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# Protective roles of meditation practice and self-esteem on cognitive functions over time: findings from the Midlife in the United States study

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## Abstract

**Background:** Cognitive function is an important component of healthy ageing. However, it is unclear whether relaxation/meditation practices provide cognitive benefits, particularly in midlife and early late life. Meditative practices are associated with higher self-esteem, and self-esteem serves as a general protective factor for many health outcomes. The current study examines associations between meditation practice, self-esteem, and change over 10 years in midlife cognitive performance.

**Methods:** Data were from waves 2 (2003–2004) and 3 (2013–2014) of the Midlife in the United States (MIDUS) study. We used structural equation modelling to examine whether persistent meditation practice at both waves or episodic practice at one wave is associated with better cognitive function over 10 years, compared to no meditation practice, while controlling for prior cognitive function and covariates (baseline socio-demographics, health, and functional status). Additionally, we assessed if self-esteem mediates the above associations.

**Results:** We included 2168 individuals ($M_{age} = 65 \pm 11$). After controlling for covariates, the findings revealed that persistent meditation practice in both waves was associated with significantly less decline in episodic memory; however, no such effects were found for executive function. Further, although participants' higher self-esteem was significantly associated with less decline in executive function and episodic memory, it did not mediate the associations between meditation practice and cognitive functions.

**Conclusions:** While both persistent meditation practice and self-esteem have associations with cognitive outcomes for middle-aged and older adults in MIDUS, self-esteem as a mediator was not supported. Thus, future investigations should examine mechanisms that underlie these protective factors on cognitive performances across adulthood.

***Key words:*** *cognitive functioning, meditation practice, MIDUS, self-esteem.*

## INTRODUCTION

Cognitive performance declines with age in adulthood[1–3]; specific areas of decline include concentration, attention and processing speed, visual and verbal memory, language, executive function, and spatial and/or psychomotor ability.[4] Episodic memory and executive function are two major cognitive domains that have been studied extensively.[1] Episodic memory includes individuals' recollections of personal experiences specific to time and place; evidence supports that episodic memory may decline throughout life.[2] In comparison, executive functions consist of cognitive abilities such as planning, organizing, reasoning, and problem-solving; many of these abilities are also associated with age-related cognitive decline.[2]

Earlier research has found that impairment in executive functioning and memory may be due to the action of the stress hormone cortisol; after crossing the blood–brain barrier, cortisol affects the hippocampus and the prefrontal cortex, which have a higher concentration of cortisol receptors.[5,6] For example, informal caregivers have elevated levels of chronic stress, and their cognitive performance has been found to be significantly worse than non-caregivers.[7,8] Although there is no specific management available for the reversal of cognitive decline, a growing body of research suggests that some non-pharmacological lifestyle intervention activities, such as mind–body practice, have the potential to yield beneficial preventative effects on various cognitive domains, including executive function, attention, processing speed, and episodic memory.[9,10] A recent randomized control trial with mild cognitively impaired participants found that group yoga, as a mind–body intervention, showed improved executive function compared to traditional memory enhancement training (active control) at the 12- and 24-week follow-up.[11] Another study found that participants who practiced yoga showed significant improvement in depression and visuospatial memory compared to participants who practiced memory enhancement training (active control).[12]

Mind–body practices such as deep breathing, yoga, tai chi, music therapy, aroma therapy, meditation, and others reflect varied behavioural protocols, but nearly all incorporate relaxation[13] and respite from daily activities.[14] Stepping away from stressful life events/thoughts for a brief period can give one some space to feel calmer and gradually generate feelings of well-being. Indeed, the popularity of mindfulness practices has burgeoned over the last decade; the number of US adults practicing mindful activities has doubled during this period.[13] Some authors have concluded that all of the components of mind–body practices, either separately or together, enhance the harmony of the human mind through mind–body relaxation techniques.[15] While the essential components may overlap with each other, most mindfulness practices share a common theme of meditative postural exercises targeting mind–body relaxation to achieve well-being.[15]

In addition to relaxation and postural exercises, mindfulness practices may offer a sense of meaning and purpose in life.[16] Relatedly, mindfulness has been found to be associated with personality traits. For instance, Jung *et al*.[17] found that mindfulness practice was associated with increased extraversion and openness and a decline in neuroticism in older adult participants. Further, it has been found that individuals who practiced meditation as a mindfulness intervention reported high self-esteem.[18] Another study reported that mindfulness-based stress reduction techniques reduced anxiety and enhanced self-esteem in individuals with social anxiety disorder.[19]

Self-esteem is the subjective perception of individuals' self-view that may bring mixed effects on well-being (Wang *et al*., 2023).[20–22] Although self-esteem is generally found to remain stable in adults (e.g., Wagner *et al*., 2015),[23] feelings of self-esteem tend to show both inter-individual and intra-individual variability.[24,25] Individuals' sense of purpose in life,[26] experiences of stress,[21] and overall quality of life[27] may be influenced by self-esteem. Self-esteem and stress have an inverse bidirectional association; stressful events impact self-esteem, and self-esteem impacts the way individuals respond to stress through their various coping strategies.[28] In this regard, researchers have found a higher state of mindfulness to be correlated with a higher level of self-esteem.[29] A positive association between mindfulness practices and self-esteem is evident in the context of psychological well-being variables, such as stress, depression, happiness, and quality of life.[29]

Indeed, as a stress management technique, yoga has been found to enhance self-esteem and visuospatial memory.[28] Relatedly, research has also found significant positive associations between positive personality features and self-esteem.[28] Furthermore, positive psychology emphasizes mindfulness and self-esteem as significant predictors of well-being.[30] However, the association between cognitive function and self-esteem is not well established[31] or shows associations in only specific culturally-related cognitive outcomes.[32] Although it has been found that individuals with high self-esteem show higher cognitive aptitudes,[33] the complexity of the relationships between and mixed findings on meditation–self-esteem–cognitive outcomes warrant further investigation.

Previous research has extensively demonstrated various benefits of mind–body practices; however, little is documented, to date, about the impacts of meditation practices on middle-aged and older adults'

cognitive functioning over time on a nationally representative sample. Given the evidence presented above, we aimed to expand prior work by comparing cognitive functioning, assessed via executive function and episodic memory, among individuals who persistently practiced meditation techniques with those who practiced episodically or never. We also examined the effect of self-esteem on cognitive functioning over time. Although self-esteem has not been identified as a consistent predictor of cognitive outcomes in prior studies (c.f.[31]), it is considered a protective factor against negative health outcomes in the stress process theory.[34] Therefore, further exploration of the role of self-esteem is warranted, particularly given the prior established relationships between mind–body practices and self-esteem.

In the current study, we use two waves (spanning 10 years) of data from a nationally representative sample of middle-aged and older adults in the United States to examine whether meditation practice at both waves, i.e., persistent meditation practice, or episodic (one-time point) meditation practice, are associated with better cognitive functioning over a 10-year period in comparison to non-practitioners. We control for covariates, i.e., socio-demographic factors, health and functional status, and cognitive functions at wave 2. We also examined whether participants' self-esteem mediates the association between meditation practice and cognitive functions over the same time frame. We hypothesized that (i) higher self-esteem would be associated with more favourable trajectories of cognitive change (tested in the domains of episodic memory and executive function) compared to non-practitioners; (ii) persistent and episodic meditation practicing status would be similarly associated with superior cognitive change; and (iii) self-esteem would mediate the associations between meditation practice and cognitive functions.

## METHODS

### Study design

The current study used data from the Midlife in the United States (MIDUS) survey, a nationally representative, longitudinal study that was initiated in 1995–1996 (wave 1), with 7108 English-speaking participants aged 24–75 years.[35] Wave 2 of this longitudinal study was conducted during 2004–2005 with 4963 participants (75% of the original respondents in wave 1), and wave 3 was conducted in 2013–2014 with 3294 participants (77% of wave 2 participants).[35] All waves of MIDUS datasets contain primary data collected directly from participants.

### Participants

In the current study, we included data from cognitive tests of executive function and episodic memory from 2168 individuals who participated in waves 2 and 3 (2004–2014) and had no missing observations. We considered waves 2 and 3 as MIDUS included cognitive data only in these two waves and not in wave 1. Both waves 2 and 3 were conducted by phone and a mailed self-administered questionnaire.

### Measures and procedure

#### *Outcomes*

As dependent variables, we used episodic memory and executive function that were assessed at waves 2 and 3 with the Brief Test of Adult Cognition by Telephone.[36] Episodic memory was measured with two tests (immediate and delayed free recall of 15 words). Executive function was measured by inductive reasoning (measured by number series completion), category verbal fluency (measured by verbal ability and fluency in 60 s), working memory span (measured by backward digit span), processing speed (measured by 30-s and Counting Task), and attention switching and inhibitory control (measured by Stop and Go Switch Task, calculating reaction times).[36] Results from factor analyses for cognitive tests in MIDUS are reported by Lachman *et al*.[36] The cognitive test scores were standardized by converting into Z-scores (Mean [M] = 0; Standard Deviation [SD] = 1) using the M and SD of the wave 2 full sample. Next, a composite score for both episodic memory and executive function was calculated from the mean of the respective standardized (Z-score) measures.[37] MIDUS applied a similar methodology to calculate composite cognitive scores for the wave 3 sample. Wave 3 executive function and episodic memory constituted outcomes in the current analysis.

#### *Predictors*

We used meditation practice status as the predictor. Participants were asked to indicate how often they used relaxation/meditation techniques "in the past 12 months, either to treat a physical health problem,

to treat an emotional or personal problem, to maintain or enhance your wellness, or to prevent the onset of illness," using a 5-point Likert scale ranging from 1 (*a lot*) to 5 (*never*). Responses indicating any meditation practice (*a lot*, *often*, *sometimes*, or *rarely*) were coded as 1; responses indicating no practice (*never*) were coded as 0 in the current study. Next, we constructed meditation practice status as a four-level categorical variable using these dichotomous meditation practice indicators in waves 2 and 3 with the following coding scheme: no meditation practice at wave 2 or wave 3 (reference [=0]), practice (any frequency) at wave 2 only [=1], practice (any frequency) at wave 3 only [=3], and consistent practice (any frequency) at waves 2 and 3 [=4]. The coding of meditative practice is discussed below in Section 2.4, Statistical analyses, specifically regarding additional sensitivity analyses.

### *Mediator*

We used self-esteem as a mediator. The self-esteem score was based on a 7-point scale in the self-administered questionnaire in MIDUS (see[24]). The sample questions included whether "I am no better and no worse than others," "I take a positive attitude toward myself" (R), "At times I feel that I am no good at all," "I am able to do things as well as most people" (R), "I wish I could have more respect for myself," "On the whole, I am satisfied with myself" (R), "I certainly feel useless at times." Response options ranged from 1 (*strongly agree*) to 7 (*strongly disagree*); some items (indicated as "R") were reverse coded. The self-esteem score is constructed in MIDUS by summing the values from each item on the 7-point scale; higher values indicate higher self-esteem (range 11–49). Self-esteem was considered missing if participants answered fewer than five items. In the current analysis, self-esteem scores were considered both at waves 2 and 3.

### *Covariates*

We used socio-demographic factors, health, and functional status (at wave 2) as covariates. Six socio-demographic variables comprised age, gender, race, marital status, education, and employment. Age was measured as a continuous variable in years. Gender (0 = *male*, 1 = *female*) was a binary variable, and race (1 = *White*, 2 = *Black*, 3 = *other*) was measured in three categories; in contrast, marital status (1 = *married*, 2 = *separated/divorced*, 3 = *widowed*, 4 = *never married*) and educational level (1 = *no/some school*, 2 = *high school graduate/in college*, 3 = *graduated from college*, 4 = *having master's/professional degree*) were measured in four categories. Employment status was measured in five categories (1 = *currently working*, 2 = *self-employed*, 3 = *retired*, 4 = *unemployed*, 5 = *other*).

We included participants' self-rated physical and mental health on a 5-point scale ranging from 1 (*excellent*) to 5 (*poor*); we recoded the responses for self-reported physical and mental health as good (1, including the responses *excellent*, *very good*, and *good*) and not good (0, including the responses *fair* and *poor*). We also included additional variables related to health, such as relative obesity based on the body mass index (1 = *underweight* [<18.5], 2 = *normal* [18.5–24.9], 3 = *overweight* [>24.9–29.9], and 4 = *obese* [>29.9]), tobacco and alcohol use (1 = *regular tobacco/alcohol user*, or 0 = *not*) and chronic condition/s (1 = *yes*, 0 = *no*). Chronic conditions included high blood pressure, stroke, heart problems, high cholesterol, diabetes, cancer, lung problem, ulcer, and aches/joint stiffness in the past 12 months. Further, we considered depressive symptoms that persisted for two/more weeks in the past 12 months based on a mean score on the 7-item DEPCON scale in MIDUS that was administered by telephone.[38] Table S1 presents the DEPCON scale measuring depressive symptoms.

Finally, because personality traits have been well documented as significant correlates of cognitive functioning,[39] mindfulness practice,[17] and self-esteem[28] across adulthood, we also considered these variables as potential confounders in our analysis. We included the Big Five personality traits, comprising agreeableness (helpful, warm, caring, soft-hearted, and sympathetic), conscientiousness (organized, responsible, hardworking, and careless [reverse coded]), extraversion (outgoing, friendly, lively, active, and talkative), openness (creative, imaginative, intelligent, curious, broadminded, sophisticated, and adventurous), and neuroticism (moody, worrying, nervous, and calm [reverse coded]).[40] Responses were measured on a 4-point Likert scale (1 = *a lot* to 4 = *not at all*) and averaged for each trait.

## Statistical analysis

Descriptive analyses of the demographic and health variables, meditation practice status, self-esteem, and cognitive tests of participants were detailed with

M (SD), number (*n*), and percentage (%) as appropriate. Next, we used structural equation modelling (SEM) to examine whether persistent meditation practice at both waves and episodic meditation practice at only one time-point is associated with cognitive functioning over 10 years, compared with no meditation practice, after controlling for prior cognitive function and covariates. Further, even though a traditional mediation analysis includes variables in different successive waves while examining the causal effect on the outcome,[41] a half-longitudinal mediation analysis design demonstrates a mediator's role in two-wave studies evaluating the contemporaneous relations between either the exogenous predictor and the mediator or the mediator and the outcome.[42,43] Wave 1 of MIDUS did not collect data on cognitive tests; therefore, in the current SEM analyses, we also applied a half-longitudinal study design to evaluate whether participants' self-esteem mediates the associations between meditation practice and executive function (Model 1) and meditation practice and episodic memory (Model 2). The SEM

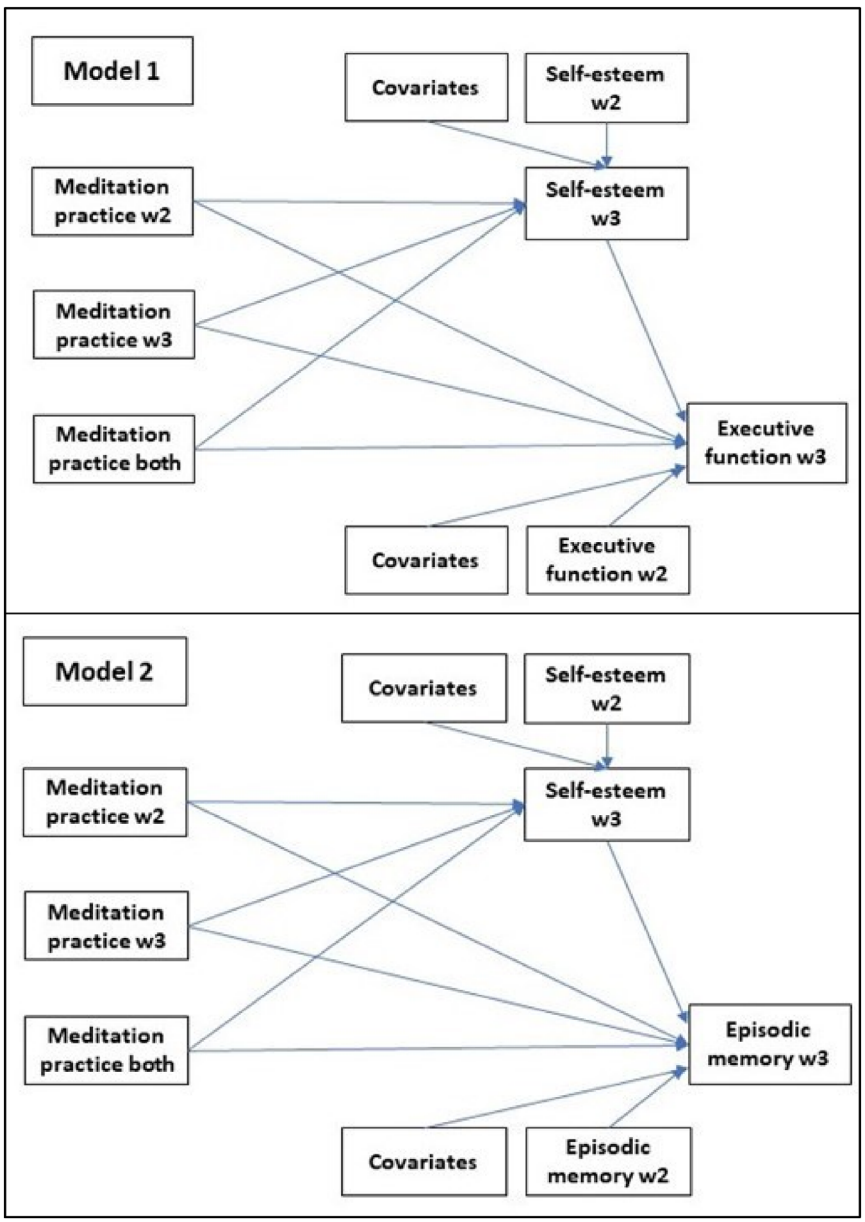


**Figure 1** Structural equation models. Path diagram showing the pathways linking the key independent variable (meditation practice status), mediator (self-esteem), and cognitive outcomes (executive function and episodic memory). w2, wave 2; w3, wave 3.

**Table 1** Characteristics of US adults who participated in MIDUS: Waves 2 and 3, stratified by meditation practice status (measured at wave 3), $n = 2168$

| | | Meditation practice status | | | | |
|---|---|---|---|---|---|---|
| Variables | Overall $n = 2168$ | Neither $n = 1389$ (64.1%) | W2 Only $n = 238$ (11.0%) | W3 Only $n = 200$ (9.2%) | Both $n = 341$ (15.7%) | *P*-value |
| Age in years, M (SD) | 64.7 (11.1) | 65.5 (11.3) | 64.0 (10.8) | 62.8 (10.6) | 63.1 (10.2) | 0.164 |
| Female (%) | 55.5 | 49.2 | 64.7 | 61.5 | 71.3 | **<0.001** |
| Race/ethnicity (%) | | | | | | 0.395 |
| White | 90.8 | 90.8 | 89.4 | 92.9 | 90.8 | |
| Black | 2.5 | 2.1 | 3.0 | 3.1 | 3.6 | |
| Other | 6.7 | 7.1 | 7.7 | 4.1 | 5.6 | |
| Marital status (%) | | | | | | **<0.001** |
| Married | 67.9 | 71.7 | 60.5 | 61.0 | 61.3 | |
| Separated/ divorced | 13.6 | 11.5 | 13.5 | 19.5 | 19.1 | |
| Widowed | 11.8 | 11.5 | 14.7 | 11.0 | 11.4 | |
| Never married | 6.7 | 5.3 | 11.3 | 8.5 | 8.2 | |
| Education (%) | | | | | | **<0.001** |
| None/some school | 4.6 | 5.2 | 3.8 | 4.5 | 2.9 | |
| Grad school | 41.8 | 46.8 | 36.1 | 33.2 | 30.8 | |
| Grad college | 34.4 | 31.2 | 41.2 | 38.7 | 40.2 | |
| Master's/prof degree | 19.2 | 16.9 | 18.9 | 23.6 | 26.1 | |
| Employment (%) | | | | | | 0.327 |
| Working | 50.2 | 48.6 | 55.4 | 55.5 | 49.5 | |
| Self-employed | 12.3 | 12.8 | 8.2 | 9.1 | 14.8 | |
| Retired | 29.1 | 30.6 | 26.2 | 26.2 | 27.2 | |
| Unemployed | 1.2 | 1.2 | 2.1 | 2.4 | 2.1 | |
| Other | 6.9 | 6.8 | 8.2 | 6.7 | 6.5 | |
| BMI (%) | | | | | | 0.791 |
| Underweight | 1.4 | 1.4 | 0.9 | 1.0 | 1.8 | |
| Normal | 29.9 | 29.6 | 27.2 | 32.6 | 31.7 | |
| Overweight | 38.0 | 38.8 | 36.2 | 36.3 | 36.6 | |
| Obese | 30.8 | 30.2 | 35.8 | 30.1 | 29.9 | |
| Tobacco user (%) | 8.3 | 8.1 | 11.3 | 7.5 | 7.3 | 0.316 |
| Alcohol user (%) | 59.0 | 57.5 | 60.1 | 61.0 | 63.6 | 0.183 |
| Self-rated physical health (%) | | | | | | 0.259 |
| Good | 84.9 | 84.5 | 85.3 | 82.0 | 88.0 | |
| Self-rated mental health (%) | | | | | | **0.019** |
| Good | 91.0 | 92.3 | 86.6 | 89.0 | 90.0 | |
| Personality traits M (SD) | | | | | | |
| Agreeableness | 3.4 (0.5) | 3.4 (0.5) | 3.5 (0.5) | 3.5 (0.5) | 3.6 (0.5) | **0.003** |
| Conscientiousness | 3.4 (0.5) | 3.4 (0.5) | 3.5 (0.5) | 3.4 (0.5) | 3.4 (0.5) | 0.787 |
| Extraversion | 3.1 (0.6) | 3.1 (0.6) | 3.1 (0.6) | 3.0 (0.6) | 3.2 (0.6) | 0.206 |
| Neuroticism | 2.0 (0.6) | 2.0 (0.6) | 2.0 (0.6) | 2.2 (0.7) | 2.0 (0.6) | 0.487 |
| Openness | 2.9 (0.5) | 2.8 (0.6) | 3.0 (0.5) | 3.0 (0.5) | 3.1 (0.5) | **0.014** |
| Chronic conditions (%) | 81.4 | 80.0 | 80.6 | 85.9 | 87.6 | **0.005** |
| Felt sad (>2 weeks) (%) | 18.5 | 15.1 | 23.1 | 26.0 | 24.6 | **<0.001** |
| Self-esteem, M (SD) | 37.88 (7.06) | 38.15 (7.11) | 37.05 (7.10) | 36.75 (7.02) | 38.04 (6.76) | 0.470 |
| Executive function, M (SD) | −0.14 (0.73) | −0.18 (0.73) | −0.13 (0.77) | −0.04 (0.73) | −0.02 (0.69) | 0.997 |
| Episodic memory, M (SD) | 0.00 (0.99) | −0.11 (0.98) | 0.07 (0.95) | 0.16 (1.01) | 0.31 (0.97) | 0.143 |

*Note*: Boldface indicates statistical significance ($P < 0.05$) from one-way between-subjects analysis of variance (ANOVA) for age and chi-squared tests of independence for all categorical variables. Abbreviations: BMI, body mass index; W2, wave 2; W3, wave 3.

strategy indicated in Figure 1 shows the pathways between meditation practice status (independent variable), self-esteem (mediator), and the cognitive outcomes. We also conducted SEM sensitivity analyses, by first categorizing meditation practice into three levels based on participant responses, as (i) regular (*a lot* and *often*), (ii) irregular (*sometimes* and *rarely*), and (iii) never, and then constructing meditation practice status as a nine-level categorical variable using those three-category meditation practice indicators in waves 2 and 3. Unstandardized regression coefficients (*b*) and standard errors (SE) are reported for interpretation. All statistical analyses were conducted with Stata 17.0 SE (College Station, TX) software, and significance was evaluated at the 0.05 level (two-sided).

## RESULTS

In Table 1, we summarize sample characteristics on socio-demographics, health, and functional status at wave 3 for the whole sample and the sample stratified by meditation practice status ($n = 2168$). The participant cohort was aged 42–92 years ($M = 65$, $SD = 11$). Overall, 541 (24.9%) participants reported practicing at least some intensities of meditation techniques in the past 12 months (at wave 3), while 75.1% never practiced. In addition, 11.0% practiced meditation at wave 2 only, 9.2% at wave 3 only, and 15.7% practiced at both waves 2 and 3. Women made up 56% of the sample, 50% were employed, and 91% were White. Substantial proportions of participants were alcohol users (59%), and a significant proportion of participants were overweight (38%) or

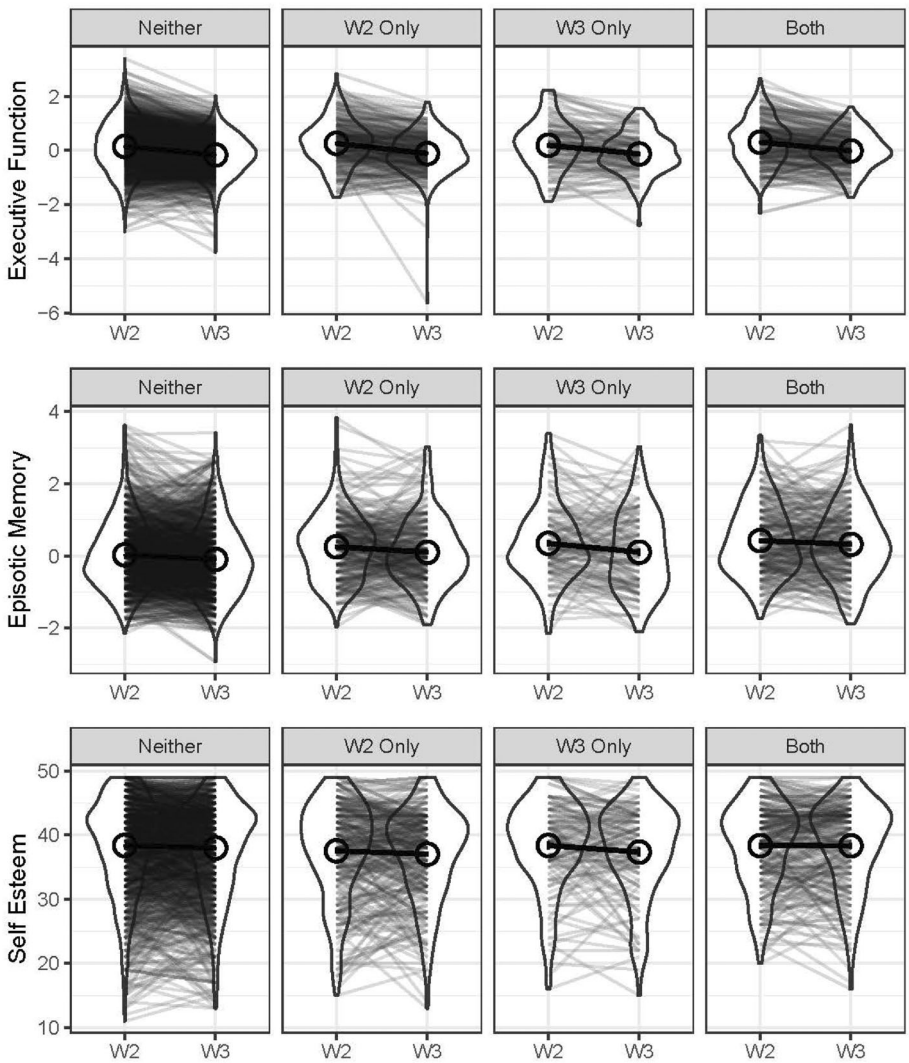


**Figure 2** Comparison of observed repeated measures over 10 years, stratified by meditation practice status in mid- and later life, $n = 2168$. Each participant is represented by a single line and the joined circles display the means. W2 = wave 2; W3 = wave 3.

obese (31%). Although 81% of the participants had at least one or more chronic conditions, a majority self-rated themselves as having good physical (85%) and mental health (91%) conditions. However, 19% of the participants reported being sad/depressed in the last 2 weeks.

Figure 2 visually displays the observed executive function, episodic memory, and self-esteem measures

**Table 2** Structural equation models examining associations of cognitive functions with meditation practice status and self-esteem in mid and later life, $n = 2168$

| | Self-esteem W3 | | | Executive function W3 | | | Episodic memory W3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1 & 2 (common) | | | Model 1 | | | Model 2 | | |
| Variables | *b* | SE | *P* | *b* | SE | *P* | *b* | SE | *P* |
| Intercept | 11.195 | 1.920 | **<0.001** | 0.125 | 0.167 | 0.456 | 0.584 | 0.290 | **0.044** |
| Key independent variable | | | | | | | | | |
| Meditation practice (reference = neither) | | | | | | | | | |
| W2 only | −0.242 | 0.368 | 0.510 | 0.002 | 0.032 | 0.943 | 0.023 | 0.055 | 0.675 |
| W3 only | −0.736 | 0.397 | 0.064 | 0.020 | 0.034 | 0.552 | 0.038 | 0.060 | 0.522 |
| Both | −0.337 | 0.328 | 0.304 | 0.030 | 0.028 | 0.298 | 0.132 | 0.049 | **0.008** |
| Mediator | | | | | | | | | |
| Self-esteem W3 | | | | 0.005 | 0.002 | **0.003** | 0.011 | 0.003 | **<0.001** |
| Self-esteem W2 | 0.517 | 0.021 | **<0.001** | | | | | | |
| Executive function W2 | | | | 0.505 | 0.013 | **<0.001** | | | |
| Episodic memory W2 | | | | | | | 0.417 | 0.019 | **<0.001** |
| Covariates | | | | | | | | | |
| Age, years | 0.003 | 0.013 | 0.819 | −0.012 | 0.001 | **<0.001** | −0.023 | 0.002 | **<0.001** |
| Female (ref. male) | 0.173 | 0.263 | 0.511 | −0.008 | 0.023 | 0.733 | 0.338 | 0.041 | **<0.001** |
| Race/ethnicity (ref. other) | | | | | | | | | |
| White | 0.437 | 0.588 | 0.458 | 0.031 | 0.051 | 0.549 | 0.001 | 0.089 | 0.987 |
| Black | 1.185 | 0.910 | 0.193 | −0.208 | 0.079 | **0.009** | −0.381 | 0.137 | **0.005** |
| Marital Status (reference = never married) | | | | | | | | | |
| Married | 1.025 | 0.432 | **0.018** | 0.056 | 0.037 | 0.138 | −0.042 | 0.065 | 0.517 |
| Separated/divorced | 0.582 | 0.516 | 0.259 | 0.010 | 0.045 | 0.827 | −0.138 | 0.078 | 0.075 |
| Widowed | 0.828 | 0.654 | 0.206 | −0.040 | 0.057 | 0.475 | 0.051 | 0.098 | 0.604 |
| Education (reference = no/some school) | | | | | | | | | |
| Graduated from school | −0.099 | 0.567 | 0.861 | −0.007 | 0.049 | 0.882 | 0.044 | 0.085 | 0.606 |
| Graduated from college | −0.012 | 0.591 | 0.984 | 0.032 | 0.052 | 0.539 | 0.073 | 0.089 | 0.415 |
| Master's/prof. degree | 0.559 | 0.620 | 0.368 | 0.063 | 0.055 | 0.249 | 0.140 | 0.094 | 0.135 |
| Employment (reference = other) | | | | | | | | | |
| Working | 0.143 | 0.423 | 0.735 | 0.119 | 0.037 | **0.001** | 0.076 | 0.064 | 0.230 |
| Self-employed | −0.086 | 0.511 | 0.867 | 0.036 | 0.044 | 0.417 | 0.026 | 0.077 | 0.736 |
| Retired | −1.016 | 0.485 | **0.036** | −0.043 | 0.042 | 0.303 | −0.022 | 0.073 | 0.762 |
| Unemployed | 0.105 | 0.887 | 0.906 | 0.036 | 0.077 | 0.637 | −0.081 | 0.133 | 0.544 |
| BMI mean (reference = underweight) | | | | | | | | | |
| Normal | 1.352 | 0.572 | **0.018** | 0.091 | 0.050 | 0.068 | −0.010 | 0.086 | 0.911 |
| Overweight | 1.068 | 0.565 | 0.059 | 0.085 | 0.049 | 0.081 | 0.026 | 0.085 | 0.756 |
| Obese | 1.371 | 0.576 | **0.017** | 0.088 | 0.050 | 0.077 | 0.010 | 0.087 | 0.911 |
| Tobacco user | −1.205 | 0.348 | **0.001** | −0.022 | 0.030 | 0.474 | −0.055 | 0.052 | 0.291 |
| Alcohol user | 0.489 | 0.241 | **0.042** | −0.019 | 0.021 | 0.364 | 0.000 | 0.036 | 0.991 |
| Self-rated physical health | −0.033 | 0.423 | 0.938 | 0.034 | 0.037 | 0.362 | 0.069 | 0.064 | 0.278 |
| Self-rated mental health | 0.545 | 0.591 | 0.356 | −0.014 | 0.051 | 0.788 | −0.020 | 0.089 | 0.823 |
| Personality traits | | | | | | | | | |
| Agreeableness | −0.119 | 0.278 | 0.667 | −0.027 | 0.024 | 0.267 | 0.002 | 0.042 | 0.962 |
| Conscientiousness | 1.287 | 0.285 | **<0.001** | −0.020 | 0.025 | 0.406 | −0.001 | 0.043 | 0.977 |
| Extraversion | 1.003 | 0.261 | **<0.001** | −0.006 | 0.022 | 0.795 | −0.016 | 0.039 | 0.685 |
| Neuroticism | −1.479 | 0.218 | **<0.001** | 0.008 | 0.019 | 0.651 | −0.027 | 0.032 | 0.399 |
| Openness | −0.145 | 0.270 | 0.591 | 0.019 | 0.023 | 0.403 | 0.017 | 0.040 | 0.675 |
| Chronic conditions | −0.007 | 0.278 | 0.981 | −0.023 | 0.024 | 0.347 | 0.016 | 0.042 | 0.701 |
| Felt sad (>2 weeks) | 0.206 | 0.320 | 0.521 | 0.000 | 0.028 | 0.991 | −0.091 | 0.048 | 0.057 |

*Note*: Estimates are direct effects. Boldface indicates statistical significance ($P < 0.05$). Abbreviations: BMI, body mass index; W2, wave 2; W3, wave 3.
* $P < 0.05$. ** $P < 0.01$. *** $P < 0.001$.

repeated across waves by meditation practice status, while Table S2 shows the descriptive statistics on the dependent, mediator, and key independent variables in more detail. Self-esteem was found to be high at both time points (i.e., waves 2 and 3; M = 38.26 and 37.88, respectively; $r = 0.652$), with a marginal decline from wave 2 to wave 3 ($P < 0.001$). Executive function scores (M = 0.19 and −0.14, respectively; $r = 0.757$, $P < 0.001$) exhibited a similar drop, while the change in episodic memory score was more modest (M = 0.13 and 0.00, respectively; $r = 0.535$, $P < 0.001$).

Table 2 presents parameter estimates from each of the two structural equation models showing direct effects on cognitive executive function (Model 1) and episodic memory (Model 2) over the 10-year study period. For a visual representation of the main findings, Figure 3 illustrates the schematic path diagram

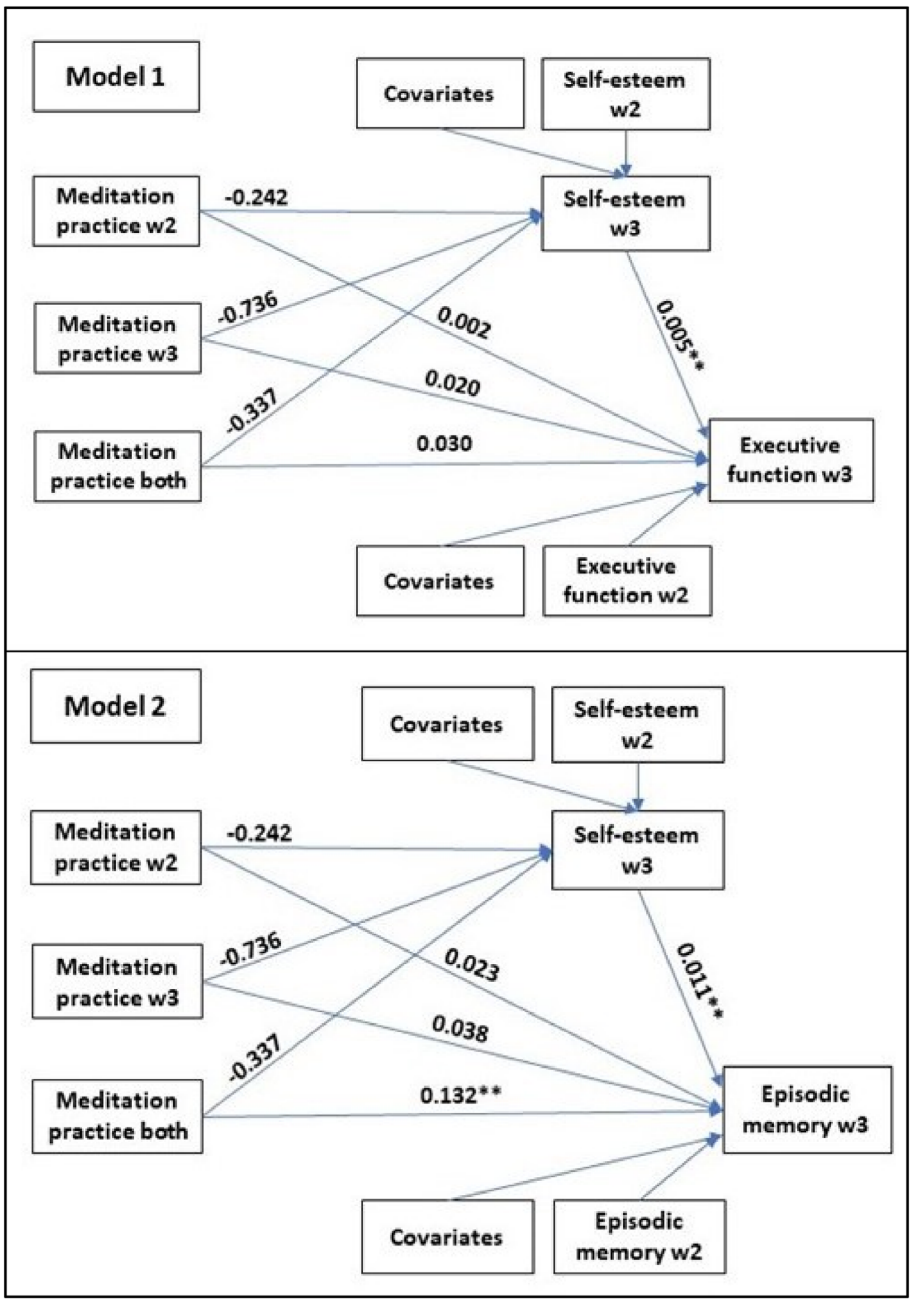


**Figure 3** Path diagram showing the pathways linking the key independent variable (meditation practice status), mediator (self-esteem), and cognitive outcomes (executive function and episodic memory) for the two structural equation models, $n = 2168$. Covariates were included in all structural equation modelling equations; however, effects of covariates/control variables are not shown in the diagram. w2 = wave 2. w3 = wave 3. *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

showing the pathways linking the key independent variable (meditation practice status), mediator (self-esteem), and each outcome, i.e., executive function (Model 1) and episodic memory (Model 2) for the two SEM analyses (effects of covariates not shown in the diagram). After controlling for baseline (wave 2) socio-demographic and health factors and cognitive episodic memory and executive function, findings revealed that persistent meditation practice was independently associated with a more favourable change in episodic memory ($b = 0.132$, SE $= 0.049$, $P = 0.008$), compared with no meditation practice. However, the same effect was not found for executive function ($b = 0.030$, SE $= 0.028$, $P = 0.298$). Further, a higher score in wave 3 self-esteem was associated with a more favourable change in executive function ($b = 0.005$, SE $= 0.002$, $P = 0.003$) and episodic memory ($b = 0.011$, SE $= 0.003$, $P < 0.001$). The model fit was good for both Model 1 (comparative fit index [CFI] $= 1.000$, root mean square error of approximation [RMSEA] $= 0.000$, and standardized root mean squared residual [SRMR] $= 0.000$) and Model 2 (CFI $= 0.999$, RMSEA $= 0.017$, and SRMR $= 0.001$).

In an SEM analysis, the total effect of an explanatory/exposure variable represents the overall effect we would find whether or not a mediator is included in the analysis.[42] After controlling for baseline (wave 2) covariates, self-esteem, and cognitive functions (where appropriate), the total effect of persistent meditation practice on episodic memory is 0.129 ($P = 0.009$). As indicated above, the direct effect of persistent meditation practice is 0.132, which is larger than the total effect (see Table S3). The total indirect effect of persistent meditation practice that passes through self-esteem is −0.004 (i.e., −0.337*0.011), but is statistically not significant. We therefore conclude that self-esteem does not mediate the relationship between meditation practice and episodic memory. On the other hand, for executive function, the total and direct effects for persistent meditation practice are 0.028 and 0.030, respectively; both are statistically not significant (see Table S3). The total indirect effect of persistent meditation practice that passes through self-esteem is −0.002 (i.e., −0.337*0.005), which is also not significant. Therefore, we conclude that persistent meditation status has neither a direct nor an indirect effect through self-esteem on executive function.

The SEM sensitivity analyses categorizing meditation practice into three levels, i.e., (i) regular (*a lot* and *often*), (ii) irregular (*sometimes* and *rarely*), and (iii) never, shows similar findings (Table S4). The result revealed that persistent regular meditation practice was independently associated with a more favourable change in episodic memory, but not executive function, compared to no practice.

## DISCUSSION

The current study examined the impact of meditative or relaxation practice (longitudinal/persistent use vs. episodic use vs. no use) and self-esteem on cognitive outcomes over 10 years (two waves of data). While cognitive change is often the focus of studies in late life, this study uses individuals across a wider age range, including mid- and late life, and includes both psychological protective factors (self-esteem) and behavioural practices (mindfulness and relaxation exercises) to examine cognitive outcomes. Results show that persistent meditation practice at both waves was positively associated with episodic memory but not executive function.

Further, the current study contributes to the existing literature with evidence that high self-esteem positively associated with both executive functions and episodic memory in MIDUS middle-aged and older adult populations. Additionally, high self-esteem did not mediate the association between meditation practice and cognitive functions in mid- and later life over 10 years. The relationship between self-esteem and cognition has been studied in children to show that higher self-esteem helps young children better complete difficult tasks successfully,[44] but for adults, the findings have been somewhat mixed. For example, Catarino and Adams[31] found no association between self-esteem and cognition; however, Strandell[32] found that higher self-esteem may positively affect cognition influenced by cultural knowledge.[32] According to the self-fulfilling prophecy theory, individuals with high self-esteem tend to show more engagement in activities that benefit their cognitive performance over time; in contrast, individuals having low self-esteem show more engagement in activities that impede their cognitive functioning (Wang *et al*., 2023).[45] Therefore, in line with research showing individuals with high self-esteem have more favourable changes in cognitive function, our study provides evidence that self-esteem may be a protective factor against cognitive decline.

Research also found that individuals with high self-esteem possess positive self-concepts, higher self-efficacy, and are motivated to engage in demanding activities, further promoting their cognitive performance, whereas individuals with low self-esteem show negative self-concepts, low self-efficacy, and are less motivated to engage in activities that benefit their cognitive functions[46,47]; this may lead to impaired cognitive function.

In partial support of our second hypothesis, persistent meditation practice in both waves 2 and 3 showed a significant positive effect on episodic memory compared to participants who never practiced meditation. However, the same effect was not found for executive functioning. Further, we found no significant association between meditation practice and self-esteem in each of the two models. Although some earlier studies found positive correlations between mindfulness and self-esteem,[29–48] others did not.[48,49] This negative finding in our study may be due to a wide variety of meditation practice techniques, a long gap between survey waves, categorizing all frequencies of practice in the same group, or the lack of a long-term effect for meditation on certain psychological states and cognitive activities. In this regard, it is worth mentioning that the findings from the sensitivity analyses also revealed an unfavourable change in the execution function in the W2R-W3IR group (those who practiced mediation regularly in wave 2, but were irregular in practice in wave 3) listed in Table S4. In this context, Gothe *et al*.[50] report in a systematic review that mind–body practice is associated with hippocampal volume, which is related to learning and memory functions but not executive functions. In addition, earlier research suggests that while excessive stress can be detrimental to cognitive functioning, milder stress may enhance cognitive performance, especially immediate memory functions,[6,51] as evidenced by higher cortisol levels.[5] Although we did not measure serum cortisol levels in this study, possibly, the quality, not the quantity of stress, is a more crucial factor that affects cognitive functioning.

Further, mind–body practices have been found to be associated with increased physical activity, reduced stress, and increased well-being[52] (Rocha *et al*., 2012).[53] Negative effects of stress on cognitive function are well documented.[52,54] During stressful periods, an individual's sympathetic nervous system is triggered; as a result, various inflammatory neurotransmitters such as cytokines are released, which may have adverse effects on (cognitive) health. Mind–body practice, such as yoga, has a downregulating effect on the sympathetic nervous system and hypothalamus–pituitary–adrenal (HPA) axis in response to stress.[55] Bridging between mind and body, mind–body practice, through various neuronal circuits, may reduce the production of inflammatory neurotransmitters.[55] Individuals may turn to mind–body practice (e.g., yoga) for these stress-reducing effects. As a physical activity, yoga can enhance muscle strength and body flexibility and improve respiratory and cardiovascular function.[56] Both of these factors have been linked with higher levels of cognitive function in previous studies (Smolarek *et al*., 2016)[56,57]; this may explain why persistent engagement in meditation practices helps in some domains of cognitive performance but not others.

## LIMITATIONS

The main strength of the current study is its expanded age range, longitudinal design, and large sample size; however, it has several limitations. For example, MIDUS did not screen participants for cognitive impairment at baseline, and we were unable to comment on the neurocognitive status of the participants in our sample. It is also not possible in the MIDUS dataset to identify the precise frequency or regularity of meditation practice with more detail, nor whether there was any overlap (i.e., two/more meditation practices simultaneously), inducing generalizability concerns. Due to the lack of precision in the measure of mediation practice in the current study, the findings might be confounded by personality traits and physical/mental health status; therefore, we controlled for the Big Five personality traits, self-rated health, and depressive symptoms to ensure the robustness of the results we obtained. Future surveys should collect more in-depth information on meditation techniques to examine potential load/dose–response associations and determine a potential causal relationship between meditation practice and cognitive functioning.

We also note that meditation practitioners often select themselves on the basis of their better physical and cognitive health and their sense that they can do the job. This self-selection bias could be potentially confounding because it may make them better than non-practitioners in some cognitive dimensions but not in others.[58] Another limitation is related to recall bias because responses were collected

retrospectively. Further, the interval between the studied waves was 10 years; our analyses were based on just two data points on cognitive function, which precluded the analysis of non-linear trends (e.g., accelerated cognitive decline). The findings of these analyses need to be interpreted with the caveat that sample sizes per category were small (i.e., between 2% and 11% for each category of meditation practice frequency other than *never*; further, we considered meditation practice as including any frequency of practice, even *rarely*). Finally, given the design and secondary data analysis of this study, no causal relationships can be definitively inferred. Despite these limitations, our findings suggest that potential positive effects in some cognitive domains can accrue only when individuals practice meditation persistently over the long run.

## CONCLUSIONS

Overall, the findings reveal that persistent meditation practice is associated with better episodic memory and that a higher self-esteem is associated with higher levels of episodic memory and executive function in mid- and later life over 10 years. While cognitive decline is often examined in relation to other risk/protective factors in late life, this study determined that self-esteem has associations with cognitive outcomes among middle-aged and older adult meditation practitioners in MIDUS. While identifying meditative practice and self-esteem as protective factors for mid- and late-life cognition is important, data from MIDUS did not support that self-esteem was a mediator in this relationship. Thus, future research should consider the mechanisms underlying the positive aspects of meditation practice, i.e., frequency of meditation practices and whether any specific technique/s are essential and, therefore, should be incorporated in meditation practice to improve cognitive outcomes among community-living middle-aged and older adults.

## ACKNOWLEDGMENT

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available in MIDUS Colectica Portal at https://www.icpsr.umich.edu/files/NACDA/MIDUS_Final.pdf. These data were derived from the following resources available in the public domain: MIDUS, https://midus.colectica.org/

## REFERENCES

1 Glisky EL, Woolverton CB, McVeigh KS, Grilli MD. Episodic memory and executive function are differentially affected by retests but similarly affected by age in a longitudinal study of normally-aging older adults. *Front Aging Neurosci* 2022; **14**: 863942. https://doi.org/10.3389/fnagi.2022.863942.
2 Harada CN, Natelson Love MC, Triebel KL. Normal cognitive aging. *Clin Geriatr Med* 2013; **29**: 737–752. https://doi.org/10.1016/j.cger.2013.07.002.
3 Hülür G, Infurna FJ, Ram N, Gerstorf D. Cohorts based on decade of death: No evidence for secular trends favoring later cohorts in cognitive aging and terminal decline in the AHEAD study. *Psychol Aging* 2013; **28**: 115–127. https://doi.org/10.1037/a0029965.
4 Yang Y, Rushton S, Park HK *et al*. Understanding the associations between caregiver characteristics and cognitive function of adults with cancer: a scoping review. *Asia Pac J Oncol Nurs* 2020; **7**: 115–128. https://doi.org/10.4103/apjon.apjon_3_20.
5 Allen AP, Curran EA, Duggan Á *et al*. A systematic review of the psychobiological burden of informal caregiving for patients with dementia: focus on cognitive and biological markers of chronic stress. *Neurosci Biobehav Rev* 2017; **73**: 123–164. https://doi.org/10.1016/j.neubiorev.2016.12.006.
6 Jütten LH, Mark RE, Sitskoorn MM. Episodic memory and executive functioning in informal dementia caregivers. *Aging Ment Health* 2020; **24**: 1681–1689. https://doi.org/10.1080/13607863.2019.1617242.
7 Corrêa MS, Vedovelli K, Giacobbo BL *et al*. Psychophysiological correlates of cognitive deficits in family caregivers of patients with Alzheimer disease. *Neuroscience* 2015; **286**: 371–382. https://doi.org/10.1016/j.neuroscience.2014.11.052.
8 Mallya S, Fiocco AJ. Impact of informal caregiving on cognitive function and well-being in Canada. *Int Psychogeriatr* 2018; **30**: 1049–1055. https://doi.org/10.1017/S1041610217002605.
9 Bhattacharyya KK, Andel R, Small BJ. Effects of yoga-related mind-body therapies on cognitive function in older adults: a systematic review with meta-analysis. *Arch Gerontol Geriatr* 2021; **93**: 104319. https://doi.org/10.1016/j.archger.2020.104319.
10 Klimova B, Valis M, Kuca K. Cognitive decline in normal aging and its prevention: a review on non-pharmacological lifestyle strategies. *Clin Interv Aging* 2017; **12**: 903–910. https://doi.org/10.2147/CIA.S132963.
11 Eyre HA, Siddarth P, Acevedo B *et al*. A randomized controlled trial of kundalini yoga in mild cognitive impairment. *Int Psychogeriatr* 2017; **29**: 557–567. https://doi.org/10.1017/S1041610216002155.
12 Eyre HA, Acevedo B, Yang H *et al*. Changes in neural connectivity and memory following a yoga intervention for older adults: a pilot study. *J Alzheimers Dis* 2016; **52**: 673–684. https://doi.org/10.3233/JAD-150653.
13 National Center for Complementary and Integrative Health. Complimentary, Alternative or Integrative Health: What's in a Name? U.S. Department of Health and Human Services, 2016. Retrieved from: https://nccih.nih.gov/health/integrative-health#cvsa.

14 Chong S, Kim YJ, Lee HW, Johnson RE, Lin S-H. Mind your own break! The interactive effect of workday respite activities and mindfulness on employee outcomes via affective linkages. *Organ Behav Hum Decis Process* 2020; **159**: 64–77. https://doi.org/10.1016/j.obhdp.2019.11.001.

15 Cramer H, Quinker D, Pilkington K, Mason H, Adams J, Dobos G. Associations of yoga practice, health status, and health behavior among yoga practitioners in Germany: results of a national cross-sectional survey. *Complement Ther Med* 2019; **42**: 19–26. https://doi.org/10.1016/j.ctim.2018.10.026.

16 Crego A, Yela JR, Gómez-Martínez MÁ, Riesco-Matías P, Petisco-Rodríguez C. Relationships between mindfulness, purpose in life, happiness, anxiety, and depression: testing a mediation model in a sample of women. *Int J Environ Res Public Health* 2021; **18**: 925. https://doi.org/10.3390/ijerph18030925.

17 Jung H, Miki Y, Tanaka R, Yamasaki M. The effects of a multicomponent lower extremity training technique on physical function in healthy older adults: a randomized controlled trial. *Gerontology & Geriatric Med* 2020; **6**: 1–10. https://doi.org/10.1177/2333721420935702.

18 Pepping CA, O'Donovan A, Davis PJ. The positive effects of mindfulness on self-esteem. *J Positive Psyc* 2013; **8**: 376–386. https://doi.org/10.1080/17439760.2013.807353.

19 Goldin PR, Gross JJ. Effects of mindfulness-based stress reduction (MBSR) on emotion regulation in social anxiety disorder. *Emotion (Washington, D.C.)* 2010; **10**: 83–91. https://doi.org/10.1037/a0018441.

20 Rosenberg M, Schooler C, Schoenbach C, Rosenberg F. Global self-esteem and specific self-esteem: different concepts, different outcomes. *Am Sociol Rev* 1995; **60**: 141–156.

21 Stokes JE. Social integration, perceived discrimination, and self-esteem in mid- and later life: intersections with age and neuroticism. *Aging Ment Health* 2019; **23**: 727–735. https://doi.org/10.1080/13607863.2018.1450834.

22 Wang WL, Lee KT, Lin WC, Yang YC, Tsai CL. The effects of a magic-based intervention on self-esteem, depressive symptoms, and quality of life among community-dwelling older adults: a randomized controlled trial. *Psychogeriatrics* 2023a; **23**: 701–712. https://doi.org/10.1111/psyg.12987.

23 Wagner J, Hoppmann C, Ram N, Gerstorf D. Self-esteem is relatively stable late in life: the role of resources in the health, self-regulation, and social domains. *Develop Psychol* 2015; **51**: 136–149. https://doi.org/10.1037/a0038338.

24 Rosenberg M. *Society and the Adolescent Self-Image*. Princeton, NJ: Princeton University Press, 1965.

25 Westerhof GJ, Whitbourne SK, Freeman GP. The aging self in a cultural context: the relation of conceptions of aging to identity processes and self-esteem in the United States and The Netherlands. *J Gerontol B Psychol Sci Soc Sci* 2012; **67**: 52–60. https://doi.org/10.1093/geronb/gbr075.

26 Noonan AE, Tennstedt SL. Meaning in caregiving and its contribution to caregiver well-being. *Gerontologist* 1997; **37**: 785–794. https://doi.org/10.1093/geront/37.6.785.

27 Zhao X, Zhang W, Su Y, Song Y, Si H, Zhu L. Death anxiety, self-esteem, and health-related quality of life among geriatric caregivers during the COVID-19 pandemic. *Psychogeriatrics* 2022; **22**: 236–242. https://doi.org/10.1111/psyg.12807.

28 Galanakis M, Palaiologou A, Patsi G, Velegraki I-M, Darviri C. A literature review on the connection between stress and self-esteem. *Psychology* 2016; **7**: 687–694. https://doi.org/10.4236/psych.2016.75071.

29 Chandna S, Sharma P, Moosath H. The mindful self: exploring mindfulness in relation with self-esteem and self-efficacy in Indian population. *Psychological Studies* 2022; **67**: 261–272. https://doi.org/10.1007/s12646-021-00636-5.

30 Chylová H, Natovová L. Stress, self-efficacy and well-being of the university students. *J Efficiency Res Edu Sci* 2013; **6**: 190–202. https://doi.org/10.7160/eriesj.2013.060306.

31 Catarino D, Adams C. Examining cognitive function and self-esteem of middle aged and older adults. *Innov Aging* 2020; **4**: 893. https://doi.org/10.1093/geroni/igaa057.3292.

32 Strandell J. Culture, cognition and behavior in the pursuit of self-esteem. *Poetics* 2016; **54**: 14–24. https://doi.org/10.1016/j.poetic.2015.08.007.

33 Mann M, Hosman CM, Schaalma HP, de Vries NK. Self-esteem in a broad-spectrum approach for mental health promotion. *Health Educ Res* 2004; **19**: 357–372. https://doi.org/10.1093/her/cyg041.

34 Juth V, Smyth JM, Santuzzi AM. How do you feel? Self-esteem predicts affect, stress, social interaction, and symptom severity during daily life in patients with chronic illness. *J Health Psychol* 2008; **13**: 884–894. https://doi.org/10.1177/1359105308095062.

35 Hughes ML, Agrigoroaei S, Jeon M, Bruzzese M, Lachman ME. Change in cognitive performance from midlife into old age: findings from the midlife in the United States (MIDUS) study. *J Int Neuropsychol Soc* 2018; **24**: 805–820. https://doi.org/10.1017/S1355617718000425.

36 Lachman ME, Agrigoroaei S, Tun PA, Weaver SL. Monitoring cognitive functioning: psychometric properties of the brief test of adult cognition by telephone. *Assessment* 2014; **21**: 404–417. https://doi.org/10.1177/1073191113508807.

37 Lachman ME, Agrigoroaei S, Murphy C, Tun PA. Frequent cognitive activity compensates for education differences in episodic memory. *Am J Geriatr Psychiatry* 2010; **18**: 4–10. https://doi.org/10.1097/JGP.0b013e3181ab8b62.

38 Cutler DM, Lleras-Muney A. Understanding differences in health behaviors by education. *J Health Econ* 2010; **29**: 1–28. https://doi.org/10.1016/j.jhealeco.2009.10.003.

39 Sutin AR, Stephan Y, Aschwanden D, Luchetti M, Strickhouser JE, Terracciano A. Evaluations of a previous day as a pathway between personality and healthy cognitive aging. *J Aging Health* 2020; **32**: 642–653. https://doi.org/10.1177/0898264319843451.

40 Zimprich D, Allemand M, Lachman ME. Factorial structure and age-related psychometrics of the MIDUS personality adjective items across the life span. *Psychol Assess* 2012; **24**: 173–186. https://doi.org/10.1037/a0025265.

41 Hayes AF. An index and test of linear moderated mediation. *Multivar Behav Res* 2015; **50**: 1–22. https://doi.org/10.1080/00273171.2014.962683.

42 Cole DA, Maxwell SE. Testing mediational models with longitudinal data: questions and tips in the use of structural equation modeling. *J Abnorm Psychol* 2003; **112**: 558–577. https://doi.org/10.1037/0021-843X.112.4.558.

43 Yang Y, Cuffee YL, Aumiller BB, Schmitz K, Almeida DM, Chinchilli VM. Serial mediation roles of perceived stress and depressive symptoms in the association between sleep quality and life satisfaction among middle-aged American adults. *Front Psychol* 2022; **13**: 822564. https://doi.org/10.3389/fpsyg.2022.822564.

44 Papadopoulos D. Examining the relationships among cognitive ability, domain-specific self-concept, and behavioral self-esteem of gifted children aged 5-6 years: a cross-sectional

study. *Behavioral Sciences (Basel, Switzerland)* 2021; **11**: 93. https://doi.org/10.3390/bs11070093.
45 Wang X, Liu Y, Zhao Z *et al*. Association of adolescent self-esteem in 2014 and cognitive performance in 2014, 2016, and 2018: a longitudinal study. *Front Psychol* 2023b; **14**: 1180397. https://doi.org/10.3389/fpsyg.2023.1180397.
46 Bandura A. Social cognitive theory: an agentic perspective. *Annu Rev Psychol* 2001; **52**: 1–26. https://doi.org/10.1146/annurev.psych.52.1.1.
47 Dos Santos SB, Rocha GP, Fernandez LL, de Padua AC, Reppold CT. Association of lower spiritual well-being, social support, self-esteem, subjective well-being, optimism and hope scores with mild cognitive impairment and mild dementia. *Front Psychol* 2018; **9**: 371. https://doi.org/10.3389/fpsyg.2018.00371.
48 Randal C, Pratt D, Bucci S. Mindfulness and self-esteem: a systematic review. *Mind* 2015; **6**: 1366–1378. https://doi.org/10.1007/s12671-015-0407-6.
49 Henderson VP, Massion AO, Clemow L, Hurley TG, Druker S, Hébert JR. A randomized controlled trial of mindfulness-based stress reduction for women with early-stage breast cancer receiving radiotherapy. *Integr Cancer Ther* 2013; **12**: 404–413. https://doi.org/10.1177/1534735412473640.
50 Gothe NP, Khan I, Hayes J, Erlenbach E, Damoiseaux JS. Yoga effects on brain health: a systematic review of the current literature. *Brain Plasticity (Amsterdam, Netherlands)* 2019; **5**: 105–122. https://doi.org/10.3233/BPL-190084.
51 O'Sullivan M, Brennan S, Lawlor BA, Hannigan C, Robertson IH, Pertl MM. Cognitive functioning among cognitively intact dementia caregivers compared to matched self-selected and population controls. *Aging Ment Health* 2019; **23**: 566–573. https://doi.org/10.1080/13607863.2018.1428937.
52 Kabataş Yıldız M, Orak OS. The effect of the mindfulness-based stress reduction program on the level of perceived stress and geriatric depression in older adults: a randomized controlled study. *Psychogeriatrics* 2023; **23**: 261–272. https://doi.org/10.1111/psyg.12929.
53 Rocha KK, Ribeiro AM, Rocha KC *et al*. Improvement in physiological and psychological parameters after 6 months of yoga practice. *Conscious Cogn* 2012; **21**: 843–850. https://doi.org/10.1016/j.concog.2012.01.014.
54 Foong HF, Hamid TA, Ibrahim R, Haron SA. Information processing speed as a mediator between psychosocial stress and global cognition in older adults. *Psychogeriatrics* 2018; **18**: 21–29. https://doi.org/10.1111/psyg.12279.
55 Ross A, Thomas S. The health benefits of yoga and exercise: a review of comparison studies. *J Altern Complement Med* 2010; **16**: 3–12.
56 Woodyard C. Exploring the therapeutic effects of yoga and its ability to increase quality of life. *Int J Yoga* 2011; **4**: 49–54. https://doi.org/10.4103/0973-6131.85485.
57 Smolarek A, Ferreira LH, Mascarenhas LP *et al*. The effects of strength training on cognitive performance in elderly women. *Clin Interv Aging* 2016; **11**: 749–754. https://doi.org/10.2147/CIA.S102126.
58 Roth DL, Fredman L, Haley WE. Informal caregiving and its impact on health: a reappraisal from population-based studies. *Gerontologist* 2015; **55**: 309–319. https://doi.org/10.1093/geront/gnu177.

## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's website: http://onlinelibrary.wiley.com/doi//suppinfo.

**Table S1.** DEPCON scale.
**Table S2.** Descriptive summary of repeated measures (total and stratified by meditation practice status) in MIDUS at both waves 2 and 3, $n = 2168$.
**Table S3.** Structural equation models showing direct, indirect, and total effects examining associations of cognitive functions with levels of meditation practice and self-esteem ($N = 2168$).
**Table S4.** Structural equation models examining associations of cognitive functions with meditation practice status (categorical) and self-esteem, $n = 2168$.