



## Experimental Aging Research

An International Journal Devoted to the Scientific Study of the Aging Process


ISSN: (Print) (Online) Journal homepage: [www.tandfonline.com/journals/uear20](http://www.tandfonline.com/journals/uear20)


# Depressive Symptoms are Associated with Decline Over Time in Verbal Fluency Performance in Female but Not Male Community-Dwelling Older Adults

Jessica S. Wasserman & Roe Holtzer


To cite this article: Jessica S. Wasserman & Roe Holtzer (2024) Depressive Symptoms are Associated with Decline Over Time in Verbal Fluency Performance in Female but Not Male Community-Dwelling Older Adults, *Experimental Aging Research*, 50:3, 360-375, DOI: [10.1080/0361073X.2023.2195295](https://doi.org/10.1080/0361073X.2023.2195295)


To link to this article: <https://doi.org/10.1080/0361073X.2023.2195295>

 View supplementary material 

 Published online: 29 Mar 2023.

 Submit your article to this journal 

 Article views: 108

 View related articles 

 View Crossmark data 

 Citing articles: 1 View citing articles 



# Depressive Symptoms are Associated with Decline Over Time in Verbal Fluency Performance in Female but Not Male Community-Dwelling Older Adults

Jessica S. Wasserman<sup>a</sup> and Roe Holtzer<sup>a,b</sup>

<sup>a</sup>Ferkauf Graduate School of Psychology, Yeshiva University, Bronx, New York, USA; <sup>b</sup>Department of Neurology, Albert Einstein College of Medicine, Bronx, New York, USA

## ABSTRACT

**Objective:** The current study was designed to examine associations between depressive symptoms and longitudinal declines in category and letter fluency performance in a gender-stratified sample of older adults.

**Method:** Participants were community-residing older adults (females:  $n = 289$ ; males:  $n = 233$ ) followed annually (2011–2018) as part of a cohort study conducted at Albert Einstein College of Medicine in New York. Depressive symptoms were assessed using the Geriatric Depression Scale (GDS). Standard forms assessed category and letter fluency performance. Participants were dementia-free during study enrollment.

**Results:** The presence of baseline depressive symptoms suggestive of subclinical depression was associated with a worse longitudinal decline in category fluency performance in female but not male participants. These associations remained significant when excluding participants with prevalent and incident mild cognitive impairment and incident dementia. Irrespective of gender, letter fluency performance did not decline over time and was not influenced by the presence of depressive symptoms.

**Discussion:** The present study's results can aid in identification of older adults who may be at greater risk for cognitive decline, and add to the limited literature examining the influence of gender on longitudinal associations between depressive symptoms and verbal fluency performance.


## ARTICLE HISTORY

Received 1 September 2022  
Accepted 16 March 2023

## Gender and Depression in Older Adults

Late-life depression is common in older adults, with prevalence rates of clinically significant depressive symptoms among older adults ranging from 8% to 16% (Taylor, 2014). Subclinical depressive symptoms are also common among older adults; research in older adult community samples has shown that prevalence of subclinical depression symptoms ranges from 8.8% to 21.3% (Chen, Chong, & Tsang, 2007; Schoevers et al., 2006). Late-life depression, including clinically significant and subclinical depression, is associated with a variety of negative outcomes, including decreased quality of life (Chachamovich, Fleck, Laidlaw, & Power, 2008),

**CONTACT** Roe Holtzer  [roee.holtzer@yu.edu](mailto:roee.holtzer@yu.edu)  Department of Neurology, Albert Einstein College of Medicine, 1225 Morris Park Avenue, Van Etten Building, Bronx, NY 10461, USA

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/0361073X.2023.2195295>.

© 2023 Taylor & Francis Group, LLC

increased risk for a decline in functional status (Stuck et al., 1999), and worse cognitive performance and worse cognitive decline (Dotson, Resnick, & Zonderman, 2008).

Whereas during adolescent years through approximately age 55, the diagnosis and symptoms of depression are more common in females compared to males (Essau, Lewinsohn, Seeley, & Sasagawa, 2010; Kessler, McGonagle, Swartz, Blazer, & Nelson, 1993) results are mixed in older adults (Anstey, von Sanden, Sargent-Cox, & Luszcz, 2007; Forlani et al., 2014; Girgus & Yang, 2015; Girgus, Yang, & Ferri, 2017; Li, Lin, & Chen, 2011; Regan, Kearney, Savva, Cronin, & Kenny, 2013; Trollor et al., 2007). Furthermore, research examining factors proposed to explain gender-related variability in the presence and symptomatology of depression among older adults, including being widowed (Glei, Goldman, Liu, & Weinstein, 2013), living alone (Oh et al., 2014), poorer health (Noh et al., 2016), having dementia (Lee, Lee, & Kim, 2017), financial strain (Glei, Goldman, Liu, & Weinstein, 2013), and burdens of caregiving (Pinquart & Sorensen, 2006), yielded inconsistent results.

### Verbal Fluency in Older Adults

Performance on measures of category and letter fluency, which are commonly utilized in clinical and research settings (Henry, Crawford, & Phillips, 2004), declines in aging (Harada, Love, & Triebel, 2013). This decline in performance is due, in part, to age-related slowing in processing speed (Salthouse, 1996). Furthermore, among healthy older adults without cognitive impairment, performance is worse on category fluency compared to letter fluency (Brickman et al., 2005; Clark et al., 2009). Kavé and Mashal (2012) have proposed that the Transmission Deficit Hypothesis might explain this finding. This hypothesis posits that older adults have weakened associations between semantic representations and phonological representations (Burke & Shafto, 2004; Burke, MacKay, Worthley, & Wade, 1991). Letter fluency requires individuals to produce words using only phonological representations, whereas category fluency requires individuals to produce words using both phonological representations and semantic representations (Kavé & Mashal, 2012). Hence, the increased demands imposed on the semantic system in category fluency might explain its greater sensitivity to age-related cognitive decline compared to letter fluency.

Older adults with Alzheimer's disease perform worse than healthy older adults on verbal fluency tasks, particularly on category fluency tasks (Clark et al., 2009; Martin & Fedio, 1983; Tröster, Salmon, McCullough, & Butters, 1989). Further, research has shown that individuals with mild cognitive impairment (MCI) and Alzheimer's disease perform worse on category fluency tasks as compared to letter fluency tasks (Clark et al., 2009; Henry, Crawford, & Phillips, 2004; Murphy, Rich, & Troyer, 2006). Clark et al. (2009) also demonstrated that, in healthy older adults and older adults with preclinical Alzheimer's disease, category fluency performance declined faster than letter fluency performance over longitudinal follow-up. Thus, category fluency appears to be more susceptible to decline than letter fluency performance in healthy older adults and in individuals with neurodegenerative disease. As such, category fluency performance has been suggested to be a useful indicator to differentiate healthy controls from adults with MCI and Alzheimer's disease (Duff Canning, Leach, Stuss, Ngo, & Black, 2004; Monsch et al., 1992).

### ***Depressive Symptoms and Verbal Fluency Performance***

Results regarding the association between depressive symptoms and verbal fluency performance in community-dwelling older adults have been mixed. In cross-sectional studies, greater levels of depressive symptoms were associated with worse performance on both category fluency and letter fluency (Auriacombe, Fabrigoule, Lafont, Jacqmin-Gadda, & Dartigues, 2001; Yochim, Mueller, & Segal, 2013), only on letter fluency (Dotson, Resnick, & Zonderman, 2008; Ravdin, Katzen, Agrawal, & Relkin, 2003), or on neither measure (Beaudreau & O'hara, 2009; Bunce, Batterham, Mackinnon, & Christensen, 2012). Longitudinal studies also show mixed results. Gkatzamanis et al. (2021) found that greater levels of depressive symptoms were associated with a longitudinal decline in category fluency performance. Additionally, Yochim, MacNeill, and Lichtenberg (2006) found that greater levels of depressive symptoms were associated with worse verbal fluency performance at 3 months and 6 months after baseline in older adults treated in an inpatient medical rehabilitation setting. In contrast to these findings, Bunce, Batterham, Mackinnon, and Christensen (2012), Burhanullah et al. (2020), and Dotson, Resnick, and Zonderman (2008) did not find longitudinal associations between depressive symptoms and verbal fluency performance in healthy community-dwelling older adults.

### ***Gender Differences in Verbal Fluency Performance***

In cross-sectional studies, McCarrey, An, Kitner-Triolo, Ferrucci, and Resnick (2016) reported that females performed better on both category fluency and letter fluency as compared to males; Auriacombe, Fabrigoule, Lafont, Jacqmin-Gadda, and Dartigues (2001) and Zhang, Zhou, Wang, and Zhang (2017) found that females performed better on category but not letter fluency as compared to males. In contrast, Munro et al. (2012) found that males demonstrated superior performance on letter fluency than females, but gender differences on category fluency performance were insignificant. Finally, Elosúa, Ciudad, and Contreras (2021) and Esteves et al. (2015) observed that gender was not associated with letter or category fluency performance. Few longitudinal studies have examined gender differences in changes in verbal fluency performance over time. Of these few studies, McCarrey, An, Kitner-Triolo, Ferrucci, and Resnick (2016) did not find gender differences in changes in verbal fluency performance over time, while Zaninotto, Batty, Allerhand, and Deary (2018) found that depressive symptoms predicted a faster decline in category fluency performance for males only.

### ***Present Study***

The present study was designed to address an important gap in the literature concerning the relationships between gender, depressive symptoms, and longitudinal declines in category and letter fluency among community-residing older adults. Specifically, we aimed to determine whether the impact of baseline levels of depressive symptoms on longitudinal changes in category and letter fluency performance was different in women as compared to men ages 65 years or older. We further evaluated whether the length of follow-up, presence of mild cognitive impairments at baseline, development of mild cognitive impairments during follow-up, and development of dementia during follow-up influenced the

associations between depressive symptoms and longitudinal changes in verbal fluency performance.

## Method

### *Participants*

Community-dwelling older adults aged 65 years or older participated in a longitudinal cohort study, Central Control of Mobility in Aging (CCMA), which examined cognitive predictors of mobility and decline in aging. Study participants ( $N = 522$ ) were recruited from Westchester County, NY via a letter sent to their home and by a telephone call inviting them to participate in the study. A structured telephone interview was administered to screen potential participants for eligibility. Participants were excluded if they had difficulty understanding or speaking English, an inability to ambulate independently, a positive screen for possible dementia, a significant loss of vision and/or hearing, current or a history of neurological or psychiatric disorders, recent or anticipated medical procedures that could affect mobility and receiving hemodialysis. Eligible study participants were scheduled for two in-person visits that consisted of neuropsychological, cognitive, psychological, neurological, and mobility assessments. Participants provided written informed consent for the study protocol, approved by the Albert Einstein College of Medicine Institutional Review Board, at their first clinic visit. Participants' baseline visits took place between June 2011 and October 2017. Participants completed yearly follow-up visits for up to 7 years. Participants' cognitive status (normal, MCI, or dementia) was evaluated using diagnostic case conference procedures as previously described (Holtzer, Verghese, Wang, Hall, & Lipton, 2008). See Holtzer, Wang, and Verghese (2014) for a more detailed description of the study procedures.

### *Measures*

#### *Depressive Symptoms*

Depressive symptoms were measured at baseline using the Geriatric Depression Scale (GDS; Yesavage et al., 1983). GDS is a 30-item self-report measure that asks respondents whether they experienced specific depressive symptoms in the past week. Respondents provide "yes" or "no" responses to each statement. Scores range from 0 to 30 and each item is worth 1 point. The GDS has been shown to be a reliable and valid measure of depression in older adult populations and is commonly used in research and clinical settings to screen for depression (Areán & Ayalon, 2005; Krishnamoorthy, Rajaa, & Rehman, 2020; Yesavage et al., 1983). Brink et al. (1982) conducted sensitivity and specificity analyses on the GDS and found that, in a sample of older adults, a score of 11 resulted in an 84% sensitivity rate and a 95% specificity rate of depression. Based on these results, Brink et al. (1982) recommended cutoff points, such that total scores of 0–10 indicate that the respondent does not have depression, whereas scores greater than or equal to 11 are considered a possible indication of depression. These cutoff scores have been utilized in prior research (Arfken, Lach, Birge, & Miller, 1994; Koizumi et al., 2005; Wang et al., 2022).

### **Verbal Fluency**

Verbal fluency performance was measured annually. The Controlled Oral Word Association Test (COWAT; Spreen & Benton, 1977) was used to examine category and letter fluency. The COWAT has commonly been used to assess verbal fluency in samples of healthy community-dwelling older adults (Axelrod & Henry, 1992). The letter fluency task instructed participants to rapidly generate words that begin with a specific letter (F, A, and S) in 60 s. Participants were asked not to give responses of proper nouns or multiple responses with the same root and different suffixes; these were denoted as incorrect responses. Repetitions and perseverations were additionally denoted as incorrect responses. Participants were also given a category fluency task and were instructed to rapidly name items that belonged to the same category in 60 s. The categories consisted of fruits, vegetables, and animals. Repetitions and perseverations were denoted as incorrect responses. Scores across the three trials in the letter fluency task and scores across the three trials in the category fluency task were separately summed for each participant. The total scores for category and letter fluency were converted into averaged *z*-scores based on the sample distribution.

### **Covariates**

Covariates included age, years of education, Wide Range Achievement Test – Third Edition (WRAT-3; Wilkinson, 1993) and a Global Health Score (GHS; Holtzer, Verghese, Xue, & Lipton, 2006). The WRAT-3 was used as a measure of estimated premorbid functioning. The GHS ranges from 0 to 10 and was used to adjust for health comorbidities, including arthritis, hypertension, stroke, and Parkinson's disease.

### **Statistical Analysis**

Data were inspected visually to examine the distributions of the variables. Descriptive statistics were calculated for demographic characteristics and baseline variables, including depressive symptoms and performances on category and letter fluency. Depressive symptoms were measured using the total GDS score. As our sample was relatively healthy, we expected most GDS scores to be within the normal range. Based on the positively skewed distribution of the scores that demonstrated that depressive symptoms were low across the sample, depressive symptoms were examined as a dichotomized variable, using Brink et al. (1982)'s cutoff points. As such, individuals whose GDS score was 10 or less were in the “no depression” group, whereas individuals whose GDS score was 11 or greater were in the “possible depression” group. As the distributions for category and letter fluency scores were normally distributed, category and letter fluency performance were examined as continuous variables. Category and letter fluency performance were examined as *z*-scores based on the sample distribution.

Linear mixed-effects models, stratified by gender, were utilized to examine whether baseline depressive symptoms predicted decline in performance on category and letter fluency over time. Linear mixed-effects models were selected for their strengths in the analysis of non-independent data and their ability to handle missing data (Brauer & Curtin, 2017). To analyze the moderating effect of the predictor variable on cognitive decline, two-way interactions between the predictor and time were examined. The predictor and covariates were entered as fixed effects, and subject and time were entered as random effects. Time was a repeated random effect and was defined by years of data collection (years

one to five). Primary analyses were restricted to years one through five to account for attrition in the last 2 years of follow-up that could have biased the results. The moderating effects of depressive symptoms on longitudinal changes in verbal fluency were examined via two-way interactions of baseline GDS scores and time. In all models, the baseline GDS score was used as the two-level predictor variable and category and letter fluency performance served as the outcome variables. Models were first run unadjusted and then adjusted for covariates. The SPSS Version 27 was utilized to run analyses.

Several supplementary sensitivity analyses were run to examine the effects of confounders on study outcomes. First, we examined whether extending the length of follow-up to include years of significant attrition impacted the relationship between depressive symptoms and changes in verbal fluency performance. Additional sensitivity analyses were run excluding participants with prevalent MCI (i.e., MCI at baseline), incident MCI (i.e., MCI developed at follow-up), and incident dementia (i.e., dementia developed at follow-up). All supplementary gender-stratified models were run first unadjusted and then adjusted for covariates.

## Results

### Participant Characteristics

Of those participants screened for eligibility, 591 participants were deemed eligible and participated in the CCMA study. Sixty participants were excluded due to missing baseline demographic variables and cognitive scores and nine were excluded due to being assigned a case consensus diagnosis of dementia at baseline. Thus, data from 522 participants were utilized in data analyses. As can be seen in Table 1, the sample of 522 participants had a mean age of 75.96 ( $SD = 6.46$ ) and had a mean of 14.60 ( $SD = 2.92$ ) years of education. Of the 522 participants, 80.30% were Caucasian and 55.40% were female. Gender and ethnicity were collected via participant self-report. Participants reported minimal levels of depression, reflected by a GDS mean of 4.72 ( $SD = 3.96$ ), and were relatively healthy, demonstrated

**Table 1.** Baseline Demographic Characteristics, Depressive Symptoms, and Verbal Fluency Scores for Total Sample and for Sample Stratified by Depressive Symptoms and by Gender.

Baseline Characteristic	Total Sample ( $N = 522$ )		Possible Depression ( $n = 44$ ) M(SD) or n(%)	$p$	Females ( $n = 289$ )		$p$
	M(SD) or n(%)	No Depression ( $n = 478$ ) M(SD) or n(%)			M(SD) or n(%)	Males ( $n = 233$ ) M(SD) or n(%)	
Age	75.96 (6.46)	75.94 (6.45)	76.20 (6.63)	.755	76.18 (6.36)	75.68 (6.58)	.229
Gender	–	–	–	.035	–	–	–
Female	289 (55.40%)	258 (89.27%)	31 (10.73%)	–	–	–	–
Male	233 (44.60%)	220 (94.42%)	13 (5.58%)	–	–	–	–
Education	14.60 (2.92)	14.67 (2.93)	13.75 (2.67)	.044	14.22 (2.69)	15.06 (3.12)	.001
GDS	4.72 (3.96)	3.84 (2.70)	14.23 (2.81)	–	4.96 (4.17)	4.42 (3.67)	.250
GHS	1.63 (1.08)	1.59 (1.08)	2.07 (1.02)	.005	1.68 (1.08)	1.58 (1.08)	.301
WRAT-3	106.88 (0.44)	107.12 (9.84)	104.25 (11.53)	.100	106.92 (9.83)	106.82 (10.27)	.900
CAT	0.21 (1.26)	0.22 (1.28)	0.15 (1.04)	.758	0.39 (1.26)	–0.01 (1.24)	<.001
LET	0.12 (1.15)	0.15 (1.14)	–0.11 (1.27)	.157	0.22 (1.16)	0.01 (1.13)	.036

Note: Age represented as years of age; education represented as years of education; GDS = Geriatric Depression Scale; GHS = Global Health Status; WRAT-3 = Wide Range Achievement Test – 3<sup>rd</sup> Edition; CAT = Category Fluency; LET = Letter Fluency; scores for Category Fluency and Letter Fluency are displayed as z-scores based on the robust norms from Holtzer, Goldin, Zimmerman, Katz, Buschke, & Lipton (2008);  $p$ -values indicate significance values for group comparisons between No Depression and Possible Depression and between Females and Males respectively.



by a GHS mean of 1.63 ( $SD = 1.08$ ). Participants demonstrated estimated premorbid functioning within the average range on the WRAT-3 ( $M = 106.88$ ,  $SD = 0.44$ ). Participants demonstrated average baseline performance on category fluency ( $z$ -score = 0.21,  $SD = 1.26$ ) and letter fluency ( $z$ -score = 0.12,  $SD = 1.15$ ). See Table 1 for further descriptive statistics of baseline demographic characteristics and variables. The mean length of follow-up was 3.64 ( $SD = 1.74$ ) years. The annual attrition rate for the first five years of follow-up was approximately 14%, and largely due to the conclusion of active data collection, the sample size was significantly reduced in the last two years of follow-up.

Based on the clinical cutoffs (Brink et al., 1982), 478 participants (91.58% of the total sample) were in the “no depression” group and 44 participants (8.42% of the total sample) were in the “possible depression” group. The “no depression” group included 258 females (89.27% of females) and 220 males (94.42% of males), and the “possible depression” group included 31 females (10.73% of females) and 13 males (5.58% of males). The “no depression” and “possible depression” groups significantly differed on gender, years of education, and GHS score. The “no depression” and “possible depression” groups did not significantly differ on other demographic or cognitive variables. As stated previously, of the 522 participants, 289 (55.40% of the total sample) were female and 233 (44.60% of the total sample) were male. Females and males significantly differed on years of education, baseline category fluency performance, and baseline letter fluency performance, with females outperforming males on baseline category and letter fluency performance. There were no gender differences in age, GDS score, GHS score, or WRAT-3 performance.

### Impact of Depressive Symptoms on Category Fluency Performance

As can be seen in Table 2, adjusted linear mixed-effects models stratified by gender revealed that category fluency performance declined significantly over time in females (estimate =  $-0.03$ ,  $p = .026$ ) and males (estimate =  $-0.04$ ,  $p = .024$ ). Furthermore, compared to no depression, the presence of possible depression predicted a greater decline in category

**Table 2.** Linear Mixed-Effects Model: A Stratified Adjusted Model Analyzing the Effect of Gender on the Relationship between Depression and Change in Category Fluency Performance Over 5 Years.

Variable	Estimate	95% CI	<i>t</i>	<i>p</i>
<b>Males</b>				
Depression	-0.15	[-0.73, 0.42]	-0.52	.601
Time	-0.04	[-0.07, -0.01]	-2.28	.024
Depression x Time	-0.03	[-0.17, 0.11]	-0.44	.658
Age	-0.04	[-0.05, -0.02]	-4.08	<.001
Education (years)	0.05	[0.01, 0.10]	2.20	.029
GHS	0.11	[0.00, 0.22]	2.06	.040
WRAT -3	0.02	[0.01, 0.04]	3.09	.002
<b>Females</b>				
Depression	0.12	[-0.26, 0.49]	0.62	.537
Time	-0.03	[-0.07, -0.01]	-2.25	.026
Depression x Time	-0.16	[-0.25, -0.06]	-3.18	.002
Age	-0.04	[-0.06, -0.03]	-5.15	<.001
Education (years)	-0.01	[-0.06, 0.03]	-0.54	.588
GHS	-0.03	[-0.12, 0.07]	-0.58	.562
WRAT -3	0.04	[0.03, 0.06]	7.07	<.001

Note: Depression indicates possible depression (reference group) vs. no depression; GHS = Global Health Status; WRAT-3 = Wide Range Achievement Test - 3<sup>rd</sup> Edition.



fluency performance for females (estimate =  $-0.16$ ,  $p = .002$ ) but not males (estimate =  $-0.03$ ,  $p = .658$ ). In regard to covariates, older age was associated with worse baseline category fluency performance for females (estimate =  $-0.04$ ,  $p < .001$ ) and males (estimate =  $-0.04$ ,  $p < .001$ ). Better WRAT-3 performance was associated with better baseline category fluency performance for females (estimate =  $0.04$ ,  $p < .001$ ) and males (estimate =  $0.02$ ,  $p = .002$ ). For males only, greater years of education (estimate =  $0.05$ ,  $p = .029$ ) and higher GHS score (estimate =  $0.11$ ,  $p = .040$ ) was associated with better baseline category fluency performance.

### **Impact of Depressive Symptoms on Letter Fluency Performance**

As can be seen in Table 3, adjusted linear mixed-effects models stratified by gender that examined the impact of depressive symptoms on changes in letter fluency performance over time found that letter fluency performance did not decline significantly over time in females or males. Further, there were no significant associations between depressive symptoms and letter fluency performance; thus, the presence of possible depression, as compared to no depression status, did not predict a decline in letter fluency performance for females or males. In regard to covariates, better WRAT-3 performance was associated with better baseline letter fluency performance for females (estimate =  $0.05$ ,  $p < .001$ ) and males (estimate =  $0.04$ ,  $p < .001$ ).

### **Supplementary Analyses**

Supplementary stratified, adjusted linear mixed-effects models were run to examine whether the results remained the same when extending the length of follow-up to 7 years and when excluding participants with prevalent and incident MCI and incident dementia. First, we ran analyses with all 522 participants including data from years 1–7 to examine whether extending the length of follow-up would impact the relationship between

**Table 3.** Linear Mixed-Effects Model: A Stratified Adjusted Model Analyzing the Effect of Gender on the Relationship between Depression and Change in Letter Fluency Performance Over 5 Years.

Variable	Estimate	95% CI	<i>t</i>	<i>p</i>
<b>Males</b>				
Depression	−0.46	[−0.97, 0.05]	−1.77	.078
Time	0.03	[−0.01, 0.06]	1.72	.087
Depression x Time	0.05	[−0.08, 0.18]	0.75	.452
Age	−0.01	[−0.02, 0.01]	−0.94	.346
Education (years)	0.02	[−0.02, 0.06]	1.03	.303
GHS	0.02	[−0.08, 0.12]	0.33	.739
WRAT-3	0.04	[0.03, 0.06]	6.73	<.001
<b>Females</b>				
Depression	0.06	[−0.29, 0.40]	0.31	.755
Time	0.02	[−0.01, 0.04]	1.28	.202
Depression x Time	−0.03	[−0.11, 0.05]	−0.67	.502
Age	−0.01	[−0.02, 0.01]	−0.67	.506
Education (years)	−0.01	[−0.05, 0.03]	−0.46	.644
GHS	−0.05	[−0.14, 0.04]	−1.05	.294
WRAT-3	0.05	[0.04, 0.06]	7.97	<.001

Note: Depression indicates possible depression (reference group) vs. no depression; GHS = Global Health Status; WRAT-3 = Wide Range Achievement Test – 3<sup>rd</sup> Edition.

depressive symptoms and verbal fluency performance. We then ran analyses excluding participants with prevalent or incident MCI ( $n = 141$ ), analyses excluding participants with incident dementia ( $n = 28$ ), and analyses excluding participants with prevalent or incident MCI or incident dementia ( $n = 169$ ). We found that for all supplementary analyses, the presence of possible depression as compared to no depression status predicted declines in category fluency performance for females only, such that extending the length of follow-up (estimate =  $-0.12$ ,  $p = .008$ ), excluding prevalent and incident MCI cases (estimate =  $-0.19$ ,  $p = .005$ ), excluding incident dementia cases (estimate =  $-0.12$ ,  $p = .017$ ), and excluding prevalent and incident MCI and incident dementia cases (estimate =  $-0.20$ ,  $p = .004$ ), did not change the results. These results are summarized in Supplementary Tables S1–8.

## Discussion

Results indicate that, among community-residing older adults, the baseline presence of depressive symptoms suggestive of possible, or subclinical, depression was associated with a worse decline in category fluency performance during longitudinal follow-up in female but not male participants. Irrespective of gender, letter fluency performance did not decline over time and was not influenced by levels of depressive symptoms. Notably, supplemental analyses demonstrated that associations between baseline depressive symptoms suggestive of subclinical depression and decline in category fluency performance over time among older women cannot be attributed to possible attrition biases nor the presence or development of mild cognitive impairments or dementia.

Importantly, the present study elucidated the influence of depressive symptoms on longitudinal changes in category and letter fluency performance in a gender-stratified sample of older adults. As depressive symptoms and verbal fluency are commonly examined in clinical and research settings, the present study's results can aid clinicians and researchers in identifying individuals who may be at a greater risk of cognitive decline. Further, subclinical depressive symptoms are prevalent among older adults (Chen, Chong, & Tsang, 2007; Schoevers et al., 2006), yet may not be as easily or quickly detected (Conner et al., 2010). Thus, it is important to examine the impact of depressive symptoms that do not reach clinical thresholds, as we have shown that there is a relationship between subclinical depressive symptoms and an important indicator of cognitive decline, namely, category fluency (Duff Canning, Leach, Stuss, Ngo, & Black, 2004). Thus, our results shed light on the lesser-understood impact of subclinical depressive symptoms on verbal fluency performance in community-dwelling older adults, and highlight gender differences for this association. Moreover, although the relationship between depression and dementia remains unclear, research has posited that depression may be a risk factor for developing Alzheimer's disease (Cantón-Habas, Rich-Ruiz, Romero-Saldaña, & Carrera-González, 2020; Ownby, Crocco, Acevedo, John, & Loewenstein, 2006), and that depression may be a prodrome to dementia (Mirza et al., 2016). Thus, it is imperative to address modifiable risk factors, such as depressive symptoms, earlier in the aging process to reduce the potential risk of cognitive decline (Gkatzamanis et al., 2021).

Consistent with research demonstrating that healthy older adults tend to perform worse on category fluency as compared to letter fluency (Brickman et al., 2005; Clark et al., 2009), we observed that category fluency performance declined over time in females and males, whereas there was no change in letter fluency performance over

time for females or males. Our findings are also congruent with research that demonstrated longitudinal associations between depressive symptoms and change in category fluency performance over time (Gkatzamanis et al., 2021; Yochim, MacNeill, & Lichtenberg, 2006; Zaninotto, Batty, Allerhand, & Deary, 2018). In contrast, Bunce, Batterham, Mackinnon, and Christensen (2012), Burhanullah et al. (2020), and Dotson, Resnick, and Zonderman (2008) did not find longitudinal associations between depressive symptoms and verbal fluency performance. Mixed evidence may, in part, be attributed to methodological differences between studies, including differing sample sizes, demographic characteristics, and measures of depressive symptoms and verbal fluency.

Research has demonstrated mixed evidence for gender differences in baseline verbal fluency performance (Auriacombe, Fabrigoule, Lafont, Jacqmin-Gadda, & Dartigues, 2001; Elosúa, Ciudad, & Contreras, 2021; Esteves et al., 2015; McCarrey, An, Kitner-Triolo, Ferrucci, & Resnick, 2016; Munro et al., 2012; Zhang, Zhou, Wang, & Zhang, 2017) and change in verbal fluency performance over time (McCarrey, An, Kitner-Triolo, Ferrucci, & Resnick, 2016; Zaninotto, Batty, Allerhand, & Deary, 2018). Notably, Zaninotto, Batty, Allerhand, and Deary (2018) found that, for males only, depressive symptoms were predictive of a faster decline in category fluency performance over time. In contrast to Zaninotto, Batty, Allerhand, and Deary (2018)'s findings, we observed that baseline presence of depressive symptoms suggestive of subclinical depression was associated with worse decline in category fluency performance for females only. It is possible that the methodological differences between our study and Zaninotto, Batty, Allerhand, and Deary (2018)'s study, including differences in participant age, depression measures, and number of categories in the category fluency task, account for the discrepancy regarding the impact of depressive symptoms on the change in verbal fluency performance over time in female and male participants. Notably, although studies examining gender differences in depression in older adults have shown mixed results (Anstey, von Sanden, Sargent-Cox, & Luszcz, 2007; Forlani et al., 2014; Girgus, Yang, & Ferri, 2017; Li, Lin, & Chen, 2011; Regan, Kearney, Savva, Cronin, & Kenny, 2013; Trollor et al., 2007), of studies that did find a gender difference, authors consistently found that females have more depressive symptoms or a greater number of depressive diagnoses as compared to males (Anstey, von Sanden, Sargent-Cox, & Luszcz, 2007; Girgus, Yang, & Ferri, 2017; Regan, Kearney, Savva, Cronin, & Kenny, 2013; Trollor et al., 2007); this is in line with the present study's findings.

Regarding covariates, better WRAT-3 performance was associated with better baseline category fluency performance and letter fluency performance for females and males. Research has shown that WRAT-3 performance is correlated to category fluency and letter fluency performance in older adults (Manly, Byrd, Touradji, & Stern, 2004). Further, older age was associated with worse baseline category fluency performance but not baseline letter fluency performance, in males and females. An association between older age and a decline in verbal fluency performance has been reported in the literature (Harada, Love, & Triebel, 2013; Singh-Manoux et al., 2012). Moreover, for males only, a greater number of years of education was associated with better baseline category fluency performance, but not baseline letter fluency performance. Higher education has been shown to be associated with superior verbal fluency performance in the previous research (e.g., Bolla, Gray, Resnick, Galante, & Kawas, 1998).

## **Strengths and Limitations**

Strengths of the present study include the use of a longitudinal design with a relatively long period of follow-up in a larger sample of community-dwelling older adults. Robust analyses were utilized to detect changes over time in verbal fluency performance and examine the impact of gender and depressive symptoms on changes in verbal fluency performance. The observation that results held when extending the length of follow-up and excluding participants with prevalent and incident MCI and incident dementia speaks to the strength of the findings. Additionally, adjusting for possible confounders and stratifying the analyses by gender allowed us to specifically assess how depressive symptoms impacted changes in verbal fluency performance in female and male participants. Moreover, we were able to adequately assess participants' cognitive decline over time, as sample-based z-scores for each follow-up visit were created by taking baseline fluency performance into account.

Limitations: as expected, there were more female than male participants in this community-based sample of older adults. The group sizes of the "no depression" and "possible depression" groups were disproportionate, and the number of females in the "possible depression" group was greater than the number of males. The latter finding is in line with research suggesting that older women may be more likely to experience worse or more depressive symptoms than older men (Anstey, von Sanden, Sargent-Cox, & Luszcz, 2007; Girgus, Yang, & Ferri, 2017; Regan, Kearney, Savva, Cronin, & Kenny, 2013; Trollor et al., 2007). It is possible that the lack of a significant association between depression and verbal fluency performance among males in the current study may be attributed, at least in part, to the small number of males in the "possible depression" group, thus reducing the power needed to demonstrate a significant association. The study's eligibility criteria excluded individuals with a diagnosis of depression. It is possible that the relationship between depressive symptoms and decline in verbal fluency performance would be stronger in a sample that included individuals with more severe depression. Further, our sample was primarily Caucasian and recruited from a specific geographic area. Research has shown that conceptualization and attribution of symptoms of depression differ across cultures (Lawrence et al., 2006). Thus, the generalizability of our results in more diverse samples should be examined in the future research. Although the GDS is a well-validated self-report measure, structured clinical assessments to confirm participants' self-reported depressive symptoms were not available. Finally, participants may have experienced a practice effect from repeated annual assessments, which may have masked a decline that otherwise may have been observed (Abner et al., 2012).

## **Conclusions**

In summary, the present study found an important relationship between the presence of subclinical depressive symptoms and worse decline in category fluency performance in female but not male participants. Irrespective of gender, participants did not demonstrate a decline in letter fluency performance nor was letter fluency performance associated with depressive symptoms. The results remained when accounting for multiple covariates and potential confounders, including participants who developed MCI and dementia during follow-up.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Funding

The work was supported by the National Institute on Aging under Grants [R01AG036921 and R01AG044007]

## References

- Abner, E. L., Dennis, B. C., Mathews, M. J., Mendiondo, M. S., Caban-Holt, A., Kryscio, R. J. . . . Crowley, J. J. (2012). Practice effects in a longitudinal, multi-center Alzheimer's disease prevention clinical trial. *Trials*, 13(1). [10.1186/1745-6215-13-2171](https://doi.org/10.1186/1745-6215-13-2171)
- Anstey, K. J., von Sanden, C., Sargent-Cox, K., & Luszcz, M. A. (2007). Prevalence and risk factors for depression in a longitudinal, population-based study including individuals in the community and residential care. *The American Journal of Geriatric Psychiatry*, 15(6), 497–505. doi:[10.1097/jgp.0b013e31802e21d8](https://doi.org/10.1097/jgp.0b013e31802e21d8)
- Areán, P. A., & Ayalon, L. (2005). Assessment and treatment of depressed older adults in primary care. *Clinical Psychology: Science and Practice*, 12(3), 321–335. doi:[10.1093/clipsy.bpi034](https://doi.org/10.1093/clipsy.bpi034)
- Arfken, C. L., Lach, H. W., Birge, S. J., & Miller, J. P. (1994). The prevalence and correlates of fear of falling in elderly persons living in the community. *American Journal of Public Health*, 84(4), 565–570. doi:[10.2105/ajph.84.4.565](https://doi.org/10.2105/ajph.84.4.565)
- Auriacombe, S., Fabrigoule, C., Lafont, S., Jacqmin-Gadda, H., & Dartigues, J. -F. (2001). Letter and category fluency in normal elderly participants: A population-based study. *Aging, Neuropsychology, and Cognition*, 8(2), 98–108. doi:[10.1076/anec.8.2.98.841](https://doi.org/10.1076/anec.8.2.98.841)
- Axelrod, B. N., & Henry, R. R. (1992). Age-related performance on the Wisconsin card sorting, similarities, and controlled oral word association tests. *The Clinical Neuropsychologist*, 6(1), 16–26. doi:[10.1080/13854049208404113](https://doi.org/10.1080/13854049208404113)
- Beaudreau, S. A., & O'hara, R. (2009). The association of anxiety and depressive symptoms with cognitive performance in community-dwelling older adults. *Psychology and Aging*, 24(2), 507–512. doi:[10.1037/a0016035](https://doi.org/10.1037/a0016035)
- Bolla, K. I., Gray, S., Resnick, S. M., Galante, R., & Kawas, C. (1998). Category and letter fluency in highly educated older adults. *The Clinical Neuropsychologist*, 12(3), 330–338. doi:[10.1076/clin.12.3.330.1986](https://doi.org/10.1076/clin.12.3.330.1986)
- Brauer, M., & Curtin, J. J. (2017). Linear mixed-effects models and the analysis of nonindependent data: A unified framework to analyze categorical and continuous independent variables that vary within-subjects and/or within-items. *Psychological Methods*, 23(3), 389–411. doi:[10.1037/met0000159](https://doi.org/10.1037/met0000159)
- Brickman, A., Paul, R., Cohen, R., Williams, L., MacGregor, K., Jefferson, A. . . . Gordon, E. (2005). Category and letter verbal fluency across the adult lifespan: Relationship to EEG theta power. *Archives of Clinical Neuropsychology*, 20(5), 561–573. doi:[10.1016/j.acn.2004.12.006](https://doi.org/10.1016/j.acn.2004.12.006)
- Brink, T. L., Yesavage, J. A., Lum, O., Heersema, P. H., Adey, M., & Rose, T. L. (1982). Screening tests for geriatric depression. *Clinical Gerontologist*, 1(1), 37–43. doi:[10.1300/j018v01n01\\_06](https://doi.org/10.1300/j018v01n01_06)
- Bunce, D., Batterham, P. J., Mackinnon, A. J., & Christensen, H. (2012). Depression, anxiety and cognition in community-dwelling adults aged 70 years and over. *Journal of Psychiatric Research*, 46(12), 1662–1666. doi:[10.1016/j.jpsychires.2012.08.023](https://doi.org/10.1016/j.jpsychires.2012.08.023)
- Burhanullah, M. H., Tschanz, J. A. T., Peters, M. E., Leoutsakos, J. -M., Matyi, J., Lyketsos, C. G. . . . Rosenberg, P. B. (2020). Neuropsychiatric symptoms as risk factors for cognitive decline in clinically normal older adults: The Cache county study. *The American Journal of Geriatric Psychiatry*, 28(1), 64–71. doi:[10.1016/j.jagp.2019.03.023](https://doi.org/10.1016/j.jagp.2019.03.023)

- Burke, D. M., MacKay, D. G., Worthley, J. S., & Wade, E. (1991). On the tip of the tongue: What causes word finding failures in young and older adults? *Journal of Memory and Language*, 30(5), 542–579. doi:10.1016/0749-596x(91)90026-g
- Burke, D. M., & Shafto, M. A. (2004). Aging and language production. *Current Directions in Psychological Science*, 13(1), 21–24. doi:10.1111/j.0963-7214.2004.01301006.x
- Cantón-Habas, V., Rich-Ruiz, M., Romero-Saldaña, M., & Carrera-González, M. D. (2020). Depression as a risk factor for dementia and Alzheimer's disease. *Biomedicines*, 8(11), 457. doi:10.3390/biomedicines8110457
- Chachamovich, E., Fleck, M., Laidlaw, K., & Power, M. (2008). Impact of major depression and subsyndromal symptoms on quality of life and attitudes toward aging in an international sample of older adults. *The Gerontologist*, 48(5), 593–602. doi:10.1093/geront/48.5.593
- Chen, C. -S., Chong, M. -Y., & Tsang, H. -Y. (2007). Clinically significant non-major depression in a community-dwelling elderly population: Epidemiological findings. *International Journal of Geriatric Psychiatry*, 22(6), 557–562. doi:10.1002/gps.1714
- Clark, L. J., Gatz, M., Zheng, L., Chen, Y. -L., McCleary, C., & Mack, W. J. (2009). Longitudinal verbal fluency in normal aging, preclinical, and prevalent Alzheimer's disease. *American Journal of Alzheimer's Disease & Other Dementias*, 24(6), 461–468. doi:10.1177/1533317509345154
- Conner, K. O., Copeland, V. C., Grote, N. K., Koeske, G., Rosen, D., Reynolds, C. F., & Brown, C. (2010). Mental health treatment seeking among older adults with depression: The impact of stigma and Race. *The American Journal of Geriatric Psychiatry*, 18(6), 531–543. doi:10.1097/jgp.0b013e3181cc0366
- Dotson, V. M., Resnick, S. M., & Zonderman, A. B. (2008). Differential Association of concurrent, baseline, and average depressive symptoms with cognitive decline in older adults. *The American Journal of Geriatric Psychiatry*, 16(4), 318–330. doi:10.1097/jgp.0b013e3181662a9c
- Duff Canning, S. J., Leach, L., Stuss, D., Ngo, L., & Black, S. E. (2004). Diagnostic utility of abbreviated fluency measures in Alzheimer disease and vascular dementia. *Neurology*, 62(4), 556–562. doi:10.1212/wnl.62.4.556
- Elosúa, M. R., Ciudad, M. J., & Contreras, M. J. (2021). Executive-function tasks in patients with mild cognitive impairment and Alzheimer's disease: Effects of decline and gender. *Applied Neuropsychology: Adult*, 1–7. doi:10.1080/23279095.2021.1961142
- Essau, C. A., Lewinsohn, P. M., Seeley, J. R., & Sasagawa, S. (2010). Gender differences in the developmental course of depression. *Journal of Affective Disorders*, 127(1–3), 185–190. doi:10.1016/j.jad.2010.05.016
- Esteves, C. S., Oliveira, C. R., Moret-Tatay, C., Navarro-Pardo, E., Carli, G. A., Silva, I. G. . . . Argimon, I. I. (2015). Phonemic and semantic verbal fluency tasks: Normative data for elderly Brazilians. *Psicologia: Reflexão e Crítica*, 28(2), 350–355. doi:10.1590/1678-7153.201528215
- Forlani, C., Morri, M., Ferrari, B., Dalmonte, E., Menchetti, M., De Ronchi, D., & Atti, A. R. (2014). Prevalence and gender differences in late-life depression: A population-based study. *The American Journal of Geriatric Psychiatry*, 22(4), 370–380. doi:10.1016/j.jagp.2012.08.015
- Girgus, J. S., & Yang, K. (2015). Gender and depression. *Current Opinion in Psychology*, 4, 53–60. doi:10.1016/j.copsyc.2015.01.019
- Girgus, J., Yang, K., & Ferri, C. (2017). The gender difference in depression: Are elderly women at greater risk for depression than elderly men? *Geriatrics*, 2(4), 35. doi:10.3390/geriatrics2040035
- Gkotszamanis, V., Koliopanos, G., Sanchez-Niubo, A., Olaya, B., Caballero, F. F., Ayuso-Mateos, J. L. . . . Panagiotakos, D. B. (2021). Determinants of verbal fluency trajectories among older adults from the English longitudinal study of aging. *Applied Neuropsychology: Adult*, 30(1), 1–10. doi:10.1080/23279095.2021.1913739
- Glei, D. A., Goldman, N., Liu, I. -W., & Weinstein, M. (2013). Gender differences in trajectories of depressive symptoms among older Taiwanese: The contribution of selected stressors and social factors. *Aging & Mental Health*, 17(6), 773–783. doi:10.1080/13607863.2013.781119
- Harada, C. N., Love, M. C., & Triebel, K. L. (2013). Normal cognitive aging. *Clinics in Geriatric Medicine*, 29(4), 737–752. doi:10.1016/j.cger.2013.07.002



- Henry, J. D., Crawford, J. R., & Phillips, L. H. (2004). Verbal fluency performance in dementia of the Alzheimer's type: A meta-analysis. *Neuropsychologia*, 42(9), 1212–1222. doi:10.1016/j.neuropsychologia.2004.02.001
- Holtzer, R., Goldin, Y., Zimmerman, M., Katz, M., Buschke, H., & Lipton, R. (2008). Robust norms for selected neuropsychological tests in older adults. *Archives of Clinical Neuropsychology*, 23(5), 531–541. doi:10.1016/j.acn.2008.05.004
- Holtzer, R., Verghese, J., Wang, C., Hall, C., & Lipton, R. (2008). Within-Person across- neuropsychological test variability and incident dementia. *JAMA*, 300(7), 823–830. doi:10.1001/jama.300.7.823
- Holtzer, R., Verghese, J., Xue, X., & Lipton, R. B. (2006). Cognitive processes related to gait velocity: Results from the Einstein aging study. *Neuropsychology*, 20(2), 215–223. doi:10.1037/0894-4105.20.2.215
- Holtzer, R., Wang, C., & Verghese, J. (2014). Performance variance on walking while talking tasks: Theory, findings, and clinical implications. *AGE*, 36(1), 373–381. doi:10.1007/s11357-013-9570-7
- Kavé, G., & Mashal, N. (2012). Age-related differences in word-retrieval but not in meaning generation. *Aging, Neuropsychology, and Cognition*, 19(4), 515–529. doi:10.1080/13825585.2011.638975
- Kessler, R. C., McGonagle, K. A., Swartz, M., Blazer, D. G., & Nelson, C. B. (1993). Gender and depression in the national comorbidity Survey I: Lifetime prevalence, chronicity and recurrence. *Journal of Affective Disorders*, 29(2–3), 85–96. doi:10.1016/0165-0327(93)90026-g
- Koizumi, Y., Awata, S., Kuriyama, S., Ohmori, K., Hozawa, A., Seki, T. . . . Tsuji, I. (2005). Association between social support and depression status in the elderly: Results of a 1-year community-based prospective cohort study in Japan. *Psychiatry and Clinical Neurosciences*, 59(5), 563–569. doi:10.1111/j.1440-1819.2005.01415.x
- Krishnamoorthy, Y., Rajaa, S., & Rehman, T. (2020). Diagnostic accuracy of various forms of geriatric depression scale for screening of depression among older adults: Systematic review and meta-analysis. *Archives of Gerontology and Geriatrics*, 87, 104002. doi:10.1016/j.archger.2019.104002
- Lawrence, V., Murray, J., Banerjee, S., Turner, S., Sangha, K., Byng, R. . . . Macdonald, A. (2006). Concepts and causation of depression: A cross-cultural study of the beliefs of older adults. *The Gerontologist*, 46(1), 23–32. doi:10.1093/geront/46.1.23
- Lee, J., Lee, K. J., & Kim, H. (2017). Gender differences in behavioral and psychological symptoms of patients with alzheimer's disease. *Asian Journal of Psychiatry*, 26, 124–128. doi:10.1016/j.ajp.2017.01.027
- Li, Y. -P., Lin, S. -I., & Chen, C. -H. (2011). Gender differences in the relationship of social activity and quality of life in community-dwelling Taiwanese elders. *Journal of Women & Aging*, 23(4), 305–320. doi:10.1080/08952841.2011.611052
- Manly, J. J., Byrd, D. A., Touradji, P., & Stern, Y. (2004). Acculturation, reading level, and neuropsychological test performance among African American elders. *Applied Neuropsychology*, 11(1), 37–46. doi:10.1207/s15324826an1101\_5
- Martin, A., & Fedio, P. (1983). Word production and comprehension in Alzheimer's disease: The breakdown of semantic knowledge. *Brain and Language*, 19(1), 124–141. doi:10.1016/0093-934x(83)90059-7
- McCarrey, A. C., An, Y., Kitner-Triolo, M. H., Ferrucci, L., & Resnick, S. M. (2016). Gender differences in cognitive trajectories in clinically normal older adults. *Psychology and Aging*, 31(2), 166–175. doi:10.1037/pag0000070
- Mirza, S. S., Wolters, F. J., Swanson, S. A., Koudstaal, P. J., Hofman, A., Tiemeier, H., & Ikram, M. A. (2016). 10-year trajectories of depressive symptoms and risk of dementia: A population-based study. *The Lancet Psychiatry*, 3(7), 628–635. doi:10.1016/s2215-0366(16)00097-3
- Monsch, A. U., Bondi, M. W., Butters, N., Salmon, D. P., Katzman, R., & Thal, L. J. (1992). Comparisons of verbal fluency tasks in the detection of dementia of the Alzheimer type. *Archives of Neurology*, 49(12), 1253–1258. doi:10.1001/archneur.1992.00530360051017



- Munro, C. A., Winicki, J. M., Schretlen, D. J., Gower, E. W., Turano, K. A., Muñoz, B. . . . West, S. K. (2012). Gender differences in cognition in healthy elderly individuals. *Aging, Neuropsychology, and Cognition*, 19(6), 759–768. doi:10.1080/13825585.2012.690366
- Murphy, K. J., Rich, J. B., & Troyer, A. K. (2006). Verbal fluency patterns in amnesic mild cognitive impairment are characteristic of Alzheimer's type dementia. *Journal of the International Neuropsychological Society*, 12(04). doi:10.1017/s1355617706060590
- Noh, J. -W., Kwon, Y. D., Park, J., Oh, I. -H., Kim, J., & Weng, X. (2016). Relationship between physical disability and depression by gender: A panel regression model. *Plos One*, 11(11), e0166238. doi:10.1371/journal.pone.0166238
- Oh, D. H., Park, J. H., Lee, H. Y., Kim, S. A., Choi, B. Y., & Nam, J. H. (2014). Association between living arrangements and depressive symptoms among older women and men in South Korea. *Social Psychiatry and Psychiatric Epidemiology*, 50(1), 133–141. doi:10.1007/s00127-014-0904-2
- Ownby, R. L., Crocco, E., Acevedo, A., John, V., & Loewenstein, D. (2006). Depression and risk for Alzheimer disease: Systematic review, meta-analysis, and metaregression analysis. *Archives of General Psychiatry*, 63(5), 530. doi:10.1001/archpsyc.63.5.530
- Pinquart, M., & Sorensen, S. (2006). Gender differences in caregiver stressors, social resources, and health: An updated meta-analysis. *The Journals of Gerontology: Series B, Psychological Sciences and Social Sciences*, 61(1). doi:10.1093/geronb/61.1.p33
- Ravdin, L. D., Katzen, H. L., Agrawal, P., & Relkin, N. R. (2003). Letter and semantic fluency in older adults: Effects of mild depressive symptoms and age-stratified normative data. *The Clinical Neuropsychologist*, 17(2), 195–202. doi:10.1076/clin.17.2.195.16500
- Regan, C. O., Kearney, P. M., Savva, G. M., Cronin, H., & Kenny, R. A. (2013). Age and gender differences in prevalence and clinical correlates of depression: First results from the Irish longitudinal study on ageing. *International Journal of Geriatric Psychiatry*, 28(12), 1280–1287. doi:10.1002/gps.3955
- Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review*, 103(3), 403–428. doi:10.1037/0033-295x.103.3.403
- Schoevers, R. A., Smit, F., Deeg, D. J. H., Cuijpers, P., Dekker, J., van Tilburg, W., & Beekman, A. T. F. (2006). Prevention of late-life depression in primary care: Do we know where to begin? *The American Journal of Psychiatry*, 163(9), 1611–1621. doi:10.1176/ajp.2006.163.9.1611
- Singh-Manoux, A., Kivimaki, M., Glymour, M. M., Elbaz, A., Berr, C., Ebmeier, K. P. . . . Dugravot, A. (2012). Timing of onset of cognitive decline: Results from Whitehall ii prospective cohort study. *The BMJ*, 344(jan04 4), d7622. doi:10.1136/bmj.d7622
- Spreen, O., & Benton, A. L. (1977). *Neurosensory center comprehensive examination for aphasia: Manual of instructions (NCCEA) (rev. ed.)*. Victoria, BC: University of Victoria.
- Stuck, A. E., Walthert, J. M., Nikolaus, T., Büla, C. J., Hohmann, C., & Beck, J. C. (1999). Risk factors for functional status decline in community-living elderly people: A systematic literature review. *Social Science & Medicine*, 48(4), 445–469. doi:10.1016/s0277-9536(98)00370-0
- Taylor, W. D. (2014). Depression in the elderly. *The New England Journal of Medicine*, 371(13), 1228–1236. doi:10.1056/nejmcp1402180
- Trollor, J., Brodaty, H., Andrews, G., Sachdev, P., & Anderson, T. (2007). Prevalence of mental disorders in the elderly: The Australian national mental health and well-being survey. *Acta Neuropsychiatrica*, 18(6), 271–272. doi:10.1017/s0924270800030829
- Tröster, A. I., Salmon, D. P., McCullough, D., & Butters, N. (1989). A comparison of the category fluency deficits associated with Alzheimer's and Huntington's disease. *Brain and Language*, 37(3), 500–513. doi:10.1016/0093-934x(89)90032-1
- Wang, J., Li, R., Zhang, L., Gao, X., Zhou, M., Zhang, X., & Ma, Y. (2022). Associations between sedentary behaviour patterns and depression among people aged 60 and older in Hebei province of China. *BMC Public Health*, 22(1). doi:10.1186/s12889-022-12727-7
- Wilkinson, G. S. (1993). *Wide range achievement test: WRAT3* (3rd ed.). Wilmington, DE: Wide Range, Inc.
- Yesavage, J. A., Brink, T., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1983). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research*, 17(1), 37–49. doi:10.1016/0022-3956(82)90033-4

- Yochim, B. P., MacNeill, S. E., & Lichtenberg, P. A. (2006). "Vascular depression" predicts verbal fluency in older adults. *Journal of Clinical and Experimental Neuropsychology*, 28(4), 495–508. doi:[10.1080/13803390590949322](https://doi.org/10.1080/13803390590949322)
- Yochim, B. P., Mueller, A. E., & Segal, D. L. (2013). Late life anxiety is associated with decreased memory and executive functioning in community dwelling older adults. *Journal of Anxiety Disorders*, 27(6), 567–575. doi:[10.1016/j.janxdis.2012.10.010](https://doi.org/10.1016/j.janxdis.2012.10.010)
- Zaninotto, P., Batty, G. D., Allerhand, M., & Deary, I. J. (2018). Cognitive function trajectories and their determinants in older people: 8 years of follow-up in the English longitudinal study of ageing. *Journal of Epidemiology and Community Health*, 72(8), 685–694. doi:[10.1136/jech-2017-210116](https://doi.org/10.1136/jech-2017-210116)
- Zhang, J., Zhou, W., Wang, L., & Zhang, X. (2017). Gender differences of neuropsychological profiles in cognitively normal older people without amyloid pathology. *Comprehensive Psychiatry*, 75, 22–26. doi:[10.1016/j.comppsy.2017.02.008](https://doi.org/10.1016/j.comppsy.2017.02.008)