Associations of Health and Financial Literacy with Mortality in Advanced Age

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Abstract

Background: Health and financial literacy are central to older adults' well-being and financial standing, but the relation of literacy with mortality in advanced age remains unclear.

Aims: To determine whether lower literacy, as reflected in measures of total literacy and subscales of health and financial literacy, was associated with an increased risk of mortality.

Methods: Participants were 931 community-based older adults from the Rush Memory and Aging Project (age: mean (SD) = 80.9 (7.6), range = 58.8–100.8), an ongoing, prospective observational cohort study of aging. Participants were without dementia at the time literacy was assessed. Proportional hazards models were used to determine whether literacy measures were associated with mortality.

Results: During up to 8 years of follow-up, 224 (24.1% of 931) participants died. In models that adjusted for age, sex, and education, lower total, health, and financial literacy were each associated with an increased risk of mortality (total literacy: HR = 1.020, 95% CI = 1.010–1.031, $p < 0.001$; health literacy: HR = 1.015, 95% CI = 1.008–1.023, $p < 0.001$; financial literacy: HR = 1.013, 95% CI = 1.003–1.023, $p = 0.014$). These associations persisted after additionally adjusting for income and indices of health status; however, only the association of lower health literacy with mortality persisted after further adjusting for a robust measure of global cognition.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (the Institutional Review Board of Rush University Medical Center) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

Discussion: We suspect that the current associations of lower literacy with mortality reflect the detrimental effect of early pathologic brain aging on literacy.

Conclusions: Lower literacy, particularly lower health literacy, is associated with mortality in advanced age.

Keywords

aging; cognition; financial literacy; health literacy; mortality

Introduction

More than reading and writing per se, literacy refers to the ability to leverage information in order to navigate commonly encountered situations in an adaptive manner [1]. Health and financial literacy, defined as the capacity to access and utilize information about health/healthcare and finances [2,3], are two specific types of literacy that underlie many of life's most consequential decisions. These include a multitude of decisions typically faced in advanced age (e.g., determining whether to undergo medical procedures, specifying advanced directives, managing retirement funds, transferring assets to loved ones). Unfortunately, however, many older adults have very low health and financial literacy [4,5], leaving them ill-equipped to make informed healthcare and financial decisions [6] and vulnerable to adverse health and financial outcomes [7–12]. The latter includes vulnerability to financial abuse [13], which results in 36 billion dollars in annual losses among older Americans [14].

While certainly germane to older adults' well-being and financial standing, it remains unclear whether lower health and financial literacy are associated with an increased risk of mortality in advanced age. Prior studies have related lower health literacy with mortality, but important caveats should be noted. Specifically, the existing studies did not adjust for cognition [15,16] or only adjusted for rough proxies of cognition, such as individual items on the Mini-Mental State Examination [17,18]. In addition, the existing studies did not address dementia [15,17,18] or diagnosed dementia via cognitive screeners that can be insensitive to dementia [16,19]. These caveats leave open the possibility that prior associations of lower health literacy with mortality may not have persisted had cognition been more thoroughly assessed or were unduly influenced by a subset of participants with lower health literacy and shortened lifespans due to incipient dementia.

Further, to our knowledge, no study has investigated the association of financial literacy with mortality. Although perhaps less intuitive than the link between health literacy and mortality, prior studies have related lower financial literacy with less frequent participation in healthy behaviors, poorer health status, and increased hospitalizations among older adults [8,20,21]. In addition, lower financial literacy has been implicated in financial hardship and exploitation [3,12,13], and these financial stressors, which are often chronic or traumatic in nature, could worsen health and accelerate death in old age [22,23].

In the current study, we examined associations of literacy (i.e., total literacy and subscales of health and financial literacy) with mortality among a group of more than 900 community-

dwelling older adults without dementia when literacy was assessed. Our data were from the Rush Memory and Aging Project, a longitudinal, clinical-pathologic study of aging that includes annual structured clinical evaluations and detailed neuropsychological testing [24]. This dataset allowed us to examine literacy-mortality associations after adjusting for performance on a comprehensive cognitive battery and ensure that associations were not driven by participants with baseline dementia. It also allowed us to examine whether associations of literacy with mortality in advanced age were domain-specific.

Methods

Participants

Participants were from the Rush Memory and Aging Project, an ongoing, Chicagoland-based, longitudinal, clinical-pathologic study of aging [24]. To enhance coverage across the socioeconomic spectrum, participant recruitment occurred through a range of settings and means, including senior housing facilities, retirement communities, subsidized housing, social service agencies, and church groups. Informed consent was obtained following a comprehensive presentation of the benefits and risks of study participation. The Rush Memory and Aging Project and the substudy that includes the assessment of health and financial literacy were each approved by the Institutional Review Board of Rush University Medical Center.

Data collection for the Rush Memory and Aging Project started in 1997, and the assessment of health and financial literacy began in 2010. At the time of the current analyses, 1,971 participants had completed the baseline evaluation. Of those, 635 passed away prior to when the literacy assessment had begun, 77 withdrew from the Rush Memory and Aging Project, and 69 had moved out of the geographic area or had severe sensory or comprehension difficulties that precluded them from completing the literacy assessment. This left 1,190 participants, of whom 40 were disinclined or refused the literacy assessment. In addition, 3 completed the literacy assessment but had not yet received a clinical diagnosis, and 48 had not yet completed the literacy assessment. Of the remaining 1,099 participants that had completed the literacy assessment, 66 were excluded due to a diagnosis of dementia at the time that literacy was assessed (i.e., at analytic baseline), and 1 had missing data. We also required that participants have at least one follow-up exam and therefore did not include 101 participants who had completed the baseline evaluation of literacy but had not yet had a follow-up exam. This left data from 931 participants for the current analyses.

Clinical Diagnosis

Participants in the Rush Memory and Aging Project undergo detailed annual structured clinical evaluations [24]. Dementia was diagnosed by clinicians experienced in the assessment of older adults and per the criteria of the National Institute of Neurologic and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association, which require deficits in at least two cognitive domains and a history of cognitive decline [25]. Participants in the current analyses were without dementia when health and financial literacy were assessed.

Assessment of Literacy

Health and financial literacy were assessed using a 32-item instrument, as described in detail elsewhere [26]. Health literacy was measured via nine items that tap into knowledge of health-related topics such as Medicare and Medicare Part D, following doctor's instructions, and causes of common diseases in advanced age. Financial literacy was measured via 23 items derived from the Health and Retirement Survey [4]. Some items were slightly simplified to better suit our cohort, which is somewhat older than the Health and Retirement Study cohort. The items require mental calculations and/or knowledge of financial concepts (e.g., compound interest, stocks, bonds). The current financial literacy measure has been used in several prior publications and related to a variety of important financial-related factors, including risk aversion, healthcare and financial decision making, and susceptibility to scams [6,13,27]. Item format was multiple choice or true/false for all literacy items. Percent correct was separately calculated for the health and financial literacy items (range = 0–100%). These two percentages also were averaged into a combined measure of total literacy.

Assessment of Cognition and Other Covariates

Cognition was measured via 19 individual, performance-based tests, as previously described [24]. Raw scores on individual cognitive tests were converted to z-scores using the baseline mean and standard deviation of the entire cohort of the Rush Memory and Aging Project (from which the current group is drawn). These z-scores were then averaged, yielding a measure of global cognition. Age was calculated from participants' date of birth relative to the date that health and financial literacy were assessed, and sex and education (years of schooling) were self-reported at the initial study evaluation. Income was measured by having participants select from among the following 10 categories: 1: $0–$4,999, 2: $5,000–$9,999, 3: $10,000–$14,999, 4: $15,000–$19,999, 5: $20,000–$24,999, 6: $25,000–$29,999, 7: $30,000–$34,999, 8: $35,000–$49,999, 9: $50,000–$74,999, 10: >$75,000. Chronic medical conditions was the sum of self-reported medical conditions including hypertension, diabetes, and cancer. Physical activity was the sum of hours per week that the participant engages in activities such as walking for exercise, gardening or yard work, and bicycle riding. Depressive symptoms was the sum of endorsed symptoms on a 10-item short form of the Center for Epidemiological Studies Depression Scale. Income, chronic medical conditions, physical activity, and depressive symptoms were assessed at the same evaluation that literacy was assessed. Cognition and our other covariates were of interest because they each have been related to mortality and health and financial literacy [10,20,26,28–31] and thus might confound associations of literacy with mortality. For additional information about the measurement of our covariates, please see Bennett et al. [24].

Determination of Vital Status

The precise date of death is known for more than four-fifths of participants in the Rush Memory and Aging Project, as organ donation is a condition of entry and the autopsy rate surpasses 80%. Additionally, death is occasionally learned of via regular searches of the Social Security Administration Databases and the National Death Index and through quarterly contact with participants. We also have excellent rates of follow-up among

survivors (approximately 95%). These steps ensured that we captured the vast majority if not all of the deaths during the follow-up period.

Statistical Analysis

Associations of total, health, and financial literacy with mortality were separately examined via three sets of proportional hazards models. The first set adjusted for age, sex, and education; the second set further adjusted for income and indices of health status (i.e., medical conditions, physical activity, and depressive symptoms); and the third and final set adjusted for all of the aforementioned covariates plus global cognition. Model assumptions were assessed graphically and analytically. There was no evidence of nonlinearity or nonproportionality.

Results

Group Characteristics

The mean age of participants at baseline was 80.9 years (SD = 7.6), with a range of 58.8 to 100.8. Mean percent correct on total, health, and financial literacy were 69.1%, 63.4%, and 74.8%, respectively. During up to 8 years of follow-up (mean = 4.45 years), 224 (24.1% of 931) participants died. Those who survived versus died are compared with respect to our literacy measures and covariates in Table 1. Bivariate associations of our literacy measures with covariates are reported in Table 2. Total and financial literacy were lower in women than men (total literacy: mean for women = 67.8%; mean for men = 73.1%; $p < 0.001$; financial literacy: mean for women = 71.8%; mean for men = 84.2%; $p < 0.001$), but health literacy did not differ by sex (health literacy: mean for women = 63.9%; mean for men = 62.0%; $p = 0.175$). Lower health literacy was associated with lower financial literacy ($r = 0.428$, $p < 0.001$).

Associations of Literacy with Mortality

In proportional hazard models that adjusted for age, sex, and education, lower total, health, and financial literacy were each associated with mortality (total literacy: HR = 1.020, 95% CI = 1.010–1.031, $p < 0.001$; health literacy: HR = 1.015, 95% CI = 1.008–1.023, $p < 0.001$; financial literacy: HR = 1.013, 95% CI = 1.003–1.023, $p = 0.014$). Thus, a person with low total literacy (49.3%, 10th percentile) was about twice as likely to die during the follow-up period compared to a person with high total literacy (percent correct = 86.7%, 90th percentile) (Figure 1). To further contextualize this finding, we compared the effect of literacy on mortality in relation to the effect of age on mortality and found that scoring one standard deviation lower on the total literacy measure (about 14% lower) equated to dying more than two years earlier. The associations of literacy with mortality persisted after additionally adjusting for income, medical conditions, physical activity, and depressive symptoms (total literacy: HR = 1.018, 95% CI = 1.008–1.029, $p < 0.001$; health literacy: HR = 1.014, 95% CI = 1.006–1.021, $p < 0.001$; financial literacy: HR = 1.011, 95% CI = 1.001–1.022, $p = 0.039$). After further adjusting for global cognition, however, the association with total literacy fell just short of the traditional threshold for statistical significance (HR = 1.011, 95% CI = 0.999–1.023, $p = 0.062$). Examination of our literacy subscales showed that the association of health literacy with mortality persisted (HR = 1.009, 95% CI = 1.001–

1.018, $p = 0.025$), whereas the association with financial literacy did not (HR = 1.003, 95% CI = 0.991–1.015, $p = 0.603$).

Discussion

In the present study, we investigated associations of literacy (i.e., total, health, and financial literacy) with mortality among 931 older adults without dementia when literacy was assessed. In models that adjusted for age, sex, and education, lower scores on each of our literacy measures were associated with an increased risk of mortality. These associations persisted after additionally adjusting for income and indices of health status, but only the association of health literacy with mortality persisted after further adjusting for global cognition. Our results demonstrate that lower literacy, particularly lower health literacy, is associated with mortality in advanced age.

Prior studies have associated lower health literacy with mortality [15–18], but these studies did not exclude participants with dementia or comprehensively control for cognition. Here, we addressed these limitations by excluding persons with dementia at the time of their literacy assessment (as determined by detailed annual structured clinical evaluations) and by adjusting for performance on an extensive cognitive battery. This allowed us to tease apart the interrelations between literacy, cognition, and mortality in advanced age at a very high level of fidelity and ensure that associations of lower literacy with mortality were not driven by persons with lower literacy and shortened lifespans due to baseline dementia. We also accounted for a number of other potential confounders, including income and multiple indices of physical and mental health.

Our primary finding – that lower health literacy remained associated with mortality after adjusting for our robust measure of global cognition – indicates that health literacy is a relatively independent predictor of mortality among older adults. Why only this association persisted, however, remains speculative. Health literacy is a multifaceted construct that reflects knowledge about health/healthcare that is accumulated across the lifespan and the capacity to apply this knowledge to ongoing health circumstances [32]. Thus, starting relatively early in life, health literacy plays a key role in virtually every health-related decision, such as whether one engages in healthy behaviors and whether or how well one accesses and navigates healthcare services and systems [9–11]. Although health literacy across the lifespan is certainly crucial to health in old age, this seems unlikely to fully account for the association of health literacy with mortality given that this association persisted above and beyond several indices of baseline health.

An alternative (but not mutually exclusive) possibility is that the association of health literacy with mortality is related to the detrimental effect of early pathologic brain aging on literacy. Not only has older adults' literacy been shown to decline as they age [33–35], but we recently associated lower literacy among non-demented older adults with the chief genetic risk factor of Alzheimer's disease (the *apolipoprotein E* (*APOE*) ε4 allele) [36], adverse cognitive outcomes (incident cognitive decline, mild cognitive impairment, dementia) [35,37], and postmortem Alzheimer's disease pathology after controlling for cognition [38]. These data raise the intriguing idea that lower literacy is a harbinger of a

dementing process that slowly emerges over the following years. Extending upon this, the current association of health literacy with mortality may suggest that the dementing process forecasted by lower literacy ultimately increases the likelihood of death. This might explain why the association of health literacy and mortality persisted above and beyond cognition, as the prior associations of literacy with *APOE* ε4, adverse cognitive outcomes, and Alzheimer's disease pathology similarly persisted after adjusting for cognition. It additionally might explain why the association of health literacy with mortality persisted above and beyond our indices of baseline health, as the pathophysiological process of dementia begins several years prior to overtly affecting health [39].

The present work also extends upon the existing literature by examining novel associations of financial literacy and a combined measure of total health and financial literacy with mortality. Lower financial literacy has been previously associated with less frequent engagement in healthy behaviors, poorer physical and mental health, and increased hospitalizations among older adults [8,20,21]. Complimenting these prior findings, the observed associations of financial literacy with mortality provide further evidence implicating financial literacy not only in monetary situations but also in health and well-being. That the association of financial literacy with mortality did not persist in models that adjusted for cognition likely reflects two factors. First, this association was less robust in general (relative to the association of health literacy with mortality). Second, financial literacy taps into computational abilities that are well-measured via our cognitive battery [40]; thus, financial literacy and cognition likely provide similar information about mortality. Also of note, the differential associations of total, health, and financial literacy with mortality after controlling for cognition illustrate the importance of examining health outcomes in relation to specific domains of literacy and comprehensive measures of total literacy.

This study has limitations and strengths. Its limitations include a relatively short follow-up period and participants that were mostly non-Hispanic white (93%) and relatively highly educated. While a longer follow-up period is always preferable, the fact that we observed literacy-mortality associations despite the shorter follow-up period potentially speaks to the robustness of our findings. We are actively collecting literacy data among minority populations and will be able to determine whether the current findings generalize to more diverse groups of participants once sufficient data have accrued. Also worth noting, the hazard ratios for the associations of literacy with mortality, while modest, do carry clinical significance. For example, we found that scoring one standard deviation lower on the total literacy measure equated to dying more than two years earlier, and this two-plus year reduction in lifespan is especially meaningful for older adults whose lifespan's are already naturally limited. A study strength, in addition to adjusting analyses for a robust measure of cognition and carefully excluding participants with dementia at baseline, is the treatment of literacy as a continuous variable. Unlike prior studies examining the association of health literacy with mortality, this allowed us to avoid categorizing literacy, for example as adequate versus inadequate, using cutoffs that have limited empirical support [41]. Treating literacy as a continuous variable also better reflects the full spectrum of literacy among older adults and better captures the gradual accumulation of neuropathology and the gradual decline of cognition in old age.

Future research investigating the neural underpinnings of health and financial literacy in advanced age holds considerable promise in our view. The current findings not only reinforce the importance of literacy with respect to overall health but also raise the intriguing possibility that literacy provides novel information about current and future brain health. For example, the differential associations of health and financial literacy with mortality in analyses that adjusted for cognition might suggest that health literacy is sensitive to the early accumulation of neuropathology in ways that financial literacy and cognition are not. Additional study of literacy and related complex abilities (e.g., decision making) via neuroimaging and clinical-pathologic approaches will advance our understanding of how aging affects capacities that are integral to daily life but fall beyond the purview of cognition as traditionally defined.

Acknowledgement

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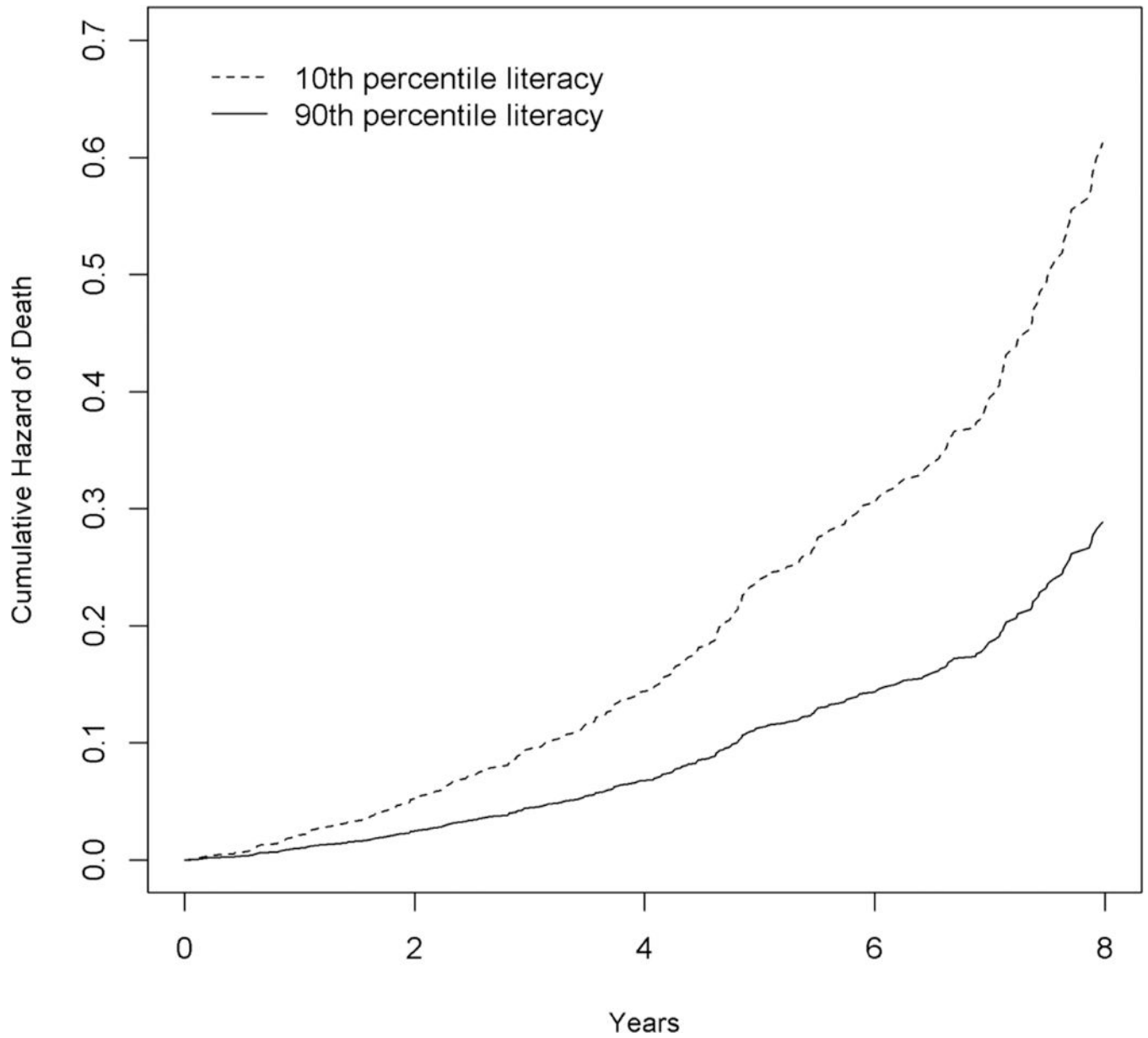
Fig. 1:
Cumulative hazard of mortality for participants with low (dotted line) versus high (solid line) total literacy derived from a model that adjusted for age, sex, and education

Table 1.

Characteristics of the group

	Survived	**Died**	**p value**[1]
N	707	224	--
Characteristic			
Age (years)	79.2 (7.19)	86.4 (5.93)	<.001
Female (%)	77.7	69.2	.010
Education (years)	15.6 (3.13)	15.2 (3.16)	.005
Income	7.30 (2.48)	6.98 (2.38)	.026
Medical conditions	1.58 (1.09)	2.00 (1.23)	<.001
Physical activity	3.78 (3.66)	2.72 (2.88)	<.001
Depressive symptoms	0.80 (1.35)	1.27 (1.86)	<.001
Global cognition	0.30 (0.50)	0.02 (0.51)	<.001
Total literacy (% correct)	71.0 (13.9)	63.4 (13.4)	<.001
Health literacy (% correct)	65.8 (17.7)	56.1 (17.5)	<.001
Financial literacy (% correct)	76.1 (14.8)	70.7 (15.8)	<.001

Note: Values are mean (SD) unless otherwise noted.

[1] Statistical significance comparing participants who survived versus those who died are based on t-tests, Mann-Whitney Wilcoxon rank sum, or X^2 as appropriate.

Table 2.

Bivariate correlations of literacy with covariates

Characteristic	Total literacy	Health literacy	Financial literacy
Age (years)	−.278 (<.001)	−.275 (<.001)	−.188 (<.001)
Education (years)	.386 (<.001)	.267 (<.001)	.395 (<.001)
Income	.359 (<.001)	.232 (<.001)	.389 (<.001)
Medical conditions	−.059 (.070)	−.023 (.483)	−.083 (.012)
Physical activity	.110 (<.001)	.099 (.002)	.085 (.009)
Depressive symptoms	−.153 (<.001)	−.111 (<.001)	−.152 (<.001)
Cognition	.588 (<.001)	.518 (<.001)	.473 (<.001)

Note: Values are Pearson correlation coefficient (*p* value).