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Trends, heterogeneity, and correlates of mental health and psychosocial well-being in later-life: study of 590 community-dwelling adults aged 40–104 years

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ABSTRACT

Objective: The goal of this study was to examine if mental health and psychosocial well-being differed between middle-aged (MA; 40–59 years), younger-old (YO; 60–79 years), and older-old (OO; 80+ years) adults with respect to their trends, heterogeneity, and correlates.

Methods: Eighteen mental health and psychosocial well-being instruments were administered to 590 adults over age 40. Cross-sectional data also included self-report-based measures of sociodemographics, cognitive functioning, physical health and activity, and body mass index.

Results: Age trends across instruments varied in magnitude and shape, but generally supported an inverted U-shaped trend in mental health and psychosocial well-being, with small increases from MA to YO age ($d = 0.29$) and smaller declines from YO to OO age ($d = -0.17$). A U-shaped association between age and mental health heterogeneity was also observed. The strongest correlates of mental health and psychosocial well-being differed by age (MA: perceived stress; YO: successful aging; OO: compassion toward others), as did the associations of a flourishing versus languishing mental health and well-being profile.

Conclusions: Our findings support the "paradox of aging," whereby declines in physical and cognitive health co-occur with relatively preserved mental health and well-being. Our findings indicate that variance in mental and psychosocial health does not increase linearly with age and support careful consideration of heterogeneity in mental health and aging research. Our findings also suggest that mental health and psychosocial well-being decouple from stress-related dimensions in MA and become increasingly associated with positive, other-oriented emotions in OO, broadly supporting socioemotional theories of aging.

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Healthy aging; resilience; wisdom; loneliness; optimism; mental health; psychological and social aspects; quality of life/wellbeing

Introduction

Given the cost of caring for older people with chronic physical and neurocognitive illnesses, and the intrinsic human desire to maximize quality of life as longevity increases, public health initiatives are increasingly focused on the trajectories and determinants of healthy aging (e.g. The World Health Organization's *Decade of Healthy Aging: 2021-2030*). 'Successful' aging is broadly defined as maintenance of mental and physical functioning, and continued engagement with life, rather than absence of disease and disability (Depp and Jeste, 2006). However, our understanding of mental health and well-being trajectories and correlates in the oldest age group (OO: "older-old", 80+ yrs), the fastest growing segment of the population, is limited, apart from studies focused on cognitively exceptional 'superagers' whose mental health and psychosocial well-being are not representative of their non-exceptional peers (Cook Maher et al., 2017).

Some investigators have reported a nadir in mental health in middle-age (MA: 40 s – 50 s) followed by improvement in the 'younger-old' (YO: 60 s – 70 s) (Cheng et al., 2017). However, it remains unclear whether these improvements persist, plateau, or degrade with aging into the older-old years. While some studies have found linear increases in mental health through 90+ years of age (Blanchflower, 2021; Magwene et al., 2017; Thomas et al., 2016), others have observed 'inverted U-shaped' changes, with low levels in MA, improvement in the YO, and worsening among the OO (Prior et al., 2020). Conflicting reports may be a result of under-sampling of the OO, as well as study-to-study variability in the specific dimensions of mental health and well-being assessed. Sociodemographic characteristics, such as gender, race and ethnicity, educational attainment, and income, as well as health behaviors, cognitive and physical functioning, and disparities in healthcare access and utilization, are also important modifiers of mental health and well-being (Meyer et al., 2014), but their role in mental health trajectories across the lifespan are understudied and thus a key research priority (Evans et al., 2015; Jeste et al., 2022). Therefore, studies with well-balanced age sampling across the older adult lifespan, particularly the OO, that comprehensively assess health and well-being, and adequately adjust for sociodemographic factors, are needed to further our understanding of healthy aging, its determinants, and correlates for the oldest adults in society.

During the aging process, medical morbidities, physical impairments, and neurocognitive limitations accumulate in unique ways across individuals (Santoni et al., 2015). Thus, a

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central tenant in gerontology and geroscience is that inter-individual variability (i.e. heterogeneity) in health and health parameters increases across the lifespan. This increase in heterogeneity is believed to mediate many of the unique challenges to successfully treating illnesses in older-old patients, such as multimorbidity and polypharmacy. Nevertheless, despite the widespread belief that heterogeneity increases with age (Anne Nelson and Dannefer, 1992; Stone et al., 2017), recent analyses indicate that linear increases in heterogeneity, in fact, do not occur in many physical and biological measures (Nguyen et al., 2021). Interestingly, age differences in heterogeneity of comprehensively assessed mental health and well-being have not been described, aside from limited reports of increased heterogeneity in health-related quality of life (Lowsky et al., 2014). Furthermore, very few analytical approaches to quantifying heterogeneity across multiple health parameters have been described (Peña and Rodríguez, 2003). Therefore, we used a multivariate method (beta dispersion) (Anderson, 2006) to examine within- and between-age group heterogeneity in mental health and psychosocial well-being across OO, YO, and MA adults.

In addition, the emotions, behaviors, and psychosocial dimensions that most strongly contribute to healthy or 'successful' aging vary with age (Depp and Jeste, 2006). For instance, in YO adults, professional status is correlated with successful aging, whereas for the OO, holistic considerations like spirituality, rather than status, are more predictive of aging well (von Humboldt and Leal, 2017). These differences align with socioemotional selectivity theory (SST), which posits that older individuals tend to focus more on fulfilling shorter-term psychosocial rewards, rather than longer-term objectives (Carstensen et al., 2003). Emotion regulation strategies, which are important mediators of mental health, also undergo age-related shifts as cognitive and social resources change over the lifespan (Urry and Gross, 2010). Therefore, what matters for mental health and well-being in the OO likely differs from what matters for the YO or MA. Yet, systematic, multidimensional explorations of the correlates and predictors of mental health and well-being in the OO compared to YO and MA adults are limited.

In this study, we examined 18 different dimensions of self-report-based mental health and psychosocial well-being among adults aged 40-104 years in a community sample within San Diego County, USA, recruited using random-digit dialing. OO adults, the focus of our study, were intentionally oversampled to adequately examine differences in these outcomes relative to MA and YO adults. We hypothesized that mental health and psychosocial well-being would follow a non-linear, U-shaped trend. We further hypothesized that heterogeneity in mental health and psychosocial well-being, operationalized using a multivariate distance-based approach, would increase linearly with age. Lastly, we explored whether positive mental health and well-being (which we call, 'flourishing' based on latent profile analysis) in OO adults would be more strongly correlated with and predicted by dimensions associated with emotional rewards, such as happiness and compassion, than YA, for whom flourishing in aging would align more with the absence of negative states, such as stress and anxiety.

Methods

Study design and population

Participants were recruited using random-digit dialing from San Diego County for the UCSD Successful AGing Evaluation (SAGE) study of mental health and psychosocial well-being across the lifespan, which has been previously described (Jeste et al., 2013; Thomas et al., 2016). It included individuals aged 21-100+ years and oversampled adults over 80 years old. Exclusion criteria were: 1) residing in a nursing home or requiring daily skilled nursing care, 2) Alzheimer's disease or related dementias (ADRD) diagnosis made by the participant's primary care clinician (physician or nurse practitioner) as reported by the participant, 3) terminal illness or need for hospice care, and 4) inability to understand written or spoken English. All participants signed a written informed consent form online or in person and completed paper and pencil or online survey questionnaires. The study participants completed a 25-minute structured telephone interview that included cognitive assessment and were subsequently mailed a survey questionnaire. Data for the present study were restricted to the most recent surveys administered during 2018-19 among participants aged 40 years or older ($n = 590$) because it included more comprehensive psychosocial assessments than any of the earlier surveys. We sought to produce balanced age groups that closely align with Medical Subject Headings (MeSH) definitions of MA, YO, and OO adults (see section 2.3).

Measures

Sociodemographic and lifestyle characteristics

Sociodemographic and lifestyle characteristics (e.g. age, sex, race/ethnicity, educational attainment, marital status, employment status, income in U.S. dollars (circa 2018-2019), smoking and alcohol use) were obtained through survey questionnaire.

Assessments of mental health and psychosocial well-being

Eighteen dimensions of mental health and psychosocial well-being were included in the analysis. The scales included the Santa Clara Brief Compassion Scale (SCBCS) (Hwang et al., 2008), Self-Reported Successful Aging (SRSA) (Jeste et al., 2013). Cognitively-stimulating activities (CSA) were assessed using a subscale derived from the Life Complexity Scale (Mitchell et al., 2012). Depression was measured using the Center for Epidemiologic Studies Depression (CESD) Scale (Kohout et al., 1993), and happiness using the Happiness Subscale (CESD-HS; Fowler and Christakis, 2008) derived from the CESD. Self-compassion used the Neff Self-Compassion Scale (NSCS) (Neff, 2003), and satisfaction with life used the Satisfaction with Life Scale (Diener et al., 1985). Overall mental health was measured using the manual-based scoring method for deriving the mental health composite score from the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) (Ware et al., 1994). Resilience was quantified using the 10-item Connor-Davidson Resilience Scale (CD-RISC) (Connor and Davidson, 2003), optimism using the Life Orientation Test-Revised (LOT-R) (Scheier et al., 1994), meaning in life with the presence subscale of the Meaning in Life Questionnaire (MLQ) (Steger et al., 2006), and personal mastery with the Personal Mastery Scale (PMS) (Pearlin and Schooler, 1978), assessed personal mastery. Patient Reported Outcomes Measurement Information System (PROMIS) Companionship 4a Short Form v2.0 (Cella et al., 2010) measured companionship, the 20-item UCLA-3 Loneliness Scale, Version 3 (ULS) (Russell, 1996) assessed loneliness, religiosity used the Brief Multidimensional Measure of Religiousness/Spirituality (BMMRS) (Idler et al., 2003), anxiety was quantified

using the Brief Symptom Inventory – Anxiety subscale (BSI-A) (Derogatis and Melisaratos, 1983), and perceived stress using the Perceived Stress Scale (PSS) (Cohen et al., 1983). Wisdom was quantified based on total scores on the 24-item San Diego Wisdom Scale (SD-WISE) (Thomas et al., 2019), which encompasses six domains, including self-reflection, prosocial behaviors, emotion regulation, acceptance of divergent perspectives, decisiveness, and social advising. Internal consistency was estimated for all assessments using McDonald's omega reliability (ω) coefficients and were ≥0.83 for all measures (except CSA = 0.75; Supplemental Table 1).

Cognitive assessment

Subjective cognitive function was determined using the Cognitive Failures Questionnaire (CFQ-25) (Broadbent et al., 1982).

Physical function

Physical function was assessed using the manual-based scoring method for deriving a physical health composite score from the SF-36. Physical activity was determined through the International Physical Activity Questionnaire (IPAQ) (Ainsworth et al., 2000). Body mass index (BMI) was calculated based on self-reported height and body weight.

Statistical analyses

Descriptive statistics

All statistical analyses were conducted in *R* (v.3.6.5). Outcome variables were visually inspected for deviations from normality using Shapiro-Wilks tests, and log-transformations were applied to BSI-A and CES-D values. Missingness for each variable was ≤ 5%. Data were assumed to be missing completely at random (MCAR) and were omitted list-wise. Locally weighted scatterplot smoothing (LOESS) plots with 1-yr interval estimates were generated to explore age associations, and first derivatives were generated to explore rates of change. To formally test for age differences, we created three 20-year age bins, hereafter referred to as "middle-aged" (MA; 40-59 yrs), "younger-old" (YO; 60-79 yrs), and "older-old" (OO; 80-104 yrs) adults. These age groups closely map onto MeSH definitions of middle-aged (45-64 yrs), aged (65-79 yrs), and "aged, 80 and over," but were shifted to balance sample sizes.

Sociodemographic and lifestyle characteristics, cognitive, and physical function were compared across groups using analyses of variance (ANOVA) or Fisher's Exact Test for categorical variables, with Tukey-adjusted post hoc *t*-tests or Cramér's V tests of age group contrasts. Bootstrapped bias-corrected accelerated confidence intervals were computed for Cramér's V. ANOVAs were applied to assess age group differences on each outcome measure, adjusting for sex, race (8-level factor: White, African-American, Hispanic, Asian, Native American, Native Hawaiian/Pacific Islander, Bi/Multi-racial, Other), marital status (currently married/partnered versus not), employment status (yes or no), education (13-level ordinal factor), and personal income (9-level ordinal factor) and *p*-values were false discovery rate (FDR)-corrected. Wald F-tests were computed and converted to adjusted partial eta-squared (i.e. epsilon-squared; ε_p^2) effect sizes (Mordkoff, 2019). Post hoc *t*-tests were converted to Cohen's *d* with 99% CIs. Cohen's *d* were pooled for between-group estimates of overall effect size using a fixed-effects meta-analytic approach (Hedges and Vevea, 1998).

Heterogeneity (inter-individual variability)

Heterogeneity of age-group dispersions (variances) across all standardized outcome variables were assessed using Mahalanobis distances between each individual and their age-group centroid (i.e. spatial median) (Anderson, 2006) with ANCOVA adjusted for physical functioning, activity level, and cognitive functioning. This analysis was necessary to better measure and understand the heterogeneity in mental health and psychosocial well-being within and across ages, rather than solely relying on univariate statistics (e.g. standard deviations), with larger values indicating greater inter-individual variability within age groups. Mahalanobis distances, which are superior to Euclidean distances when variables are intercorrelated, were used in the present analyses. Sensitivity analyses concluded that sample size did not appreciably change the reported heterogeneity statistics (i.e. analyses were rerun after permutation replacement sampling was conducted).

Latent profile analysis

To determine the mental health and psychosocial well-being dimensions that best differentiated individuals in each age group, latent profile analysis (LPA) was performed in R using the *tidyLPA* package. Imputation of missing variables was carried out using a random forest machine learning algorithm-based method (Stekhoven and Bühlmann, 2012). LPA is a data-driven method that uses observed variables to identify latent classes or groupings of subjects. Using this approach, we grouped participants into 'flourishing,' 'languishing,' or 'moderate' classes based on observed, graded relationships between class membership and assessment scores within each age group. To characterize each class's composition, ANOVAs (or Chi-squared tests for categorical variables) were performed using individual-level sociodemographic characteristics. ANOVAs and post hoc *t*-tests for class contrasts were implemented to describe the variables that best discriminated each class. *F*-test and *t*-test statistics were converted to partial epsilon-squared and Cohen's *d*, respectively, with standard errors and 99% CIs. Effect sizes were interpreted according to Cohen (1992) (small: $d \cong 0.20$, $\varepsilon_p^2 < 0.13$, $r < 0.3$, $V \cong 0.10$; moderate: $d \cong 0.50$, $0.13 < \varepsilon_p^2 < 0.26$, $0.3 < r < 0.5$, $V \cong 0.30$; large: $d \cong 0.80$, $\varepsilon_p^2 > 0.26$, $r > 0.5$, $V \cong 0.50$). Further description of the statistical approach can be found within the Supplemental Methods.

Results

Sociodemographics, health behaviors, physical health, and cognition across age groups

The 590 participants' mean age was 70.8 years (SD = 16.1; range = 40-104), and 50% were female. Participants predominantly identified as non-Hispanic White (75%), 14% as Hispanic, 8% Asian-American, 1% African American, and 2% other ethnic or racial backgrounds. Nearly half (48%) were retired, 42% were currently employed, 4% were full-time homemakers, and 6% were unemployed, volunteering, disabled, or on temporary medical leave. Sixty-two percent had received a bachelor's degree or higher level of education, 25% had received an associate's degree or completed some college, while 13% had a high school education/equivalency or less. More than half (51%) of participants had personal annual incomes greater than $50,000, 46% earned less, and 3% either did not know or report. Sixty-two percent were married or partnered, 15% were

Table 1. Sociodemographic, health behaviors, physical health and cognition characteristics of the study population.

Measure	Middle-aged ($n=166$)	Younger-old ($n=223$)	Older-old ($n=201$)
Age	50.0 (5.3)^{2,3}	70.4 (5.5)^{1,3}	88.6 (5.5)^{1,2}
Gender (%F)	55.7	48	46.8
Education	9.3 (1.8)	9.1 (1.9)	8.8 (2.3)
Race (%White)	69	90.6	70.6
Employed (%)	81.6	34.5	3
Partnered (%)	77.2	65.9	50.8
Income (% <$35k)	31.2	32.6	30.6
Smokers (%)	18.6	43.5	49.7
Alcohol use (*n*)	13/51/24/15	22/88/33/14	31/65/41/37
BMI	27.4 (6.8)	27.3 (5.2)	24.9 (5.2)^{1,2}
Cognitive functioning (CFQ-25)^	23.5 (11.0)	24.9 (11.2)	33.0 (12.9)^{1,2}
Physical functioning (SF-36)	50.6 (8.5)^{2,3}	46.6 (10.0)^{1,3}	37.4 (11.7)^{1,2}
Physical activity (IPAQ: L/M/H)	48/65/41^{2,3}	75/72/62^{1,3}	90/41/29^{1,2}

Comparisons performed across age groups for continuous variables using ANOVA with 99% CI; categorical variable comparisons were performed using Fisher's Exact Test or χ^2 on frequency matrices. Significant main effects indicated with bold, posthoc test significance at $p<0.01$ indicated by: 1 differs from middle-aged, 2 differs from younger-old, 3 differs from older-old. BMI: body mass index. CFQ-25: Cognitive Failures Questionnaire. SF-36-Physical: RAND Short Form-36 Physical Component Score. ^Responses to CFQ-25 received from subsamples of participants (middle-aged: $n=89$; younger-old: $n=63$; older-old: $n=94$). Alcohol use: lifetime abstainer/current infrequent/current regular/former use. Smoking status based on lifetime (yes/no) usage. IPAQ: International Physical Activity Questionnaire; H = high activity; M = medium; L = low. Education operationalized on a 12-point scale, ranging from 1.0 (no schooling) to 12.0 (doctoral degree).

widowed, 12% were divorced or separated, and 10% were never married.

Participants were grouped into three, 20-year age bins: MA (40-59 yrs; $\bar{x}=50.0$, $\sigma=5.3$), YO (60-79 yrs; $\bar{x}=70.4$, $\sigma=5.5$), and OO (80-104 yrs; $\bar{x}=88.6$, $\sigma=5.5$) for downstream analyses (Table 1). Relative to the older age groups, MA adults had higher rates of employment, were more likely to be married or partnered, and less likely to have ever smoked. Our sample of YO adults contained more non-Hispanic White (90.6%) individuals than the MA (69.0%) or OO (70.6%) groups. Age groups did not differ by gender, educational attainment, income, or alcohol use.

Subjective cognitive functioning scores (CFQ-25) were lower in the OO relative to the YO ($d=-0.70, -1.13 - -0.28$), whereas the MA and YO did not differ ($d=-0.12, -0.50 - 0.25$) (Table 1). Physical activity was moderately lower in OO compared to YO ($V=0.20$, 99% CI: 0.08 – 0.32), with only slightly lower activity in YO compared to MA adults ($V=0.08$, 0.01 – 0.19). Large differences in physical functioning scores were observed between YO and OO ($d=-0.90, -1.17 - -0.64$), with small-to-moderate differences between MA and YO ($d=-0.39, -0.65 - -0.12$). BMI was also lower in the OO (Table 1). In summary, the OO had significantly poorer scores on assessments of physical and cognitive functioning relative to younger age groups.

Mental health and psychosocial well-being across age groups

Unadjusted scores on mental health and well-being measures were lowest in the MA, highest for YO, and intermediate in OO. Across all 18 measures, their values (Figure 1, solid lines) and 1-year rates of change (Figure 1, dashed lines) were varied, but scores generally followed an inverted U-shaped relationship with age. Within the MA group, higher scores with older age (i.e. positive rate of change) were observed in some measured dimensions, such as loneliness, successful aging, and perceived stress. For many dimensions, the largest year-to-year score differences (toward higher scores) occurred in early YO age (e.g. 60-70 yrs). From 80+ yrs onwards, lower scores with larger year-to-year differences (toward lower scores) were observed in most dimensions.

Age group analyses adjusted for sex, race, employment and marital status, income, and educational attainment, confirmed that 14 dimensions varied significantly across age groups (Table 2; Supplemental Table 2). Relative to YO adults, the OO had poorer scores on 6 dimensions (pooled Cohen's $d=-0.17$, 99% CI: $-0.27 - -0.07$), specifically personal mastery, happiness, depressive symptoms, companionship, wisdom, and optimism. Relative to MA adults, the OO overall did not differ (pooled Cohen's $d=0.10$, 99% CI: $-0.06 - 0.27$), but did engage in more cognitively stimulating activities, had less anxiety, and better self-rated mental health. Relative to MA adults, the YO reported better mental health and psychosocial function on 11 dimensions (pooled Cohen's $d=0.29$, 99% CI: 0.18 – 0.41). Thus, after adjusting for sociodemographic characteristics, mental health and psychosocial well-being followed an inverted U-shaped relationship with age.

Age group heterogeneity in mental health and psychosocial well-being

Consistent with our hypothesis, heterogeneity in mental health and psychosocial well-being differed across age groups

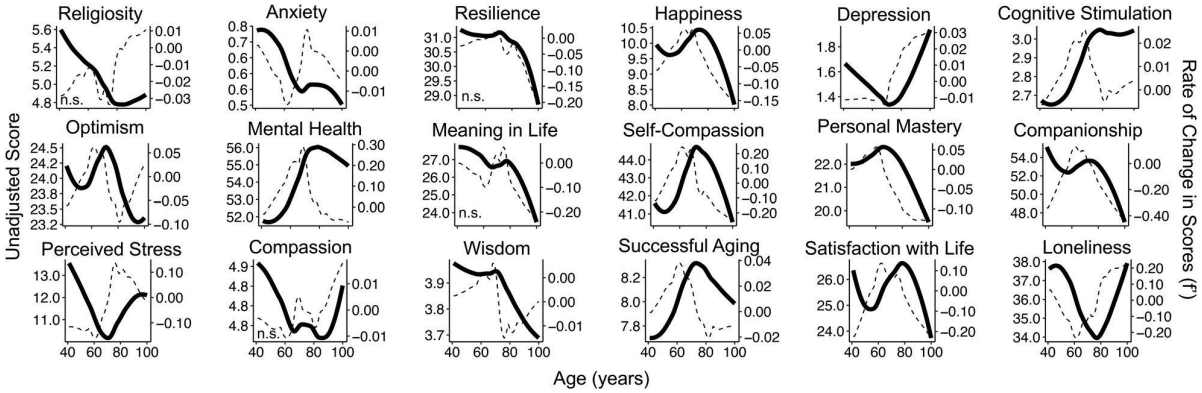


Figure 1. Mental health and psychosocial well-being assessment scores and rates of change across age. Unadjusted total or scaled scores (left axis) shown with locally weighted scatterplot smoothing (LOESS) lines of best fit computed at 1-year intervals (dark line). Rates of change (i.e. first derivatives) computed at 1-year intervals indicated by dashed line with values (change/year) on right axis. Note that higher scores on Religiosity (Brief Multidimensional Measure of Religiousness/Spirituality; BMMRS) indicate lower levels of religiosity or spirituality. Depression and anxiety scores were log-transformed to approximate normality for visualization. n.s. indicates the domain-age group association was not significant ($p<0.01$) after covariate adjustment.

Table 2. Mental health and psychosocial well-being scores within and comparisons between age groups.

	Middle-aged (40–59 years)	Younger-old (60–79 years)	Older-old (80-104 years)			Cohen's *d* (99% CI)		
						Middle-aged vs. younger-old	Middle-aged vs. Older-old	Younger-old vs. Older-old
	N = 166	*N* = 223	*N* = 201	*F*	=			
Personal mastery	22.09 ± 3.7	22.66 ± 3.2	20.79 ± 3.8	11.109	0.036	**-0.36 (-0.67, −0.05)**	0.10 (-0.27, 0.47)	**0.46 (0.18, 0.75)**
Cognitive stimulation	2.68 ± 0.7	2.95 ± 0.7	3.01 ± 0.7	9.621	0.031	**-0.46 (-0.78, −0.14)**	**-0.61 (-0.99, −0.23)**	−0.15 (-0.43, 0.14)
Self-compassion	41.23 ± 8.6	44.34 ± 6.8	42.59 ± 7.2	8.929	0.028	**-0.50 (-0.81, −0.19)**	−0.32 (-0.69, 0.05)	0.18 (-0.10, 0.47)
Happiness	9.64 ± 2.6	10.33 ± 2.4	9.42 ± 2.9	8.744	0.027	**-0.43 (-0.74, −0.12)**	−0.11 (-0.48, 0.25)	**0.32 (0.03, 0.60)**
Perceived stress	12.68 ± 6.5	10.12 ± 5.8	12.18 ± 5.6	8.654	0.027	**0.46 (0.15, 0.77)**	0.20 (-0.17, 0.56)	−0.26 (-0.55, 0.02)
Depression	5.27 ± 4.6	4.40 ± 4.8	6.01 ± 5.0	7.82	0.024	**0.38 (0.07, 0.70)**	0.05 (-0.31, 0.42)	**-0.33 (-0.61, −0.04)**
Loneliness	37.77 ± 11.2	34.44 ± 9.0	35.85 ± 9.6	7.303	0.023	**0.46 (0.15, 0.77)**	**0.35 (-0.02, 0.73)**	−0.11 (-0.39, 0.18)
Anxiety	1.84 ± 2.5	1.31 ± 2.5	1.43 ± 2.3	7.08	0.021	**0.44 (0.13, 0.75)**	**0.43 (0.06, 0.79)**	−0.01 (-0.29, 0.27)
Mental health	51.98 ± 7.3	55.21 ± 7.8	55.33 ± 9.1	6.925	0.021	**-0.42 (-0.73, −0.11)**	**-0.46 (-0.82, −0.09)**	−0.04 (-0.32, 0.25)
Companionship	52.82 ± 9.0	53.63 ± 8.0	50.90 ± 8.4	5.863	0.017	−0.20 (-0.51, 0.11)	0.16 (-0.21, 0.52)	**0.36 (0.08, 0.64)**
Successful aging	7.78 ± 1.4	8.27 ± 1.4	8.06 ± 1.7	5.63	0.016	**-0.40 (-0.71, −0.09)**	−0.29 (-0.66, 0.07)	0.11 (-0.17, 0.39)
Wisdom	3.95 ± 0.5	3.93 ± 0.4	3.75 ± 0.4	5.153	0.015	−0.13 (-0.43, 0.18)	0.22 (-0.15, 0.58)	**0.34 (0.06, 0.62)**
Optimism	23.90 ± 4.4	24.46 ± 3.8	23.26 ± 3.7	4.169	0.012	−0.17 (-0.48, 0.14)	0.13 (-0.24, 0.50)	**0.31 (0.02, 0.59)**
Satisfaction with life	25.01 ± 6.7	26.25 ± 5.9	25.59 ± 6.4	3.55	0.009	**-0.31 (-0.62, 0.00)**	−0.17 (-0.54, 0.20)	0.14 (-0.14, 0.42)
Resilience	30.94 ± 6.5	31.32 ± 5.4	30.21 ± 6.3	2.467	0.005	−0.25 (-0.56, 0.06)	−0.13 (-0.50, 0.23)	0.12 (-0.16, 0.40)
Meaning in life	27.60 ± 5.4	26.78 ± 5.8	25.59 ± 5.8	1.098	0	−0.08 (-0.39, 0.23)	0.08 (-0.29, 0.44)	0.16 (-0.12, 0.44)
Religiosity	5.32 ± 1.8	5.02 ± 1.7	4.84 ± 1.8	1.051	0	0.14 (-0.17, 0.45)	0.20 (-0.17, 0.57)	0.06 (-0.23, 0.34)
Compassion	4.89 ± 1.4	4.74 ± 1.3	4.72 ± 1.6	1.048	0	0.05 (-0.25, 0.36)	0.19 (-0.18, 0.56)	0.14 (-0.15, 0.42)
Pooled effect size						**-0.29 (-0.41, −0.18)**	**-0.10 (-0.27, 0.06)**	**0.17 (0.07, 0.27)**

Wald *F*-statistics and partial Epsilon-squared from type-II ANOVAs for effect of age group on 18 aging-related outcomes, adjusted for sex, race, employment, marital status, education, and income. Top 14 outcomes passed significance at FDR-corrected $P < 0.05$. Cohen's *d* and 99% CIs computed from posthoc *t* tests and boldface indicates significant contrasts. Pooled effect size estimates based on fixed-effects meta-analysis with 99% CI. Personal Mastery: Personal Mastery Scale. Cognitive Stimulation: Derived from Life Complexity Scale. Self-Compassion: Neff Self-Compassion Scale. Happiness: 4-item Center for Epidemiologic Studies Depression (CES-D) Subscale. Perceived Stress: Perceived Stress Scale. Depression: CES-D. Loneliness: UCLA Loneliness Scale total score. Anxiety: Brief Symptom Inventory Anxiety Subscale. Mental Health: Mental Component Subscale of SF-36. Companionship: PROMIS Companionship 4a SF v2.0. Successful Aging: 1-item, 10-point self-appraisal. Wisdom: San Diego Wisdom Scale. Optimism: Life Orientation Test-Revised. Satisfaction with Life: 5-item Satisfaction with Life Scale. Resilience: Connor-Davidson Resilience Scale. Meaning in Life: Presence subscale of the Meaning in Life Questionnaire. Religiosity: Religiosity/Spirituality ranking of Brief Multidimensional Measure of Religiousness/Spirituality. Compassion: Santa Clara Brief Compassion Scale.

($F_{(2,244)}$=4.57; ε_p^2 = 0.04, 0.00 – 0.08) (Supplemental Figure 1), adjusted for scores on cognitive and physical functioning assessments, and for physical activity. Greater heterogeneity was found in the OO group than the YO group (d = 0.36, 0.00 – 0.73); however, relationships across age groups were non-linear, as the OO group was not more heterogeneous than the MA group (d = –0.06, –0.45 – 0.33). Rather, the MA group was more heterogeneous than the YO group (d = 0.42, 0.12 – 0.72), indicative of an overall U-shaped association between age and heterogeneity of mental health and psychosocial well-being.

3.4. Age group differences in the correlates of mental health and well-being

Correlations across dimensions are reported in Supplemental Figure 2, and correlation contrasts between age groups are presented in Supplemental Table 3 and Supplemental Figure 3. Generally, correlations between dimensions were similar across age groups; though, there were notable exceptions. For the OO, *compassion* (toward others) was the strongest correlate of mental health and psychosocial well-being compared to the YO (pooled r_{diff} = 0.07 [0.01, 0.13]) or the MA (pooled r_{diff} = 0.08 [0.02, 0.15]). Among the YO, *successful aging* was the strongest correlate compared to the OO (pooled r_{diff} = 0.13 [0.05, 0.20]) or MA (pooled r_{diff} = 0.15 [0.09, 0.20]). For MA adults, *self-compassion* was the strongest correlate with other variables compared to other age groups (versus YO: pooled r_{diff} = 0.11 [0.05, 0.16]; versus OO: pooled r_{diff} = 0.06 [0.01, 0.11]). *Perceived stress* was also a stronger correlate in the MA compared to the OO (pooled r_{diff} = 0.07 [0.02, 0.12]).

Exploring differential predictors of flourishing mental health and well-being by age group

LPA indicated a three class solution in each age group with graded levels of mental health and psychosocial well-being, which we refer to as 'languishing,' 'flourishing,' and 'moderate' classes (Keyes, 2005). Class membership differed across age groups (χ_4^2 =68.1, p < 0.01), with low languishing class membership in the YO (20%) and OO (25%) groups compared to MA adults (54%) (Table 3). Sociodemographic factors generally did not differentiate the three classes, apart from income in the MA and employment status in the YO. *Happiness*, *personal mastery*, *perceived stress*, *mental health*, and *depression* most strongly differentiated the three classes of OO adults; *happiness*, *loneliness*, *optimism*, *successful aging*, and *mental health* most strongly differentiated the YO adults; and *perceived stress*, *wisdom*, *optimism*, *loneliness*, and *self-compassion* most strongly differentiated the MA adults (Figure 2, left). Among the OO, physical functioning and activity differentiated the three classes, but cognitive functioning did not, whereas for the YO, physical and cognitive functioning differed across classes (Table 3; Figure 2, right), suggesting that preserved cognition is less important for flourishing in OO than the YO.

Discussion

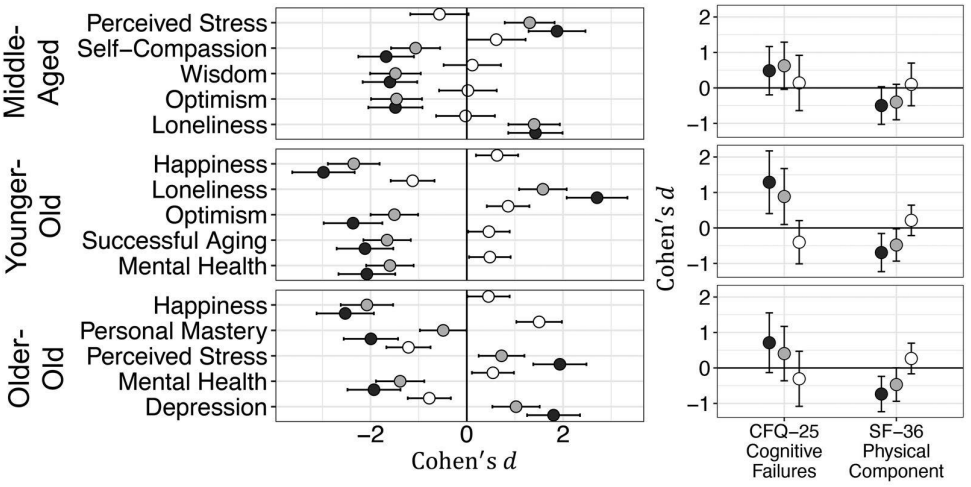
This study set out to examine how mental health and psychosocial well-being, assessed across 18 dimensions, differed between MA (40-59 yrs), YO (60-79 yrs), and OO (80+ yrs) adults with respect to their trends, heterogeneity and correlates. Age trends across these dimensions varied greatly in magnitude and shape (e.g. linear versus non-monotonic), but generally supported an inverted U-shaped trend in mental health and psychosocial well-being, with small declines from YO to OO age (d = –0.17), and small-to-moderate increases from MA to YO age (d = 0.29). Physical and cognitive functioning seemed to decline with age, though cognitive functioning did not significantly decline until OO age, whereas physical functioning and activity declined consistently across age groups.

These findings are generally consistent with epidemiologic reports of lower mental illness prevalence in older adults (65+ yrs) (Kessler et al., 2012) and support the "paradox of aging," whereby functional declines in physical and cognitive health co-occur with relatively preserved mental health and well-being (Jeste et al., 2013; Thomas et al., 2016). We found small declines in mental health and psychosocial well-being in the OO, though declines in cognitive (d = –0.70) and physical (d = –0.90) functioning were relatively greater. Covariate adjustments, age bins, and mental health dimensions used here differed somewhat,

Table 3. Sociodemographic, health behaviors, physical health, and cognition characteristics across latent classes within and comparisons between age groups.

	Middle-aged adults			Younger-old adults			Older-old adults		
	Languishing	Moderate	Flourishing	Languishing	Moderate	Flourishing	Languishing	Moderate	Flourishing
Measure	(n = 90)	(n = 42)	(n = 34)	(n = 45)	(n = 127)	(n = 51)	(n = 51)	(n = 83)	(n = 67)
Age	49.6 (5.4)	51.0 (4.9)	49.7 (5.4)	69.2 (5.5)	70.3 (5.5)	71.6 (5.3)	**90.0 (6.0)**[b]	**87.4 (5.1)**	**89.0 (5.4)**
Gender (%F)	53.3	64.3	47	53.3	48	43.1	45.1	47	47.8
Education	9.1 (1.9)	9.5 (1.5)	9.8 (1.6)	8.6 (2.2)	9.1 (1.7)	9.5 (1.9)	8.2 (2.8)	8.9 (2.0)	9.1 (2.2)
Race (%White)	64.4	66.7	79.4	95.6	88.2	92.2	76.5	69.9	67.2
Employed (%)	78.9	90.5	82.4	**24.4**	**41.7**	**25.5**	2	3.6	3
Partnered (%)	72.2	78.6	88.2	64.4	55.9	92.2	39.2	55.4	50.7
Income (% <$35k)	**40**	**23.8**	**17.6**	40	29.1	31.4	29.4	36.1	22.4
Smokers (%)	19.6	14.3	22.2	36.1	44.3	50	62.8	45.8	44.8
Alcohol Use (n)	9/25/11/11	4/16/6/4	0/10/7/0	5/24/4/4	16/45/20/8	1/19/9/2	8/8/11/15	15/34/15/12	8/23/15/10
BMI	27.9 (7.5)	28.7 (6.8)	24.6 (3.3)	28.5 (6.9)	27.3 (4.9)	26.3 (4.2)	23.9 (7.8)	25.6 (4.4)	24.7 (3.1)
CFQ-25^	26.3 (11.5)	19.6 (8.9)	21.1 (10.3)	**34.0 (16.6)**[a,b]	**24.7 (9.9)**	**20.5 (7.3)**	37.7 (14.0)	32.6 (12.6)	28.7 (11)
SF-36-Physical	49.1 (10.0)	51.6 (6.8)	53.2 (4.7)	**42.4 (11.8)**[a,b]	**47.1 (9.4)**	**49.2 (8.9)**	**32.5 (10.9)**[a,b]	**37.8 (12.4)**	**40.8 (10.1)**
IPAQ (L/M/H)	31/31/20	13/17/9	17-04-2012	21/13/8	42/44/34	15-12-2020	**30/7/5**	**40/15/12**	**20/19/12**

Latent class contrasts (e.g. flourishing vs. languishing, flourishing vs. moderate, languishing vs. moderate) performed within age groups for continuous variables using ANOVA with 99% CI. Latent classes defined based on graded scores across 18 mental health and psychosocial well-being assessments. Categorical variable comparisons were performed using Fisher's Exact Test or χ^2 on frequency matrices. Significant main effects indicated with bold, posthoc test significance at p < 0.01 as a differs from flourishing, or b differs from moderate. BMI: body mass index. CFQ-25: Cognitive Failures Questionnaire. SF-36-Physical: RAND Short Form-36 Physical Component Score. ^Responses to CFQ-25 received from subsamples of participants (middle-aged: n = 89; younger-old: n = 63; older-old: n = 94). Alcohol use: lifetime abstainer/current infrequent/current regular/former use. Smoking status based on lifetime (yes/no) usage. IPAQ: International Physical Activity Questionnaire; H = high activity; M = medium; L = low. Education operationalized on a 12-point scale, ranging from 1.0 (no schooling) to 12.0 (doctoral degree).



Pooled Cohen's *d* [99% CI] across all 18 mental health and well-being domains

Age Group	■ Languishing – Flourishing	■ Languishing – Moderate	□ Flourishing – Moderate
Middle-Aged (*n*=166)	-1.10 [-1.23, -0.97]	-1.09 [-1.21, -0.97]	-0.03 [-0.17, 0.11]
Younger-Old (*n*=223)	-1.79 [-1.93, 1.66]	-1.11 [-1.23, -1.00]	0.68 [0.57, 0.78]
Older-Old (*n*=201)	-1.31 [-1.43, -1.18]	-0.73 [-0.85, -0.62]	0.60 [0.50, 0.71]

Figure 2. Differentiating dimensions across latent classes within each age group. Three-class Gaussian mixture models indicated a graded relationship with eighteen standardized mental health and psychosocial well-being assessments. Based on these graded differences, classes were labeled as 'flourishing,' 'moderate,' and 'languishing.' Effect sizes based on posthoc contrasts with 99% CIs from ANOVAs with largest effect sizes, representing the top five class-differentiating dimensions in each age group (left panels). ANOVAs with post hoc Cohen's *d* quantified class differences in cognitive (CFQ-25: Cognitive Failures Questionnaire) and physical functioning (SF-36 Physical Component Score) (right panels). Meta-analytic summary of class contrast effect sizes across all 18 assessments shown in the table at bottom.

which may partially account for the discrepancies. Nonetheless, our approach allowed us to critically examine three key developmental time periods across adulthood and to make direct comparisons with OO adults, a rapidly expanding, but markedly under-studied age demographic.

Our findings suggest a U-shaped association between age and heterogeneity in mental health and psychosocial well-being in adults over age 40. This contrasts with the widely held view in gerontology that heterogeneity in health generally increases with age (Anne Nelson & Dannefer, 1992; Stone et al., 2017). Until now, research on health heterogeneity in aging has mainly focused on physical measures, vital signs, or biomarkers, such as blood chemistry values, and more recently on epigenetic and 'omics' markers (Jylhävä et al., 2017). Physical health heterogeneity was recently reported to increase non-linearly with age, peaking around 70 yrs (i.e. younger-old age), then decreasing somewhat in the OO (Nguyen et al., 2021), which is opposite of the trend we report here. A recent survey of the literature found that heterogeneity in 2/3 of psychological and social outcomes is stable with age, but was reported to increase in 1/3 of studies (Stone et al., 2017). Further examination of dimension-specific, non-monotonic changes in mental health and psychosocial well-being heterogeneity is therefore warranted, and may have important implications for gerontology, epidemiology, and geriatric psychiatry. Heterogeneity may have predictive value, for example, if subgroups of individuals with the highest (or lowest) heterogeneity in certain dimensions demonstrate poor physical or cognitive functioning, or greater mortality risk over time. Studies that incorporate mental health or psychosocial well-being predictors (or outcomes) with age-patterned heterogeneity should assess whether estimated associations are less precise at certain ages, and if so, incorporate the appropriate statistical tools to adjust for heterogeneity. Consideration of age-specific variance can also inform participant selection in research studies, whereby individuals with high variability relative to their age group, rather than the entire age range of participants, may be more ideally suited for inclusion or intervention.

The results support our hypothesis that the correlates of mental health and psychosocial well-being differ by age. *Compassion* (toward others) was most strongly correlated with mental health and psychosocial well-being in the OO compared to YO or MA adults, even though levels of compassion did not vary across age groups. This extends prior studies indicating that compassion, an other-oriented, prosocial attitude, is positively associated with mental health and psychosocial well-being in older adults (Kahana et al., 2021) and with decreased loneliness (Lee et al., 2021). The importance of compassion in the OO aligns with socioemotional selectivity theory, and with other studies suggesting that OO adults derive more emotional meaning from providing help and support than younger adults (Donisi et al., 2021). Thus, being compassionate toward others may be particularly relevant to mental health and well-being among the OO. While our cross-sectional analysis cannot establish causal relationships between compassion and mental health, they do support further exploration of compassion-focused interventions among the OO for improving mental and psychosocial outcomes.

Happiness and *personal mastery* were the strongest correlates of flourishing mental health and well-being in the OO, which aligns with socioemotional selectivity theory and prior findings that older adults have higher positivity-seeking, rather than negativity-avoidance, relative to MA (Livingstone and Isaacowitz, 2021). Interestingly, *loneliness* was not a top determinant of mental health and well-being class, unlike for MA or YO, which suggests that OO may be relatively more resilient to the detrimental effects of loneliness than younger age groups, though this warrants further investigation.

Perceived stress was highest in MA, was the strongest differentiator between languishing and flourishing, and was

generally a stronger correlate of other dimensions than in the OO. This suggests that in MA, moderating psychological stress may be relatively more important to mental health and well-being than for older adults. For MA adults, stressors associated with day-to-day responsibilities of employment and caregiving for children and elders are likely more common than for the YO or OO, most of whom in our study were not employed (i.e. retired) and less burdened by operational concerns of daily life. *Self-compassion* was also a stronger correlate and differentiator of mental health and psychosocial well-being in MA adults, despite being at lower levels than older age groups. This finding supports our prior finding that self-compassion increases with aging, at least until 80+ years of age (Lee et al., 2021), and is a stronger predictor of improved physical well-being at 5-yr follow-up in adults <60 than adults ≥60 yrs. Our finding also supports the notion that self-compassion is a key factor in emotion regulation and stress mitigation in younger adults (Finlay-Jones et al., 2015), and that OO adults utilize different emotion regulation strategies compared to MA (Birditt, 2014), who likely rely upon more cognitively intensive strategies. Because self-compassion is both a personality disposition and a trainable skill, these findings further support the implementation of behavioral interventions designed to cultivate self-compassion in community samples of MA adults (Ferrari et al., 2019).

We found that self-reported *successful aging* was a top determinant and a stronger correlate of mental health and psychosocial well-being in the YO, and therefore relatively decoupled from mental health and psychosocial well-being in MA and OO adults. Consistent with prior studies, successful aging in the YO was negatively correlated with depression, anxiety, stress, and loneliness, and positively associated with all 'positively-valenced' dimensions (except compassion toward others). In particular, *happiness* and *satisfaction with life* were much stronger correlates of successful aging in the YO compared to MA or OO, suggesting that positive emotional affect is a driver of aging well among YO adults. Further studies are needed, however, to examine whether physical functioning or demographic or other health factors are differentially associated with successful aging in the YO compared to the OO.

This study had several limitations. First, our analyses were survey-based and cross-sectional, which means that we cannot examine causality or rule out survivorship effects. For example, the YO group contains individuals who will, and others who will not, reach OO age. Unlike longitudinal or prospective study designs, our was also not specifically designed to assess birth cohort effects, which may bias our conclusions. However, it should be noted that the relatively large sample size and use of random-digit dialing are likely to have some mitigating effects on issues related to sampling bias. Second, sex differences were adjusted for, but not the focus of the present study. We did not find evidence that mental health and well-being classes differed by sex, though a handful of specific dimensions (e.g. compassion, cognitive stimulation, and meaning in life) showed effects of sex. Further studies would benefit from examining the extent to which sex moderates the age-associated changes observed in the present analysis. Third, our age group-based approach may have masked more complex age associations that occurred on a smaller timescale (e.g. 1-5 yrs). However, a central aim of this analysis was to examine the OO specifically, and thus age grouping according to important developmental transitions (e.g. MA to YO, YO to OO) were necessary. Fourth, our sample came from Southern California and was predominately non-Hispanic White; therefore, our results may not apply to other geographic locations or more ethnically diverse populations. More specifically, the proportion of non-Hispanic Whites within the OO group (70.6%) closely reflects recent US Census Bureau estimates of 80+ year-old non-Hispanic Whites in San Diego County (74.3% for 85+ yrs; 66.3% for 75-84 yrs). However, YO (90.6% non-Hispanic White) and MA (69% non-Hispanic White) adults in this study are under-representative of marginalized racial/ethnic groups of similar age in San Diego County, as non-Hispanic Whites are estimated between 65.9% (65-74 years old) and 50.8% (45-54 years old) of the population. Therefore, although racial and ethnic differences in scores on assessments of cognitively-stimulating activities, compassion, and meaning in life were observed (Supplemental Table 2), these findings should be interpreted with caution given the small representative sample sizes for Hispanic, Asian, and African-American subgroups. Future studies designed to oversample marginalized racial/ethnic groups are necessary to determine the extent to which race and ethnicity moderate age-associated changes in mental health and psychosocial well-being reported here. Similarly, more studies are needed to examine the role of social determinants and health disparities, such as discrimination, poverty, adverse childhood experience, and poor access to and utilization of healthcare, on mental health and well-being trajectories in the aging population (a strategic objective of the National Institute of Mental Health; Evans et al., 2015), which our study was unable to assess. Fifth, all of our measures were based on self-report.

Our study also had several notable strengths. We administered eighteen different assessments of mental health and psychosocial well-being, which exceeds that of most studies in aging and mental health and facilitated a comprehensive, multi-construct analysis. All these measures are published and have been shown to have good to excellent psychometric properties. Our study utilized a random-digit dialing-based sampling approach, which despite its aforementioned racial and ethnic sampling biases, yielded comparable numbers of women and men, and oversampled for the OO, who are often under-represented in mental health research. Lastly, we incorporated a novel analytical approach to examine age group differences in mental health and well-being heterogeneity.

In summary, our findings support the "paradox of aging," whereby functional declines in physical and cognitive health co-occur with relatively preserved mental health and well-being. Our findings indicate that variance in mental and psychosocial health does not increase linearly with age and support careful consideration of heterogeneity in mental health and aging research. Our findings also suggest that mental health and psychosocial well-being decouple from stress-related dimensions in MA and become increasingly associated with positive, other-oriented emotions, such as happiness and compassion toward others in YO and OO age, broadly supporting socioemotional theories of aging and mental health.

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