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Rates of cognitive and functional impairments in older adults residing in a continuing care senior housing community

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Abstract

Objective: The current cross-sectional study examined cognition and performance-based functional abilities in a Continuing Care Senior Housing Community (CCSHC) that is comparable to other CCSHCs in the U.S. with respect to residents' demographic characteristics.

Method: Participants were 110 older adult residents of the independent living unit. We assessed sociodemographics, mental health, neurocognitive functioning, and functional capacity.

Results: Compared to normative samples, participants performed at or above expectations in terms of premorbid functioning, attention span and working memory, processing speed, timed set shifting, inhibitory control, and confrontation naming. They performed below expectation in verbal fluency and verbal and visual learning and memory, with impairment rates (31.4% [>1 SD below the mean] and 18.49% [>1.5 SD below the mean]) well above the general population (16% and 7%, respectively). Within the cognitive test battery, two tests of delayed memory were most predictive of a global deficit score. Most cognitive test scores correlated with performance-based functional capacity.

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Conflicts of Interest disclosure

Authors report no conflict of interests or financial disclosures.

Conclusions: Overall, results suggest that a subset of older adults in the independent-living sector of CCSHCs are cognitively and functionally impaired and are at risk for future dementia. Results also argue for the inclusion of memory tests in abbreviated screening batteries in this population. We suggest that CCSHCs implement regular cognitive screening procedures to identify and triage those older adults who could benefit from interventions and, potentially, a transition to a higher level of care.

Keywords

Neuropsychology; assessment; instrumental activities of daily living; aging; assisted living; independence

Introduction

The aging of the U.S. population (Ortman, Velkoff, & Hogan, 2014) necessitates increased stable housing and supportive communities for older adults. Although many older community-dwelling adults prefer to age in place (Wiles, Leibing, Guberman, Reeve, & Allen, 2011), continuing care senior housing communities (CCSHCs) offer a potentially attractive alternative (Jeste & Childers, 2017; Shippee & Henning-Smith, 2015; Zarem, 2010), particularly for those who are socially isolated and/or lonely (Kneale, 2013). There are approximately 1,800 CCSHC properties in the U.S., with roughly 604,000 individual units (NIC Executive Summary, 2018). CCSHCs are a specific type of senior housing community; they offer multiple nonoverlapping levels of housing and care, from independent living to assisted living to skilled nursing and memory care. If an older adult acquires a disease or disability that limits their functional independence, they can "step up" to a higher level of care without leaving the broader CCSHC campus, thereby reducing the disruption associated with transitioning (Shippee & Henning-Smith 2015). Indeed, CCSHCs have been conceptualized as a multi-component intervention (Holland et al., 2017) due to frequently available healthcare, wellness, security, social/community, dining, and physical activity options available in these settings (Zarem, 2010). Such supports are associated with multiple benefits, including lower mortality rates (Netten, Darton, Bäumker, & Callaghan, 2011), increased perceived health and decreases in anxiety and depression (Holland et al., 2017), and reduced ageism (Biggs, Bernard, Kingston, & Nettleton, 2000). Importantly, CCSHCs can expand the so-called "life space" of older adults, allowing for safe and comfortable movement through a campus environment on a daily basis, as opposed to confinement within a small home; such broadening of older adults' social worlds is associated with reduced risk of mild cognitive impairment and dementia from Alzheimer's disease (James, Boyle, Buchman, Barnes, & Bennett, 2011).

Despite the importance of reducing dementia risk in the older adult population, cognitive functioning has been understudied in CCSHCs. Cognition is an important contributor to functional capacity and quality of life in older adults without dementia (Pan, Wang, Ma, Sun, Xu, & Wang, 2015; Pereira et al., 2015; Rebok et al., 2014), with multiple reviews suggesting that cognitive performance explains about one-quarter of the variance in functional status (Mcalister, Schmitter-Edgecomb, & Lamb, 2016; Royall, Lauterbach, Kaufer, Malloy, Coburn, & Black, 2007), and yet most investigations of CCSHC residents

either do not measure cognitive performance or do so using only very brief cognitive screening instruments or abbreviated batteries (e.g., Hsu et al., 2014; Kerr et al., 2013; Rosenberg et al., 2016; Wrights, Fain, Miller, Rejeski, Williamson, & Marsh, 2015).

The available literature suggests that community-dwelling older adults without dementia who choose to transition from their current residence to a CCSHC have worse initial cognitive performance than do those who remain in their homes (Holland et al., 2017), likely representing a selection bias. Over time, however, residence in a CCSHC is associated with improvements in terms of both cognition and functional independence (Holland et al., 2017; Netten et al., 2011), possibly due to the aforementioned structural supports available in these communities. Unfortunately, even multifaceted interventions available in a CCSHC cannot stave off age-related cognitive and functional decline indefinitely, and reductions in performance of activities of daily living (ADLs) predict transition to higher levels of care in CCSHCs (Sloan, Shayne, & Conover, 1995; Wick & Zanni, 2009). Consequently, it is important to understand cognitive functioning and instrumental ADL status in CCSHCs for the sake of both a) provision of appropriate interventions to maximize independence and quality of life, and b) identification of those older adults who have declined to the point where a higher level of care is necessary to ensure safety.

In the current cross-sectional study, we examined cognitive status and performance-based functional abilities (finance and communication) in a CCSHC that resembles other CCSHCs with regard to residents' demographic characteristics (American Seniors Housing Association, 2013). Ultimately, our goal is to generalize to the larger population of older Americans residing in the independent living sectors of these communities. Two prior studies using subsamples of the current cohort have reported on data from the Montreal Cognitive Assessment (MoCA) and UCSD Performance-based Skills Assessment – Brief (UPSA-B). Jeste and colleagues (2019) found that a cognitive composite comprised of the MoCA and UPSA-B correlated with composites of physical but not mental health characteristics. Van Patten and colleagues' (2019) results showed that the timed up-and-go task – a measure requiring a sit-to-stand movement, a 3-meter walk, a 180-degree turn, a second 3-meter walk, and a stand-to-sit maneuver – was more strongly associated with MoCA performance than were measures from a broad battery assessing aging, psychiatric symptoms, sleep, and physical health. However, these preliminary studies included smaller samples than the current study (Jeste et al., 2019: N=104; Van Patten et al., 2019: N=93), and neither paper included any neuropsychological data beyond the MoCA and UPSA-B. Consequently, we believe that a follow-up investigation of our full cognitive battery is warranted in order to fully characterize cognitive and functional impairment rates in the sample. Moreover, prior studies in CCSHCs have not specified the sector of the community from which the sample is drawn (i.e., independent living, assisted living, or memory care; e.g., Biggs et al., 2000; Holland et al., 2017; Kerr et al., 2013). We addressed this issue by limiting our sample to the independent living sector of a CCSHC.

In the current study, we describe data from a comprehensive neuropsychological evaluation assessing attention, processing speed, language, learning and memory, and executive functioning. Given mixed results on cognitive abilities in individuals residing in CCSHCs compared to community-dwelling older adults (Holland et al., 2017), we considered

the investigation of overall cognitive and functional performance compared to published normative data and cutoff scores to be exploratory. After calculating a global deficit score (Heaton et al., 1994; Heaton et al., 1995), we tested relationships between each cognitive test and the global deficit score, with the goal of identifying a shorter screening battery that could capture a majority of the variance in the full battery. Finally, a growing literature suggests that scores on cognitive tests account for significant variance in performance-based functional capacity (e.g., McClure et al., 2007; Moore, Paolillo, Heaton, Fazeli, Jeste, & Moore, 2017). Consequently, we hypothesized that worse cognitive performance on individual tests would be associated with lower scores on a measure of functional capacity.

Methods

Participants

Participation in the current study was offered to all current independent living residents of a CCSHC in San Diego County that includes independent living, assisted living, and memory care sectors. Out of approximately 300 independent living residents, 110 (37%) elected to participate and were included in the current study (see Table 1). All 110 participants were part of the independent living unit and were enrolled in a larger longitudinal investigation of biopsychosocial functioning in independently living older adults. Data collection for this study took place between July 2018 and October 2019. Inclusion criteria were the following: a) English-speaking, b) aged 65 or older, c) capacity to complete study procedures, and d) no known dementia or other severe disability. The affiliated university's Institutional Review Board approved the study and all participants provided written informed consent.

Measures

Participants provided demographic and mental health information via interviews and structured testing. We measured past and current cigarette use and alcohol consumption with interview questions. We assessed depressive symptoms with the Patient Health Questionnaire 9-item (Kroenke, Spitzer, & Williams, 2001).

We administered the Wide Range Achievement Test, 4th edition (WRAT-4; Wilkinson & Robertson, 2006) to estimate premorbid cognitive functioning and the MoCA (Nasreddine et al., 2005) as a cognitive screening test. We administered the Wechsler Adult Intelligence Scale, 4th edition (WAIS-IV; Wechsler, 2008) Digit Span subtest to assess attention span and working memory, the WAIS-IV Coding subtest for processing speed, and the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001) Trails and Color-Word Interference Tests (CWIT; a variant of the Stroop test) for processing speed and executive functioning. D-KEFS Trails includes a Number Sequencing item, which is analogous to Trails A, and a Letter-Number Sequencing item, which is analogous to Trails B, as well as Visual Scanning, Motor Speed, and Letter Sequencing items. We also administered the letter fluency (FAS; Heaton, Miller, Taylor, & Grant, 2004) and animal fluency (Heaton et al., 2004) tests, as well as the Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 1983) for language, and the Hopkins Verbal Learning Test-Revised (HVLT-R; Brandt & Benedict, 2001) and Brief Visuospatial Memory Test-

Revised (BVMT-R; Benedict, Groninger, Schretlen, Dobraski, & Shpritz, 1996) for verbal and visual learning and memory, respectively.

In order to assess performance-based functional capacity in finance and communication, we administered the UPSA-B (Mausbach, Harvey, Goldman, Jeste, & Patterson, 2007). The UPSA and UPSA-B were originally developed and validated in severe mental illness (Mausbach et al., 2007; Patterson, Goldman, McKibbin, Hughs, & Jeste, 2001), but have since been successfully utilized in a variety of populations, including HIV (Moore et al., 2017), homeless adults (Mahmood et al., in press; Van Patten, Vella, Mahmood, Clark, Maye, & Twamley, 2020), and aging and Alzheimer's disease (Gomar, Harvey, Bobes-Bascaran, Davies, & Goldberg, 2011; Jeste et al., 2019; Van Patten et al., 2019). The UPSA-B is a performance-based test of functional capacity using role-play scenarios to measure a participant's ability to complete real-world tasks related to finance and communication. In these scenarios, the examiner provides prompts and the examinee demonstrates the requisite knowledge and skills to perform tasks. For example, several items on the finance subscale require the examinee to count change and write a check in order to pay a bill. Example items on the communication subscale include a prompt to make an appropriate call in the event of an emergency and to change a doctor's office appointment via telephone. The total UPSA-B score ranges from 0–100, with lower scores indicating worse performance, and T scores are also available for analysis (Vella et al. 2017).

For each neuropsychological test, we used appropriate demographically-corrected normative data to produce the standardized (T score, scaled score, standard score) values reported on in the Results section. This included normative comparisons based on age or age/education/gender/race. In order to calculate the global deficit score, we followed the standard procedure for creating deficit scores (e.g., Blackstone et al., 2012; Gonzalez et al., 2003). We first converted all T scores and scaled scores to deficit scores (Table 2), which emphasize gradations of poor performance without discriminating between levels of average or above average performance. We then calculated the global deficit score by generating the mean of all deficit scores for each individual across the cognitive battery.

Statistical Analyses

We utilized two methods of determining cognitive impairment on each test. First, where appropriate, we identified test scores at the 50th percentile (SS=100, T=50, ss=10) as an estimate of the population mean and as a comparison point for one-sample *t* tests to determine whether our sample data differed significantly from what would be expected in the population of healthy older adults. Second, we calculated proportions of the sample who earned standardized scores at two levels of impairment: >1 SD and >1.5 SD below the mean. For the MoCA, we used the published cutoffs of <26 (Nasreddine et al., 2005) and <23 (Carson, Leach, & Murphy, 2018), which are both designed to detect mild cognitive impairment in older adults. For UPSA-B impairment rate analyses, we converted raw scores to T scores based on recently published normative data (Vella et al., 2017). In addition to descriptive data, we conducted χ^2 tests on the cognitive battery, assessing whether our sample's performance on each test differed from an expected level of impairment (16%, based on a normal distribution) in the population.

In order to examine the relative utility of each cognitive test in explaining variance in the global deficit score, we first conducted one-tailed Pearson correlations between each test and the global deficit score. Regarding distributional characteristics of the variables, we inspected skewness/kurtosis parameters and histograms rather than relying on significance tests (e.g., Kolmogorov-Smirnov, Shapiro-Wilk) because a) large samples lead to frequent false positives on these tests and b) small deviations from normality do not negatively impact parameter estimates in large samples (Field, 2018). Results suggested that most variables were normally distributed. For those variables with the potential for non-normality, non-parametric (Spearman) correlation results did not differ from parametric (Pearson) correlation results and we present findings from the parametric analyses. We did not include the MoCA total score in this analysis because it is not associated with a standardized score and because it is a screening instrument; we did not include the WRAT-4 Reading score because it is a test of premorbid functioning not designed to detect impairment. Next, the global deficit score was regressed onto those individual tests with significant Pearson correlation coefficients. We excluded Digit Span Total Score (VIF=59.38; tolerance=.02) and HVLT Delayed Recall (VIF=28.59; tolerance=.04) from this analysis due to multicollinearity; for the remaining variables, multicollinearity was not an issue (all VIF values <4.5; all tolerance values >.23).

Finally, as a test of the hypothesis, we present one-tailed relationships between individual cognitive test scores and performance-based functional capacity in finance and communication (the UPSA-B) determined via Pearson correlations. We used one-tailed tests in this case because our hypothesis was directional; that is, there is strong evidence to suggest that neuropsychological measures and tests of performance-based functional capacity will be positively correlated. We also regressed the UPSA-B onto those tests with significant Pearson correlation coefficients. Finally, in order to control for multiple comparisons, we interpreted all inferential tests at the $p<.01$ level.

Results

Sample demographic, health status, substance use, and mood characteristics are presented in Table 1. Compared to normative samples, the CCSHC group performed at or above expectation in terms of their premorbid functioning (WRAT-4 Reading, Cohen's $d=0.85$), attention span and working memory (WAIS-IV Digit Span, $d=0.13–0.37$), processing speed (WAIS-IV Coding, $d=0.99$; D-KEFS Trails Visual Scanning, Number Sequencing, Letter Sequencing, and Motor Speed, $d=0.34–0.52$; D-KEFS Color-Word Interference Test [CWIT] Color Naming and Word Reading, $d=0.03$ and 0.09, respectively), confrontation naming (Boston Naming Test, $d=0.34$), timed set-shifting (D-KEFS Letter-Number Sequencing, $d=0.04$), and inhibitory control (D-KEFS CWIT Inhibition, $d=0.24$; Inhibition/Switching, $d=0.21$; Table 3). Furthermore, the means of the percentages of participants with cognitively impaired scores on the WRAT-4, WAIS-IV Digit Span and Coding, D-KEFS subtests, and the Boston Naming Test were 8.7% (>1 SD below the mean) and 5.3% (>1.5 SD below the mean; Table 4). In other words, each of the aforementioned cognitive tests is associated with a proportion of our sample who scored in the impaired range. We calculated means based on those percentages and we report them here. The mean impairment rates (8.7% and 5.3%) are lower than would be expected based upon a normal distribution of cognitive healthy

people (16% and 7%, respectively), although the difference was not statistically significant (χ^2=1.77, p=.18).

Participants performed below expectations on letter fluency (FAS; d=–0.56), semantic (animal) fluency (d=–0.31), and on two tests of verbal and visual learning and memory (HVLT-R Total Recall, Delayed Recall, Retention, and Recognition Discrimination, d=–0.36–0.50; BVMT-R Total Recall and Delayed Recognition, d=–0.67 and –0.52, respectively). The means of the percentages of participants with cognitively impaired scores on letter fluency, animal fluency, the HVLT-R, and the BVMT-R were 31.4% (>1 SD below the mean) and 18.5% (>1.5 SD below the mean), which are well above the expected impairment rates of 16% and 7% (χ^2=7.23, p=.007). Similarly, we observed high rates of impairment on the MoCA, with 69.2% of the sample scoring below 26 and 34.6% of the sample scoring below 23. Finally, on the UPSA-B, 51.8% of the sample earned scores >1 SD below the mean and 45.5% of the sample earned scores >1.5 SD below the mean (1 SD criterion: χ^2=29.63, p<.001).

Results of the Pearson correlations between the global deficit score and individual cognitive tests are presented in Table 5. With the exception of the Boston Naming Test, all measures correlated significantly with the global deficit score. All other test indices except Digit Span Total Score, and HVLT Delayed Recall were included in the simultaneous multiple regressions (Table 6 and Table 7). The omnibus global deficit score regression model was significant, F(20, 77)=19.43, p<.001, adjusted R^2=.79. In terms of individual predictors, only HVLT-R Retention (p<.001) and BVMT-R Delayed Recognition (p=.003) were significant predictors of the global deficit score. D-KEFS Trails Motor Speed and D-KEFS CWIT Color Naming and Inhibition/Switching approached significance (p<.05).

Consistent with our hypothesis, 18/25 cognitive tests correlated significantly with the UPSA-B at the p<.01 level (Table 5). Coefficients for the 18 tests ranged from r=.31–.57. Six of the seven tests that did not predict UPSA-B performance included a processing speed component; the seventh was a premorbid functioning measure (the WRAT-4). The UPSA-B regression model was significant, F(20, 76)=3.27, p<.001, adjusted R^2=.32. In terms of individual predictors, only BVMT-R Total Recall (p<.001) predicted the UPSA-B. D-KEFS Color Naming approached significance (p<.05).

After completing our a priori analytic plan, we re-ran each of the models, excluding the nine participants who scored at or above 10 on the PHQ-9 (indicating at least moderate depression). Results were identical following the exclusions, with two exceptions. The correlations between UPSA-B and Coding (r=.22; p=.012; prior to exclusions: r=.25, p=.009) and the BNT (r=.23; p=.011; prior to exclusions: r=.27, p=.005) became non-significant. However, effect sizes were comparable for these analyses, and we ultimately elected to present results from the full sample (including the nine participants with at least moderate depression) in order to maximize generalizability.

Discussion

This is the first study to comprehensively measure objective neurocognitive status and performance-based functional abilities (finance and communication) in a well-characterized sample of older adults residing in a CCSHC, with the aim of examining: 1) cognition and functional capacity relative to normative expectations, 2) individual tests accounting for significant variance in global cognition, and 3) associations between cognitive and functional performances. Our results revealed higher rates of cognitive impairment in our sample than in the general population on tests of verbal fluency and visual/verbal learning and memory. Moreover, 35% of our sample scored below 23 on the MoCA and 51.8% of the sample met criteria for performance-based functional impairment (1 SD criterion), as assessed by the UPSA-B. Test scores on measures of premorbid functioning, attention span/working memory, processing speed, confrontation naming, timed set shifting, and inhibitory control were average or above average. Only two tests of delayed memory were significant predictors of the global deficit score, suggesting that memory tests be used in abbreviated cognitive screening batteries in CCSHC residents (a test of timed set-shifting approached significance). Only one test of visual learning (BVMT-R) was a significant predictor of the UPSA-B score, suggesting that visual learning may be an important contributor to everyday finance and communication skills. Finally, consistent with our hypothesis, we found that lower cognitive scores in general were associated with worse performance-based functional capacity in finance and communication, underscoring the need for routine cognitive screening to determine CCSHC-residing older adults' needs for a higher level of care.

Although mean performances on measures of verbal fluency and verbal/visual memory were average to low average, impairment rates were at or nearly double (31.4% [1 SD criterion] and 18.5% [1.5 SD criterion]) the rates seen in the general population (16% and 7%, respectively). Participants had the highest frequency of impairment (>40%) within the visual memory domain, as assessed by the BVMT-R. These impairments, in the context of average to high average estimates of premorbid functioning, represent a probable decline from previous levels of functioning. Consequently, it is likely that a substantial subset of older adults residing in the independent-living sectors of CCSHCs have measurable cognitive deficits and are at risk for continued cognitive decline and dementia.

Rates of impairment on a brief cognitive screening measure (i.e., the MoCA) ranged from 34.6% to 69.2% when utilizing the recommended cutoffs of 23 (Carson et al. 2018) and 26 (Nasreddine et al., 2005), respectively. Relative to the Mini Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), the MoCA is considered to be a reliable and more sensitive screening tool for cognitive impairments (Dong et al., 2010; Larner, 2012). The conservative cutoff of 23 is associated with an improved false positive rate and overall diagnostic accuracy (Carson et al., 2018), suggesting that rates of mild cognitive impairment within the current sample probably are closer to 35%.

Declines in language and memory functioning occur in a subset of healthy older adults, are predictive of later cognitive decline, and are present in people with Alzheimer's dementia (Hart, Smith, & Swash, 1988; McCullough, Bayles, & Bouldin, 2019; Taler,

& Phillips, 2008; Twamley, Ropacki, & Bondi, 2006). Insight into these deficits may underlie an older adult's decision to move to a CCSHC; indeed, available evidence suggests that older adults who recently transitioned to CCSHCs demonstrate worse memory and verbal fluency performance compared to those who remain in their own homes (Holland et al., 2017; Netten et al., 2011). CCSHC residents also show greater self-reported functional limitations and overall worse psychological functioning than their community counterparts (Holland et al., 2017). Results from the current study extend these findings by demonstrating higher than expected rates of impairment in verbal fluency, verbal/visual memory, and objective functional capacity. Findings also suggest expected relationships between neuropsychological test scores and performance-based functional capacity. Tests of attention span, language, memory, and executive functions correlated with functional status, whereas several tests of processing speed did not. These findings are consistent with review papers, which report that, with respect to individual cognitive domains, tests of executive functioning explain the greatest degree of variance in functional outcomes, and tests of processing speed explain the least (Mcalister et al., 2016; Royall et al., 2007). However, it was unexpected that an index of visual learning (on the BVMT-R) was the only significant predictor of functional capacity in a simultaneous regression model. Prior research has suggested that visuospatial abilities (Fukui & Lee, 2009; Maeshima, Itakura, Nakagawa, Nakai, & Komai, 1997) and episodic memory (Overdorp, Kessels, Claassen, & Oosterman, 2016) are both associated with instrumental ADLs in older adults, so it is possible that a visuospatial learning test such as the BVMT-R captures relevant skills in both domains.

Overall, results suggest that a subset of residents within independent living sectors of CCSHCs would likely benefit from further assistance with their instrumental activities of daily living. For example, cognitive training interventions can teach patients strategies to bypass primary cognitive deficits (e.g., Choi & Twamley, 2013; Huckans, Hutson, Twamley, Jak, Kaye, & Storzbach, 2013; Twamley, Vella, Burton, Heaton, & Jeste, 2012; Twamley et al., 2014). Cognitive skills could target memory, including the use of calendars and reminding systems, for example. Staff at CCSHCs could be trained in teaching and reinforcing skill use for residents with memory impairments, with the ultimate goal of delaying functional decline and maximizing independence for as long as possible.

Results also underscore the need for more frequent assessment of objective neurocognitive functioning and integration of targeted cognitive interventions in these community settings to improve cognitive and functional outcomes. For example, CCSHCs may consider conducting brief (approximately 40 minutes) cognitive screening batteries on an annual or biennial basis. The batteries would sample each cognitive domain, with an emphasis on episodic memory. Older adults whose scores suggest the possibility of cognitive and/or functional decline could be referred for comprehensive neuropsychological testing. Finally, CCSHCs may also consider incorporating behavioral interventions to enhance cognitive protective factors (e.g., physical functioning; Jeste et al., 2019; Van Patten et al., 2019), in order to improve residents' overall health outcomes.

The current study is limited in its cross-sectional design, thereby restricting causal inferences. The sample is primarily White and highly educated, thereby limiting the generalizability of the findings to the larger racially and socioeconomically diverse older

adult population in the U.S. (see Cahn-Weiner, Malloy, Boyle, Marran, & Salloway, 2000; McDougall, Becker, & Arheart, 2006; Mitchell & Miller, 2008; and Mitchell et al., 2011, who examined IADLs in community samples). On the other hand, the current sample is representative of the population of older adults residing in CCSHCs in the U.S. (American Seniors Housing Association, 2013); consequently, our findings generalize well to the independent living sectors of other CCSHCs. Overall, results highlight the importance of integrating objective cognitive and functional capacity screening/assessment into standard practice within CCSHCs to identify those who could most benefit from additional care. Future longitudinal investigations should determine modifiable predictors of cognitive and functional outcomes for those in initial stages of care in CCSHCs to inform early targeted interventions to delay the need for advanced care and reduce associated cost burden.

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Table 1.

Sociodemographic and health characteristics

Demographics	Range	N or M±(SD)	%
Age, years	67–98	83.11 (6.70)	
Sex (female)		73/110	66.4
Education, years	12–20	15.79 (2.44)	
Race			
White (non-Latinx)		101/110	91.8
African American		4/110	3.6
Latinx		2/110	1.8
Asian		5/110	4.5
Currently married/cohabitating		47/110	42.7
Personal income			
<$35,000		18/92	19.6
$35,000 – $74,000		43/92	46.7
$75,000+		31/92	33.7
Veteran		29/110	26.4
Health status			
Body mass index	18–45	28.0 (5.2)	
Smoked cigarettes (past and/or current)		45/102	44.1
Alcohol use history			
Lifetime abstainer		11/100	11.0
Current infrequent drinker		49/100	49.0
Current regular drinker		23/100	23.3
Former drinker		17/100	17.0
PHQ-9			
Total score	0–20	3.12 (4.09)	
Mild depression (≥5)		24/98	24.5
Moderate depression (≥10)		9/98	9.2

Note. PHQ = Patient health questionnaire

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Table 2.

T-score and scaled score to deficit-score conversion.

T-score	Scaled score	Descriptor	Deficit score assignment
≥40	≥7	Normal	0
35–39	6	Mild	1
30–34	4–5	Mild-moderate	2
25–29	3	Moderate	3
20–24	<3	Moderate-severe	4
<20		Severe	5

Table 3.

Comparisons of sample cognitive performance to normative data.

	Sample		Comparison				
Test scores	**M**	**SD**	**M**	***t***	***df***	***p***	**Cohen's *d***
Cognitive tests (N)							
WRAT-4 Reading (110)	110.15	11.96	100	8.89	109	<.001	0.85
WAIS-IV Digit Span							
Total Score (109)	10.48	2.73	10	1.82	108	.07	0.18
Forward (110)	9.63	2.80	10	1.40	109	.17	–0.13
Backward (110)	10.39	2.95	10	1.39	109	.17	0.13
Sequencing (109)	11.16	3.16	10	3.82	108	<.001	0.37
WAIS-IV Coding (106)	13.12	3.15	10	10.21	105	<.001	0.99
D-KEFS Trails							
Visual Scanning (108)	11.13	2.71	10	4.33	107	<.001	0.42
Number Sequencing (108)	11.21	3.21	10	3.93	107	<.001	0.38
Letter Sequencing (108)	11.04	3.05	10	3.54	107	.001	0.34
Letter-Number Sequencing (108)	10.18	3.87	10	0.47	107	.64	0.04
Motor Speed (108)	11.44	2.79	10	5.35	107	<.001	0.52
D-KEFS Color-Word Interference Test							
Color Naming (109)	10.10	3.06	10	0.34	108	.73	0.03
Word Reading (109)	10.21	2.46	10	0.90	108	.37	0.09
Inhibition (107)	10.78	3.22	10	2.49	106	.01	0.24
Inhibition/Switching (105)	10.71	3.40	10	2.13	104	.04	0.21
Letter fluency (110)	44.96	8.89	50	5.95	109	<.001	–0.56
Animal fluency (110)	46.48	11.21	50	3.29	109	.001	–0.31
Boston Naming Test (110)	54.09	11.91	50	3.60	109	<.001	0.34
HVLT-R							
Total Recall (109)	46.22	10.37	50	3.80	108	<.001	–0.36
Delayed Recall (109)	43.83	12.60	50	5.11	108	<.001	–0.49
Retention (109)	42.25	15.54	50	5.21	108	<.001	–0.50
Recognition Discrimination (109)	44.55	12.84	50	4.43	108	<.001	–0.42

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Test scores	Sample		Comparison				
	M	SD	M	*t*	*df*	*p*	Cohen's *d*
BVMT-R							
Total Recall (106)	41.03	13.40	50	6.89	105	<.001	–0.67
Delayed Recognition (106)	42.94	13.69	50	5.31	105	<.001	–0.52
Performance-based functional status (N)							
UPSA-B							
Total (109)	38.88	31.53	50	3.71	108	<.001	–0.35
Cognitive screening (N)							
MoCA (107)							
Total score	23.68	3.48					

Note. BVMT-R = Brief Visuospatial Memory Test-Revised; D-KEFS = Delis-Kaplan Executive Function System; HVLT-R = Hopkins Verbal Learning Test-Revised; MoCA = Montreal Cognitive Assessment; UPSA-B = UCSD Performance-based Skills Assessment – Brief. WAIS-IV = Wechsler Adult Intelligence Scale, 4th edition; WRAT-4 = Wide Range Achievement Test – Fourth Edition.

Objective neuropsychological and functional capacity measures are expressed as follows: The WRAT-4 Word Reading subtest is expressed as a standard score (M=100, SD=15); The D-KEFS and WAIS-IV subtests are expressed as scaled scores (M=10, SD=3); letter fluency, animal fluency, Boston Naming Test, HVLT-R, BVMT-R, and UPSA-B tests are expressed as T scores (M=50, SD=10). The MoCA is expressed as a raw score.

WRAT-4 Reading, WAIS-IV subtests, D-KEFS subtests, the HVLT-R, and the BVMT-R used publisher normative data based on age. Letter fluency (FAS), animal fluency, and the Boston Naming Test used Heaton et al. (2004) norms based on age, gender, education, and race.

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Table 4.

Sample cognitive impairment rates compared to expected rates in healthy adults

Test scores	% Impaired		χ^2	*p*
	1 SD	1.5 SD	1 SD	
Cognitive tests (N)				
WRAT-4 Reading (110)	<1.0	0	14.46	<.001
WAIS-IV Digit Span				
Total Score (109)	11.9	2.8	0.20	.65
Forward (110)	5.5	2.7	5.30	.02
Backward (110)	11.8	2.7	0.46	.50
Sequencing (109)	8.3	6.4	2.33	.13
WAIS-IV Coding (106)	1.9	<1	11.69	<.001
D-KEFS Trails				
Visual Scanning (108)	5.6	3.7	5.10	.02
Number Sequencing (108)	8.3	6.5	2.26	.13
Letter Sequencing (108)	9.3	5.6	1.62	.20
Letter-Number Sequencing (108)	18.5	15.7	0.46	.50
Motor Speed (108)	7.4	6.5	3.04	.08
D-KEFS Color-Word Interference Test				
Color Naming (109)	11.9	7.3	0.42	.51
Word Reading (109)	5.5	3.7	5.20	.02
Inhibition (107)	8.4	6.5	2.19	.14
Inhibition/Switching (105)	13.3	9.5	0.12	.73
Boston Naming Test (110)	10.9	3.6	0.78	.38
Mean	8.7	5.3	1.77	.18
Letter fluency (110)	26.4	12.7	4.08	.04
Animal fluency (110)	29.1	13.6	5.99	.01
HVLT-R				
Total Recall (109)	27.5	11.9	4.84	.03
Delayed Recall (109)	31.2	24.8	7.41	.006
Retention (109)	32.1	22.0	9.19	.002

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Test scores	% Impaired		χ^2	*p*
	1 SD	**1.5 SD**	**1 SD**	
Recognition Discrimination (109)	22.9	14.7	2.12	.15
BVMT-R				
Total Recall (106)	41.5	27.4	25.91	<.001
Delayed Recognition (106)	40.6	20.8	16.63	<.001
Mean	31.4	18.5		
Performance-based functional status (N)				
UPSA-B				
Total score (109)	51.8	45.5	29.63	<.001
Cognitive screening (N)				
MoCA (107)	**<26**	**<23**		
Total score	69.2	34.6		

Note. BVMT-R = Brief Visuospatial Memory Test-Revised; D-KEFS = Delis-Kaplan Executive Function System; HVLT-R = Hopkins Verbal Learning Test-Revised; MoCA = Montreal Cognitive Assessment; UPSA-B = UCSD Performance-based Skills Assessment – Brief. WAIS-IV = Wechsler Adult Intelligence Scale, 4th edition; WRAT-4 = Wide Range Achievement Test – Fourth Edition.

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Table 5.

Pearson correlations between cognitive tests and a) functional abilities (UPSA-B) and b) Global Deficit Scores

Cognitive test	N	*r* (UPSA-B)	*p*	N	*r* (Global Deficit Score)	*p*
WRAT-4 Reading	109	.02	.83			
WAIS-IV Digit Span						
Total Score	108	.44	<.001	109	−.45	<.001
Forward	109	.33	<.001	110	−.29	.001
Backward	109	.30	<.001	110	−.33	<.001
Sequencing	108	.41	<.001	109	−.41	<.001
WAIS-IV Coding	105	.25	.009	106	−.47	<.001
D-KEFS Trails						
Visual Scanning	107	.14	.14	108	−.34	<.001
Number Sequencing	107	−.004	.97	108	−.30	.001
Letter Sequencing	107	.33	.001	108	−.58	<.001
Letter-Number Sequencing	107	.45	<.001	108	−.62	<.001
Motor Speed	107	.17	.08	108	−.38	<.001
D-KEFS CWIT						
Color Naming	108	.40	<.001	109	−.61	<.001
Word Reading	108	.22	.02	109	−.47	<.001
Inhibition	106	.21	.03	107	−.54	<.001
Inhibition/Switching	104	.33	.001	105	−.51	<.001
FAS	109	.23	.02	110	−.36	<.001
Animal fluency	109	.46	<.001	110	−.51	<.001
Boston Naming Test	109	.27	.005	110	−.19	.025
HVLT-R						
Total Recall	108	.38	<.001	109	−.45	<.001
Delayed Recall	108	.46	<.001	109	−.61	<.001
Retention	108	.45	<.001	109	−.64	<.001
Recognition Discrimination	108	.31	.001	109	−.39	<.001
BVMT-R						
Total Recall	105	.54	<.001	106	−.68	<.001
Delayed Recognition	105	.46	<.001	106	−.74	<.001

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Cognitive test	N	*r* (UPSA-B)	*p*	N	*r* (Global Deficit Score)	*p*
MoCA total score	106	.57	<.001	107		

Note. BVMT-R = Brief Visuospatial Memory Test-Revised; D-KEFS = Delis-Kaplan Executive Function System; HVLT-R = Hopkins Verbal Learning Test-Revised; MoCA = Montreal Cognitive Assessment; UPSA-B = UCSD Performance-based Skills Assessment – Brief. WAIS-IV = Wechsler Adult Intelligence Scale, 4th edition; WRAT-4 = Wide Range Achievement Test – Fourth Edition.

Table 6.

Simultaneous multiple regression with global deficit score as the outcome and cognitive tests as the predictors.

Variable	*B*	*SE B*	β	*p* value
Constant	1.91	0.13		
WAIS-IV Digit Span				
Forward	.001	.01	.01	.91
Backward	−.01	.01	−.13	.06
Sequencing	.01	.01	.05	.42
WAIS-IV Coding	.01	.01	.09	.16
D-KEFS Trails				
Visual Scanning	.01	.01	.06	.37
Number Sequencing	−.002	.01	−.02	.77
Letter Sequencing	−.02	.01	−.14	.08
Letter-Number Sequencing	−.01	.01	−.15	.05
Motor Speed	−.02	.01	−.15	.02
D-KEFS Color-Word Interference Test				
Color Naming	−.02	.01	−.20	.02
Word Reading	−.002	.01	−.02	.84
Inhibition	.002	.01	.02	.77
Inhibition/Switching	−.01	.01	−.16	.02
Letter fluency	−.001	.002	−.01	.91
Animal fluency	−.002	.002	−.08	.16
HVLT-R				
Total Recall	<.001	.002	−.02	.86
Retention	−.01	.001	−.41	<.001
Recognition Discrimination	−.002	.002	−.09	.14
BVMT-R				
Total Recall	.003	.003	.12	.24
Delayed Recognition	−.01	.003	−.31	.001

Note. BVMT-R = Brief Visuospatial Memory Test-Revised; D-KEFS = Delis-Kaplan Executive Function System; HVLT-R = Hopkins Verbal Learning Test-Revised; WAIS-IV = Wechsler Adult Intelligence Scale, 4th edition; WRAT-4 = Wide Range Achievement Test – Fourth Edition.

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Overall model: $R = .91$; adjusted $R^2 = .79$; $F(20, 77) = 19.43$, $p < .001$.

Table 7.

Simultaneous multiple regression with UPSA-B as the outcome and cognitive tests as the predictors.

Variable	*B*	*SE B*	β	*p* value
Constant	56.99	8.69		
WAIS-IV Digit Span				
Forward	.48	.42	.13	.26
Backward	−.05	.44	−.01	.91
Sequencing	.29	.42	.08	.49
WAIS-IV Coding	−.02	.42	−.004	.97
D-KEFS Trails				
Visual Scanning	−.91	.47	−.21	.06
Number Sequencing	−.90	.45	−.26	.05
Letter Sequencing	.99	.54	.26	.07
Letter-Number Sequencing	.63	.42	.20	.13
Motor Speed	.54	.46	.14	.24
D-KEFS Color-Word Interference Test				
Color Naming	1.36	.58	.35	.02
Word Reading	−.98	.64	−.20	.13
Inhibition	−.81	.49	−.22	.10
Inhibition/Switching	.42	.40	.13	.30
Letter fluency	−.13	.14	−.11	.35
Animal fluency	.01	.11	.01	.95
HVLT-R				
Total Recall	<.001	.14	<.001	.99
Retention	.01	.09	.02	.90
Recognition Discrimination	.13	.10	.15	.19
BVMT-R				
Total Recall	.50	.17	.51	.005
Delayed Recognition	−.28	.17	−.29	.09

Note. BVMT-R = Brief Visuospatial Memory Test-Revised; D-KEFS = Delis-Kaplan Executive Function System; HVLT-R = Hopkins Verbal Learning Test-Revised; MoCA = Montreal Cognitive Assessment; UPSA-B = UCSD Performance-based Skills Assessment – Brief. WAIS-IV = Wechsler Adult Intelligence Scale, 4th edition; WRAT-4 = Wide Range Achievement Test – Fourth Edition.

Overall model: $R = .68$; adjusted $R^2 = .32$; $F(20, 76) = 3.27$, $p < .001$.