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Associations between COVID-19 Severity, Cognitive Impairment, and Quality of Life in Individuals in Need of Care: Results from the Multicentre Registry Study BaCoM

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Keywords
COVID-19 · Individuals in need of care · Nursing home residents · Cognitive impairment · Quality of life

Abstract

Introduction: Older adults in need of care are at high risk for severe COVID-19 and cognitive impairment. This study investigates the association between COVID-19 severity, quality of life, and cognitive impairment in individuals requiring care. ***Methods:*** Data from 531 participants (68.4% female; n = 363; median age = 82.0 years, interquartile range = 13.0) of the Bavarian ambulatory COVID-19 Monitor (BaCoM) – all of whom were in need of care and had a prior SARS-CoV-2 infection – were analysed. We compared sociodemographic and health-related characteristics, cognitive performance, COVID-19 disease features, and quality of life between 80 individuals hospitalized for COVID-19 and 451 individuals who were infected but not hospitalized. Associations between cognitive impairment and COVID-19 severity were examined using binary logistic regressions with the MoCA Blind and Six-Item Screener as dependent variables. The association between quality of life and COVID-19 severity was analysed using multiple linear regression with the EQ VAS as the dependent variable. ***Results:*** Hospitalized individuals had significantly lower MoCA Blind scores than non-hospitalized peers (17.0 vs. 19.0, p = 0.039), while SIS scores

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showed no difference. EQ VAS scores were similar between the groups, but hospitalized individuals had lower EQ-5D-5L Index scores (0.57 vs. 0.75, p = 0.004). COVID-19 severity (hospitalization, symptom duration) was not associated with MoCA Blind <18 or with the EQ VAS. ***Conclusion:*** The study found lower MoCA-Blind scores and reduced quality of life in hospitalized individuals, but adjusted analyses showed no significant link between COVID-19 severity and cognition or quality of life.

Introduction

As of November 2025, over 7 million COVID-19-related deaths have been reported worldwide, with older adults and individuals in need of care being disproportionately affected [1–3]. Individuals in need of care are those who require assistance with basic activities of daily living due to age, chronic illness, or disability. By 2050, approximately one in ten people in Germany is expected to require care [4], with similar trends emerging globally [5]. People in need of care – whether in nursing homes or outpatient settings – face an elevated risk of SARS-CoV-2 infection [6]. High transmission rates within care facilities [7], shared communal spaces [8], and frequent close contact with multiple caregivers increase exposure, while difficulties adhering to hygiene and distancing measures may further heighten infection risk [9]. Furthermore, access to medical care was not consistently ensured during the pandemic, as many countries reported declines in in-person primary care visits [10]. In contrast, visits related to anxiety and depression increased in several countries during the pandemic and often remained elevated into the recovery period [11]. As SARS-CoV-2 continues to circulate worldwide [12], these factors underscore the importance of examining its effects in this vulnerable population. Older adults not only have a greater likelihood of severe disease progression but also face increased risk of long-term complications. Approximately 80% of hospitalized COVID-19 cases involve individuals aged 65 and older, with multimorbidity, polypharmacy, immunosenescence and frailty contributing to disease severity [13, 14]. Neurological symptoms, such as fatigue, myalgia, headache, dizziness, smell and taste impairment, confusion, and delirium, may occur in mild cases [15] but are reported more frequently in individuals with severe infections and those requiring hospitalization [16].

While previous research has examined the cognitive consequences of SARS-CoV-2 infection in older adults [6, 17, 18], little is known about how COVID-19 severity affects cognition and quality of life in individuals requiring care. Moreover, the prevalence and impact of long-COVID (symptoms persisting beyond 4 weeks) and post-COVID syndrome (persisting beyond 12 weeks without an alternative diagnosis) [19] in this population remain unclear.

To address these knowledge gaps, this study examines the associations between COVID-19 severity, quality of life, and cognitive impairment in people in need of care. Specifically, we investigated (1) whether sociodemographic and health-related characteristics, quality of life, cognition, and COVID-19-related variables differ between care-dependent individuals who were hospitalized due to COVID-19 and those who were not; (2) whether the severity of SARS-CoV-2 infection is associated with cognition and quality of life in people requiring care.

Materials and Methods

Study Design

The "Bavarian Outpatient COVID-19 Monitor (BaCoM)" was a multicenter, cross-sectional study conducted in Bavaria over a period of 2.5 years. It consisted of three groups: study group (individuals in need of care, SARS-CoV-2 positive), control group 1 (individuals in need of care, SARS-CoV-2 negative) and control group 2 (independent living individuals, SARS-CoV-2 positive) [20]. In the present analysis, only data from individuals in need of care with a history of SARS-CoV-2 infection (N = 531) were included. The study was registered with the German Clinical Trials Register (DRKS ID: DRKS00026039). Sample size calculation and stratification were published in [20].

Data Collection

Trained study staff conducted data collection for the BaCoM study by visiting the study participants at home or in the care facilities. This comprehensive process included semi-structured interviews (gathering information on participants' sociodemographic, health-related and COVID-19-related data as well as cognitive status, and quality of life), blood sample collection, and recording vital data [20]. Baseline data were obtained from people in need of care who had a prior SARS-CoV-2 infection.

Inclusion/Exclusion Criteria

Individuals in need of care were included in the study if they met the following criteria: aged ≥18, provided signed informed consent (by themselves or a legal guardian), sufficient German proficiency or access to a

translator, resided in Bavaria, confirmed prior SARS-CoV-2 infection, either PCR-confirmed, or, for rapid antigen test results, confirmation via nucleocapsid antibody testing [20]. Need for care was defined as individuals receiving assistance according to care levels I–V or having a score of ≥5 on the Clinical Frailty Scale [21]. Exclusion criteria included refugees/asylum seekers, individuals with an estimated life expectancy of less than 6 months, and those lacking health insurance [20].

Sociodemographic and Health-Related Data

Sociodemographic data included sex, age, Barthel Index [22], care level, type of care facility, living situation, and education level. Educational level was categorized according to the Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) classification [23]. Health-related data included BMI, NRS, Generalized Anxiety Disorder 7-item (GAD-7) score, and Patient Health Questionnaire-9 (PHQ-9). The numerical rating scale is an eleven-point scale used to measure current pain intensity. A score of 0 corresponds to no pain, while a score of 10 corresponds to the most severe pain imaginable [24]. The GAD-7 is a screening tool consisting of seven questions used to identify generalized anxiety disorder [25]. Scores range from 0 to 21, assessing the severity of anxiety symptoms based on their frequency. Scores of 5 or higher indicate mild anxiety, 10 or higher indicate moderate anxiety, and 15 or higher indicate severe anxiety symptoms [26]. The PHQ-9 is a tool designed to assess depressive disorders, consisting of nine questions that evaluate the frequency of depressive symptoms over the past 2 weeks. Scores on the PHQ-9 range from 0 to 27, with a score of 10 or higher indicating mild depression, 15 or higher indicating moderate depression, and 20 or higher suggesting severe depression [27].

Cognition and Quality of Life

The Six-Item Screener (SIS) and the Montreal Cognitive Assessment Blind (MoCA-Blind) were used to assess cognitive status in the study population. The SIS measures cognitive impairment relevant to everyday life by testing memory and temporal orientation, with scores ranging from 0 to 6 [28]. A score below 4 indicates cognitive impairment relevant to everyday life, with a sensitivity of 88.7% and a specificity of 88.0%, using the clinical diagnosis of dementia as the reference standard [29]. Participants scoring <4 points were assessed through proxy interviews with caregivers or relatives [20]. For those scoring ≥4 on the SIS, the MoCA Blind was administered to evaluate mild cognitive impairment (MCI). This adapted version of the MoCA, designed for individuals without visual abilities, evaluates memory, attention, language, abstraction, recall, and orientation. The scoring ranges from 0 to 22, with a cut-off score below 18 points indicating MCI. This cutoff yields a sensitivity of 63% and a specificity of 98% [30]. The European Quality of Life 5 Dimensions 5 Level Version (EQ-5D-5L) is a widely used patient-reported outcomes questionnaire designed to assess health-related quality of life [31]. It covers five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, each rated on five levels. Responses generate a five-digit score (e.g., 11,323), which is converted into a one-dimensional index value (e.g., 0.61), with lower values indicating poorer health-related quality of life. Index values can be negative, and the calculation formula is country-specific to account for socio-cultural differences [32]. The EuroQol Visual Analog Scale (EQ VAS), a visual analogue scale from 0 to 100, is part of the EQ-5D-5L and allows subjective self-assessment of health and quality of life [33].

COVID-19-Related Data

Study participants were asked if they had experienced symptoms during their SARS-CoV-2 infection. If symptoms had been present, the COVID-19 course was classified as symptomatic, allowing for an assessment of symptom duration. Symptom duration was categorized into three groups: "acute COVID-19 infection" (symptoms up to 4 weeks), "Long COVID" (symptom duration for 4 weeks and longer), and "post-COVID syndrome" (symptoms lasting over 12 weeks, with no alternative diagnosis) [19]. Participants were divided into two groups: those who were hospitalized (regular ward or ICU) and those who were not.

Statistical Analysis

Metric variables underwent testing using histograms and the Shapiro-Wilk test to assess normal distribution. Analysis revealed that the data did not follow normal distribution.

To characterize the study population, categorical variables were presented using absolute and relative frequencies, while the not normal distributed metric variables were summarized using the median and interquartile range (IQR).

Since the metric variables were not normally distributed, statistically significant group differences between the hospitalized and non-hospitalized group were assessed using the Mann-Whitney U test for metric variables and the chi-square test for categorical variables.

To examine the relationship between COVID-19 severity and cognition, binary logistic regressions were performed. COVID-19 severity was measured using hospitalization status and symptom duration. The dependent variables were the SIS for "cognitively impaired relevant to everyday life" and the MoCA Blind for MCI. To assess the association between COVID-19 severity and quality of life, a multiple linear regression was conducted with the EQ VAS as the dependent variable. For all regressions sociodemographic and health-related factors were included as independent variables to adjust for potential confounders, selected based on clinical relevance. Care levels 4 and 5 were combined due to the small sample size for care level 5 ($n < 25$). Due to the limited number of variables, the enter method was used for regression models.

The binary logistic models included continuous variables (BMI, PHQ-9, COVID-19 symptom duration) and categorical variables (sex, age-groups, living situation, education level, care level, and COVID-19 hospitalization status). The multiple linear regression model included continuous variables (age, education level, care level, NRS, BMI, PHQ-9, SIS, COVID-19 symptom duration) and categorical variables (sex, living situation, COVID-19 hospitalization status). Sociodemographic and health-related data were incorporated into the regression models to adjust for potential confounders. The selection of these variables was based on their clinical relevance. A two-sided p value <0.05 was considered statistically significant for all tests. The statistical analysis of the data was performed using the statistical software SPSS (SPSS, IBM, Version 29).

Results

Sociodemographic Data of the Study Population

Of 531 included participants in need of care and infected with SARS-CoV-2, 80 were hospitalized due to COVID-19 while 451 were infected but not hospitalized. Sociodemographic data of the study population is shown in Table 1. The median age was 82.0 years (IQR: 13.0), and 68.4% ($n = 363$) were female, with no significant differences in age or sex between the hospitalized and non-hospitalized groups. Overall, 66.5% ($n = 353$) of participants had a care level, while 33.5% ($n = 178$) had a frailty score between ≥5 and <9 according to the Clinical Frailty Scale [34]. Most participants (55.4%) were living in inpatient care (nursing homes), while 44.6% received outpatient care from relatives or nursing services. Hospitalized individuals were more likely to come from outpatient care (60.3% vs. 41.6%; $p = 0.003$). Additionally, 70.6% ($n = 369$) lived alone, but those hospitalized were more likely to live with a partner (45.0% vs. 26.6%; $p < 0.001$). Educational levels showed that 53.4% ($n = 274$) had a low level according to CASMIN classification, 26.9% ($n = 138$) had a medium level, and 19.7% ($n = 101$) had a high level of education, with hospitalized individuals tending to have lower educational levels than non-hospitalized participants (low education level: 65.8% vs. 51.3%, $p = 0.010$).

Health-Related Data of the Study Population

The median BMI of the study population was 26.2 kg/m^2 (IQR: 7.2), classifying most participants as overweight (≥25 kg/m^2). Hospitalized people in need of care had a higher median BMI than non-hospitalized people in need of care (27.0 kg/m^2 [IQR: 7.7] vs. 26.2 kg/m^2 [IQR: 6.9], $p = 0.030$), with a greater proportion of obesity in the hospitalized group (35.4% vs. 23.9%, $p = 0.023$).

The median GAD score was 2.0 (IQR: 4.0), with 9.3% of participants showing moderate to severe anxiety. Moderate and severe anxiety were more common among hospitalized individuals ($p = 0.002$). The median PHQ-9 score for depression was 4.0 (IQR: 6.0), below the threshold for mild depressive disorder, but hospitalized individuals had higher scores (median 6.0 vs. 4.0, $p = 0.028$). Pain intensity, measured by the Numerical Rating Scale (NRS), had a median score of 2.0 (IQR: 5.0), with no significant difference between hospitalized and non-hospitalized groups ($p = 0.819$). Health-related data is detailed in Table 1.

COVID-19-Related Data of the Study Population

Of the 531 individuals, the vaccination status was known for 474. Among them, 444 (93.7%) had received at least one COVID-19 vaccine dose. A significant difference was found between hospitalized and non-hospitalized individuals, with hospitalized participants being less likely to be vaccinated (83.3% vs. 95.5%, $p < 0.001$). 79.2% ($n = 411$) of participants experienced symptomatic COVID-19, while 20.8% were asymptomatic, exclusively among the non-hospitalized group. Among the 80 hospitalized participants, 73.8% were treated in regular wards, and 26.2% required intensive care.

The median duration of COVID-19 symptoms was 6 weeks (IQR: 29.7), with hospitalized individuals having significantly longer symptom duration (19.3 weeks vs. 4.0 weeks, $p < 0.001$).) Acute COVID-19 was present in 35.3% ($n = 156$), 40.3% ($n = 178$) met criteria for long

Table 1. Sociodemographic and health characteristics of the study population

	Total, *n* = 531	Not hospitalized, *n* = 451	Hospitalized, *n* = 80	*p* value
Sex, *n* (%)				
Female	363 (68.5)	313 (69.4)	50 (62.5)	0.211
Male	167 (31.5)	137 (30.4)	30 (37.5)	
Age				
Median (IQR)	82.0 (13.0)	83.0 (13.0)	81.0 (13.8)	0.315
Age grouped, *n* (%)				0.291
<60 years	37 (7.1)	32 (7.3)	5 (6.3)	
60–69 years	50 (9.6)	43 (9.8)	7 (8.8)	
70–79 years	109 (20.9)	87 (19.7)	22 (27.5)	
80–89 years	246 (47.2)	208 (47.2)	38 (47.5)	
>90 years	79 (15.2)	71 (16.1)	8 (10.0)	
Barthel Index				0.056
Median (IQR)	85.0 (30.0)	85.0 (31.3)	80.0 (40.0)	
Care level, *n* (%)				
Frailty ≥5 and <9 points	178 (33.5)	161 (35.7)	17 (21.3)	**0.044**
1	42 (7.9)	36 (9.0)	6 (7.5)	
2	111 (20.9)	89 (19.7)	22 (27.5)	
3	134 (25.2)	109 (24.2)	25 (31.3)	
4 and 5	66 (12.4)	56 (12.4)	10 (12.5)	
Type of care facility, *n* (%)				
Inpatient care	252 (55.4)	223 (58.4)	29 (39.7)	**0.003**
Outpatient care	203 (44.6)	159 (41.6)	44 (60.3)	
Living situation, *n* (%)				<**0.001**
Living alone	369 (70.6)	325 (73.4)	44 (55.0)	
Living with partner	154 (29.4)	118 (26.6)	36 (45.0)	
Education level, *n* (%)				
Low	274 (53.4)	224 (51.3)	50 (65.8)	**0.010**
Middle	138 (26.9)	120 (27.5)	18 (23.7)	
High	101 (19.7)	93 (21.3)	8 (10.5)	
BMI, kg/m^2	26.2 (7.2)	26.2 (6.9)	27.0 (7.7)	**0.030**
Median (IQR)				
BMI grouped, *n* (%)				**0.023**
Underweight	12 (2.4)	12 (2.9)	0 (0.0)	
Normal weight	178 (36.1)	154 (37.2	24 (30.4)	
Overweight	176 (35.7)	149 (36.0)	27 (34.2)	
Obese	127 (25.8)	99 (23.9)	28 (35.4)	
GAD-7 Score				0.074
Median (IQR)	2.0 (4.0)	1.0 (4.0)	2.0 (6.0)	
Anxiety symptoms – GAD-7, *n* (%)				**0.002**
Minimal	368 (75.6)	322 (78.2)	46 (61.3	
Mild	74 (15.2)	55 (13.3)	19 (25.3)	
Moderate	31 (6.4)	26 (6.3)	5 (6.7)	
Severe	14 (2.9)	9 (2.2)	5 (6.7)	
Depression symptoms – PHQ-9				**0.028**
Median (IQR)	4.0 (6.0)	4.0 (6.0)	6.0 (6.8)	
PHQ-9 grouped, *n* (%)				0.098
Unremarkable	406 (81.7)	349 (82.9)	57 (75.0)	
Mild depression	69 (13.9)	55 (13.1)	14 (18.4)	
Moderate and severe depression	22 (4.4)	17 (4.0)	5 (6.6)	

Table 1 (continued)

	Total, n = 531	Not hospitalized, n = 451	Hospitalized, n = 80	p value
NRS				0.819
Median (IQR)	2.0 (5.0)	2.0 (5.0)	2.0 (5.0)	

IQR, interquartile range; BMI, body mass index; GAD-7, Generalized Anxiety Disorder 7-item score; PHQ-9, Patient Health Questionnaire-9; NRS, numeric rating scale. Education level according to the CASMIN classification. Statistically significant results ($p < 0.05$) are highlighted in bold font. Missing data n (%): age = 10 (1.9); Barthel index = 18 (3.4); BMI = 38 (7.2); care level = 0 (0); education level = 18 (3.4); GAD-7 Score = 44 (8.3); living situation = 8 (1.5); NRS = 37 (7.0); PHQ-9 = 34 (6.4); sex = 1 (0.2); type of care facility = 76 (14.3).

COVID, and 29.4% (n = 130) for post-COVID syndrome. Hospitalized individuals had significantly higher rates of long COVID (69.2% vs. 35.3%, $p < 0.001$) and post-COVID syndrome (53.8% vs. 25.2%, $p < 0.001$). Further details are shown in Table 2.

Cognition and Quality of Life of the Study Population

The median SIS score was 6.0 (IQR: 1.3), and the median MoCA-Blind score was 18.0 (IQR: 6.0). Cognitive impairment relevant to everyday life (SIS <4) was found in 10.5% of participants, while MCI (MoCA Blind <18) was present in 41.8%, with no significant difference between hospitalized and non-hospitalized people in need of care. However, the hospitalized group had a lower median MoCA-Blind score than the non-hospitalized group (17.0 vs. 19.0, $p = 0.039$).

Regarding quality of life, the median EQ VAS score was 60.0 (IQR: 30.0), with no significant difference between hospitalized and non-hospitalized individuals. However, hospitalized participants had lower EQ-5D-5L Index scores (0.57 vs. 0.75, $p = 0.004$) and reported more problems across all five EQ-5D-5L categories, particularly in "self-care" and "usual activities." Cognition and quality of life data are presented in Table 3.

Regression Analysis

Binary Logistic Regression Analyses: Association between Cognitive Impairment and COVID-19 Severity

Results from the binary logistic regression analyses are shown in Tables 4 and 5. The regression analysis showed that a higher care level was associated with increased odds of cognitive impairment relevant to everyday life (OR for care levels 4 and 5: 5.72, 95% CI: 1.64–19.89, $p = 0.006$). Furthermore, higher PHQ-9 depression scores were likewise associated with greater odds of cognitive impairment (OR: 1.11, 95% CI: 1.02–1.21, $p = 0.017$). Hospitalization due to COVID-19 was also linked to higher odds of cognitive impairment (OR: 2.48, 95% CI: 0.90–6.83), although this association did not reach statistical significance ($p = 0.079$).

Regarding MCI, medium and high education levels according to the CASMIN classification showed a protective effect on cognition. The OR for MCI was 0.31 (95% CI: 0.17–0.57) for medium and 0.30 (95% CI: 0.16–0.60) for high education, compared to low education level ($p < 0.001$). Higher care levels were linked to an increased risk of MCI ($p = 0.002$), with odds ratios of 2.13 (95% CI: 1.06–4.26) for care level 2 ($p = 0.034$), 3.53 (95% CI: 1.77–7.06) for care level 3 ($p < 0.001$), and 3.96 (95% CI: 1.52–10.33) for care levels 4/5 ($p = 0.005$), using frailty grade ≥5 and <9 points as a reference. Hospitalization showed an OR of 1.37 (95% CI: 0.67–2.78) for MCI but was not significant ($p = 0.389$), nor was the duration of COVID-19 symptoms ($p = 0.572$).

Multivariate Linear Regression Analyses: Association between Quality of Life and COVID-19 Severity

The multiple linear regression analysis (Table 6) with EQ VAS scores as the dependent variable showed that a higher level of education had a protective effect on the EQ VAS ($\beta = 3.174$; $p = 0.012$). Conversely, higher care levels ($\beta = -1.547$; $p = 0.038$), increased NRS pain scores ($\beta = -1.372$; $p < 0.001$), a higher BMI ($\beta = -0.389$; $p = 0.017$), and higher scores on the PHQ-9 depression scale ($\beta = -1.519$; $p < 0.001$) were negatively associated with the EQ VAS. Hospitalization due to COVID-19 ($p = 0.067$) and the duration of COVID-19 symptoms ($p = 0.517$) were not significantly associated with EQ VAS scores.

Discussion

In this analysis of data from the Bavarian ambulatory COVID-19 Monitor (BaCoM), we investigated, that hospitalized individuals in need of care had lower

Table 2. COVID-19 related data of the study population

	Total, *n* = 531	Not hospitalized, *n* = 451	Hospitalized, *n* = 80	*p* value
COVID-19 vaccination, *n* (%)				<**0.001**
Yes	444 (93.7)	384 (95.5)	60 (83.3)	
No	30 (6.3)	18 (4.5)	12 (16.7)	
Symptomatic COVID-19 infection, *n* (%)				<**0.001**
Yes	411 (79.2)	331 (75.4)	80 (100.0)	
No	108 (20.8)	108 (24.6)	0 (0.0)	
Hospital, *n* (%)				
Regular ward	59 (11.1)	X	59 (73.8)	x
Intensive care unit	21 (4.0)		21 (26.2)	
Acute COVID-19, *n* (%)				0.408
yes	156 (35.3)	136 (36.1)	20 (30.8)	
no	286 (64.7)	241 (63.9)	45 (69.2)	
Long COVID, *n* (%)				<**0.001**
Yes	178 (40.3)	133 (35.3)	45 (69.2)	
No	264 (59.7)	244 (64.7)	20 (30.8)	
Post-COVID-19 syndrome, *n* (%)				<**0.001**
Yes	130 (29.4)	95 (25.2)	35 (53.8)	
No	312 (70.6)	282 (74.8)	30 (46.2)	
Symptom duration				<**0.001**
Median (IQR)	6.0 (29.7)	4.0 (23.1)	19.29 (41.4)	

IQR, interquartile range Acute COVID-19: symptoms <4 weeks, long COVID: symptoms ≥4 weeks, post-COVID-19 syndrome: symptoms >12 weeks. Statistically significant results ($p < 0.05$) are highlighted in bold font. Missing data *n* (%): acute/long COVID/post-COVID-19 syndrome = 89 (16.7); COVID-19 vaccination = 57 (10.7); hospital = 0 (0.0); symptomatic COVID-19 infection = 12 (2.3); symptom duration = 89 (16.7).

MoCA-Blind scores than non-hospitalized counterparts. Other studies have already shown that SARS-CoV-2 infections, particularly severe cases of COVID-19, can negatively impact cognition. While previous research primarily focused on individuals from the general population with severe COVID-19, the present study is among the few to demonstrate this association specifically in people requiring care. Unlike the MoCA-Blind results, SIS scores did not differ significantly between the two groups, likely due to the MoCA-Blind's broader range (22 points vs. 6 points), making it more sensitive to subtle cognitive differences. Although hospitalized individuals initially showed lower MoCA-Blind scores, this association disappeared once sociodemographic and health-related factors were included in the regression models. This suggests that the lower cognitive performance is more strongly explained by underlying characteristics such as education or care dependency rather than hospitalization or COVID-19 symptom duration themselves. In addition, the relatively small number of hospitalized participants may have limited the statistical power to detect adjusted effects. Further studies with larger samples of hospitalized individuals in need of care may be able to identify this association.

Care level correlated with both MCI and cognitive impairment affecting daily life, consistent with research linking cognitive decline to greater dependency in daily activities [35, 36]. Regression analysis also showed that higher education was associated with increased odds of MCI, in line with studies highlighting the role of education in cognitive functioning [18, 37]. Our analysis also revealed a significant association between higher depression scores (PHQ-9) and increased odds of cognitive impairment relevant to everyday life, supporting previous research linking depression to lower cognitive performance [38]. While hospitalization due to COVID-19 showed a trend toward higher odds of cognitive impairment, this was not statistically significant. Our analyses confirmed previous research which found a correlation between the level of dependency (care level) and cognitive impairments [39].

Regarding quality of life, our findings indicate that individuals in need of care who were hospitalized due to COVID-19 exhibited lower EQ-5D-5L Index scores.

Table 3. Cognitive status and quality of life of the study population

	Total, $n = 531$	Not hospitalized, $n = 451$	Hospitalized, $n = 80$	p value
SIS				0.261
Median (IQR)	6.0 (1.3)	6.0 (2.0)	5.0 (1.0)	
Cognitively impaired relevant to everyday life (SIS <4), *n* (%)				0.930
No	430 (86.3)	365 (86.3)	65 (86.7)	
Yes	68 (13.7)	58 (13.7)	10 (13.3)	
MoCA Blind				**0.039**
Median, IQR	18.0 (6.0)	19.0 (5.0)	17.0 (6.0)	
MCI (MoCA Blind <18), *n* (%)				0.087
No	249 (58.2)	218 (59.9)	31 (48.4)	
Yes	179 (41.8)	146 (40.1)	33 (51.6)	
Mobility, *n* (%)				0.059
You have no problems in walking about?	110 (21.4)	97 (22.2)	13 (16.7)	
You have slight problems in walking about?	79 (15.2)	75 (17.2)	4 (5.1)	
You have moderate problems in walking about?	119 (23.1)	98 (22.4)	21 (26.9)	
You have severe problems in walking about?	127 (24.7)	96 (22.0)	31 (39.7)	
You are unable to walk about?	89 (15.5)	71 (16.2)	9 (11.5)	
Self-care, *n* (%)				**0.032**
You have no problems washing or dressing yourself?	230 (44.8)	203 (46.6)	27 (35.1)	
You have slight problems washing/dressing yourself?	73 (14.2)	64 (14.7)	9 (11.7)	
You have moderate problems washing/dressing yourself?	70 (13.6)	56 (12.8)	14 (18.2)	
You have severe problems washing/dressing yourself?	72 (14.0)	58 (13.3)	14 (18.2)	
You are unable to wash/dress yourself?	68 (13.3)	55 (12.6)	13 (16.9)	
Usual activities, *n* (%)				**0.035**
You have no problems doing your usual activities?	174 (34.1)	149 (34.5)	25 (32.1)	
You have slight problems doing your usual activities?	116 (22.7)	106 (24.5)	10 (12.8)	
You have moderate problems doing your usual activities?	79 (15.5)	68 (15.7)	11 (14.1)	
You have severe problems doing your usual activities?	89 (17.5)	71 (16.4)	18 (23.1)	
You are unable to do your usual activities?	52 (10.2)	38 (8.8)	14 (17.9)	
Pain or discomfort, *n* (%)				0.145
You have no pain or discomfort?	175 (34.3)	153 (35.4)	22 (28.2)	
You have slight pain or discomfort?	95 (18.6)	82 (19.0)	13 (16.7)	
You have moderate pain or discomfort?	138 (27.1)	114 (26.4)	24 (30.8)	
You have severe pain or discomfort?	91 (17.8)	72 (16.7)	19 (24.4)	
You have extreme pain or discomfort?	11 (2.2)	11 (2.5)	0 (0.0)	
Anxiety or depression, *n* (%)				**0.**123
You are not anxious or depressed?	299 (58.7)	158 (59.6)	41 (53.9)	
You are slightly anxious or depressed?	93 (18.3)	83 (19.2)	10 (13.2)	
You are moderately anxious or depressed?	89 (17.5)	72 (16.6)	17 (22.4)	
You are severely anxious or depressed?	19 (3.7)	13 (3.0)	6 (7.9)	
You are extremely anxious or depressed?	9 (1.8)	7 (1.6)	2 (2.6)	
EQ-5D-5L Index				**0.004**
Median (IQR)	0.73 (0.47)	0.75 (0.47)	0.57 (0.43)	
EQ VAS				0.989
Median (IQR)	60.0 (30.0)	60.0 (30.0)	60.0 (30.0)	

IQR, interquartile range; SIS, Six-Item Screener; MoCA, Montreal cognitive assessment; EQ-5D-5L Index, European quality of life 5 dimensions 5 level Index; EQ VAS, European quality of life visual analogue scale. Statistically significant results ($p < 0.05$) are highlighted in bold font. Missing data *n* (%): SIS = 33 (6.2); MoCa Blind = 103 (19.4); mobility = 16 (3.0); self-care = 18 (3.4); usual activities = 21 (4.0); pain or discomfort = 21 (4.0); anxiety or depression = 22 (4.1); EQ-5D-5L index = 29 (5.5); EQ VAS = 37 (7.0).

Table 4. Association between cognitive impairment relevant to everyday life and the COVID-19 severity – results of the binary logistic regression analysis

Dependent variable	Six-item screener (n = 382)			
	OR from univariate analysis (95% CI)	p value	OR from multivariate analysis (95% CI)	p value
Main variables				
Hospitalization due to Covid-19 (ref.: not hospitalized)	0.968 (0.471; 1.991)	0.930	2.481 (0.901; 6.829)	0.079
COVID-19 symptom duration	**0.981 (0.964; 0.998)**	**0.028**	0.992 (0.974; 1.010)	0.378
Adjustment variables				
Sex (ref.: female)	0.754 (0.424; 1.340)	0.335	0.637 (0.224; 1.812)	0.397
Age grouped (ref.: <60)				
60–69 years	0.970 (0.203; 4.636)	0.969	2.897 (0.216; 38.769)	0.422
70–79 years	0.948 (0.237; 3.795)	0.940	2.638 (0.271; 25.670)	0.403
80–89 years	1.886 (0.547; 6.495)	0.315	3.140 (0.356; 27.722)	0.303
≥90 years	2.201 (0.585; 8.285)	0.243	4.068 (0.413; 40.073)	0.229
Living situation (ref.: living alone)	**0.390 (0.193; 0.789)**	**0.009**	0.529 (0.184; 1.521)	0.237
Education level (ref.: Low)				
Middle	**0.511 (0.265; 0.986)**	**0.045**	0.624 (0.232; 1.683)	0.352
High	**0.258 (0.099; 0.671)**	**0.005**	0.389 (0.101; 1.498)	0.170
Care level (ref.: frailty ≥5 and <9 points)				
1	0.275 (0.035; 2.147)	0.218	0.459 (0.050; 4.196)	0.490
2	1.142 (0.493; 2.644)	0.757	0.724 (0.180; 2.920)	0.650
3	**2.657 (1.337; 5.280)**	**0.005**	2.384 (0.769; 7.392)	0.133
4 and 5	**5.213 (2.379; 11.426)**	**<0.001**	**5.719 (1.644; 19.890)**	**0.006**
BMI	0.965 (0.914; 1.019)	0.202	0.949 (0.868; 1.017)	0.124
PHQ-9	1.022 (0.959; 1.090)	0.499	**1.110 (1.019; 1.209)**	**0.017**

CI, confidence interval; BMI, body mass index; SIS, Six-Item Screener; OR, odds ratio; PHQ-9, Patient Health Questionnaire-9; ref., reference. Statistically significant results (p < 0.05) are highlighted in bold font.

Another study examining individuals after hospitalization for COVID-19 similarly found that they experienced significant restrictions in self-care and daily activities [17]. Such limitations may contribute to a loss of independence and, in turn, a further decline in quality of life. These results emphasize the importance of preventing both the disease and its complications, particularly in this vulnerable group.

However, the results showed no significant difference in EQ VAS scores between hospitalized and non-hospitalized individuals in need of care. A possible explanation is that the EQ VAS is a purely subjective measure of current quality of life, allowing participants to incorporate various aspects of their health in their assessment [40]. This differs from the EQ-5D-5L assessment, which uses predefined categories, leaving less room for individual interpretation. A systematic review concluded that patients experience reduced quality of life following intensive care due to COVID-19 [41]. Further studies with a larger number of care-dependent patients treated in intensive care are needed to determine whether this finding also applies to people requiring care.

Regression analyses revealed that higher BMI, depression (PHQ-9), care level, and pain (NRS) were all negatively associated with EQ VAS, reflecting their impact on physical and mental well-being. Other studies have similarly confirmed the association between these factors and reduced quality of life [42–45]. Consistent with previous research [46], we found a significant positive link between higher education levels and EQ VAS scores. Hospitalized individuals in need of care had lower education levels and higher BMI than non-hospitalized participants, suggesting that higher educational attainment promotes better health awareness and enhances physical and mental resilience [47]. Furthermore, research has identified overweight as a significant risk factor for severe outcomes associated with COVID-19 [48, 49].

Hospitalization due to COVID-19 can have significant effects on the mental health of affected individuals

Table 5. Association between MCI and the COVID-19 severity – results of the binary logistic regression analysis

Dependent variable	MoCA blind (n = 349)			
	OR from univariate analysis (95% CI)	p value	OR from multivariate analysis (95% CI)	p value
Main variables				
Hospitalization due to Covid-19 (ref.: not hospitalized)	1.589 (0.933; 2.709)	0.088	1.367 (0.671; 2.784)	0.389
COVID-19 symptom duration	0.994 (0.987; 1.001)	0.100	0.997 (0.989; 1.006)	0.572
Adjustment variables				
Sex (ref.: female)	0.755 (0.498; 1.145)	0.186	1.072 (0.607; 1.892)	0.811
Age grouped (ref.: <60)				
60–69 years	0.716 (0.278; 1.847)	0.490	0.896 (0.282; 2.847)	0.852
70–79 years	0.524 (0.224; 1.226)	0.136	0.433 (0.152; 1.233)	0.117
80–89 years	1.213 (0.564; 2.611)	0.621	0.988 (0.376; 2.594)	0.980
≥90 years	1.385 (0.580; 3.305)	0.463	1.302 (0.429; 3.951)	0.641
Living situation (ref.: living alone)	**0.557 (0.363; 0.856)**	**0.008**	0.878 (0.494; 1.559)	0.656
Education level (ref.: low)				
Middle	**0.281 (0.174; 0.455)**	**<0.001**	**0.314 (0.174; 0.566)**	**<0.001**
High	**0.225 (0.130; 0.391)**	**<0.001**	**0.304 (0.155; 0.595)**	**<0.001**
Care level (ref.: frailty ≥5 and <9 points)				
1	1.432 (0.675; 3.040)	0.349	1.103 (0.462; 2.635)	0.825
2	**3.298 (1.930; 5.637)**	**<0.001**	**2.125 (1.060; 4.260)**	**0.034**
3	**3.667 (2.140; 6.284)**	**<0.001**	**3.534 (1.769; 7.058)**	**<0.001**
4 and 5	**4.675 (2.187; 9.995)**	**<0.001**	**3.962 (1.519; 10.332)**	**0.005**
BMI	1.009 (0.978; 1.042)	0.567	0.974 (0.933; 1.017)	0.231
PHQ-9	1.034 (0.989; 0.082)	0.143	1.055 (0.992; 1.122)	0.089

CI, confidence interval; BMI, body mass index; MoCA, Montreal cognitive assessment; OR, odds ratio; PHQ-9, Patient Health Questionnaire-9; ref., reference. Statistically significant results (p < 0.05) are highlighted in bold font.

[50], as reflected in our findings. Individuals in need of care who were hospitalized exhibited moderate to severe anxiety symptoms more frequently than their non-hospitalized counterparts. Although PHQ-9 scores also differed statistically, there was no corresponding difference in the prevalence of moderate or severe depressive symptoms, indicating that the statistical difference in the PHQ-9 scores is likely not clinically meaningful. It should additionally be noted that the PHQ-9 and GAD-7 are screening instruments; nevertheless, elevated scores may signal underlying mental distress. These observations underscore the importance of addressing the psychological needs of this vulnerable population both during and after hospitalization and highlight the need to investigate this association further in future studies.

Additionally, non-hospitalized individuals in need of care were more frequently vaccinated against COVID-19, reinforcing evidence that vaccination reduces the risk of severe outcomes [51–53]. A systematic review of 120 studies investigating the prevalence of Long-COVID found wide variability, ranging from 0% to 93%, depending on the cohort and data collection methods used [54]. Our study found a higher prevalence of long-COVID (69.2% vs. 35.3%) and post-COVID syndrome (53.8% vs. 25.2%) among hospitalized individuals compared to non-hospitalized individuals requiring care. Other studies investigating non-care-dependent individuals have concluded that disease severity is associated with the persistence of symptoms over time [55, 56]. These findings underscore the importance of infection prevention and reducing severe cases, particularly among vulnerable populations.

The study focused on adults in Bavaria requiring care. Consequently, the generalizability of the findings is limited to care-dependent populations in countries with similar care structures.

Strengths and Limitations

However, the study lacks baseline cognitive and quality of life data from before SARS-CoV-2 infection, limiting causal conclusions. The 2.5-year data collection

Table 6. Association between quality of life and the COVID-19 severity – results of the multiple regression analysis

Dependent variable	EQ VAS (n = 375)			
	β coefficient univariate analysis (95% CI)	p value	β coefficient multivariate analysis (95% CI)	p value
Main variables				
Hospitalization due to COVID-19 (ref.: not hospitalized)	−0.226 (−5.472; 5.021)	0.933	5.039 (−0.359; 10.438)	0.067
COVID-19 symptom duration	−0.049 (−0.116; 0.018)	0.155	−0.021 (−0.085; 0.043)	0.517
Adjustment variables				
Sex (ref.: female)	**5.751 (1.726; 9.777)**	0.005	0.424 (−3.837; 4.684)	0.845
Age	−0.054 (−0.213; 0.105)	0.507	−0.032 (−0.199; 0.134)	0.701
Living situation (ref.: living alone)	−1.729 (−5.811; 2.353)	0.406	−3.290 (−7.606; 1.026)	0.135
Education level	**3.600 (1.228; 5.971)**	**0.003**	**3.174 (0.704; 5.643)**	**0.012**
Care level	**−2.334 (−3.640; −1.029)**	**<0.001**	**−1.547 (−3.010; −0.083)**	**0.038**
NRS	**−2.550 (−3.224; −1.875)**	**<0.001**	**−1.372 (−2.153; −0.591)**	**<0.001**
BMI	**−0.525 (−0.841; −0.208)**	**0.001**	**−0.389 (−0.708; −0.069)**	**0.017**
PHQ-9	**−2.068 (−2.445; −1.690)**	**<0.001**	**−1.519 (−2.003; −1.035)**	**<0.001**
SIS	0.119 (−1.229; 1.467)	0.862	−0.260 (−1.862; 1.341)	0.749
Model aspects				**<0.001**
R^2			0.250	
corrected R^2			0.227	

CI, confidence interval; BMI, body mass index; EQ VAS, European quality of life visual analogue scale; NRS, numeric rating scale; PHQ-9, Patient Health Questionnaire-9, ref., reference; SIS, Six-Item Screener. Statistically significant results (p < 0.05) are highlighted in bold font.

period introduced variability due to changing viral variants and public health restrictions. Recall bias may also be present, as some infections occurred months before the interviews.

Diagnosing dementia requires comprehensive assessments, including physical examinations, neuroimaging procedures and laboratory analyses etc. Psychometric instruments such as the SIS thus represent only a minor component of the diagnostic and are insufficient on their own to establish a diagnosis of dementia. The SIS is considered a valid tool for identifying cognitive impairments relevant to everyday life; however, it is not suitable for detecting MCI [57]. In such cases, we followed the recommendation of the German dementia guideline and employed the MoCA [58]. However, with a sensitivity of only 63%, it remains likely that some participants with mild cognitive deficits were not identified as impaired when assessed using the MoCA Blind.

A limitation of this study is the relatively small number of hospitalized participants compared with those who were not hospitalized. This imbalance likely reflects the underlying distribution of COVID-19 severity in the general population, as most infections did not require hospital admission. Research indicates that elderly with severe COVID-19 are more likely to die or experience lasting health impairments that hinder study participation, thereby introducing potential survival and participation bias.

Additionally, caregivers completed questionnaires for participants with SIS scores below 4, potentially introducing reporting bias. Several studies have already examined the association between COVID-19 severity, cognitive impairment and quality of life. However, this study is among the first to investigate this relationship specifically in individuals requiring care. Another strength is the inclusion of older adults with severe cognitive impairment, who are often excluded from similar research, as caregivers completed the questionnaires on their behalf, ensuring that individuals with high care needs were adequately represented. Another strength of this work is that the BaCoM study is a multicenter study. The involvement of multiple independent research teams and the inclusion of a broader patient population enhance the scientific validity of the findings compared to studies conducted at a single site.

Conclusion

Hospitalized patients in need of care initially showed lower cognition and quality of life compared to non-hospitalized patients; however, after adjusting for

relevant confounders, this association was no longer significant. These findings suggest that pre-existing vulnerability largely accounts for the observed differences. Nevertheless, individuals requiring care remain a particularly vulnerable group who should be protected from severe COVID-19. Further longitudinal studies are needed to clarify the long-term impact of COVID-19 on cognition and quality of life in this population.

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Statement of Ethics

The BaCoM study was conducted in accordance with the Declaration of Helsinki. The study protocol was reviewed and approved by the Ethics Committee of the Medical Faculty at LMU Munich (approval #20-860). The study included both non-vulnerable and vulnerable participants. Written informed consent was obtained from all participants. If patients were unable to provide consent themselves, they were considered vulnerable in terms of their capacity to consent. In these cases, written informed consent was obtained from the legal guardians of all vulnerable patients.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Draft of manuscript: K.L. and S.H.; conceptualization: T.D., J.G., and K.L.; methodology: M.R., S.H., and T.D.; data analysis: S.H. and M.R.; interpretation of results: K.L., S.H., J.G.; I.G., M.S., and M.D.; data acquisition: S.H.; supervision: J.G., K.L., and T.D.; revision of draft: M.S., S.W., D.T., G.I., A.H., M.H., C.J., T.K., D.T., and J.G.; project administration: S.W.; funding acquisition: T.D., J.G., and S.W. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data that support the findings of this study are available from the consortia of BaCoM study. Due to legal regulations, the data are not publicly accessible. However, data can be obtained upon reasonable request. Data requests may be directed at "Stiftung Allgemeinmedizin – The Primary Health Care Foundation" (www.stiftung-allgemeinmedizin.de). Mail: office@stiftung-allgemeinmedizin.de.

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