57 (9.1%)	29 (9.1%)	
BMI	Under/Normal weight	52 (6.8%)	10 (5.3%)	0.237	43 (6.9%)	19 (6.0%)	0.153
	Overweight	196 (25.6%)	52 (27.7%)		160 (25.5%)	84 (26.3%)	
	Obese	271 (35.3%)	70 (37.2%)		212 (33.8%)	127 (39.8%)	
	Severe obesity	67 (8.7%)	23 (12.2%)		58 (9.3%)	31 (9.7%)	
	Not recorded	181 (23.6%)	33 (17.6%)		154 (24.6%)	58 (18.2%)	
IMD quintile‡	1—most deprived	175 (22.8%)	40 (21.3%)	0.528	140 (22.3%)	75 (23.5%)	0.121
	2	170 (22.2%)	50 (26.6%)		150 (23.9%)	65 (20.4%)	
	3	155 (20.2%)	40 (21.3%)		115 (18.3%)	75 (23.5%)	
	4	135 (17.6%)	25 (13.3%)		115 (18.3%)	40 (12.5%)	
	5—least deprived	130 (16.9%)	35 (18.6%)		100 (15.9%)	60 (18.8%)	
	Unknown	§	§		§	§	
Educational level	None	42 (5.5%)	8 (4.3%)	0.135	39 (6.2%)	10 (3.1%)	0.331
	Primary school	219 (28.6%)	53 (28.2%)		180 (28.7%)	89 (27.9%)	
	Secondary school	94 (12.3%)	20 (10.6%)		72 (11.5%)	42 (13.2%)	
	Sixth form college	98 (12.8%)	35 (18.6%)		82 (13.1%)	50 (15.7%)	
	Vocational qualification	131 (17.1%)	24 (12.8%)		106 (16.9%)	48 (15.0%)	
	Undergraduate	103 (13.4%)	20 (10.6%)		76 (12.1%)	46 (14.4%)	
	Postgraduate	80 (10.4%)	28 (14.9%)		72 (11.5%)	34 (10.7%)	
	Unknown	91 (11.9%)	24 (12.8%)		66 (10.5%)	47 (14.7%)	
Healthcare worker	494 (64.4%)	111 (59.0%)	0.273	398 (63.5%)	201 (63.0%)	0.128	
Shielding status prior to admission	Not	130 (16.9%)	30 (16.0%)	0.145	108 (17.2%)	50 (15.7%)	0.653
	Voluntary shielding	32 (4.2%)	11 (5.9%)		25 (4.0%)	18 (5.6%)	
	Extremely vulnerable	57 (7.4%)	13 (6.9%)		48 (7.7%)	21 (6.6%)	
	Letter issued by HCP	54 (7.0%)	23 (12.2%)		48 (7.7%)	29 (9.1%)	
	Unknown	175 (22.8%)	40 (21.3%)		140 (22.3%)	75 (23.5%)	

Unless otherwise specified, numbers are shown as counts (percentages) and p values have been calculated using χ^2 test; 20% of respondents who answered the question had swallow problems, patients were significantly more likely to be younger and female; 34% of respondents voice problems; there do not appear to be any significant differences in the demographics of patients who had voice problems compared with those who did not.

*P value calculated using Kruskal-Wallis, $p < 0.05$ are bolded.

†Includes mixed and unknown.

‡Where numbers could be calculated, the other values have been rounded to the nearest 5 and % calculated on this new value.

§Numbers ≤ 5 have been suppressed.

BMI, body mass index; HCP, healthcare professional; ICU, intensive care unit; IMD, indices of multiple deprivation.

Table 2 Demographics at the time of initial COVID-19 admission split by whether respondents have communication or cognitive issues at visit 1 or visit 2

	Visit 1 cognitive issues			Visit 2 cognitive issues			Visit 1 communication issues			Visit 2 communication issues		
	No	Yes	P value	No	Yes	P value	No	Yes	P value	No	Yes	P value
N (%)	677 (29.8%)	1598 (70.2%)		537 (30.4%)	1231 (69.6%)		1748 (76.8%)	527 (23.2%)		1372 (77.5%)	399 (22.5%)	
Age at admission (years)												
Median* (IQR)	60 (49–68)	58 (50–66)	0.976	60 (50–68)	60 (52–68)	0.361	60 (51–68)	56 (49–63)	<0.001	61 (52.5–69)	57 (51–64)	<0.001
Under 40	64 (9.5%)	118 (7.4%)	0.002	49 (9.1%)	68 (5.5%)	0.102	142 (8.1%)	40 (7.6%)	<0.001	86 (6.3%)	31 (7.8%)	<0.001
40–49	106 (15.7%)	252 (15.8%)		74 (13.8%)	159 (12.9%)		262 (15.0%)	96 (18.2%)		172 (12.5%)	61 (15.3%)	
50–59	158 (23.3%)	494 (30.9%)		143 (26.6%)	368 (29.9%)		451 (25.8%)	201 (38.1%)		362 (26.4%)	151 (37.8%)	
60–69	203 (30.0%)	461 (28.8%)		163 (30.4%)	378 (30.7%)		528 (30.2%)	136 (25.8%)		432 (31.5%)	110 (27.6%)	
70–79	119 (17.6%)	225 (14.1%)		91 (16.9%)	214 (17.4%)		299 (17.1%)	45 (8.5%)		265 (19.3%)	38 (9.5%)	
80 and over	27 (4.0%)	48 (3.0%)		17 (2.2%)	44 (3.6%)		66 (3.8%)	9 (1.7%)		55 (4.0%)	8 (2.0%)	
Sex												
Female	186 (27.5%)	699 (43.7%)	<0.001	140 (26.1%)	525 (42.6%)	<0.001	631 (36.1%)	254 (48.2%)	<0.001	490 (35.7%)	177 (44.4%)	0.002
Male	491 (72.5%)	899 (56.3%)		397 (73.9%)	706 (57.4%)		1117 (63.9%)	273 (51.8%)		882 (64.3%)	222 (55.6%)	
Ethnicity												
White	458 (67.7%)	1243 (77.8%)	<0.001	382 (71.1%)	980 (79.6%)	<0.001	1297 (74.2%)	405 (76.9%)	0.629	1060 (77.3%)	304 (76.2%)	0.404
South Asian	103 (15.2%)	153 (9.6%)		69 (12.8%)	92 (7.5%)		203 (11.6%)	53 (10.1%)		126 (9.2%)	35 (8.8%)	
Black	61 (9.0%)	99 (6.2%)		44 (8.2%)	78 (6.3%)		123 (7.0%)	36 (6.8%)		98 (7.1%)	25 (6.3%)	
Other†	55 (8.1%)	103 (6.4%)		42 (7.8%)	81 (6.6%)		125 (7.2%)	33 (6.3%)		88 (6.4%)	35 (8.8%)	

Continued

Table 2 Continued

	Visit 1 cognitive issues			Visit 2 cognitive issues			Visit 1 communication issues			Visit 2 communication issues		
	No	Yes	P value	No	Yes	P value	No	Yes	P value	No	Yes	P value
BMI												
Under/Normal weight	68 (10.0%)	137 (8.6%)	<0.001	61 (11.4%)	85 (6.9%)	<0.001	166 (9.5%)	39 (7.4%)		119 (8.7%)	27 (6.8%)	0.047
Overweight	197 (29.1%)	390 (24.4%)		163 (30.4%)	285 (23.2%)		456 (26.1%)	131 (24.9%)	0.259	365 (26.6%)	83 (20.8%)	
Obese	231 (34.1%)	611 (38.2%)		176 (32.8%)	460 (37.4%)		645 (36.9%)	196 (37.2%)		487 (35.5%)	150 (37.6%)	
Severe obesity	45 (6.6%)	191 (12.0%)		27 (5.0%)	122 (9.9%)		170 (9.7%)	66 (12.5%)		110 (8.0%)	40 (10.0%)	
Not recorded	136 (20.1%)	269 (16.8%)		110 (20.5%)	279 (22.7%)		311 (17.8%)	95 (18.0%)		291 (21.2%)	99 (24.8%)	
IMD quintile†												
1—most deprived	142 (21.0%)	388 (24.3%)	0.149	100 (18.6%)	300 (24.4%)	<0.001	390 (22.3%)	140 (26.6%)	0.010	308 (22.4%)	95 (23.8%)	0.020
2	162 (23.9%)	367 (23.0%)		110 (20.5%)	275 (22.3%)		390 (22.3%)	135 (25.6%)		276 (20.1%)	108 (27.1%)	
3	132 (19.5%)	265 (16.6%)		100 (18.6%)	220 (17.9%)		300 (17.2%)	95 (18.0%)		250 (18.2%)	65 (16.3%)	
4	110 (16.2%)	274 (17.1%)		100 (18.6%)	220 (17.9%)		320 (18.3%)	65 (12.3%)		262 (19.1%)	59 (14.8%)	
5—least deprived	123 (18.2%)	296 (18.5%)		125 (23.3%)	215 (17.5%)		330 (18.9%)	90 (17.1%)		269 (19.6%)	72 (18.0%)	
Unknown	8 (1.2%)	8 (0.5%)		\$	\$		\$	\$		7 (0.5%)	0	
Educational level												
None	14 (2.1%)	46 (2.9%)	<0.001	10 (1.9%)	34 (2.8%)	0.008	44 (2.5%)	16 (3.0%)	0.009	36 (2.6%)	9 (2.3%)	0.020
Primary school	14 (2.1%)	40 (2.5%)		10 (1.9%)	26 (2.1%)		43 (2.5%)	11 (2.1%)		30 (2.2%)	6 (1.5%)	
Secondary school	166 (24.5%)	511 (32.0%)		161 (30.0%)	393 (31.9%)		519 (29.7%)	159 (30.2%)		429 (31.3%)	126 (31.6%)	
Sixth form college	97 (14.3%)	198 (12.4%)		63 (11.7%)	161 (13.1%)		225 (12.9%)	70 (13.3%)		159 (11.6%)	65 (16.3%)	
Vocational qualification	65 (9.6%)	204 (12.8%)		50 (9.3%)	165 (13.4%)		185 (10.6%)	84 (15.9%)		157 (11.4%)	59 (14.8%)	
Undergraduate	142 (21.0%)	258 (16.1%)		106 (19.7%)	198 (16.1%)		329 (18.8%)	70 (13.3%)		255 (18.6%)	49 (12.3%)	
Postgraduate	109 (16.1%)	197 (12.3%)		95 (17.7%)	149 (12.1%)		242 (13.8%)	64 (12.1%)		193 (14.1%)	51 (12.8%)	
Unknown	70 (10.3%)	144 (9.0%)		42 (7.8%)	105 (8.5%)		161 (9.2%)	53 (10.1%)		113 (8.2%)	34 (8.5%)	

Continued

Table 2 Continued

	Visit 1 cognitive issues			Visit 2 cognitive issues			Visit 1 communication issues			Visit 2 communication issues		
	No	Yes	P value	No	Yes	P value	No	Yes	P value	No	Yes	P value
Healthcare worker	84 (12.4%)	238 (14.9%)	0.252	70 (13.0%)	180 (14.6%)	0.210	230 (13.2%)	91 (17.3%)	0.010	186 (13.6%)	64 (16.0%)	0.452
Shielding status prior to admission	464 (68.5%)	988 (61.8%)	<0.001	377 (70.2%)	750 (60.9%)	0.001	1142 (65.3%)	309 (58.6%)	0.001	884 (64.4%)	244 (61.2%)	0.091
Voluntary shielding	112 (16.5%)	284 (17.8%)		91 (16.9%)	226 (18.4%)		309 (17.7%)	88 (16.7%)		253 (18.4%)	65 (16.3%)	
Extremely vulnerable	24 (3.5%)	99 (6.2%)		21 (3.9%)	79 (6.4%)		83 (4.7%)	40 (7.6%)		75 (5.5%)	26 (6.5%)	
Letter issued by HCP	24 (3.5%)	121 (7.6%)		22 (4.1%)	91 (7.4%)		96 (5.5%)	49 (9.3%)		77 (5.6%)	36 (9.0%)	
Unknown	53 (7.8%)	106 (6.6%)		26 (4.8%)	85 (6.9%)		118 (6.8%)	41 (7.8%)		83 (6.0%)	28 (7.0%)	

Unless otherwise specified, numbers are shown as counts (percentages) and p values have been calculated using χ^2 test; 70% of respondents at both visits 1 and 2 reported cognitive issues, and 23% of respondents reported communication issues. There did not appear to be significant difference in the proportion of patients who reported problems by whether or not they were healthcare workers. For communication issues, there did not appear to be any significant difference based on ethnicity or BMI.

*P value calculated using Kruskal-Wallis, $p < 0.05$ are bolded.

†Includes mixed and unknown.

‡Where numbers could be calculated, the other values have been rounded to the nearest 5 and % calculated on this new value.

§Numbers ≤ 5 have been suppressed.

BMI, body mass index; HCP, healthcare professional; IMD, indices of multiple deprivation.

Table 3 COVID-19 symptoms and treatments before and during the index admission for respondents who answered questions about voice or swallow problems

		ICU swallow*			ICU voice*		
		No	Yes	P value	No	Yes	P value
Duration of COVID-19 symptoms	Median (IQR)†	8 (6–11)	8 (6–12)	0.791	8 (6–11)	8 (6–12)	0.228
COVID-19 symptoms*	Fever	582 (81.4%)	144 (85.2%)	0.245	475 (80.0%)	247 (87.6%)	0.006
	Cough	603 (84.2%)	135 (81.3%)	0.364	497 (83.7%)	234 (83.9%)	0.940
	Sore throat	70 (12.0%)	24 (17.1%)	0.101	53 (10.7%)	41 (18.1%)	0.006
	Runny nose	26 (4.4%)	12 (8.8%)	0.041	27 (5.4%)	11 (4.9%)	0.781
	Shortness of breath	626 (86.7%)	152 (88.9%)	0.443	511 (86.3%)	257 (88.3%)	0.375
	Loss of taste	111 (19.8%)	30 (21.7%)	0.602	102 (21.1%)	38 (17.9%)	0.334
	Loss of smell	91 (16.1%)	26 (19.3%)	0.373	86 (17.8%)	31 (14.5%)	0.275
	Headache	128 (21.4%)	37 (26.8%)	0.170	103 (20.4%)	59 (26.0%)	0.094
	Confusion	89 (14.2%)	25 (16.9%)	0.400	74 (14.0%)	41 (16.9%)	0.306
Pre-admission medications	Immunosuppressant	71 (10.5%)	23 (14.5%)	0.153	58 (10.3%)	35 (13.3%)	0.207
	Anti-infectives	84 (12.3%)	22 (14.1%)	0.549	77 (13.6%)	28 (10.6%)	0.233
	ACEI	107 (15.8%)	23 (14.2%)	0.616	75 (13.3%)	53 (19.9%)	0.013
	ARBS	49 (7.3%)	16 (10.0%)	0.245	38 (6.7%)	27 (10.2%)	0.083
	NSAID	48 (7.2%)	17 (11.0%)	0.115	38 (6.8%)	27 (10.6%)	0.065
Respiratory support	Supplemental O2	708 (94.4%)	172 (93.0%)	0.460	576 (93.2%)	295 (95.5%)	0.199
	CPAP	361 (50.3%)	97 (56.4%)	0.154	283 (47.5%)	168 (59.2%)	0.001
	Bi-level NIV	78 (11.4%)	24 (14.6%)	0.245	58 (10.2%)	43 (15.7%)	0.021
	High flow nasal O2	306 (44.0%)	61 (37.4%)	0.125	244 (42.1%)	119 (43.9%)	0.627
	Invasive mechanical ventilation	319 (42.3%)	103 (59.6%)	<0.001	223 (35.6%)	201 (64.8%)	<0.001
	ECMO	24 (3.3%)	9 (5.2%)	0.242	22 (3.7%)	11 (3.8%)	0.925
Highest respiratory level	WHO class 3–4	40 (5.2%)	11 (5.9%)	<0.001	39 (6.2%)	12 (3.8%)	<0.001
	WHO class 5	142 (18.5%)	28 (14.9%)		132 (21.1%)	36 (11.3%)	
	WHO class 6	260 (33.9%)	39 (20.7%)		227 (36.2%)	68 (21.3%)	
	WHO class 7–9	325 (42.4%)	110 (58.5%)		229 (36.5%)	203 (63.6%)	
Treatments given	Antibiotic therapy	644 (87.5%)	167 (92.3%)	0.079	521 (86.3%)	282 (92.8%)	0.005
	Systemic steroids	452 (64.5%)	89 (54.3%)	0.014	368 (63.3%)	167 (60.5%)	0.406
	Therapeutic dose anticoagulation	396 (56.1%)	93 (56.4%)	0.949	320 (55.0%)	164 (58.6%)	0.320
	Prone	267 (39.9%)	75 (49.0%)	0.039	194 (34.9%)	141 (54.4%)	<0.001
	Renal replacement therapy	75 (10.6%)	21 (12.5%)	0.473	58 (9.8%)	37 (13.3%)	0.132
Other diagnoses made during admission	PE/Microthrombi	123 (17.0%)	22 (12.8%)	0.181	87 (14.5%)	55 (19.1%)	0.080
	Renal failure requiring dialysis	60 (8.3%)	20 (11.8%)	0.155	44 (7.4%)	35 (12.2%)	0.013
Duration of stay	Median (IQR)†	16 (9–33)	24 (12–42.5)	<0.001	14 (8–28)	28 (14–47)	<0.001

Unless otherwise specified, numbers are shown as counts (percentages) and p values have been calculated using χ^2 test. Patients who had invasive mechanical ventilation were significantly more likely to report swallow and voice problems, likewise patients who were treated with systemic steroids and prone were significantly more likely to report swallow problems. Patients with swallow and voice problems had a significantly longer length of stay.

*The denominators vary for most variables, the number of excluded records due to missing data are recorded in online supplemental table S1.

†P value calculated using Kruskal-Wallis, $p < 0.05$ are bolded.

ACEI, ACE inhibitors; ARBS, angiotensin II receptor blockers; CPAP, continuous positive airway pressure; ECMO, extracorporeal membrane oxygenation; ICU, intensive care unit; NIV, non-invasive ventilation; NSAID, non-steroidal anti-inflammatory drugs; PE, pulmonary embolism.

Table 4 Self-reported comorbidities recorded at baseline visit for those respondents who answered questions on voice or swallow problems

	ICU swallow			ICU voice		
	No	Yes	P value	No	Yes	P value
N (%)	767 (80.3%)	188 (19.7%)		627 (66.3%)	319 (33.7%)	
Myocardial infarction	34 (4.4%)	6 (3.2%)	0.446	25 (4.0%)	15 (4.7%)	0.605
Ischaemic heart disease	46 (6.0%)	14 (7.4%)	0.463	37 (5.9%)	22 (6.9%)	0.549
Atrial fibrillation	33 (4.3%)	10 (5.3%)	0.547	30 (4.8%)	13 (4.1%)	0.620
Hypertension	298 (38.9%)	65 (34.6%)	0.279	236 (37.6%)	124 (38.9%)	0.712
Congestive heart failure/ Congenital heart disease/ Valvular heard disease/ Pacemaker/Implantable device/Peripheral vascular disease	40 (5.2%)	11 (5.9%)	0.728	34 (5.4%)	18 (5.6%)	0.888
Hypercholesterolaemia/ Dyslipidaemia	166 (21.6%)	35 (18.6%)	0.362	138 (22.0%)	62 (19.4%)	0.359
Cerebrovascular accident/ Transient ischaemic attack	42 (5.5%)	8 (4.3%)	0.501	33 (5.3%)	17 (5.3%)	0.966
Depression or anxiety	103 (13.4%)	41 (21.8%)	0.004	86 (13.7%)	56 (17.6%)	0.118
Chronic fatigue syndrome, fibromyalgia, chronic pain	37 (4.8%)	19 (10.1%)	0.006	32 (5.1%)	24 (7.5%)	0.136
Any previous treatment with antidepressant medication	81 (10.6%)	40 (21.3%)	<0.001	78 (12.4%)	40 (12.5%)	0.965
Any previous treatment by a mental health professional for a mental health problem	33 (4.3%)	21 (11.2%)	<0.001	25 (4.0%)	27 (8.5%)	0.004
Chronic obstructive pulmonary disease	32 (4.2%)	8 (4.3%)	0.959	27 (4.3%)	12 (3.8%)	0.690
Asthma	126 (16.4%)	49 (26.1%)	0.002	96 (15.3%)	74 (23.2%)	0.003
Obstructive sleep apnoea	39 (5.1%)	14 (7.4%)	0.205	35 (5.6%)	18 (5.6%)	0.969
Interstitial lung disease/ Bronchiectasis/Obesity hypoventilation syndrome/ Pleural effusion	*	*	*	14 (2.2%)	11 (3.4%)	0.271
Rheumatoid arthritis	*	*	*	20 (3.2%)	9 (2.8%)	0.756
Osteoarthritis	75 (9.8%)	21 (11.2%)	0.570	57 (9.1%)	38 (11.9%)	0.172
Peptic ulcer disease/Liver disease	41 (5.3%)	6 (3.2%)	0.221	34 (5.4%)	13 (4.1%)	0.367
Gastro-oesophageal reflux disease	62 (8.1%)	29 (15.4%)	0.002	52 (8.3%)	39 (12.2%)	0.052
Irritable bowel syndrome	21 (2.7%)	9 (4.8%)	0.149	14 (2.2%)	16 (5.0%)	0.021
Diabetes	186 (24.3%)	45 (23.9%)	0.928	151 (24.1%)	77 (24.1%)	0.985
Hypothyroidism	38 (5.0%)	9 (4.8%)	0.924	30 (4.8%)	17 (5.3%)	0.716
Chronic kidney disease (any stage)	43 (5.6%)	7 (3.7%)	0.299	39 (6.2%)	11 (3.4%)	0.072
Cancer	58 (7.6%)	9 (4.8%)	0.182	44 (7.0%)	23 (7.2%)	0.913
Infectious disease	*	*	*	11 (1.8%)	8 (2.5%)	0.435
Number of comorbidities	2 (1–3)	2 (1–3)	0.528	2 (1–3)	2 (1–3)	0.171

Unless otherwise specified, numbers are shown as counts (percentages) and p values have been calculated using χ^2 test.

*Numbers ≤ 5 have been suppressed, $p < 0.05$ are bolded. Patients reporting asthma, gastro-oesophageal reflux disease, depression, chronic fatigue syndrome and previous treatments for a mental health problem were significantly more likely to report a swallow problem, likewise patients reporting irritable bowel syndrome, asthma and previous treatment by a mental health professional were more likely to report voice problems.

ICU, intensive care unit.

Table 5 Outcomes for respondents who stated they had voice or swallow problems

	ICU swallow—visit 1*			ICU swallow—visit 2*			ICU voice—visit 1*			ICU voice—visit 2*		
	No	Yes	P value	No	Yes	P value	No	Yes	P value	No	Yes	P value
EQ-5D-5L												
Mobility												
Improved	30 (5.9%)	9 (6.5%)	<0.001	34 (7.5%)	7 (6.4%)		25 (6.1%)	14 (6.0%)		25 (7.1%)	16 (7.7%)	
Stayed the same	300 (58.8%)	54 (38.8%)		269 (59.5%)	42 (38.5%)	<0.001	247 (60.5%)	104 (44.4%)	<0.001	217 (61.8%)	93 (44.9%)	<0.001
Worsened	180 (35.3%)	76 (54.7%)		149 (33.0%)	60 (55.0%)		136 (33.3%)	116 (49.6%)		109 (31.1%)	98 (47.3%)	
Self-care												
Improved/Stayed the same	270 (52.9%)	51 (36.7%)	<0.001	262 (57.8%)	39 (35.8%)	<0.001	228 (55.7%)	90 (38.6%)	<0.001	213 (60.5%)	86 (41.5%)	<0.001
Worsened	240 (47.1%)	88 (63.3%)		191 (42.2%)	70 (64.2%)		181 (44.3%)	143 (61.4%)		139 (39.5%)	121 (58.5%)	
Usual activities												
Improved	20 (3.9%)	7 (5.0%)	0.005	24 (5.3%)	7 (6.4%)		20 (4.9%)	7 (3.0%)		19 (5.4%)	11 (5.3%)	
Stayed the same	274 (53.7%)	53 (38.1%)		259 (57.2%)	37 (33.9%)	<0.001	231 (56.5%)	91 (39.1%)	<0.001	208 (59.1%)	86 (41.5%)	<0.001
Worsened	216 (42.4%)	79 (56.8%)		170 (37.5%)	65 (59.6%)		158 (38.6%)	133 (57.1%)		125 (35.5%)	110 (53.1%)	
Pain/Discomfort												
Improved	99 (19.4%)	22 (15.8%)	0.006	98 (21.6%)	22 (20.2%)		82 (20.1%)	39 (16.7%)		78 (22.2%)	40 (19.3%)	
Stayed the same	246 (48.3%)	52 (37.4%)		226 (49.9%)	35 (32.1%)	<0.001	200 (49.0%)	94 (40.3%)	0.009	177 (50.3%)	83 (40.1%)	0.006
Worsened	164 (32.2%)	65 (46.8%)		129 (28.5%)	52 (47.7%)		126 (30.9%)	100 (42.9%)		97 (27.6%)	84 (40.6%)	
Anxiety / Depression												
Improved	68 (13.4%)	8 (5.8%)	0.001	60 (13.3%)	11 (10.1%)		52 (12.7%)	24 (10.3%)		50 (14.2%)	21 (10.2%)	
Stayed the same	242 (47.5%)	53 (38.1%)		229 (50.7%)	40 (36.7%)	0.004	203 (49.6%)	89 (38.4%)	0.004	177 (50.3%)	89 (43.2%)	0.030
Worsened	199 (39.1%)	78 (56.1%)		163 (36.1%)	58 (53.2%)		154 (37.7%)	119 (51.3%)		125 (35.5%)	96 (46.6%)	
Summary—How good or bad is your health overall?												
Current score*	75 (60–85)	64 (50–80)	<0.001	80 (60–90)	60 (50–80)	<0.001	79 (60–86)	65 (50–80)	<0.001	80 (60–90)	70 (50–80)	<0.001
Improved	67 (13.6%)	14 (10.7%)	0.152	80 (18.3%)	14 (13.9%)		54 (13.6%)	26 (11.8%)		62 (18.3%)	32 (16.3%)	
Stayed the same	109 (22.1%)	21 (16.0%)		74 (16.9%)	13 (12.9%)	0.264	100 (25.2%)	29 (13.2%)	0.001	64 (18.9%)	23 (11.7%)	0.057
Worsened	317 (64.3%)	96 (73.3%)		283 (64.8%)	74 (73.3%)		243 (61.2%)	165 (75.0%)		213 (62.8%)	141 (71.9%)	
MRC Dyspnoea Scale												
Improved/Stayed the same	110 (43.8%)	28 (33.7%)	0.106	53 (57.0%)	19 (51.4%)	0.560	86 (44.1%)	50 (37.0%)	0.207	45 (61.6%)	27 (47.4%)	0.104
Worsened	141 (56.2%)	55 (66.3%)		40 (43.0%)	18 (48.6%)		109 (55.9%)	85 (63.0%)		28 (38.4%)	30 (52.6%)	
Dyspnoea 12+												
Overall score	3 (0–9)	8 (2–19)	<0.001	2 (0–7)	8 (1–18)	<0.001	2 (0–8)	6 (1–15)	<0.001	1 (0–6)	5 (1–15)	<0.001
Physical domain	2 (0–7)	6 (2–12)	<0.001	2 (0–6)	6 (1–11)	<0.001	2 (0–6)	4 (1–10)	<0.001	1 (0–5)	4 (1–10)	<0.001
Affective domain	0 (0–2)	1.5 (0–7)	<0.001	0 (0–1)	2 (0–6)	<0.001	0 (0–1)	1 (0–5)	<0.001	0 (0–1)	0 (0–5)	<0.001

Continued

Table 5 Continued

	ICU swallow—visit 1*			ICU swallow—visit 2*			ICU voice—visit 1*			ICU voice—visit 2*		
	No	Yes	P value	No	Yes	P value	No	Yes	P value	No	Yes	P value
PCL-5	9 (3–24)	25 (8–41.5)	<0.001	7 (2–21)	19.5 (7–42)	<0.001	7 (2–21)	20 (7–39)	<0.001	6 (1–19)	15 (5–38)	<0.001
Overall score ^x												
Overall score ^x >32	107 (16.0%)	65 (36.1%)	<0.001	79 (11.8%)	48 (26.4%)	<0.001	78 (14.6%)	91 (29.7%)	<0.001	54 (10.0%)	71 (23.1%)	<0.001
MoCA§	26.5 (24–28)	26 (23–28)	0.306	27 (25–29)	27 (25–29)	0.439	26 (24–28)	27 (24–28)	0.757	27 (25–29)	27 (25–29)	0.612
Overall score ^x												
Normal function	346 (61.1%)	78 (53.8%)	0.071	337 (69.8%)	81 (66.4%)	0.471	275 (59.5%)	143 (59.6%)	0.937	267 (69.2%)	149 (69.3%)	
Mild impairment	204 (36.0%)	58 (40.0%)		146 (30.2%)	41 (33.6%)		172 (37.2%)	88 (36.7%)		109 (28.2%)	59 (27.4%)	0.884
Moderate/Severe impairment	16 (2.8%)	9 (6.2%)					15 (3.2%)	9 (3.8%)		10 (2.6%)	7 (3.3%)	
RCF¶	41 (6.3%)	23 (14.6%)	<0.001	22 (3.9%)	21 (15.2%)	<0.001	27 (5.1%)	36 (13.5%)	<0.001	19 (4.2%)	23 (9.1%)	0.009

Outcomes taken from the same visit as reported visit or swallow problems. Unless otherwise specified, numbers are reported as count (percentage) and p values are the result of a χ^2 test. P<0.05 are bolded.

*The denominators vary for most variables, the number of excluded records due to missing data are recorded in online supplemental table S1.

†Values are shown as median (IQR) and Kruskal-Wallis test is used.

§Normal cognitive function score >25, mild cognitive impairment score 18–25, moderate or severe cognitive impairment score <18.

¶Frail defined as RCF \geq 5.

|| ICU, intensive care unit; MoCA, Montreal Cognitive Assessment; PCL-5, Post-traumatic Checklist for DSM-5; RCF, Rockwood Clinical Frailty.

a fever (88% vs 80%) and to have experienced a sore throat (18% vs 11%) than those without (table 3).

Respondents with voice problems spent on average 2 weeks longer in hospital than those without (median length of stay: 28 vs 14 days) and were more likely to report a worsening of their mobility, self-care, usual activities, pain or discomfort, anxiety or depression and have a lower health score (table 5). They had a higher overall score on the Dyspnoea 12 questionnaire (both physical and affective), had a higher PCL-5 overall score and were more likely to be classified as clinically frail. Variables included in the final model chosen by cross-validation are detailed in online supplemental data 1.2. Voice problems were only collected at one time point so it is not possible to comment on how long these problems lasted.

Communication issues

Visit 1

Approximately one in four experienced communication issues at visit 1 (527/2375, 23%), they were younger (median: 56 vs 60 years), a higher proportion were female (48% vs 36%), came from more deprived areas (27% vs 22%), were healthcare workers (17% vs 13%) and had been shielding prior to admission (34% vs 28%) (table 2). This is important clinical information, identifying those who recognised deterioration in their ability to communicate. They were more likely to report COVID-19 symptoms; fever (81% vs 77%, $p=0.023$), shortness of breath (88% vs 83%, $p=0.014$), sore throat (19% vs 13% $p=0.003$) and confusion (18% vs 11%, $p=0.001$) (online supplemental table 6). They reported worse; mobility (51% vs 29%), self-care (64% vs 40%), usual activities (57% vs 35%), pain or discomfort (40% vs 25%) anxiety or depression (49% vs 35%) on the EQ-5D-5L, and worse overall health (online supplemental table 7) than pre-COVID-19. Their MRC Dyspnoea Scale was also worse (61% vs 50%) and they had higher Dyspnoea 12 (9 vs 2) scores, PCL-5 (25 vs 7), with more classed as frail (12% vs 4%). Respondents were also more likely to have mild cognitive impairment (42% vs 34%) or moderate/severe impairment (4% vs 3%) according to the MoCA. Variables included in the final model chosen by cross-validation are detailed in online supplemental data 1.3.

Visit 2

Just under one in four identified as having communication issues ($n=399/1771$, 23%), they were more likely to have been admitted to ICU (42% vs 36%), and to report headache (33% vs 26%) or sore throat (20% vs 14%) as COVID-19 symptoms (online supplemental table 6). They had significantly worse outcomes, with the exception of MoCA where there did not appear to be a significant difference (online supplemental table 7). Variables included in the final model chosen by cross-validation are detailed in online supplemental data 1.4

Cognitive issues

Visit 1

Over two-thirds reported cognitive issues at visit 1 ($n=1598/2275$, 70%) and were more likely to have been female (44% vs 27%), white (78% vs 68%), not educated beyond secondary school level (32% vs 25%) to have been shielding (32% vs 24%), to have more comorbidities at baseline (online supplemental table 8) median: 2 vs 1, but with no difference in age (table 2). There were no significant difference in treatments, respiratory support, additional diagnoses, admission to ICU nor the overall length of stay between respondents who did or did not state they had cognitive issues except those with cognitive issues at visit 2 were more likely to have received NIV (6% vs 3%).

Respondents with cognitive issues were more likely to report worsening mobility (42% vs 16%), self-care (56% vs 23%), usual activities (49% vs 20%), pain or discomfort (35% vs 13%), anxiety or depression (46% vs 20%), overall health (65% vs 52%) and MRC Dyspnoea Scale (58% vs 37%) compared with pre-COVID-19. The Dyspnoea 12 overall score was significantly higher for respondents with cognitive issues (median: 5 vs 0), as was the PCL-5 summary score (median 14 vs 3). There were slightly more respondents with self-reported cognitive issues classified as having moderate or severe cognitive impairment on the MoCA (4% vs 2%) and were significantly more likely to have been deemed clinically frail at the follow-up visit (8% vs 2%). Variables included in the final model chosen by cross-validation are detailed in online supplemental data 1.5.

Visit 2

A similar proportion of respondents self-reported cognitive issues at visit 2 (1231/1768, 70%), more likely to be female (43% vs 26%), white (80% vs 71%), shielding (32% vs 25%) and to have come from a more deprived area (Q1 24% vs 19%) (table 2). Significantly more respondents with cognitive issues at visit 2 were treated via CPAP (29% vs 24%) and had longer length of stay (8 vs 7 days). As with respondents who identified as having cognitive issues at visit 1, worsening in mobility (38% vs 14%), self-care (53% vs 20%), usual activities (46% vs 18%), pain or discomfort (33% vs 13%) and anxiety or depression (44% vs 18%) and overall worsening in their health (67% vs 50%) were identified (online supplemental table 8). They were also more likely to have worsening in breathing according to the MRC Dyspnoea Scale (49% vs 23%) and Dyspnoea 12 (4 vs 0), and more respondents were classed as frail (7% vs 1%). Significantly fewer respondents were classified as having normal cognitive function according to the MoCA (68% vs 75%). Variables included in the final model chosen by cross-validation are detailed in online supplemental data 1.6.

DISCUSSION

This is the first large-scale prospective analysis of swallowing, communication, voice and cognitive function



following hospitalisation with COVID-19 in the UK, with prevalent and persistent compromise identified. These data raise important questions about management and potential rehabilitation requirements for those individuals with complex symptoms and their recovery.

Swallow compromise following an ICU stay was associated with variables inherently linked to increased illness severity and treatment burden, specifically proning and mechanical ventilation, rather than pre-existing factors such as sociodemographics or number of comorbidities. This is reported in critical illness data predating COVID-19 and may reflect iatrogenic impact of ventilation on the upper airway,^{7 21 35–37} reiterating the importance of identification of swallow and voice problems and their aetiology post-ICU admission, to facilitate differential diagnosis and rehabilitation to improve function and positively influence bed stay.³⁸ Patients with swallow/voice problems stayed in hospital over a week and 2 weeks longer than those without, respectively. They also had resultant frailty, poor mobility and worse quality of life scores.

Associations between swallow/voice symptoms and previous mental health problems were identified. Concurrent mental and physical health compromise are complex and costly for the individual, and for the economy if left untreated. Conservative estimates suggest³⁹ poor mental health costing the UK economy £74–94 billion a year as a result of lost output. Given our findings regarding associations with physiological symptoms and mental health, devising interventions where the whole person and their symptoms are supported and rehabilitated must be prioritised.⁴⁰ The ‘unknown illness’ of the pandemic, insufficient ‘medical spaces’⁴¹ and until now, under-recognised symptomatology described in this paper require urgent and collective attention from clinicians and commissioners to reduce physical, emotional and economic burden.

Nearly one in four participants reported communication issues at visits 1 and 2, with worse mobility, self-care, pain, anxiety or depression and overall health scores compared with pre-COVID-19. These people were more likely to be younger, female, health workers, from areas of social deprivation and have cognitive compromise. These are concerning conglomerate issues, with overt self-limiting realities regarding the ability to self-manage and seek support when cognition and communication skills are compromised. Early diagnosis and assessment may be challenged by this unusual profile or presentation for an individual reporting communication issues, so healthcare professionals may overlook this symptom in a clinical setting. The mechanism of injury, rehabilitation needs and recovery trajectory is not yet understood and future studies require detailed culturally appropriate assessments to fully uncover language pathology to determine appropriate, effective treatment interventions.

There are conflicting perspectives regarding associations between compromised cognition following COVID-19^{15 42} with severity of disease,^{43 44} severity of

respiratory compromise⁴⁵ and being female⁴⁶ reported as independent variables by some groups, with others not identifying these relationships.^{47 48} Methodological variation and limitations of existing outcome measures are important factors to consider when comparing findings, along with the novel nature of this disease, reiterating the importance of creating core datasets.⁴⁹ In our analysis, associations between worse self-reported cognition and social deprivation at visit 2 were identified. In the context of public health, social deprivation is linked to worse global health outcomes and mortality^{50 51} and is of practical importance when considering health literacy, access to health services and the individual’s ability to broadly navigate health systems to support their own recovery, perhaps without the appropriate tools or facilities.⁵² In context of the UK health system, finding solutions to these problems is challenged by conglomerate social and political drivers affecting identification, management and implementation of all health interventions. We offer suggestions from the insights generated in this analysis, while acknowledging the healthcare landscape and its realities.

Strengths and limitations

This analysis was not set-up as a formal prevalence study. There is acquisition bias in the cohort and therefore we can only report what is observed in the study rather than assuming this is representative of the wider population. We have not reported on incidence, the frequency or rate of occurrence of new self-reported functional compromise, as we sought to explore all cases reported in the time frame and their persistence over a specific time frame. Notwithstanding this limitation, it is the biggest study to date and therefore a rich dataset and a valuable observation. For the first time, we have been able to detail the prevalence of self-reported swallow, communication, voice and cognitive symptoms, defining associations and independent variables which may influence these outcomes. Triangulating these findings with intelligence around clinical provision will support understanding around how to design and commission services to support patients experiencing these issues.

Limitations include the following: only people admitted to ICU were asked to report on their swallowing and voice. We could therefore only report on this subgroup, and so are likely to be over-representing the prevalence but under-representing the total burden. In addition, lack of detail within the communication and swallow assessments means we are able to report on overall (self-reported) symptoms only. Direct laryngoscopy and assessment of swallow was not undertaken. We do not have the fine-grained information on swallow, or communication compromise required to identify what specific aspects of swallow, speech, language and/or communication have been impacted (and how), or if these were pre-existing and/or exacerbated. Data were collected over the first year post hospitalisation, but not beyond that point, so we

do not yet know how these symptoms progress or change over time. Similarly, some data points, such as BMI, were only collected at visit 1 so comparisons of index scores cannot be made between visits. Missing data, as described in the ‘Methods’ section, is an important limitation of this study.

CONCLUSION

This is the first study to explore prevalence of swallow, communication, voice and cognitive issues post hospitalisation with COVID-19. These data are fundamental to identify and understand the complex functional compromise people experienced, and to determine what future interventions are required to reduce the burden of these symptoms. The individuals with greatest functional compromise were frequently those who had been most acutely unwell, women, from areas of social deprivation. We recommend; ring-fenced research funding to identify mechanism of injury and rehabilitation requirements, culturally appropriate communication and swallowing assessments to help understand the impact on the individual rehabilitation required and trajectories of recovery and access to dedicated swallow, communication, voice and cognitive evaluation within long COVID clinics.

Swallow, voice, communication and cognition are the cornerstones of human interaction and existence. Their compromise following COVID-19 has significant and far-reaching potential impact on the individual, their communities and the economy. There is a time-specific opportunity to research these challenges, to provide practical approaches to help people improve these key functions.

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Contributors CD wrote the manuscript in collaboration with GC, FE, SW, AK, NS and SD. MC and AK conceptualised and formalised the data access. FE undertook the statistical analysis. DGW, CB, WM, SS, ED, JSa, MMcN, TC, MR, CEB, NJG, LVW, OCL, ARH, RMS, JKQ, L-PH, MM, JW, NH, NIL, RAE and HMcA all reviewed and provided updates and iterations to the drafting of the manuscript. CD is responsible for overall content as guarantor. The guarantor accepts full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish. The PHOSP collaboration all supported data collection.

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Supplementary data

1.1 Swallow problems

In addition to age and sex the following variables were included in the final model chosen by cross validation; South Asian ethnicity, Vocational level qualification, having depression or being previously treated by a mental health professional, reporting a COVID symptom of cough, sore throat or runny nose, being overweight, receiving class 6 respiratory support, or receiving anti-biotic therapy during the index admission

1.2 Voice problems

The following variables were selected via the lasso cross validation model; age at admission, sex, IMD quintiles 3 and 4, no or primary only education, depression, previous treatment by a mental health professional, asthma, bronchiectasis, GORD, CKD, infectious disease, recording a COVID symptom of sore throat, not answering the question about loss of taste, being previously on anti-infectives, ACEIs, NSAIDs or not recording NSAID usage, being obese, respiratory class 7-9, no answer as to whether the patient had systemic steroids, being prone, having RRT, a new diagnosis of myocarditis or cardiomyopathy

1.3 Communication problems

Along with age and sex the following variables were included in the final model selected by lasso; South Asian, IMD quintiles, 3,4 and 5, education to undergraduate level, depression, chronic fatigue syndrome, previous treatment by a mental health professional, asthma, liver disease, GORD, diabetes, hypertension, reporting of fever, sore throat and shortness of breath as COVID symptoms, either reporting confusion as a COVID symptom or not answering the question, receiving ACEI, NSAID and not answering the question about receiving antibiotic therapy

1.4 Communication problems visit 2

In addition to sex and age at admission the following variables were selected to be included in the final model; IMD quintile 2, education to secondary school level, sixth form level, undergraduate level, ischaemic heart disease, depression, previous treatment by a mental health professional, asthma, obesity hypoventilation syndrome, GORD, reporting of sore throat or confusion as a COVID symptom, either reporting fever as a COVID symptom or not answering the question, not answering the question about previously receiving immunosuppressants, receiving NSAID, receiving systemic steroids, and not answering the question about being treated via proning

1.5 Cognitive issues visit 1

The following variables were selected by the lasso regression; Black and South Asian ethnicity, primary level, vocational level, undergraduate and postgraduate level education, valvular heart disease, depression, previous treatment with an antibiotic and by a mental health professional, COPD, asthma, osteoarthritis, diabetes, cancer, severe obesity not answering whether sore throat was a COVID symptom, reporting headache as a COVID symptom, previous treatment with ABBS, and not answering whether the patient was prone.

1.6 Cognitive issues visit 2

The lasso model selected the following variables; all minority ethnic groups, IMD quintile 5 and not recorded, post-graduate level education and

unknown education level, valvular heart disease, TIA, depression, chronic fatigue, previous treatment using antidepressant and by a mental health professional, COPD, pleural effusion, osteoarthritis, liver disease, diabetes, hypertension, infectious disease, recording fever, cough or sore throat as a COVID symptom, either reporting shortness of breath as a COVID symptom or not answering the question, not responding to the question about immunosuppression, use of NSAID, being overweight or severely obese, respiratory support class 5 or 7-9, treated with antibiotic therapy, not responding to question about being treated via proning, and requiring RRT

Table 6 COVID symptoms and treatments pre- and during the index admission split by whether respondents have communication or cognitive issues at visit 1 or visit 2.

		V1 cognitive issues			V2 cognitive issues			V1 communication issues			V2 communication issues		
		No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value
COVID symptoms' duration	median (IQR)*	8 (6-11)	8 (6-11)	p=0.565	8 (6-11)	8 (6-11)	p=0.901	8 (6-11)	8 (6-11)	p=0.542	8 (6-11)	8 (5-11)	p=0.284
COVID symptoms	Fever	501 (78.3%)	1164 (77.3%)	p=0.633	405 (78.5%)	906 (78.6%)	p=0.967	1267 (76.5%)	398 (81.4%)	p=0.023	999 (77.6%)	315 (81.8%)	p=0.078
	Cough	542 (83.5%)	1255 (82.6%)	p=0.592	426 (82.7%)	965 (82.2%)	p=0.796	1389 (82.9%)	408 (82.8%)	p=0.952	1075 (81.9%)	319 (83.9%)	p=0.365
	Sore throat	63 (11.8%)	201 (15.7%)	p=0.028	57 (12.8%)	158 (16.3%)	p=0.086	184 (13.2%)	79 (19.0%)	p=0.003	151 (13.8%)	64 (20.2%)	p=0.005
	Runny nose	26 (4.9%)	88 (7.0%)	p=0.095	32 (7.3%)	59 (6.2%)	p=0.442	88 (6.3%)	26 (6.4%)	p=0.951	70 (6.4%)	21 (6.7%)	p=0.862
	Ear pain	6 (1.1%)	33 (2.6%)	p=0.045	6 (1.4%)	22 (2.3%)	p=0.274	26 (1.9%)	13 (3.2%)	p=0.101	20 (1.8%)	8 (2.6%)	p=0.421
	Fatigue	330 (57.7%)	847 (61.8%)	p=0.093	268 (58.4%)	655 (62.4%)	p=0.137	881 (58.8%)	296 (66.4%)	p=0.004	705 (60.5%)	221 (64.1%)	p=0.229
	Shortness of breath	533 (81.5%)	1315 (85.8%)	p=0.011	430 (83.2%)	1000 (84.9%)	p=0.370	1403 (83.4%)	444 (87.9%)	p=0.014	1104 (84.0%)	329 (85.7%)	p=0.431
	Loss of taste	124 (23.2%)	316 (24.8%)	p=0.464	100 (22.8%)	241 (24.9%)	p=0.397	331 (23.7%)	109 (26.5%)	p=0.243	259 (23.5%)	82 (26.9%)	p=0.222
	Loss of smell	109 (20.3%)	280 (22.0%)	p=0.417	92 (20.9%)	209 (21.7%)	p=0.751	297 (21.2%)	92 (22.5%)	p=0.575	233 (21.1%)	68 (22.4%)	p=0.615
	Headache	146 (25.9%)	388 (29.7%)	p=0.095	110 (24.2%)	288 (28.9%)	p=0.060	400 (27.7%)	134 (31.5%)	p=0.125	290 (25.7%)	108 (33.3%)	p=0.006
	Confusion	67 (11.6%)	181 (13.3%)	p=0.310	53 (11.5%)	153 (14.8%)	p=0.087	171 (11.3%)	77 (17.6%)	p=0.001	152 (13.1%)	54 (16.0%)	p=0.164
Pre-admission Medications	Immunosuppressant	58 (9.1%)	172 (11.6%)	p=0.092	47 (9.3%)	119 (10.5%)	p=0.450	173 (10.6%)	57 (11.8%)	p=0.465	129 (10.1%)	37 (10.3%)	p=0.933
	Anti-infectives	65 (10.4%)	200 (13.6%)	p=0.042	41 (8.2%)	162 (14.4%)	p<0.001	196 (12.1%)	68 (14.1%)	p=0.249	150 (11.8%)	55 (15.2%)	p=0.087
	ACEI	82 (13.0%)	228 (15.4%)	p=0.151	67 (13.3%)	173 (15.4%)	p=0.292	223 (13.7%)	87 (17.9%)	p=0.022	186 (14.6%)	54 (15.0%)	p=0.843
	ARBS	32 (5.1%)	122 (8.3%)	p=0.011	29 (5.8%)	86 (7.6%)	p=0.190	113 (7.0%)	41 (8.5%)	p=0.274	91 (7.2%)	24 (6.7%)	p=0.748
	NSAID	35 (5.7%)	140 (9.7%)	p=0.002	27 (5.5%)	105 (9.6%)	p=0.007	120 (7.6%)	55 (11.7%)	p=0.005	91 (7.4%)	41 (11.7%)	p=0.009
Respiratory support	Supplemental O2	561 (83.6%)	1309 (83.0%)	p=0.727	450 (84.7%)	1028 (85.1%)	p=0.849	1451 (84.1%)	420 (80.3%)	p=0.041	1158 (85.8%)	323 (82.4%)	p=0.099
	CPAP	154 (23.7%)	424 (27.7%)	p=0.055	121 (23.5%)	350 (29.5%)	p=0.012	449 (26.8%)	130 (25.7%)	p=0.629	354 (26.9%)	118 (30.4%)	p=0.174
	Bi-level NIV	18 (2.9%)	87 (5.8%)	p=0.004	17 (3.4%)	62 (5.3%)	p=0.087	74 (4.5%)	31 (6.2%)	p=0.129	62 (4.8%)	17 (4.5%)	p=0.810
	High Flow Nasal O2	138 (21.6%)	330 (21.7%)	p=0.933	108 (21.2%)	254 (21.7%)	p=0.800	361 (21.8%)	107 (21.4%)	p=0.864	284 (21.9%)	78 (20.4%)	p=0.531
	IMV	113 (17.0%)	278 (17.7%)	p=0.683	90 (17.0%)	231 (19.1%)	p=0.308	293 (17.0%)	98 (18.9%)	p=0.334	243 (18.0%)	79 (20.1%)	p=0.359
	ECMO	9 (1.4%)	22 (1.4%)	p=0.942	6 (1.2%)	13 (1.1%)	p=0.906	*	*	*	*	*	*
Highest respiratory level	WHO class 3-4	111 (16.4%)	270 (16.9%)	p=0.564	81 (15.1%)	180 (14.6%)	p=0.298	274 (15.7%)	103 (19.5%)	p=0.150	193 (14.1%)	68 (17.0%)	p=0.221
	WHO class 5	300 (44.3%)	665 (41.6%)		249 (46.4%)	518 (42.1%)		759 (43.4%)	206 (39.1%)		612 (44.6%)	157 (39.3%)	
	WHO class 6	143 (21.1%)	375 (23.5%)		116 (21.6%)	295 (24.0%)		400 (22.9%)	119 (22.6%)		317 (23.1%)	94 (23.6%)	
	WHO Class 7-9	123 (18.2%)	288 (18.0%)		91 (16.9%)	238 (19.3%)		312 (17.8%)	99 (18.8%)		250 (18.2%)	80 (20.1%)	
Treatments given	Antibiotic therapy	520 (78.5%)	1208 (77.7%)	p=0.642	401 (77.0%)	959 (79.9%)	p=0.177	1327 (78.2%)	398 (76.8%)	p=0.513	1063 (79.6%)	299 (76.9%)	p=0.250
	Systemic steroids	364 (55.9%)	908 (60.1%)	p=0.070	275 (53.5%)	681 (58.6%)	p=0.054	984 (59.2%)	289 (57.7%)	p=0.535	760 (58.3%)	198 (52.5%)	p=0.045
	Therapeutic dose anti-coagulation	298 (45.6%)	701 (46.4%)	p=0.736	237 (46.3%)	554 (47.7%)	p=0.590	757(45.6%)	242 (48.1%)	p=0.323	611 (47.1%)	180 (47.5%)	p=0.895
	Proning	131 (21.2%)	276 (19.5%)	p=0.406	100 (20.3%)	221 (20.5%)	p=0.907	305 (19.5%)	103 (22.1%)	p=0.229	249 (20.1%)	73 (21.8%)	p=0.504
	Renal Replacement Therapy	25 (3.8%)	72 (4.7%)	p=0.347	18 (3.5%)	55 (4.7%)	p=0.258	74 (4.4%)	23 (4.5%)	p=0.951	57 (4.4%)	16 (4.2%)	p=0.921
Other Diagnoses made during admission	PE/micro thrombi	76 (11.6%)	138 (9.0%)	p=0.064	58 (11.3%)	108 (9.2%)	p=0.169	169 (10.1%)	45 (8.9%)	p=0.445	135 (10.3%)	31 (8.1%)	p=0.202
	Renal failure requiring dialysis	19 (2.9%)	56(3.7%)	p=0.381	26 (5.0%)	43 (3.7%)	p=0.186	54 (3.2%)	21 (4.2%)	p=0.305	53 (4.0%)	16 (4.2%)	p=0.876
Admitted to ICU ²		219 (32.9%)	547 (34.9%)	p=0.365	190 (35.8%)	465 (38.3%)	p=0.337	570 (33.2%)	195 (37.6%)	p=0.063	490 (36.2%)	166 (42.0%)	p=0.037
Duration of Stay	Median(IQR)*	8 (4-14)	8 (4-16)	p=0.253	7 (4-14)	8 (4-17)	p=0.007	8 (4-16)	8 (4-17)	p=0.287	8 (4-16)	8 (4-18)	p=0.558

Unless otherwise specified numbers are shown as counts (percentages) and p-values have been calculated using Chi-squared test. ¹This is the duration in days of COVID symptoms for patients who had COVID prior to admission. ²This information is only available from Tier 2 respondents at either of the follow-up visits for patients who completed the PSQ. ³The denominators vary for most variables, the number of excluded records due to missing data are recorded in supplementary Table s1. *p-value calculated using Kruskal Wallis, p-values <0.05 are bolded. ACEI =Angiotensin-Converting Enzyme Inhibitors, ARBS = Angiotensin II Receptor Blockers, NSAID = Non-Steroidal Anti-Inflammatory Drugs , CPAP= Continuous Positive Airway Pressure, NIV =Non-Invasive Ventilation, ECMO = Extra Corporeal Membrane Oxygenation, WHO =World Health Organisation

Table 7 Outcomes reported during the same visit

		V1 cognitive issues			V2 cognitive issues			V1 communication issues			V2 communication issues		
		No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value
EQ-5D-5L													
Mobility	Improved	30 (6.1%)	98 (8.7%)		28 (6.7%)	92 (9.7%)		100 (8.0%)	28 (7.5%)		95 (8.9%)	25 (8.2%)	
	Stayed the Same	382 (78.3%)	562 (49.6%)	p<0.001	330 (79.3%)	493 (52.0%)	p<0.001	793 (63.5%)	152 (41.0%)	p<0.001	695 (65.4%)	129 (42.4%)	p<0.001
	Worsened	76 (15.6%)	472 (41.7%)		58 (13.9%)	363 (38.3%)		356 (28.5%)	191 (51.5%)		272 (25.6%)	150 (49.3%)	
Self-care ^	Improved	*	*		*	*		15 (1.2%)	7 (1.9%)		13 (1.2%)	7 (2.3%)	
	Stayed the Same	370 (76.0%)	480 (42.5%)	p<0.001	325 (78.3%)	430 (45.4%)	p<0.001	728 (58.4%)	126 (34.1%)	p<0.001	641 (60.4%)	116 (38.2%)	p<0.001
	Worsened	110 (22.6%)	630 (55.8%)		85 (20.5%)	500 (52.7%)		503 (40.4%)	237(64.1%)		704 (66.4%)	181 (59.5%)	
Usual Activities	Improved	21 (4.3%)	77 (6.8%)		19 (4.6%)	64 (6.7%)		72 (5.8%)	26 (7.0%)		63 (5.9%)	20 (6.6%)	
	Stayed the Same	367 (75.4%)	503 (44.5%)	p<0.001	320 (77.1%)	447 (47.1%)	p<0.001	737 (59.1%)	134 (36.1%)	p<0.001	648 (61.0%)	120(39.5%)	p<0.001
	Worsened	99 (20.3%)	551 (48.7%)		76 (18.3%)	438 (46.2%)		438 (35.1%)	211 (56.9%)		351 (33.1%)	164 (53.9%)	
Pain/Discomfort	Improved	94 (19.4%)	268 (23.7%)		88 (21.2%)	253 (26.7%)		287 (23.0%)	75 (20.3%)		272 (25.6%)	70 (23.0%)	
	Stayed the Same	329 (67.8%)	470 (41.6%)	p<0.001	275 (66.3%)	383 (40.4%)	p<0.001	654 (52.5%)	146 (39.5%)	p<0.001	548 (51.6%)	110 (36.2%)	p<0.001
	Worsened	62 (12.8%)	393 (34.8%)		52 (12.5%)	313 (33.0%)		305 (24.5%)	149 (40.3%)		242 (22.8%)	124 (40.8%)	
Anxiety /Depression	Improved	52 (10.6%)	179 (15.9%)		50 (12.0%)	139 (14.7%)		173 (13.9%)	58 (15.6%)		140 (13.2%)	49 (16.2%)	
	Stayed the Same	337 (68.9%)	432 (38.3%)	p<0.001	290 (69.9%)	389 (41.1%)	p<0.001	638 (51.2%)	132 (35.6%)	p<0.001	577 (54.4%)	104 (34.3%)	p<0.001
	Worsened	100 (20.4%)	518 (45.9%)		75 (18.1%)	419 (44.3%)		436 (35.0%)	181 (48.8%)		344 (32.4%)	150 (49.5%)	
Summary - How good or bad is your health overall?	Current - score ^x	80 (70-90)	70 (50-80)	p<0.001	85 (75-90)	70 (50-80)	p<0.001	79 (60-90)	60 (45-77)	p<0.001	80 (62-90)	60 (45-79)	p<0.001
	Improved	79 (17.1%)	165 (15.4%)		90 (22.7%)	165 (18.4%)		185 (15.7%)	59(16.7%)		204 (20.1%)	51 (18.0%)	
	Stayed the Same	144 (31.2%)	216 (20.1%)	p<0.001	107 (27.0%)	128 (14.2%)	p<0.001	315 (26.7%)	45 (12.7%)	p<0.001	206 (20.3%)	29 (10.2%)	p<0.001
	Worsened	239 (51.7%)	693 (64.6%)		199 (50.3%)	606 (67.4%)		682 (57.8%)	250 (70.6%)		603 (59.5%)	204 (71.8%)	
MRC Dyspnoea Scale	Improved	26 (10.9%)	47 (6.6%)		11 (11.8%)	27 (9.4%)		59 (8.5%)	14 (5.4%)		27 (8.9%)	11(14.5%)	
	Stayed the Same	124 (51.9%)	255 (35.6%)	p<0.001	61 (65.6%)	119 (41.5%)	p<0.001	291 (41.9%)	88 (33.7%)	p=0.006	158 (52.0%)	22 (28.9%)	p<0.001
	Worsened	88 (36.8%)	415 (57.9%)		21 (22.6%)	141 (49.1%)		344 (49.6%)	159 (60.9%)		119 (39.1%)	43 (56.6%)	
Dyspnoea 12 ^x	Overall score	0 (0-3)	5 (1-13)	p<0.001	0 (0-2)	4 (1-11)	p<0.001	2 (0-7)	9 (3-17)	p<0.001	1 (0-6)	7 (2-17)	p<0.001
	Physical domain	0 (0-2)	4 (1-9)	p<0.001	0 (0-1)	4 (1-8)	p<0.001	2 (0-6)	6 (2-11)	p<0.001	1 (0-5)	6 (2-11)	p<0.001
	Affective domain	0 (0-0)	0 (0-4)	p<0.001	0 (0-0)	0 (0-3)	p<0.001	0 (0-1)	2 (0-6)	p<0.001	0 (0-1)	1 (0-6)	p<0.001
PCL-5	Overall score ^x	3 (0-8)	14 (5-30)	p<0.001	1 (0-5)	12 (4-28)	p<0.001	7 (2-17)	25 (12-43)	p<0.001	5 (1-14)	23 (9-43)	p<0.001
	Overall Score >32	23 (4.9%)	332 (22.0%)	p<0.001	11 (3.2%)	222 (19.5%)	p<0.001	167 (11.5%)	188 (36.1%)	p<0.001	101 (9.2%)	132 (34.3%)	p<0.001
MOCA ¹	Overall Score ^x	27 (24-28)	26 (24-28)	p=0.014	28 (25-29)	27 (25-28)	p<0.001	26 (24-28)	26 (23-28)	p<0.001	27 (25-29)	27 (24.5-28)	p=0.016
	Normal function	329 (63.9%)	768 (59.8%)		317 (74.8%)	667 (67.5%)		873 (63.2%)	225 (53.8%)		762 (70.4%)	223 (67.2%)	
	Mild impairment	177 (34.4%)	470 (36.6%)	p=0.062	97 (22.9%)	295 (29.9%)	p=0.023	471 (34.1%)	175 (41.9%)	p=0.002	295 (27.2%)	99 (29.8%)	p=0.509
	Moderate/severe impairment	9 (1.7%)	46 (3.6%)		10 (2.4%)	26 (2.6%)		37 (2.7%)	18 (4.3%)		26 (2.5%)	10 (3.0%)	
RCF ²	Frail	11 (1.8%)	115 (8.0%)	p<0.001	7 (1.5%)	77 (6.9%)	p<0.001	69 (4.4%)	57 (12.2%)	p<0.001	43 (3.5%)	41 (11.4%)	p<0.001

Outcomes taken from the same visit as reported visit or swallow problems. Unless otherwise specified numbers are reported as count (percentage) and p-values are the result of a Chi-square test. p-values <0.05 are bolded. ^x are shown as median (IQR) and Kruskal Wallis test is used. ¹Normal cognitive function score > 25, mild cognitive impairment score 18-25, moderate or

severe cognitive impairment score < 18 ² Frail defined as RCF ≥ 5 ^a The denominators vary for most variables, the number of excluded records due to missing data are recorded in supplementary Table s2

Table 8 Co-morbidities listed at time of initial COVID admission split by whether respondents have communication or cognitive issues at visit 1 or visit 2.

	Visit 1 cognitive issues			Visit 2 cognitive issues			Visit 1 communication issues			Visit 2 communication issues		
	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value
n (%)	677 (29.8%)	1598 (70.2%)		537(30.4%)	1231 (69.6%)		1748 (76.8%)	527 (23.2%)		1372 (77.5%)	399 (22.5%)	
Myocardial Infarction	28 (4.1%)	78 (4.9%)	p=0.793	19 (3.5%)	62 (5.0%)	p=0.166	72 (4.1%)	26 (4.9%)	p=0.419	63 (4.6%)	18 (4.5%)	p=0.946
Ischaemic Heart Disease	37 (5.5%)	115 (7.2%)	p=0.131	28 (5.2%)	87 (7.1%)	p=0.146	113 (6.5%)	39 (7.4%)	p=0.451	84 (6.1%)	31 (7.8%)	p=0.240
Atrial Fibrillation	27 (4.0%)	81 (5.1%)	p=0.268	26 (4.8%)	64 (5.2%)	p=0.753	78 (4.5%)	30 (5.7%)	p=0.244	71 (5.2%)	19 (4.8%)	p=0.741
Hypertension	235 (34.7%)	554 (34.7%)	p=0.984	172 (32.0%)	466 (37.9%)	p=0.019	600 (34.3%)	189 (35.9%)	p=0.515	502 (36.6%)	137 (34.3%)	p=0.409
Congestive Heart Failure	6 (0.9%)	40 (2.5%)	p=0.012	9 (1.7%)	28 (2.3%)	p=0.419	31 (1.8%)	16 (3.0%)	p=0.074	27 (2.0%)	10 (2.5%)	p=0.508
Valvular Heart Disease	15 (2.2%)	18 (1.1%)	p=0.047	*	*	*	27 (1.5%)	6 (1.1%)	p=0.494	12 (0.9%)	9 (2.3%)	p=0.025
Pacemaker/Implantable defibrillator	6 (0.9%)	16 (1.0%)	p=0.798	*	*	*	13 (0.7%)	9 (1.7%)	p=0.047	*	*	*
Peripheral vascular disease	*	*	p=0.078	*	*	*	25 (1.4%)	7 (1.3%)	p=0.862	19 (1.4%)	7 (1.8%)	p=0.589
Hypercholesterolemia/dyslipidaemia	120 (17.7%)	341 (21.3%)	p=0.050	108 (20.1%)	254 (20.6%)	p=0.803	339 (19.4%)	122 (23.1%)	p=0.060	284 (20.7%)	78 (19.5%)	p=0.616
CVA/TIA	26 (3.8%)	78 (4.9%)	p=0.277	19 (3.5%)	56 (4.5%)	p=0.332	71 (4.1%)	33 (6.3%)	p=0.034	52 (3.8%)	23 (5.8%)	p=0.085
Depression or Anxiety	44 (6.5%)	342 (21.4%)	p<0.001	47 (8.8%)	237 (19.3%)	p<0.001	227 (13.0%)	159 (30.2%)	p<0.001	181 (13.2%)	104 (26.1%)	p<0.001
Chronic Fatigue Syndrome, Fibromyalgia, Chronic Pain	20 (3.0%)	127 (7.9%)	p<0.001	13 (2.4%)	90 (7.3%)	p<0.001	88 (5.0%)	59 (11.2%)	p<0.001	62 (4.5%)	41 (10.3%)	p<0.001
Any previous Treatment with Antidepressant Medication	25 (3.7%)	257 (16.1%)	p<0.001	27 (5.0%)	180 (14.6%)	p<0.001	168 (9.6%)	114 (21.6%)	p<0.001	134 (9.8%)	73 (18.3%)	p<0.001
Any previous Treatment by a Mental Health Professional	14 (2.1%)	125 (7.8%)	p<0.001	16 (3.0%)	76 (6.2%)	p=0.005	77 (4.4%)	62 (11.8%)	p<0.001	53 (3.9%)	39 (9.8%)	p<0.001
COPD	25 (3.7%)	103 (6.4%)	p=0.009	15 (2.8%)	83 (6.7%)	p=0.001	93 (5.3%)	35 (6.6%)	p=0.249	79 (5.8%)	20 (5.0%)	p=0.568
Asthma	73 (10.8%)	335 (21.0%)	p<0.001	75 (14.0%)	230 (18.7%)	p=0.016	280 (16.0%)	128 (24.3%)	p<0.001	211 (15.4%)	94 (23.6%)	p<0.001
Obstructive Sleep Apnoea	24 (3.5%)	95 (5.9%)	p=0.019	18 (3.4%)	73 (5.9%)	p=0.024	88 (5.0%)	31 (5.9%)	p=0.443	60 (4.4%)	31 (7.8%)	p=0.007
ILD/Bronchiectasis/Obesity Hypoventilation Syndrome/Pleural Effusion	20 (3.0%)	47 (2.9%)	p=0.987	15 (2.8%)	42 (3.4%)	p=0.498	52 (3.0%)	15 (2.8%)	p=0.878	44 (3.2%)	13 (3.3%)	p=0.959
Connective Tissue Disease	*	*	*	*	*	*	10 (0.6%)	9 (1.7%)	p=0.012	7 (0.5%)	6 (1.5%)	p=0.041
Rheumatoid Arthritis	11 (1.6%)	53 (3.3%)	p=0.026	10 (1.9%)	39 (3.2%)	p=0.124	49 (2.8%)	15 (2.8%)	p=0.958	36 (2.6%)	13 (3.3%)	p=0.497
Osteoarthritis	48 (7.1%)	188 (11.8%)	p=0.001	42 (7.8%)	142 (11.5%)	p=0.019	172 (9.8%)	64 (12.1%)	p=0.128	134 (9.8%)	50 (12.5%)	p=0.111
Peptic Ulcer Disease	8 (1.2%)	24 (1.5%)	p=0.553	*	*	*	26 (1.5%)	6 (1.1%)	p=0.551	*	*	*
Liver Disease	21 (3.1%)	77 (4.8%)	p=0.065	16 (3.0%)	62 (5.0%)	p=0.053	59 (3.4%)	39 (7.4%)	p<0.001	55 (4.0%)	23 (5.8%)	p=0.133
Gastro-Oesophageal Reflux Disease	54 (8.0%)	199 (12.5%)	p=0.002	43 (8.0%)	139 (11.3%)	p=0.037	170 (9.7%)	83 (15.7%)	p<0.001	131 (9.5%)	51 (12.8%)	p=0.061
Inflammatory Bowel Disease	12 (1.8%)	26 (1.6%)	p=0.804	9 (1.7%)	21 (1.7%)	p=0.964	30 (1.7%)	8 (1.5%)	p=0.756	22 (1.6%)	8 (2.0%)	p=0.584
Irritable Bowel Syndrome	8 (1.2%)	56 (3.5%)	p=0.002	8 (1.5%)	39 (3.2%)	p=0.044	38 (2.2%)	26 (4.9%)	p=0.001	33 (2.4%)	14 (3.5%)	p=0.277
Diabetes	121 (17.9%)	354 (22.2%)	p=0.022	87 (16.2%)	287 (23.3%)	p=0.001	346 (19.8%)	129 (24.5%)	p=0.020	283 (20.6%)	91 (22.8%)	p=0.348
Hypothyroidism	25 (3.7%)	103 (6.4%)	p=0.009	21 (3.9%)	75 (6.1%)	p=0.063	90 (5.1%)	38 (7.2%)	p=0.072	71 (5.2%)	25 (6.3%)	p=0.397

Hyperthyroidism	7 (1.0%)	16 (1.0%)	p=0.943	8 (1.5%)	10 (0.8%)	p=0.192	15 (0.9%)	8 (1.5%)	p=0.184	*	*	*
Chronic Kidney Disease (Any Stage)	29 (4.3%)	84 (5.3%)	p=0.329	22 (4.1%)	61 (5.0%)	p=0.433	85 (4.9%)	28 (5.3%)	p=0.677	63 (4.6%)	20 (5.0%)	p=0.726
Cancer	58 (8.6%)	106 (6.6%)	p=0.103	41 (7.6%)	101 (8.2%)	p=0.685	135 (7.7%)	29 (5.5%)	p=0.084	108 (7.9%)	35 (8.8%)	p=0.561
Infectious Disease	16 (2.4%)	37 (2.3%)	p=0.945	15 (2.8%)	25(2.0%)	p=0.321	43 (2.5%)	10 (1.9%)	p=0.453	34 (2.5%)	6 (1.5%)	p=0.249
Number of co-morbidities – Median (IQR)	1 (0-3)	2 (1-3)	p<0.001	1 (0-2)	2 (1-3)	p<0.001	2 (1-3)	2 (1-4)	p<0.001	2 (1-3)	2 (1-4)	p=0.003

Unless otherwise specified numbers are shown as counts (percentages) and p-values have been calculated using Chi-squared test. * numbers ≤5 have been suppressed, p-values <0.05 are bolded.

Supplementary Table S1- Number of respondents who did not answer questions on Symptoms, previous treatments or events during index admissions

	ICU Swallow		ICU Voice		Cognitive issues – V1		Cognitive issues – V2		Communication issues – V1		Communication issue – V2s	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N	767	188	627	319	677	1598	537	1231	1748	527	1372	399
Symptom Duration	91	28	67	50	75	174	64	118	194	55	143	39
Fever	52	19	33	37	37	93	21	79	92	38	85	14
Cough	51	22	33	40	28	79	22	57	73	34	60	19
Sore throat	184	48	133	93	141	321	92	264	352	112	274	82
Runny nose	181	51	130	96	144	340	96	275	361	122	284	87
Shortness of breath	45	17	35	28	23	66	20	53	66	22	58	15
Loss of taste	207	50	144	107	143	326	99	265	354	116	270	94
Loss of smell	203	53	145	105	140	328	97	267	349	118	268	96
Headache	170	50	123	92	114	293	82	236	306	102	242	75
Confusion	141	40	100	76	98	234	75	196	241	89	208	62
Immunosuppressant	90	29	63	55	42	118	33	103	116	43	98	39
Anti-infectives	85	32	62	56	49	124	38	105	129	44	106	38
ACEI	89	26	61	53	47	121	35	104	125	42	100	40
ABBS	92	28	64	55	51	125	39	104	132	43	104	40
NSAID	103	34	71	65	60	161	47	134	165	55	134	48
Supplemental O2	*	*	9	10	6	20	6	23	*	*	22	7
Continuous Positive Airway Pressure	50	16	31	35	27	65	23	44	71	21	56	11
Bi-level Non-Invasive Ventilation	80	24	58	45	46	89	34	66	109	26	79	21
High Flow Nasal O2	72	25	48	48	37	79	27	63	89	27	73	17
Invasive Mechanical Ventilation	*	*	7	9	11	25	8	20	28	8	*	*
Extra-Corporeal Membrane Oxygenation*	42	14	26	29	24	45	19	42	55	15	50	10
Antibiotic therapy	31	7	23	15	15	44	16	30	50	9	36	10
Systemic (oral or IV) steroids	66	24	46	43	26	86	23	68	86	26	69	22
Therapeutic dose anti-coagulation	61	23	45	39	24	88	25	70	88	24	75	20
Proning	97	35	71	60	58	186	44	155	184	60	135	64
Renal Replacement Therapy	58	20	38	40	21	71	21	63	77	15	62	22
Pulmonary embolism/micro thrombi	43	16	28	31	23	73	25	53	73	23	61	17
Renal failure requiring dialysis	44	18	31	31	25	68	21	56	68	23	57	20
ITU admission	N/a	N/a	N/a	N/a	11	30	7	16	32	9	*	*

*Numbers less than 5 have been suppressed, where values suppressed could be calculated from other values (including those cross-referenced to other tables), other values have been rounded to the nearest 5

Supplementary Table S2- Number of respondents who did not answer questions on outcomes at the follow-up research visits

	ICU Swallow – v1		ICU Swallow – v2		ICU Voice – v1		ICU Voice – v2		Communication issues – V1		Cognitive issues- V2		Communication issue – V2s	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N	767	188	767	188	627	319	627	319	677	1598	1748	527	537	1231
Mobility	257	49	315	79	219	85	276	112	189	466	500	156	121	283
Self-care	257	49	246	59	218	86	275	112	190	470	502	157	120	285
Usual Activities	257	49	246	59	218	86	275	112	190	467	502	156	122	282

Pain/Discomfort	258	49	246	59	219	86	275	112	192	469	503	157	122	283
Anxiety/Depression	258	49	247	59	218	87	275	113	188	470	503	156	122	285
Summary	274	57	262	67	230	99	288	123	215	526	568	173	141	332
MRC Dyspnoea Scale	516	105	676	151	432	184	554	262	438	881	1054	266	444	944
Dyspnoea 12	101	20	225	59	92	13	89	74	45	166	156	57	40	115
PCL-5	98	8	216	56	88	28	89	75	207	92	294	6	192	93
MOCA	201	43	286	66	165	79	241	104	162	314	367	109	113	243
RCF	111	31	197	50	99	52	175	66	80	169	189	60	55	112