Published in final edited form as:

J Appl Gerontol. 2021 November ; 40(11): 1579–1586. doi:10.1177/0733464820984283.

Frequency of but not Capacity for Participation in Everyday Activities is Associated with Cognitive Impairment in Late Life

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Abstract

We examined features of everyday activities (capacity;frequency) between older adults with and without cognitive impairment over 12 months. Participants were aged 60 years at-risk for depression, 26% (n=69) had an acquired cognitive impairment at baseline. Cognitive impairment was defined as one standard deviation below norms on the Repeatable Battery for the Assessment of Neuropsychological Status. Features of everyday activities were measured by a computerized adaptive test version of Late-Life Function and Disability Instrument (LLFDI) at 6 timepoints (baseline,6 weeks,3,6,9,12 months). There were significant between-group differences in activity frequency ($p=.04$), but not activity capacity ($p=.05$). The group difference in activity frequency exceeded minimal detectable changes ($MDC_{90}=3.7$) and reached moderate clinical meaningfulness (at 6 timepoints=3.7-4.7). Generalized linear mixed models revealed no group*time interactions on activity capacity and frequency ($p=.65;p=.98$). Practitioners may assess

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IRB numbers: The University of Pittsburgh institutional review board approved procedures (PRO10110050; PRO10110251; PRO10100591). Written consent was obtained.

Conflict of interest: The authors declare that there is no conflict of interest.

changes in activity frequency to monitor cognitive status of clients even when there is no loss of activity capacity.

Introduction

Understanding cognitive impairment in late-life is an aging research priority due to the elevated risk of dementia and disability (Davis et al., 2018). The estimated prevalence of cognitive impairment in older adults varies from 5.1% to 35.9% in population studies, depending on the measurement approach (Ward, Arrighi, Michels, & Cedarbaum, 2012). Common methods include neurocognitive assessments of domains of attention, memory, executive function, and processing speed (Eshkoor, Hamid, Mun, & Ng, 2015). At the outset, subtle changes in cognitive function may not be easily detected, particularly among individuals with higher education or greater cognitive reserve (Kirova, Bays, & Lagalwar, 2015). Therefore, declines in attention, memory, executive function, and processing speed may be difficult to detect (Kirova et al., 2015). In these cases, considering additional clinical manifestations to complement neurocognitive assessments may optimize the understanding of cognitive impairment in older adults (US Food and Drug Administration, 2018).

Cognitive decline and its clinical manifestations evolve in parallel trajectories, as cognitive decline is often associated with declining abilities in performance of everyday activities (Lindbergh, Dishman, & Miller, 2016). Features of performance of everyday activities can be characterized in terms of “activity capacity” and “activity frequency” (Freedman et al., 2014). Activity capacity describes the “ability” to complete a daily task (can do), while activity frequency suggests the “periodicity and willingness” of doing everyday activities (does do) (Carlson et al., 2012). Changes in activity capacity are well documented in people with dementia and Mild Cognitive Impairment (MCI), and serve as diagnostic criteria for neurocognitive disorders in the Diagnostic and Statistical Manual of Mental Disorders – 5 (DSM–5). Systematic reviews reveal that older adults with MCI experience deficits with complex everyday tasks, especially financial management (Jekel et al., 2015; Lindbergh et al., 2016). These deficits may not be characterized as “incapacity,” as they may be able to complete daily tasks, but older adults may require supervision or verbal reminders from others (Rodakowski et al., 2014).

More challenging to observe, measure, and describe is activity frequency (Eckel et al., 2014). However, changes in activity frequency – a proxy of change in daily routines – may emerge prior to problems with activity capacity, overt disability, and functional decline in late life (Freedman et al., 2014; Fried, Herdman, Kuhn, Rubin, & Turano, 1991; Gignac, Cott, & Badley, 2002). That said, the relationship between cognitive impairment and activity frequency has not been clarified. Knowledge pertaining to the trajectories of activity capacity and frequency may improve understanding of the clinical manifestations of cognitive decline, and potentially inform the timing of interventions to slow down cognitive impairment in late life.

The aim of the study was to investigate activity capacity and activity frequency in older adults with and without cognitive impairment over time. We hypothesized that there would be group differences (between people with and without cognitive impairment) in activity

capacity and activity frequency, and that activity capacity and activity frequency would decline more rapidly in the cognitive impairment group over 12 months.

Methods

We conducted a secondary analysis of data combined from three parallel clinical trials examining learning-based interventions to prevent depression in older adults at risk for major depression and anxiety disorders. These studies are described in detail elsewhere (Albert et al., 2016; Gildengers et al., 2016; Karp et al., 2016). Briefly, these studies developed and tested selective and indicated prevention interventions for older adults at-risk for depression due to cognitive impairment, knee pain, or multiple chronic conditions. Selective and indicated prevention interventions target on those who are at-risk or showing early signs of depression. These parallel intervention studies utilized problem-solving therapy for older adults to identify problems, develop personalized strategies, break them down to manageable components, and generate strategies to regulate situations that trigger negative mood. All three intervention studies assessed cognitive function at baseline, as well as activity capacity and frequency at 6 assessment time points, being baseline, post-intervention (6 weeks), 3, 6, 9, and 12-month follow-up. All the data were collected at either a clinic or the participants' home. With a computerized adaptive test version of Late Life Function Disability Instrument (LLFDI), participants were instructed by the assessor to answer questions via a software installed on a portable study computer. The University of Pittsburgh institutional review board approved procedures (PRO10110050; PRO10110251; PRO10100591) and written informed consent was obtained in the parent studies.

Participants

Participants aged 60 years and older, who had depressive symptoms (defined as Patient Health Questionnaire-9 (PHQ-9) score between 1-9 and at least a score of 1 for one of the two cardinal symptoms of depression) were included in the three parent studies (Table 2). Those with dementia, major depressive disorder, or anxiety disorder at baseline were excluded. In addition, participants met the specific criteria for one of the three studies: Mild Cognitive Impairment (MCI), knee osteoarthritis, or disability conditions with low socioeconomic status. MCI diagnosis was conferred through diagnostic adjudication sessions via neuropsychiatric testing scores, medical history, and report of changes by an informant. Knee arthritis was diagnosed by clinicians based on the American College of Rheumatology clinical criteria for knee osteoarthritis. Disability condition was defined by reporting difficulties in at least one instrumental or personal self-maintenance activity. Low socioeconomic status was defined by residing in subsidized senior housing or being eligible for long-term care services in the homes (Albert et al., 2016).

Measurement

Characteristics of participants.—Participants' age, gender, race, years of education, retirement status, comorbidity, depressive symptoms, anxiety symptoms, and mobility disability were collected via interviews and standardized testing from the parent studies (Table 2).

Features of everyday activities (activity capacity & activity frequency).—

Activity capacity and activity frequency were assessed with the computerized adaptive test version of Late Life Function Disability Instrument (LLFDI) – Disability component (Jette et al., 2002). The LLFDI is a valid and reliable measure (Beauchamp, Schmidt, Pedersen, Bean, & Jette, 2014) that is based on Nagi's model of disability (Jette et al., 2002) and the International Classification of Function, Disability, and Health (ICF) (World Health Organization, 2002). The disability component assesses socially-defined activities of daily living (i.e., visit friends and family in their homes) and instrumental and basic activities of daily living (i.e., take care of your own personal care needs, includes bathing, dressing, and toileting; take care of house hold business and finances). The component has two scales (activity capacity and activity frequency), providing an estimate of each respondent's activity capacity and activity frequency, in relation to others who have completed the measure. Each scale is unidimensional and has been validated using item response theory. In the LLFDI, each respondent is provided 5 – 7 questions, selected based on responses to the first 2 questions. The activity capacity scale questions are rated on a 5-point scale ranging from 1 to 5, where 1 is “not at all” and 5 is “completely limited”. The activity frequency scale questions are rated on a 5-point scale ranging from 1 (“never”) to 5 (“very often”).

Each respondent's raw LLFDI score is converted into a 0-100 scaled scale. Higher scores indicate higher capacity and greater frequency of everyday activities. The standard error of measurement (SEM) is 1.6, and the minimal detectable change with 90% confidence (MDC₉₀) is 3.7 for small changes in activities. A minimal clinically important difference (MCID) ranges from 2 to 4.5, with 2 and 4.5 points indicating small and substantial changes in mobility and functioning (Beauchamp, Ward, Jette, & Bean, 2019).

Cognitive impairment.—The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) yields a standardized total scores based performance in five cognitive domains (immediate memory, visuospatial/constructional, language, attention, delayed memory) (Randolph, Tierney, Mohr, & Chase, 1998). The standardized score compares with a population mean of 100 and a standard deviation of 15, with a higher score indicating better cognitive function. In the current study, cognitive impairment was operationalized by a standardized total score one standard deviation lower than the population mean (total scaled score < 85) at baseline.

Data analyses

All analyses were conducted using Statistical Packages for the Social Sciences (SPSS, v. 25) and Statistical Analysis Software (SAS, v. 9.4) with a significance level of $\alpha = .05$. Prior to analyses, data were screened to assess assumptions. The main effects of groups on activity capacity and frequency were examined. Changes in activity capacity and activity frequency were examined separately using longitudinal generalized linear mixed models with SAS PROC GLIMMIX. In each model, group (with or without cognitive impairment) and time (baseline, post intervention, 3, 6, 9, and 12 months), along with the group X time interaction, were included as fixed effects, while subjects were considered random effects. To control for potential covariates, demographic variables that showed significant group differences were included in the model. Variables that showed moderate correlation to the dependent variable

(Spearman's $r = 0.5$) were included as covariates (Assmann, Pocock, Enos, & Kasten, 2000). We did not conduct the baseline adjustment of dependent variables to avoid potential biased causal effect estimates (Glymour, Weuve, Berkman, Kawachi, & Robins, 2005).

Results

Participant characteristics were presented in Table 1. Participants were on average 73.92 (SD = 8.75) years old, mostly white, female, and had an average of 14.38 (SD = 2.67) years of education. A total of 260 participants were included in the analyses, and 69 had cognitive impairment [RBANS mean score: intact cognition group = 100.20 (SD = 9.58); cognitive impairment group = 79.22 (SD = 5.68)] (Figure 1). Baseline group differences were detected in race, years of education, severity of mobility disability, LLFDI activity capacity, and activity frequency. Activity capacity was moderately correlated activity frequency ($r = .68$) to be treated as a covariate controlled in the model.

There was no statistically significant effect of group ($F_{1,1225} = 3.74, p = .05$) or time ($F_{5,1225} = 1.06, p = .38$) in activity capacity. The mean difference in activity capacity was 2.6 points across 6-time points (range of mean differences at 6-time points = 1.8-3.7 points), which is associated with a small clinically meaningful difference based on the MCID of LLFDI (Figure 2). The group by time interaction effect was not significant for activity capacity ($F_{5,1225} = 0.67, p = .65$), after controlling for covariates (treatment assignment; race; years of education; mobility disability; baseline activity frequency).

There was a statistically significant effect of group in activity frequency ($F_{1,1232} = 4.13, p = .04$), but no effect of time ($F_{5,1232} = 1.69, p = .13$). The mean difference in activity frequency was 4.1 points across 6 time points (range of mean differences at 6-time points = 3.7-4.7 points) (Figure 3), which is a moderately-to-substantially clinically meaningful based on the MCID of LLFDI. The group by time interaction effect was not significant for activity frequency ($F_{5,1232} = 0.15, p = .98$), after controlling for covariates (treatment assignment; race; years of education; mobility disability; baseline activity capacity).

Discussion

We examined the group differences in activity capacity (can do) and activity frequency (does do) between older adults with and without cognitive impairment over 12 months. We found group differences in the activity frequency were moderately-to-substantially clinically meaningful, regardless of the time points over 12 months. In contrast, only small clinical differences between groups in the activity capacity were detected over the 12 months. Our findings suggest that low activity frequency is one of the clinical manifestations of cognitive impairment in older adults, even with preserved capacity for performing activities of daily living. That is, older adults with cognitive impairment may reduce the frequency with which they perform activities of daily living, even before their ability to perform these activities is compromised (Cassel, 2002; Wang et al., 2013). The DSM-5 diagnostic criteria for neurocognitive disorders includes changes in activity capacity without considering the potential of activity frequency as a signal for potentially having a neurocognitive

disorder. Future diagnostic criteria for neurocognitive disorders may consider frequency of performance of everyday activities as complementary clinical manifestations.

Doody et al. (2010) have shown that the individuals who showed declined cognition at baseline had a faster 15-year progression rate of IADL than those who were cognitively stable. We did not observe group by time effects in activity capacity and frequency within a year. There may be several explanations for these findings. The selection of these samples may have contributed to our findings. It may be that the participants in the parent studies were still able to compensate their cognitive loss, rather than those were declining in their cognition within the 12 months. Furthermore, 12 months may not have been long enough to observe differences. Previous studies suggest that cognitive decline progresses slowly; therefore cognitive decline could be harder to detect until more accumulation of brain damage, which could lead to clinically overt changes in activity frequency after years (Salthouse, 2012). Future studies should recruit a broader sample and examine associations among cognitive impairment and performance of everyday activities.

Another interesting finding is that standardized mean activity capacity scores were higher than activity frequency scores. This aligns with previous studies that suggest that lower levels of activity frequency may be due to loss in activity capacity (Brown et al., 2009). For example, the inability to manage medication leads to low frequency in managing medication. However, our results may reveal that low levels of activity frequency may appear even in the presence of relatively preserved activity capacity. There may be more than one potential explanation for this phenomenon. First, older adults with cognitive impairment may experience fatigue when initiating everyday activities, even though they are capable of doing activities. Second, cognitive impairment may lead to inefficiency in navigating complex daily tasks and routines. Thus, those with cognitive impairment may choose to prioritize and optimize important activities and give up things they used to enjoy, such as socializing, traveling (Buchman et al., 2014; Gignac et al., 2002). Third, cognitive impairment may be associated with depressive symptoms, and these somatic symptoms of depression may prevent older adults from engaging in everyday activities (Karp et al., 2009). Altogether, low frequency of activities may, in turn, worsen cognitive impairments, contributing to the loss of activity capacity in everyday routines, eventually contributing to a pernicious path toward dementia and mortality risks (Menec, 2003).

We found between-group differences in both activity frequency and capacity at baseline. Yet after controlling for covariates (treatment assignment; race; years of education; mobility disability), only activity frequency remained significant. Plausibly, mobility disability explains more variances in activity capacity relative to the influences of cognition, while activity frequency is highly associated with cognitive status regardless of mobility status.

Previous studies have examined the types of activities that older adults “give up” early in the progression of cognitive decline. Peterson et al. found that older adults with mild cognitive impairment spent 1.6 hours less out-of-home comparing to their healthy peers (Petersen, Austin, Mattek, & Kaye, 2015). It is likely that older adults with cognitive decline are more sedentary (Falck et al., 2017), spend more time at home (Petersen et al., 2015), and spend less time engaged in the community than their healthy peers due to the decline in

executive function or processing speed (Suzuki & Murase, 2010). Unfortunately, the trend of decreased frequency in daily activities may take years to detect, assuming that these trends are associated with slow progression of cognitive decline (Crowe et al., 2008). There are also internal and external reasons besides cognition (personal interests or geographic locations) that may result in people ceasing certain activities before others. More research is needed to explore the longitudinal changes in personal interests and in-home routines in older adults with early cognitive impairment.

In this study, we used a computerized version of LLFDI to assess features of everyday activities. This tool was efficient and satisfactory, and may be useful as a complementary, screening tool for cognitive impairment in older adults. A strength of this tool is that it utilizes item response theory and adaptive selection of questions to efficiently estimate a respondent's "placement" in reference to others in the population. However, this strength limits the ability to systematically describe what domains of activities were most strongly associated with low levels in activity frequency. Additionally, activity capacity and activity frequency were self-reported, which may differ from objective, performance-based measurement (Rogers et al., 2003). Future studies could include ecological momentary assessments or sensor-based assessments in evaluating the performance of everyday activities (Hayes et al., 2008). Another limitation is that changes in cognition may interfere with changes in activity frequency and capacity, which we did not control for over-time.

That said, it appears that frequency of performance of everyday activities may be an important clinical manifestation of cognitive impairment when seeking to detect cognitive impairment among older adults. Practitioners and home care providers may utilize a brief interview to monitor the change of frequency in meaningful activities to better glimpse cognitive status of their clients. Future studies seeking to elucidate trajectories and mechanisms that lead to aging-related cognitive decline may benefit from including brief measures of activity capacity and frequency to lineate the complex interactions among cognitive processes and performance of everyday activities.

Acknowledgments:

We thank all the participants in the DEP-ABC, RAPID, and RECALL studies.

Funding: The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by National Institutes of Health (NIH) Grant P30 MH090333 (Reynolds, Dew, Butters, Skidmore) and Clinical and Translational Science Institute Grants UL1RR024153 (Reynolds), UL1TR000005 (Reynolds).

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Figure 1.
RBANS total score between groups

Figure 2.

Raw scores of activity capacity and cognitive groups

Note: *significant between-group difference ($p < .05$), without controlling covariates

Figure 3.

Raw scores of activity frequency and cognitive groups

Note: *significant between-group difference ($p < .05$), without controlling covariates

Table 1.

Baseline participant characteristics

Characteristics [n (%)]	All	With cognitive impairment	Without cognitive impairment	<i>t</i> -statistics/ χ^2 -statistics	<i>p</i> -value
	260 (100%)	69 (26.5)	191 (73.5%)		
Age [mean (SD)]	73.92 (8.75)	73.70 (8.99)	73.99 (8.68)	$t_{(258)}=-0.24$	0.81
Female [n (%)]	179 (68.8)	48 (69.6)	131 (68.6)	$\chi^2_{(1)}=0.02$	0.88
White [n (%)]	200 (76.9)	43 (62.3)	157 (82.2)	$\chi^2_{(1)}=11.29$	<0.01 *
Years of education [mean (SD)]	14.38 (2.67)	13.15 (2.73)	14.83 (2.51)	$t_{(256)}=-4.63$	<0.01 *
Retired [n (%)]	191 (73.5)	50 (72.5)	141 (73.8)	$\chi^2_{(1)}=0.05$	0.83
Comorbidity [mean (SD)] [†]	9.73 (3.83)	10.00 (3.94)	9.63 (3.80)	$t_{(256)}=0.69$	0.49
Depressive symptoms [mean (SD)] [†]	5.94 (2.48)	6.07 (2.61)	5.89 (2.44)	$t_{(258)}=0.52$	0.60
Anxiety [mean (SD)] [†]	3.23 (2.73)	3.10 (2.67)	3.28 (2.76)	$t_{(258)}=-0.47$	0.64
Mobility disability [mean (SD)]	7.57 (3.80)	5.94 (4.30)	8.16 (3.43)	$t_{(99.5)}=-3.83$	<0.01 *
RBANS [mean (SD)]					
Immediate memory	98.52 (14.56)	85.09 (10.61)	103.27 (12.93)	$t_{(258)}=-10.74$	<0.01 *
Visuospatial/constructional	90.51 (16.28)	77.36 (12.94)	95.59 (14.44)	$t_{(258)}=-9.23$	<0.01 *
Language	98.54 (10.63)	92.32 (8.42)	100.83 (10.49)	$t_{(258)}=-6.72$	<0.01 *
Attention	97.93 (16.29)	84.46 (12.46)	103.05 (14.29)	$t_{(258)}=-9.57$	<0.01 *
Delayed memory	95.01 (14.39)	81.39 (13.64)	100.12 (11.07)	$t_{(258)}=-10.25$	<0.01 *
Total	94.63 (12.72)	79.22 (5.68)	100.20 (9.58)	$t_{(258)}=-21.56$	<0.01 *
LLFDI [mean (SD)]					
Activity capacity	52.04 (6.83)	50.92 (5.57)	52.68 (7.07)	$t_{(250)}=-2.05$	0.04 *
Activity frequency	47.69 (8.36)	45.32 (9.07)	49.09 (7.74)	$t_{(246)}=-3.22$	<0.01 *

[†]Higher scores indicate worse;

* *p*-value<0.05;

Cumulative Illness Rating Scale-Geriatric (CIRS-G); Patient Health Questionnaire-9 (PHQ-9); Generalized Anxiety Disorder-7 (GAD-7); Short Physical Performance Battery (SPPB); Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)

Table 2.

Description of measurements

Concept	Measurement	Items	Item scale	Total score
Comorbidity	Cumulative Illness Rating Scale-Geriatric (CIRS-G)(Miller et al., 1992)	14	5-point scale (0-no problem; 4-extremely severe/immediate treatment required)	0 (no comorbidity) to 56 (severe comorbidity)
Depressive symptoms	Patient Health Questionnaire-9 (PHQ-9)(Kroenke & Spitzer, 2002; Kroenke, Spitzer, & Williams, 2001)	9	4-point scale (0-not at all; 3-Nearly every day)	0 (no depressive symptoms) to 27 (severe depressive symptoms)
Anxiety	Generalized Anxiety Disorder-7 (GAD-7)(Spitzer, Kroenke, Williams, & Löwe, 2006)	7	4-point scale (0-not at all; 3-Nearly every day)	0 (no anxiety) to 21 (severe anxiety symptoms)
Mobility disability	Short Physical Performance Battery (SPPB)(Guralnik et al., 1994)	3 components (balance, gait speed, transfer)	4-point scale (0-not at all; 3-Nearly every day)	0 (worse lower extremity functioning) to 12 (no lower extremity functioning impairment)