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Frequency and correlates of subjective cognitive complaints and objective cognitive screening results in African American adults following COVID-19 infection

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ABSTRACT

Background: Subjective cognitive complaints are frequent following COVID-19 infection, but assessment of whether these complaints map onto objective cognitive findings may not be routine in busy clinical settings. Consequently, opportunities to confirm these complaints and to provide follow-up referrals and appropriate care may be missed, thereby impacting patients' functional independence and quality of life. African Americans are vulnerable to poor outcomes from COVID-19, and thus represent a minority group in whom subjective concerns are especially important to investigate. Towards this end, we examined the frequency and correlates of subjective complaints and objective screening results of African American patients referred to the Post-Acute Sequelae of SARS-CoV-2 (PASC) Clinic at Grady Memorial Hospital, a large county teaching hospital in Atlanta, Georgia.

Methods: Eighty seven African American patients (mean age = 52.5, SD = 10.5, range = 30–73) were evaluated between January 28, 2021–October 14, 2021 in the Grady PASC clinic. They ranged from 1 to 17 months post positive SARS-COV-2 antigen testing. Patients were administered a subjective cognitive complaint questionnaire (PROMIS Cognitive Function Scale Short Form 8a) as well as cognitive screening measures including the Mini-Cog (3 item recall, clock) and the Digit Symbol Substitution Test (timed visuomotor sequencing). Mood was assessed via the Patient Health Questionnaire-9, and anxiety via the Generalized Anxiety Disorders Scale. Published norms were used to identify clinically elevated scores.

Results: Sixty six (76%) patients denied experiencing meaningful cognitive concerns, and of these, 25 (38%) had positive cognitive screens indicating impaired performance on objective testing. Of 21 patients with subjectively elevated cognitive concerns, 17 (81%) also had positive cognitive screens. There were no significant differences in sociodemographic factors (p values = .07-.71), days post-acute positive SARS-COV-2 Antigen Test (p = .99), disease severity (p values = .67-.75), or COVID-19 comorbidity indices (medical conditions (p values = .20-.77), substance abuse (p = .79), psychiatric history (p values = .11-.99) in those with or without subjective complaints and objective cognitive findings. However, patients with subjective complaints and objective cognitive findings reported more post-COVID-19 anxiety (p = .02) and depression (p = .001).

Conclusions: Findings indicate a high concordance between subjective complaints on the PROMIS Cognitive Scale and objectively confirmed cognitive impairments in African Americans. Further, almost 40% who reported no cognitive complaints screened positive for cognitive impairment. Although depression and anxiety are associated with subjective complaints, they do not account for positive cognitive screening results, as those patients without depressive complaints also had similar rates of positive objective screens. The findings suggest that cognitive screening using assessment tools should be routinely performed in African Americans, especially those reporting cognitive symptoms on outcome scales. While future studies are needed to assess long-term outcomes, we highly recommend follow-ups in those with positive screens to characterize the specific domains that are impacted and that could affect activities of daily living and quality of life.

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1. Introduction

Subjective cognitive complaints such as poor memory and attention are frequent following COVID-19 infection and include a broad range of sequelae that may persist for longer than two years with unknown prognosis (Cirulli et al., 2020; Davis et al., 2023; Hanson et al., 2022; Ladds et al., 2020; Logue et al., 2021; Mizrahi et al., 2023; O'Keefe et al., 2021; Perlis et al., 2022; Pihlaja et al., 2023; Taquet et al., 2022). Increases in the severity of symptoms are associated with greater perceived functional disability and poorer overall health (Sivan et al., 2022). Studies confirm the presence of cognitive impairments based on objective testing (Akinci et al., 2023; Almeria et al., 2020; García-Sánchez et al., 2022; Hampshire et al., 2021; Miskowiak et al., 2023). Ceban et al. (2022) conducted a meta-analysis of studies of patients with confirmed COVID-19 infections who were ≥12 weeks post diagnosis. The investigators found that studies with objective screening assessments reported a significantly greater proportion of persons with cognitive impairment compared to studies that relied on self-report measures only (0.36 vs. 0.18, respectively). Comprehensive neuropsychological evaluations also document the presence of performance decrements in those with subjective complaints (Krishnan et al., 2022; García-Sánchez et al., 2022), with one study reporting that 60% of persons with subjective complaints an average of 6 months post COVID-19 infection exhibited multi-domain cognitive impairments, with attention, memory, and executive function most affected (García-Sánchez et al., 2022).

These studies suggest the added clinical value of screening for cognitive impairment with objective testing following COVID-19 infection, yet no clear guidance exists for primary care and Post-Acute Sequelae of SARS-CoV-2 (PASC) providers. Furthermore, associations have been largely investigated in white research cohorts, and little is known about the frequency and correlates in African Americans. African Americans have been disproportionately vulnerable to poor outcomes from COVID-19, with significantly higher morbidity and mortality rates (Cyrus et al., 2020; Mangum, 2021; Millett et al., 2020; Muñoz-Price et al., 2020; Raj et al., 2022). Apart from global outcomes, though, studies into both the subjective and objective cognitive consequences in this minority group have not to our knowledge been examined. Racial disparity in COVID-19 risk and poor outcomes in African Americans have been attributed, in part, to social determinants of health such as low education, low socioeconomic status, and reduced access to healthcare (Baker et al., 2021; Maness et al., 2021). These, in turn, impede the ability to engage in preventative health behaviors such as primary care visits and healthy diets. Other factors further increase African American susceptibility to poor COVID-19 outcomes and include higher prevalence and severity of health related comorbidities including hypertension, diabetes, kidney disease, and obesity (Gupta et al., 2021; Killerby et al., 2020). All of these risk factors may also impact cognitive symptoms.

African American patients in the current study were evaluated in the PASC Clinic at Grady Memorial Hospital. Grady Memorial Hospital is a county hospital that serves predominantly African American communities in Atlanta, Georgia and surrounding areas. Seventy five percent of patients seen at Grady are African American, with 50% living at or below 125% of the federal poverty level. Patients were administered self-report measures of subjective cognitive concerns and objective cognitive screening tests. We investigated the frequency of subjective cognitive concerns, their association with objective cognitive screening results, and sociodemographic, COVID-19 severity, and comorbid medical and psychiatric correlates. By including both objective and self-report measures, we were able to compare the percentages of patients identified as having or endorsing COVID-19 cognitive sequelae. Consistent with the findings of Ceban et al. (2022), we expected a higher percentage of patients identified as having cognitive impairment based on objective vs. subjective methods. We also included measures of depression and anxiety to evaluate their relationship to subjective cognitive complaints. There is a high prevalence of depression and anxiety following COVID-19 infection as well as a positive correlation between subjective complaints and mood symptoms (Mazza et al., 2020; Pihlaja et al., 2023; Raman et al., 2021). We were interested in whether depression and anxiety were necessary conditions for self-report of cognitive symptoms.

2. Materials and methods

2.1. Participants

Patients were referred to the PASC Clinic if they had new or worsening symptoms (fatigue, dyspnea, anosmia/dysgeusia, brain fog, palpitations, tachycardia, dizziness, headache, pain syndromes, neuropathies, gastrointestinal manifestations, etc.). For the cross-sectional study in this report, we consecutively recruited adults aged ≥18 years with new or worsening symptoms lasting ≥3 weeks from confirmed SARS-CoV-2 test from the Grady Memorial Hospital PASC Clinic. We excluded participants who had no new or persistent symptoms >3 weeks from disease onset. The sample reported in the current study included 87 patients (mean age = 52.5 years, SD = 10.5, range = 30–73) who were predominantly female (n = 75; 86%) and who all self-identified as African Americans. Seventy-eight (90%) tested positive for COVID-19 as evidenced by detection of SARS-CoV-2 RNA or antigen in nasopharyngeal swab during the Alpha strain wave (March 1–June 30, 2021), and 9 (10%) tested positive during the Delta variant wave (July 1, 2021–December 31, 2021) (Datta et al., 2020; Nalbandian et al., 2021). All patients had no known prior COVID-19 infection, were ≥4 weeks (mean = 148.6 days, SD = 107.5, range = 30–512) from the acute COVID-19 infection phase, and were recruited from the Grady PASC Clinic between January 28, 2021–October 14, 2021.

2.2. Measures

Subjective cognitive concerns were evaluated using the Patient-Reported Outcomes Measurement Information System Cognitive Function-Concerns® (PROMIS®-CF-Concerns)-Short Form 8a Scale, an 8-question measure of perceived cognitive functioning (https://www.healthmeasures.net/index.php?option=com_instruments&view=measure&id=769&Itemid=992). The Scale we administered (Appendix A) enquires about the frequency of cognitive difficulties over the past 7 days involving concentration, memory, language, and mental ability. The respondent is asked to select one of five choices indicating either Never (5 points), Rarely (Once; 4 points), Sometimes (Two or Three Times; 3 points), Often (About Once a Day; 2 points), or Very Often (Several Times a Day; 1 point) to statements such as "My thinking has been slow" or "I have had trouble forming thoughts." Scores range from 8 to 40 points, with higher scores indicating better self-perceived functioning.

Objective cognitive performance was measured using the Mini-Cog (Borson et al., 2000) and the Digit Symbol Substitution Test (DSST) (Wechsler, 1955). Together they required an average of 5 min to administer. The Mini-Cog consisted of recall of three words and drawing a clock to indicate a specified time. Scores were assigned for word recall (max = 3 points) and for clock drawing (numbers in proper place and correct position of hands: max = 2 points), yielding a total score of 0–5 points. For the DSST, the patient was handed a piece of paper with a key at the top showing nine boxes, each with a printed number ranging from 1 to 9 and a unique symbol paired with each number. Below the key, a series of boxes with numbers only was shown, and the patient was instructed to write in the symbol that belonged with each number. The total score was the number of correctly completed pairings within 90 s.

We screened for depression using the validated Patient Health Questionnaire (PHQ-9) (Kroenke et al., 2001) consisting of 9 statements asking the patient to rate how often they have been bothered by any of the following problems over the last two weeks such as "Little interest of

pleasure in doing things" or "Feeling down, depressed, or hopeless." Choices for each statement are Not at All (0 points), Several Days (1 point), More Than Half the Days (2 points) or Nearly Every Day (3 points). Scores range from 0 to 27, with a score of 10 or higher used to characterize the presence of clinically significant depression. Anxiety was evaluated via the validated Generalized Anxiety Disorder Scale-7 (GAD-7) (Spitzer et al., 2006) enquiring about whether the respondent has been bothered by certain problems in the last two weeks such as "Feeling nervous, anxious, or on edge" or "Not being able to stop or control worrying." Response choices are identical to the PHQ-9 and range from Not At All (0 points) to Nearly Every Day (3 points), with a total score from 0 to 21 points. A score of 10 or higher is used to characterize clinically significant anxiety.

New symptoms or worsening symptoms since COVID-19 onset persisting ≥3 weeks were collected using a standardized review of systems with dichotomous scoring (presence/absence) and were confirmed by clinician interview.

2.3. Procedures

Patients signed informed consent forms approved by the Emory Institutional Review Board and the Grady Research Oversight Committee, and all procedures were performed in accord with the ethical standards of the Committee on Human Experimentation at Emory and with the Helsinki Declaration of 1975. Sociodemographic, disease severity, and COVID-19 comorbidity (medical, substance abuse, psychiatric) data were collected by physicians during the in-person visit and confirmed by electronic health record review. Patients were asked about symptoms of brain fog, defined as trouble concentrating, memory loss, or difficulties with multitasking. The PROMIS V2.0 Cognitive Function-Short Form 8a, PHQ-9, and GAD-7 were self-administered by the patient using forms with standardized instructions, and answers were reviewed by the physicians. The DSST and Mini-Cog were administered by the physician.

2.4. Statistical analysis

Study data were deidentified and entered into a REDCap electronic data capture tool (Harris et al., 2009) hosted at Emory University. Our primary focus was to compare patients with vs. without clinically significant subjective concerns and with vs. without clinically significant objective findings. In the clinical setting, providers typically use cutoff scores to interpret the meaningfulness of values on screening tests. We also wanted to use a comparable method to categorize both the subjective scores and the objective scores in order to compare them, and we thus adopted a z score cutoff. A positive result (i.e., substantial subjective complaints or impaired objective performance) on either the PROMIS Cognitive Function 8a or the DSST was determined based on a patient obtaining a raw score on that test corresponding to a z score falling ≥1.5 standard deviations below the mean, i.e., at or below the 5th percentile. (For the PROMIS Cognitive Function 8a, this corresponded to a raw score of <18 points (PROMIS_Cognitive_Function_Scoring_Manual_03June2022.pdf (healthmeasures.net). For the DSST, we used published norms for persons 50–80 years old (Joy et al., 2000), and we converted raw scores to age adjusted z scores to obtain the cutoff values for the number of correctly completed number/symbol pairings: 50–59 year olds: ≤36: 60–69 year olds: ≤31; 70–79 year olds: ≤24. For patients 30–49 years of age, we used a cutoff of ≤41 correct pairings, based on a z score of −1 SD for 50–59 year olds. The Mini-Cog cutoff for a positive screen was set at ≤ 3 points, using data from a clinic sample of patients with mild cognitive impairment (Steenland et al., 2008).

Analyses of variance with post hoc Sheffe tests and Chi-Square and Fisher's Exact tests were performed to compare the groups based on subjective cognitive concerns and positive or negative cognitive screening results on sociodemographic factors, disease severity, COVID-19 comorbidity indices (medical, substance abuse, psychiatric), depression, and anxiety. Pearson correlations were performed to examine the association between scores on the DSST and the Mini-Cog and mood measures on the PHQ-9 and the GAD-7. SPSS V28 was used, and a two-tailed p-value of < .05 was required for statistical significance. No adjustment for multiple comparisons was employed due to the exploratory nature of this report.

3. Results

3.1. Frequency of subjective cognitive concerns and positive cognitive screening results

Sixty-six (76%) of the 87 patients reported minimal to no cognitive symptoms on the PROMIS Cognitive Function Scale. Of these, 25 (38%) had objective positive cognitive screens (DSST: n = 16, 64%; Mini-Cog: n = 7, 25%; Both: n = 2, 8%). Of 21 patients with subjectively elevated cognitive symptoms, 17 (81%) also obtained positive cognitive screens. Ten (59%) patients had impaired DSST scores, 4 (35%) had impaired Mini-Cog Scores, and 3 (18%) had impaired scores on both tests. Only 4 of 21 patients (19%) had elevated subjective concerns and negative cognitive screens. The PROMIS Cognitive Function Scale had a 91% specificity and 40% sensitivity for impairment using these cognitive screens. Forty-seven (54%) of the 87 patients reported no brain fog. Of these 18 (38%) had objective positive cognitive screens. Of the 40 subjects reporting brain fog, 24 (60%) had positive cognitive screens, resulting in a specificity of 64% and sensitivity of 57%.

3.2. Association of subjective and objective findings with demographics, insurance status, COVID-19 infection severity, and comorbidities

Table 1 shows scores for three groups: 1) patients without elevated subjective cognitive concerns and without positive cognitive screens (-Subjective/-Objective; n = 41); 2) patients without elevated subjective cognitive concerns and with positive cognitive screens (-Subjective/+Objective; n = 25); and 3) patients with both elevated subjective cognitive concerns and positive cognitive screens (+Subjective/+Objective; n = 17). Those with subjective concerns and negative screens (n = 4) were not analyzed due to the small sample size. Their data are included in an Appendix for visual inspection for the interested reader.

There were no significant differences among the groups in age and distribution of sex. Over half the patients in all three groups were uninsured or receiving Medicaid, a federal-state supported program providing insurance coverage for those requiring financial assistance. There were also no significant differences among the groups in the average number of days post acute infection and COVID-19 severity in terms of whether patients were hospitalized and if yes, whether they were admitted to the intensive care unit. In addition, the groups did not significantly differ in the number of PASC symptoms they experienced or in pre-illness medical conditions. None had a pre-existing diagnosis of mild cognitive impairment or dementia, including Alzheimer's disease or vascular dementia. Hypertension was the most prevalent condition for the three groups of patients, present in 49/83 (59%) of the total sample. Smoking was equally prevalent in the three groups, present in 22/83 (27%) of the total sample.

3.3. Association of subjective and objective findings with depression and anxiety

The groups did not differ in pre-COVID-19 diagnoses of depression, anxiety, or bipolar illness. Post-COVID-19 depression scores on the PHQ-9 and the percentage of patients with elevated scores ≥10 points were significantly greater for the +Subjective/+Objective group compared to the -Subjective/-Objective and -Subjective/+Objective groups. Post-COVID-19 anxiety scores were significantly higher in the +Subjective/

Table 1
Association of subjective and objective findings with demographics, insurance status, COVID-19 infection severity, and comorbidities.

	No Subjective Complaints and Negative Cognitive Screen N = 41	No Subjective Cognitive Complaints and Positive Cognitive Screen N = 25	Subjective Cognitive Complaints and Positive Cognitive Screen N = 17	P value (Effect Size)[a]
Years Age (mean, SD)	52.3 (9.6)	54.2 (12.1)	54.1 (8.8)	.71 (n^2=.01)
Sex (n, %)				
Male	6 (15%)	6 (24%)	0 (0%)	.07 (V = .24)
Female	35 (85%)	19 (76%)	17 (100%)	
Insurance Status (n, %)				
Uninsured	14 (34%)	9 (36%)	12 (71%)	.28 (V = .26)
Medicaid	8 (20%)	8 (32%)	1 (6%)	
Medicare	6 (15%)	3 (12%)	1 (6%)	
Private	11 (27%)	5 (20%)	3 (18%)	
Undocumented	2 (5%)	0 (0%)	0 (0%)	
Days Post-Acute Positive SARS-COV-2 Antigen Test (mean, SD)	146.3 (99.1)	146.8 (124.3)	147.7 (90.8)	.99 (n^2 = .00)
Severity of Acute Illness (n, %)				
Asymptomatic	0 (0%)	1 (4%)	0 (0%)	
Symptoms and Not Hospitalized	21 (51%)	12 (48%)	9 (53%)	
Hospitalized	16 (39%)	11 (44%)	8 (47%)	
Intensive Care Unit	4 (10%)	1 (4%)	0 (0%)	.75 (V = .17)
Persistent COVID-19 Symptoms (mean, SD)	3.4 (2.3)	3.0 (1.6)	3.0 (1.2)	.59 (n^2 = .01)
Presence of Pre-Existing Conditions (n, %)				
Pre-COVID-19 Medical Conditions				
Mild Cognitive Impairment	0 (0%)	0 (0%)	0 (0%)	–
Dementia	0 (0%)	0 (0%)	0 (0%)	–
Hypertension	24 (59%)	16 (64%)	9 (53%)	.77 (V = .08)
Hyperlipidemia	8 (20%)	3 (12%)	2 (12%)	.73 (V = .11)
Diabetes	16 (39%)	6 (24%)	4 (24%)	.37 (V = .16)
Congestive Heart Failure	1 (2%)	3 (12%)	2 (12%)	.20 (V = .18)
Coronary Artery Disease	1 (2%)	2 (8%)	0 (0%)	.44 (V = .16)
Stroke	0 (0%)	0 (0%)	1 (6%)	.21 (V = .22)
Chronic Obstructive Pulmonary Disease	2 (5%)	2 (8%)	0 (0%)	.67 (V = .13)
Obstructive Sleep Apnea	4 (10%)	5 (20%)	1 (6%)	.41 (V = .17)
Asthma	9 (22%)	3 (12%)	3 (18%)	.66 (V = .11)
Substance Abuse				
Smoking	10 (24%)	8 (32%)	4 (24%)	.79 (V = 11)
Pre-COVID-19 Psychiatric Conditions				
Depression	8 (20%)	4 (16%)	5 (29%)	.60 (V = .12)
Anxiety	4 (10%)	2 (8%)	5 (29%)	.11 (V = .24)
Bipolar Disorder	0 (0%)	0 (0%)	0 (0%)	–
Scores on Mood Measures Post-COVID				
PHQ-9 Score (mean, SD)	6.2 (4.3)a	8.4 (6.5)b	14.2 (6.7)a,b	.001 (n^2 = .24)
Score≥10 points (n, %)	8 (20%)a	7 (28%)b	13 (76%)a,b	.001 (V = .47)
GAD-7 Score (mean, SD)	6.5 (5.3)a	7.5 (7.1)	11.5 (7.1)a	.02 (n^2 = .09)
Score≥10 points (n, %)	14 (34%)	8 (33%)	10 (59%)	.18 (V = .21)

[a] Effect sizes are reported as n^2 for Anovas and as Cramer's V (V) for Chi-Square and Fisher's Exact Tests. η^2, ≥.01 is considered a small effect, η^2, ≥.06 is considered a medium effect, and η^2, ≥.14 is considered a large effect. Cramer's V ≥ .10 is considered a small effect, ≥.30 a medium effect, and ≥.50 a large effect.

+Objective group compared to the -Subjective/-Objective group. Due to the wide variability in time elapsed since a positive COVID-19 infection as well as the fact that some patients were vs. were not hospitalized, we repeated the ANOVAs controlling for these two variables. Again, the findings regarding the same group differences were replicated for the depression score ($p < .001$, $n^2 = 0.27$) but not for the anxiety score ($p = .14$, $n^2 = 0.09$).

3.4. Associations between cognitive test scores and depression and anxiety

Those with higher scores on the PHQ-9, indicative of higher self-ratings of depression, showed worse performance on the DSST ($r = -0.29$, $p = .01$, 95% CI = −0.48 to −0.08) and not the Mini-Cog ($r = -0.19$, $p = -0.09$, 95% CI = −0.39 to 0.03). Higher scores on the GAD-7 were associated with worse performance on the Mini-Cog ($r = -0.30$, $p = .01$, 95% CI = −0.48 to −0.09) and not the DSST ($r = -0.07$, $p = .53$, 95% CI = 0.15 to −0.29). Due to these relationships and the higher depression and anxiety scores in the +Subjective/+Objective group, we examined whether the groups differed in raw scores on the Mini-Cog and the DSST. There was a significant main effect of Group ($p < .001$) for both the Mini-Cog ($n^2 = 0.23$) and the DSST ($n^2 = 0.38$). The -Subjective/-Objective group obtained significantly ($p < .001$) better scores on both tests (Mini-Cog: mean = 4.6, SD = 0.5; DSST: mean = 44.8, SD = 8.1) than the -Subjective/+Objective group (Mini-Cog: mean = 3.6, SD = 1.3; DSST: mean = 32.5, SD = 10.5) and the +Subjective/+Objective group (Mini-Cog: mean = 3.4, SD = 1.5; DSST: mean = 28.1, SD = 10.4). In contrast, the scores of the latter two groups were not significantly different from each other.

4. Discussion

The findings indicate that subjective cognitive concerns are clinically significant after COVID-19 infection as they are associated with objective evidence of cognitive impairment in close to 80% of African Americans with PASC. This study extends the literature to encompass an African American patient sample, a group that has been found to be especially vulnerable to poorer COVID-19 morbidity and mortality relative to other groups (Cyrus et al., 2020; Mangum, 2021; Millett et al., 2020; Muñoz-Price et al., 2020; Raj et al., 2022), but one that has not been systematically studied with respect to cognitive concerns. The rate of cognitive impairment seen here is higher than that reported in other populations, previously ranging from 50 to 75% (Chang et al., 2022;

Mazza et al., 2021). Our estimates may be inflated due to the higher specificity of the PROMIS Cognitive scale compared with subjective report, which commonly triggered neurocognitive testing in previous studies. However, these studies investigated additional cognitive domains, expanding detection of impairments and were conducted at earlier post-COVID-19 time points, both of which should result in higher prevalence than was observed in our population. These findings underscore the importance of investigating the long-term impacts of COVID-19 on cognitive function in high-risk populations.

We observed that one quarter of our sample (21/87) had elevated cognitive concerns on the PROMIS Cognitive Function questionnaire. This tool had 91% specificity for cognitive impairment in our population compared with dichotomous patient report of brain fog, which was observed in 54%, with low specificity and commensurately low sensitivity. Follow-up screening of patients with subjective concerns may not be routinely performed in clinic settings for many reasons, including time and personnel demands. However, these findings support implementation of the cost-effective and efficient PROMIS Cognitive Function questionnaire in primary care and PASC clinics. Given the high specificity, those with elevated scores could be considered for referral for comprehensive neuropsychological testing.

Of concern, positive cognitive screens were found in nearly 40% of the patients who did not have subjective concerns. Our overall findings of a higher rate of positive screens based on objective testing versus subjective self-reports is consistent with the meta-analysis by Ceban et al. (2022) of studies with persons who were ≥12 weeks post-COVID-19 infection. The investigators noted a significantly greater proportion of persons with cognitive impairment who received cognitive screening assessments compared to studies that relied on self-report measures only (0.36 vs. 0.18, respectively). Our results could reflect a multitude of factors such as unawareness of deficits in patients or false positive screenings. With respect to the latter possibility, the cutoffs we applied did not adjust for 'race', a surrogate measure reflecting a myriad on factors such as quality of education, cultural exposures, and social determinants of health. Studies have shown that there are racial/ethnic performance differences on traditional cognitive screening measures such as the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005) and that these influences affect the sensitivity and specificity of the cutoffs used to differentiate normal from mild cognitive impairment in diverse racial and ethnic groups. For example, the MoCA cutoff score of 26 points rather than 24 points has been found to inaccurately classify African Americans as being cognitively impaired (Goldstein et al., 2014; Rossetti et al., 2019). A group of participants without COVID-19 who completed the subjective and objective measures and were matched for demographic and socioeconomic factors would have been ideal for normative comparisons. In the current study, the screening measures were chosen due to their sensitivity to cognitive impairment (Borson et al., 2006; Jaeger, 2018; Steenland et al., 2008) and to the domains specifically affected by COVID-19 including episodic memory, executive function, and processing speed (García-Sánchez et al., 2022; Hampshire et al., 2021; Krishnan et al., 2022; Perrottelli et al., 2022). Visuomotor processing speed involving rapid transcription of numbers and symbols on the DSST appeared to be the most sensitive screening measure, with 62% of the patients obtaining impaired scores compared to 26% on the Mini-Cog only, versus the remaining 12% of patients exhibiting impaired scores on both measures. Thus, for those with negative PROMIS Cognitive Function screens, speeded set shifting measures may provide useful clinical information and could be considered as candidate tools for rapid screening in resource-limited primary care and PASC clinics.

The current study was also interested in examining whether depression and anxiety are found only in those patients with subjective complaints. One factor that may discourage cognitive screening is the high prevalence of depression and anxiety following COVID-19 infection as well as a positive correlation between subjective complaints and mood symptoms (Mazza et al., 2020; Pihlaja et al., 2023; Raman et al., 2021). Thus, mood disturbance may be misattributed as the sole cause for subjective complaints. Olanipekun et al. (2022) observed that 1/3 of 73 African American COVID-19 patients discharged from the ICU at Grady Memorial Hospital had PHQ-9 scores ≥10 points, indicative of clinically significant depression. Similarly, we found elevated PHQ-9 scores of ≥10 points in 37% of our Grady Memorial Hospital sample. While scores were significantly higher in those with subjective complaints, depression was not confined to this group only. We also found a high prevalence of anxiety (42%) in our entire sample, but again this was not confined only to those with elevated subjective concerns. The scores on both the DSST and the Mini-Cog were not significantly different in the -Subjective/+Objective and +Subjective/+Objective groups, despite significantly higher depression scores in the latter group. Our results are consistent with Almeria et al. (2020) who administered a neuropsychological battery to 35 COVID-19 patients 10–35 days after hospital discharge. There were no differences in cognitive test performance between those with and without complaints, but those with complaints had higher anxiety and depression scores. Thus, while depression and anxiety are higher in those with subjective concerns, they are not necessary or sufficient conditions for positive cognitive screens. Taquet et al. (2022) in fact observed that while anxiety and depression return to normal levels over time, cognitive impairment persisted for at least two years. Further studies are needed to investigate whether depression and anxiety are rather the direct result of the impact of COVID-19 sequelae on daily function and quality of life.

Associations between subjective concerns and objective screening results were not observed for demographics, insurance status, COVID-19 infection severity, number of PASC symptoms, and medical comorbidities. Insurance status is a surrogate marker for social determinants of health, and thus might be expected to impact outcomes. Valdes et al. (2022) reported that education level ≤12 years, black race, and pre-Covid employment status (employed vs. unemployed) were associated with impaired performance on the telephone version of the Montreal Cognitive Assessment in patients who had been hospitalized for COVID-19. However, other social determinants including health insurance status were not risk factors. As our patients were receiving medical care, regardless of their insurance status, it makes sense that this variable may not have emerged as a correlate of outcomes. An association in our study was also not observed with subjective concerns/objective screening results and severity of illness as measured by COVID-19 hospitalization status. This finding is consistent with other studies (García-Sánchez et al., 2022; Mizrahi et al., 2023; Valdes et al., 2022) observing that cognitive symptoms and deficits extend across COVID-19 severity levels, highlighting that all populations are vulnerable to developing long-term neurocognitive sequelae of COVID-19.

Limitations of our study include its cross sectional and correlational design, thereby impacting the ability to identify cause-effect relationships and potential recovery. The study findings are also based on a small sample size as well as wide-variability in both the post follow-up infection interval and in COVID-19 illness severity. With respect to the latter, it will be important for follow-up studies to differentiate between the more acute vs. long-term cognitive sequelae of COVID-19. In addition, the potential effect of current treatment of symptoms as well as measurement of immune or inflammatory markers were not taken into account as explanatory mechanisms. These are all areas for further investigation. Although medical records and self-reports of participants did not indicate a premorbid history of cognitive impairments, it is possible that some of our patients had pre-existing cognitive difficulties prior to their COVID-19 infections. Future studies are needed to identify patients in whom cognitive status was objectively assessed prior to COVID-19 infection in order to definitively establish whether there are changes in post-infection cognitive status. In addition, we do not know how these subjective concerns and objective findings impact everyday functioning. These measures screen for deficits within certain domains, but they do not comprehensively assess all domains that may be impacted. Therefore, reliance on these measures may underestimate the

rate of −/+ and +/+ cases, further underscoring the importance of comprehensive screening among COVID-19 survivors and the need for further investigation into the long-term effects of COVID-19 on cognition.

5. Conclusions

In summary, our findings indicate a high concordance between subjective complaints on the PROMIS Cognitive Function Scale and objective cognitive findings in African Americans post COVID-19 infection. Positive cognitive screens are found even among those without subjective complaints, and depression and anxiety do not fully account for positive objective findings. Additional workup is needed to identify domains that could impact daily function and quality of life. Future research is imperative to find treatment solutions for patients with these cognitive impairments.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bbih.2023.100691.

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