ijbd

International Journal of Behavioral Development
37(6) 475–484

DOI: 10.1177/0165025413492605
ijbd.sagepub.com
SAGE

Trajectories and personality correlates of change in perceptions of physical and mental health across adulthood and old age

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Abstract

Subjective health is known to predict later outcomes, including survival. However, less is known about subjective health changes across adulthood, how personality moderates those changes, and whether such associations differ with age. We applied growth models to 10 waves of data from the Household, Income and Labour Dynamics in Australia Survey (HILDA, $N = 7{,}172$; median ages 20–93) to examine age-related differences in trajectories of subjective physical and mental health. On average, perceptions of physical health declined with increasing steepness in old age, whereas self-rated mental health remained relatively stable across all ages. Higher neuroticism and lower extraversion and conscientiousness were each related to less successful aging. The health implications of personality did not differ by age for physical health, but were weaker for mental health in old age. We discuss implications of our results for accelerated longitudinal designs and consider avenues for future more mechanism-oriented research.

Keywords

adulthood and old age, growth curve model, longitudinal, self-rated health, well-being

Maintenance of physical and mental health is among the central ingredients of successful aging and quality of life (Baltes & Baltes, 1990; Ryff & Singer, 1998). For example, Rowe and Kahn (1997) define successful aging in part as the maintenance of health and low disease and disability. A large body of evidence has accumulated that between-person differences in self-perceptions of health predict key outcomes such as mortality (for review, see Idler & Benyamini, 1997). However, less is known about how perceptions of health change across adulthood, what moderates those changes, and whether such moderator associations differ with age. In this report, we make use of a large, nation-wide sample assessed annually for 10 years to track how perceptions of physical and mental health develop across adulthood and old age (for people in a First World nation), to examine the role personality plays in health change, and to investigate whether that role differs with age. Precisely understanding how people perceive their health to change can inform public health and policy aimed at promoting the well-being and health of our society. In the present study, we applied growth curve models to 10 waves of annual longitudinal data from the Household, Income, and Labour Dynamics in Australia Survey (HILDA). We first modeled age-related differences in change trajectories of perceived physical and mental health for individuals aged 20 to 93 years (the median age of each participant across all of his or her waves). We then investigated whether and how personality factors were related to between-person differences in perceived health trajectories and whether the direction and strength of these associations differed with age.

Typical age-related changes in physical and mental health

Physical health can be construed as a multi-dimensional construct encompassing physician-diagnosed health symptoms, limitations in completing everyday tasks of living, and self-ratings of health (Lawton & Lawrence, 1994). Age-related differences in each facet are well documented, with older adults (e.g. age 50 and over) often reporting poorer physical health and suffering from more frequent and severe limitations than younger adults (McCullough & Laurenceau, 2004; Rook et al., 2007; Sargent-Cox et al., 2010; Smith et al., 2002; Suzman et al., 1992). On average, the older someone is then the worse his or her health will be compared to a younger person. Mental health can be construed as a multi-dimensional construct that includes the absence of mental disorders, the ability to deal with life's problems effectively, the cognitive evaluation of life, emotional well-being, and social functioning including feelings of social integration (Gatz & Zarit, 1999; Keyes, 2005). In contrast to physical health, aspects of mental health usually remain relatively stable across adulthood and old age, with larger age-related decrements being observed only in very old age (e.g. age 85+; Aldwin et al., 1989; Baltes & Smith, 2003; Zarit, 2010) and at the end of life (e.g. approaching death; Gerstorf, Ram et al., 2010).

Personality correlates of age-related changes in physical and mental health

There are substantial between-person differences in how physical and mental health change with age. Some people maintain good health until late in life, and others experience precipitous declines

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early on (Spiro, 2007). Here, we are interested in how personality and age-based selection contribute to heterogeneity in the trajectories of individuals' self-reported health. Personality traits have been linked with physical and mental health. Most prominently, higher neuroticism is often related to poorer subjective physical and mental health, primarily because of heightened stress in anticipating and reacting to challenging situations (Aldwin et al., 2001; Charles et al., 2008; Lahey, 2009). In contrast, people with higher conscientiousness tend to report better physical and mental health, perhaps because they tend to participate in health preventative (e.g. colorectal exams, mammography) and promoting behaviours (e.g. Boggs & Roberts, 2004; Friedman, Kern, Hampson, & Duckworth, 2012). Less is known, however, about how extraversion, openness, and agreeableness are associated with health (Lockenhoff, Sutin, Ferrucci, & Costa, 2008; Turiano et al., 2012). Initial evidence suggests that extraverted individuals tend to report better health and live longer (Turiano et al., 2012; Wilson, Mendes de Leon, Bienas, Evans, & Bennett, 2004), a trajectory that might be linked to the frequent experience of positive emotions and associated feelings of vitality and energy (Duberstein et al., 2003). For openness, several studies suggest a positive relationship with subjective health (e.g. Duberstein et al., 2003; Hampson & Friedman, 2008; Jerram & Coleman, 1999), perhaps because more open individuals lead more active lives, have greater mental flexibility, and deal with changes in life circumstances better than less open individuals. In turn, such engagement may have positive implications for both mental and physical health (Duberstein et al., 2003; Jerram & Coleman, 1999). Agreeableness has also been linked with better health behaviours and subjective health (Booth-Kewley & Vickers, 1994; Turiano et al., 2012). It is possible that agreeable individuals' conflict avoidant and prosocial natures make it easier for them to seek out and utilize social support, which in turn is linked with health in a multitude of different ways (e.g. discouraging risky behaviours or buffering stress; Berkman, Glass, Brisette, & Seeman, 2001; Cohen, 2004).

Research has also suggested that the relationship between personality and health is moderated by age. Although few studies have examined this, there is some evidence that the relationship of personality and health is different for older and younger individuals (Duberstein et al., 2003; Lockenhoff et al., 2008; Quinn, Johnson, Poon, & Martin, 1999). One hypothesis is that aging-related losses may magnify the effects of personality on health. For example, individuals with high levels of neuroticism may become even more likely to report poor health later in life because of the accumulation of age-related losses, which could accentuate the anxious and worrisome tendencies of these individuals. Alternatively, age-related declines may become too pervasive for personality to make a difference later in life (e.g. in the fourth age, 85+; Baltes & Smith, 2003). Conflicting evidence has been reported in the few studies examining such age moderation, with some reports supporting the notion that personality–health associations were stronger at older ages (Duberstein et al., 2003; Quinn et al., 1999), whereas others do not (Lockenhoff et al., 2008).

The present study

Taken together, our study aimed to describe age differences in trajectories of perceived physical and mental health, identify personality moderators of successful development/aging (i.e. high levels and maintenance of physical and mental health), and explore whether personality associations differ with age. We note that the observation interval (10 years) was relatively sparse compared with the broad age range across the adult life span that our model parameters generalize to (20 to 93 years). As a consequence, we used the accelerated longitudinal study design to model health trajectories over time and examine age-related differences therein as opposed to modeling change in health directly over age. Going this route allowed us to test rather than assume age convergence (i.e. that the younger individuals would turn into the older individuals in the sample; for discussion, see Sliwinski, Hoffman, & Hofer, 2010). We hypothesized that perceptions of physical health are characterized by decline across much of adulthood, with some concave curvature that manifests as pronounced decline in old age. In contrast, mental health is expected to remain relatively stable across the adult life span. Considering personality differences, we expected that higher neuroticism and lower conscientiousness each relate to less favourable trajectories, as characterized by lower levels of and steeper declines in self-rated health. We also explored the roles of extraversion, openness, and agreeableness and tested whether or not the direction and strength of associations differ with age.

To control for important correlates of self-rated health, our models also included gender, education, disability, and negative life events as covariates. Specifically, accumulated opportunity disadvantages (in most countries) along with limited financial resources to access healthcare and greater chronic strain often contribute to women having poorer physical and mental health, a greater number of incapacitating conditions and acute health issues, as well as a higher risk for depression than men (Case & Paxson, 2005; Crimmins et al., 2010; McCullough & Laurenceau, 2004; Moen, 1996; Nolen-Hoeksema, 1999; Smith & Baltes, 1998). Higher education and the accompanying resources such as financial assets and health-promoting behaviours are often associated with better health and may also serve as protective factors against health declines (Adler et al., 1994). Finally, poorer health is typically reported by individuals with a disability (e.g. Lucas, 2007; Zarit, Johansson, & Berg, 1993) and those who experience negative life events, presumably because of the stress and challenges involved (e.g. Cohen, Tyrrell, & Smith, 1993).

Method

Participants and procedure

The HILDA is a nationally representative, longitudinal panel survey of randomly selected households from a set of randomly selected census districts across Australia (for details, see Dyrenforth et al., 2010; Lucas & Donnellan, 2009; Watson, 2010). Within a household, all persons aged 15 and over were invited to participate. As new members have entered households, they have also been invited to participate. Data are collected annually, since 2001, via a combination of face-to-face and telephone interviews and self-completed questionnaires. We utilized data from the first ten waves of assessment (2001–2010), including in our analyses all participants with valid data on physical and mental health and all the correlates. Of particular note, personality was only measured at Wave 5 and was the main constraint on sample size, so that the study subsample consisted of $n = 7{,}172$ of the total $N = 19{,}914$ sample. Compared to participants who were not included in our sample, our "personality-rich" subsample was older ($M = 44.8$, $SD = 15.9$ vs. $M = 42.4$, $SD = 19.3$; $F[1, 13{,}967] = 65.62$, $p < .001$), more highly educated (57% vs. 42% with post-high school education; χ^2 [1, $N = 12{,}783$] = 261.70, $p < .001$), consisted of

Table 1. Means, standard deviations, and interrcorrelations among study constructs.

Construct	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
Outcomes														
1. Physical health	49.43	9.91	–											
2. Mental health	50.50	9.68	−.03	–										
Correlates														
3. Age	49.13	15.91	−.35*	.18*	–									
4. Gender	0.54	0.50	−.01	−.07*	−.02	–								
5. Education	0.57	0.50	.12*	−.02	−.16*	−.14*	–							
6. Neuroticism	1.75	1.08	.00	−.31*	−.26*	−.06*	.01	–						
7. Conscientiousness	5.17	1.02	.04*	.17*	.15*	.10*	.03*	−.30*	–					
8. Extraversion	4.39	1.07	.05*	.11*	−.06*	.13*	.01	−.20*	.14*	–				
9. Openness	4.19	1.05	.04*	−.10*	−.13*	−.06*	.22*	.20*	.08*	.06*	–			
10. Agreeableness	5.41	0.91	−.00	.05*	.04*	.25*	−.00	−.16*	.30*	.17*	.26*	–		
11. Disability	0.22	0.41	−.54*	−.13*	.22*	−.05*	−.08	.01	−.04*	−.04*	−.00	−.00	–	
12. Negative major events	0.69	0.92	−.13*	−.13*	.02	.01	.01	.05*	−.01	.02	.06*	.05*	.12*	–

Note. Mean scores and standard deviations taken from T1 (except for age which was measured as the median age of participants across time in study, health conditions status from T2, and personality measures which were only collected at T5). *$p < .01$.

more women (54% vs. 49%; χ^2 [1, $N = 19{,}914$] = 50.61, $p < .001$), and reported greater physical health ($M = 49.4$, $SD = 9.9$ vs. $M = 48.8$, $SD = 10.8$; F[1, 12,321] = 9.97, $p = .002$) and mental health ($M = 50.5$, $SD = 9.7$ vs. $M = 49.2$, $SD = 10.2$; F[1, 12,321] = 48.90, $p < .001$) at Wave 1. Effect sizes for selectivity differences were in the small range ($R^2 < .005$ for all comparisons).

On average, these individuals provided 9.1 (of 10 possible) repeated reports ($SD = 1.4$; 75% provided data on 9 or more occasions). Relative to participants who provided fewer waves of data (5 waves or less; $n = 236$), participants who provided six or more waves of data ($n = 6{,}936$) were younger ($M = 44.6$, $SD = 15.7$ vs. $M = 51.2$, $SD = 20.2$; F[1, 7,170] = 39.46, $p < .001$), more highly educated (57% vs. 39% with post-high school education; χ^2 [1, $N = 7{,}172$] = 31.69, $p < .001$), and reported better physical health ($M = 49.5$, $SD = 9.8$ vs. $M = 45.4$, $SD = 12.5$; F[1, 6,689] = 25.84, $p < .001$) at Wave 1. No gender or mental health differences were found. Effect sizes for selectivity differences were in the small range ($R^2 < .005$ for all comparisons). Descriptive statistics for all measures are given in Table 1.

Measures

Physical and mental health. Annually, participants completed the SF-36 short form health survey, a tool validated for examination of health differences and population health changes (Butterworth & Crosier, 2004; Hemingway, Stafford, Stansfeld, Shipley, & Marmot, 1997; Hopman et al., 2006; Mishra, Ball, Dobson, & Byles, 2004). Extensive details on scale construction can be found in Ware and colleagues (1993). The scale consists of eight subscales: physical functioning (10 items), role limitations due to physical problems (4 items), bodily pain (2 items), general health (5 items), vitality (4 items), social functioning (2 items), role limitations due to emotional problems (3 items), and mental health (5 items). The eight subscales are typically grouped into two higher-order factors representing physical health and mental health summary scores (e.g. Butterworth & Crosier, 2004). All subscales load on and contribute to the higher order physical health and mental health factors, but the subscales physical functioning, role limitations due to physical problems, bodily pain, and general health contribute the most to the physical health factor. In contrast, the subscales vitality, social functioning, mental health, and role limitations due to emotional problems contribute primarily to the mental health factor. Following standard scoring procedures (see Ware, Kosinski, & Keller, 1994), we standardized each of the eight subscale scores using US normed population averages and standard deviations, calculated the weighted (factor score coefficients from the scoring manual) sums of those z-scores to obtain the physical and mental health factors scores, and transformed to t-scores (Note: scores are in US normed population units with $Mean = 50$, $SD = 10$). Higher scores indicate better health. Internal consistencies for both scales were good ($\alpha \geq .82$ for each subscale; see also Ware et al., 1995).

Age. An individual's *age* was indexed as the median age across all waves that he or she participated. As a time-invariant, between-person characteristic, median age (rather than age at T1) facilitated more precise placement of the individual's time series within the 20–93 year age span.

Personality. *Personality* was measured in 2005 using Saucier's Mini-Marker Inventory (1994). Respondents were asked to indicate how well a set of adjectives described them, using a scale from 1 (*does not describe me at all*) to 7 (*describes me very well*). For each trait, the average of six items (except for agreeableness with four items) indicated individuals' level of neuroticism (e.g. moody, fretful), conscientiousness (e.g. systematic, disorganized), extraversion (e.g. talkative, lively), openness (e.g. intellectual, creative), and agreeableness (e.g. cooperative, sympathetic). Internal consistency for each scale was adequate (Cronbach's $\alpha \geq .74$).

Covariates. *Gender* was a dichotomous variable with 54% of our sample being women. *Education* was indexed as either high school graduate or less (43%) vs. post high-school education (57%). *Disability* was measured by a single item from Wave 1 asking participants to indicate whether or not they had a health condition, which limited their everyday activity and lasted for six months or more. 22% of the sample reported a health condition (0 = no health condition, 1 = health condition present). *Major negative life events* were indexed by how many negative events (separation from spouse or long-term partner, serious injury or illness to self, injury or illness to close relative, death of spouse or child, death of a close relative, death of close friend, victim of physical violence, victim of

a property crime, detained in jail, close family member detained in jail, fired or made redundant by employer, major worsening in financial situation) participants had experienced in the past 12 months (adapted from Holmes & Rahe, 1967). We used the measure from Wave 2 to stay consistent with using data from the first wave available for each covariate.

Data analysis

We estimated separate growth curve (i.e. multilevel) models (e.g. McArdle & Nesselroade, 2003; Ram & Grimm, 2007; Singer & Willett, 2003) to examine age-related differences in self-rated physical and mental health changes over time and to examine how personality variables were related to those changes. Models were specified as

$$\text{Health}_{ti} = \beta_{0i} + \beta_{1i}(\text{time}_{ti}) + \beta_{2i}(\text{time}_{ti}^2) + \text{e}_{ti}, \quad (1)$$

where person i's physical or mental health at time t, $Health_{ti}$, is a function of an individual-specific intercept parameter, $\beta_{0i,}$ individual-specific linear and quadratic slope parameters, β_{1i} and β_{2i}, that capture the linear rate and acceleration of change per year of time in study, and residual error, e_{ti}. Following standard growth curve modeling procedures, individual-specific intercepts, β_{0i}, linear slopes, β_{1i}, and quadratic slopes β_{2i}, were modeled as

$$\begin{aligned}\beta_{0i} = {} & \gamma_{00} + \gamma_{01}(\text{age}_i) + \gamma_{02}(\text{age}_i^2) + \gamma_{03}(\text{gender}_i) \\ & + \gamma_{04}(\text{education}_i) + \gamma_{05}(\text{neuroticism}_i) \\ & + \gamma_{06}(\text{conscientiousness}_i) + \gamma_{07}(\text{extraversion}_i) \\ & + \gamma_{08}(\text{openness}_i) + \gamma_{09}(\text{agreeableness}_i) + \gamma_{010}(\text{disability}_i) \\ & + \gamma_{011}(\text{negative events}_i) + u_{0i}\end{aligned} \quad (2)$$

$$\begin{aligned}\beta_{1i} = {} & \gamma_{10} + \gamma_{11}(\text{age}_i) + \gamma_{12}(\text{age}_i^2) + \gamma_{13}(\text{gender}_i) \\ & + \gamma_{14}(\text{education}_i) + \gamma_{15}(\text{neuroticism}_i) \\ & + \gamma_{16}(\text{conscientiousness}_i) + \gamma_{17}(\text{extraversion}_i) \\ & + \gamma_{18}(\text{openness}_i) + \gamma_{19}(\text{agreeableness}_i) + \gamma_{110}(\text{disability}_i) \\ & + \gamma_{111}(\text{negative events}_i) + u_{1i}\end{aligned}$$

$$\beta_{2i} = \gamma_{20} + u_{2i},$$

where the γs are the sample-level associations between sociodemographic and personality factors and the 10-year trajectories (level and slope), and u_{0i}, u_{1i}, and u_{2i} are unexplained differences. We note that between-person differences in curvature, u_{2i}, were left un-modeled. $Time_{ti}$ was centred at the middle of each person's repeated measures series, and all person-level predictors were centred at sample means. Models were estimated in SAS 9.2 using PROC MIXED (Littell et al., 2006) using full information maximum likelihood estimation, thereby treating incomplete data as missing at random (Little & Rubin, 1987) and adjusting for unbalanced data (Singer & Willett, 2003). Personality interactions with age were also tested in the models and trimmed iteratively, so that the final model included only those age interaction effects that were significant at the $\alpha = .01$ level.

Results

Using intercept-only models, we first estimated the proportion of between-person and within-person variation (intraclass correlation) in the repeated measures of health. Although the majority of the total variance was between-persons (physical: 70%; mental: 53%), there was substantial within-person variance as well (physical health: 30%; mental health: 47%).With both within-person and between-person variability to model, we used growth models to describe and evaluate how this variation was structured over time and across age. Results from the final models are given in Table 2. We present results from each portion of the model in turn.

Age-related differences in physical and mental health trajectories

The prototypical Australian (49-year-old) participant's self-rated *physical health* declined a little over 2 ½ T-score units over the 10 years of time in study ($\gamma_{10} = -0.252$, $p < .01$), with negligible curvature ($\gamma_{20} = -.005$, $p > .01$), at comparable average levels to the US ($\gamma_{00} = 48.954$, $p < .01$). Because the SF-36 data was standardized using US normed population averages and standard deviations, we could compare the average level of our Australian sample to the US average level (e.g. 50). Trajectories of change were significantly related to age and age^2, such that older age was associated with both lower levels of physical health ($\gamma_{01} = -0.216$ and $\gamma_{02} = -0.003$, ps < .01) and steeper rates of decline ($\gamma_{11} = -0.013$, $p < .01$). The pattern of age-related moderation of 10-year changes is shown in the top panel of Figure 1. Age convergence in the sample would be evident if the 10 year trajectories fit well to one continuous trajectory over all ages. However, non-convergence of 10-year age differences and 10-year changes is readily discernible by the mainly non-overlapping trajectories.

In contrast to prototypical declines in physical health, the prototypical Australian (49-year-old) participant's self-rated *mental health* increased about 1 T-score unit over the 10 years of study time ($\gamma_{10} = 0.124$, $p < .01$), with negligible curvature ($\gamma_{20} = -.004$, $p > .01$), at a level similar to US averages ($\gamma_{00} = 50.832$, $p < .01$). Trajectories of change were again significantly related to age and age^2. In contrast to self-rated physical health, older age was associated with higher levels of mental health ($\gamma_{01} = 0.061$, $p <$ .01) and steeper rates of decline ($\gamma_{11} = -0.004$ and $\gamma_{12} = -0.0003$, ps < .01). The resulting pattern of age-related moderation of 10-year changes is shown in the bottom panel of Figure 1. Relative convergence of 10-year age-related differences across slices of 10-year change is apparent at younger ages by mostly overlapping 10-year trajectories, but becomes more and more non-convergent with increasing age. In particular, intercepts gradually get higher in older ages with older adults in the sample appearing to have greater levels of mental health at baseline.

Personality differences in physical and mental health trajectories

Table 2 also presents parameter estimates for the personality moderators of perceived health trajectories. Many of the personality traits were found to moderate levels and changes in perceived health. Specifically, higher neuroticism was associated with both poorer physical and mental health ($\gamma_{05} = -0.392$; -2.239, respectively). Similarly, participants high in conscientiousness and extraversion each reported better physical ($\gamma_{06} = 0.535$; $\gamma_{07} = 0.276$) and mental health ($\gamma_{06} = 0.653$; $\gamma_{07} = 0.698$). Participants scoring high on openness to experience perceived their mental health less favourably than

Table 2. Growth models of physical and mental health over time, as applied to ten waves of annual (2001–2010) longitudinal data from the Household, Income and Labour Dynamics in Australia Survey (HILDA).

	SF-36 Component Measures			
Effect (se)	Physical health		Mental health	
Fixed effects				
Intercept (age 49), γ_{00}	48.954*	(0.112)	50.832*	(0.106)
Time (age 49), γ_{10}	– 0.252*	(0.015)	0.124*	(0.015)
Time^2 (age 49), γ_{20}	– 0.005	(0.003)	– 0.004	(0.004)
Age, γ_{01}	–0.216*	(0.005)	0.061*	(0.005)
Age^2, γ_{02}	–0.003*	(0.000)	0.000	(0.000)
Gender (women)	– 0.816*	(0.165)	– 1.813*	(0.157)
Education	0.757*	(0.165)	0.034	(0.156)
Neuroticism	–0.392*	(0.082)	–2.239*	(0.078)
Conscientiousness	0.535*	(0.084)	0.653*	(0.080)
Extraversion	0.276*	(0.076)	0.698*	(0.072)
Openness	0.032	(0.082)	–0.393*	(0.078)
Agreeableness	– 0.095	(0.097)	0.270*	(0.092)
Disability	–8.927*	(0.195)	-3.423*	(0.186)
Negative life events	–0.909*	(0.085)	–0.977*	(0.081)
Age X time, γ_{11}	– 0.013*	(0.001)	–0.004*	(0.001)
Age^2 X time, γ_{12}	–0.000	(0.000)	–0.000*	(0.000)
Gender X linear slope	– 0.074*	(0.023)	0.042	(0.024)
Education X linear slope	0.018	(0.023)	0.013	(0.024)
Neuroticism X linear slope	– 0.008	(0.012)	– 0.010	(0.012)
Conscientiousness X linear slope	0.023	(0.012)	–0.014	(0.012)
Extraversion X linear slope	0.024	(0.011)	0.003	(0.011)
Openness X linear slope	–0.016	(0.012)	0.027	(0.012)
Agreeableness X linear slope	0.008	(0.014)	0.020	(0.014)
Disability X linear slope	0.287*	(0.028)	–0.003	(0.029)
Negative life events X linear slope	–0.002	(0.012)	0.054*	(0.013)
Age X openness	–		0.018*	(0.004)
Random effects				
Variance of intercept, σ^2_{u0}	47.873*	(0.917)	38.818*	(0.814)
Variance of linear slope, σ^2_{u1}	0.470*	(0.015)	0.398*	(0.016)
Variance of quadratic slope, σ^2_{u2}	0.026*	(0.001)	0.029*	(0.002)
Cov. intercept, linear slope, σ_{u1u0}	1.096*	(0.083)	0.570*	(0.080)
Cov. intercept, quadratic slope, σ_{u2u0}	–0.011*	(0.003)	– 0.365*	(0.030)
Cov. slopes, σ_{u2u1}	– 0.011*	(0.003)	– 0.026*	(0.004)
Residual variance, σ^2_e	26.642*	(0.180)	37.583*	(0.253)
–2LL	425,518		442,568	

Note. Age refers to the median age of participants and is centred at age 49. Time centred at T4. Numbers in the parentheses are the standard errors of the estimates. $N = 7{,}172$. *$p < .01$.

those low on openness ($\gamma_{08} = -0.393$). Finally, more agreeable individuals reported better mental health ($\gamma_{09} = 0.270$).

In addition, several of the covariates related to level and linear change in physical and mental health. Results indicated that being a woman related to poorer physical ($\gamma_{03} = -0.816$) and mental health ($\gamma_{03} = -1.813$) as well as to steeper 10-year declines in physical health ($\gamma_{13} = -0.074$). In addition, lower education was associated with poorer physical health ($\gamma_{14} = 0.757$). As can be expected, health conditions ($\gamma_{010} = -8.927$ and $\gamma_{010} = -3.423$, respectively) and negative major life events ($\gamma_{011} = -0.909$ and $\gamma_{011} = -0.977$, respectively) were both associated with poor physical and mental health. Over time, suffering from a health condition related to less decline in physical health ($\gamma_{110} = 0.287$), and negative events related to somewhat stronger increases in mental health ($\gamma_{111} = 0.054$).

Personality effects moderated by age. To test whether the effects of the personality traits (on level or change in health) differed by age, age interaction terms were tested for all personality traits, with only statistically significant terms retained in the final models ($p < .01$). Overall, results revealed that the effects of personality associated with physical and mental health were unrelated to age with the exception of openness, which had a weaker association to mental health with increasing age ($\gamma_{012} = 0.018$). The Johnson-Neyman technique (Johnson & Neyman, 1936; Preacher, Curran, & Bauer, 2006) was used to probe the interaction. This technique identifies the values of the moderator variable for which the focal predictor variable and outcome variable have a significant association. These probes indicated that openness and mental health were significantly related for ages less than 57 years and greater than 99 years. However, we note that the upper boundary is beyond the age range (ages 20–93) of the sample. Thus we qualify the generalization to note that in this data, greater levels of openness were related to worse levels of mental health until age 57 and unrelated after. Figure 2 shows the pattern of age-related moderation of 10-year changes in mental health for individuals with high levels of openness

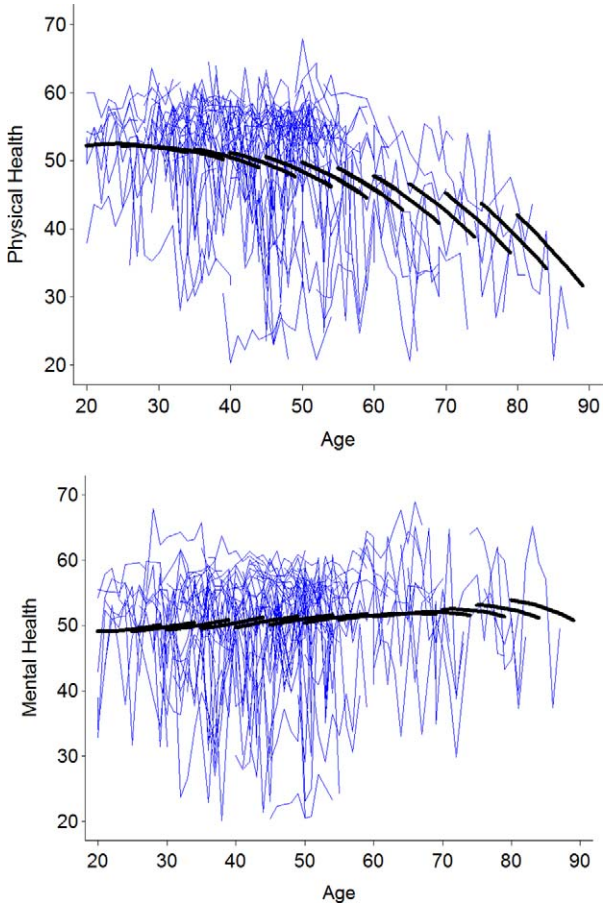

Figure 1. Age-related differences (for 10-year slices of age) in trajectories of self-rated physical health (top panel) and mental health (bottom panel) scales of the SF-36. Self-rated physical health becomes lower throughout adulthood and shows steep declines in old age. In contrast, mental health remains relatively stable across most of the adult life with slightly steeper declines in later life.

(+1 *SD*) and low levels of openness (–1 *SD*). A vertical line extends from age 57 to indicate the age cut-off for a significant openness-mental health association (e.g. before age 57). The older people were, the less difference openness appeared to make.

Discussion

We applied growth models to 10 waves of data from the HILDA study to describe age-related differences in self-rated physical and mental health trajectories over time, to investigate whether and how personality traits were associated with between-person differences in perceived health trajectories, and to test if these associations differ with age. Our findings suggest that physical health declines throughout adulthood and exhibits progressively steeper decrements through old age. In contrast, mental health appears to remain steady across adult life. We also found that higher neuroticism and lower extraversion and conscientiousness were each related to less favourable health trajectories. Surprisingly, participants high on openness reported lower mental health. Our results also revealed that the health implications of the personality correlates did not differ by age for physical health and were weaker for mental health in later life (e.g.

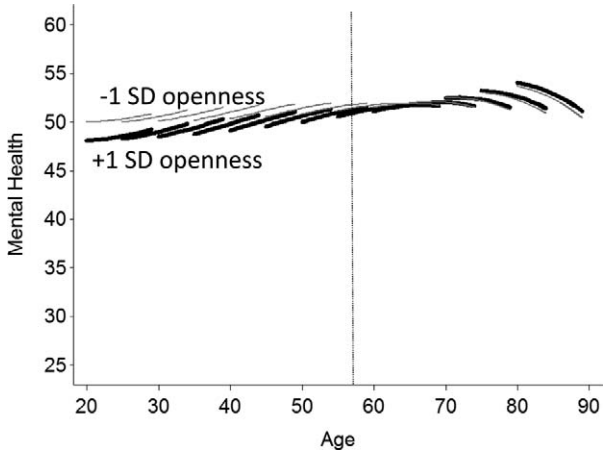

Figure 2. The pattern of age-related moderation of 10-year changes in mental health for individuals high (+1 *SD*) and low (-1*SD*) in openness. Younger adults with high levels of openness report worse mental health compared to younger adults with low levels of openness, but the difference becomes less pronounced with increasing age. In particular, the vertical line represents that the openness-mental health association becomes non-significant at age 57 and over.

openness). Methodologically, our modeling strategy allowed us to relax the often-made convergence assumption and provided clear evidence for selection effects. In particular, increasing intercepts for mental health with age indicated that younger participants (e.g. 50-year-olds) will not turn into older participants (e.g. 80-year-olds). With this accommodation, we discuss implications of our results for use of accelerated longitudinal designs and consider avenues for future more mechanism-oriented research to better understand the pathways by which these perceived health disparities emerge.

Age-related differences in physical and mental health trajectories

Our findings of steeper declines in self-rated physical health in older ages corroborate previous reports of normative physical health trajectories across adulthood (Aldwin et al., 2006; McCullough & Laurenceau, 2004; Rook et al., 2007; Sargent-Cox et al., 2010; Smith et al., 2002). Strains associated with increased risks for functional limitations and early precursors or the onset of (chronic) diseases experienced in midlife make it more and more difficult for people to perceive their physical health as stable. Compared to physical health, we found that mental health remained relatively unchanging throughout adulthood. This finding is in line with conceptual work and a myriad of empirical reports illustrating that the self-regulation system remains highly efficient in helping people adapt to a variety of (changes in) life circumstances (Baltes & Smith, 2003; Carstensen et al., 2000; Charles et al., 2001; Diener & Suh, 1998; Mroczek & Kolarz, 1998; Zarit, 2010). Moreover, some work has suggested that the stability of mental health may be due to its strong association with mostly static personality traits (e.g. Steel, Schmidt, & Shultz, 2008). Precipitous declines in mental health may only emerge at the very end of life when regulatory and/or other supporting structures break down (Gerstorf, Ram et al., 2010; Mroczek & Spiro, 2007). On the other hand, some studies have reported an increase in well-being throughout late life (Stone, Schwartz, Broderick, & Deaton, 2011). However, such results come from primarily cross-sectional studies which cannot address changes

but rather only level differences. The difference in levels is likely due to selection effects with older adults who participate in the study having better mental health than those who do not participate.

Our findings corroborate previous studies examining longitudinal changes in the SF-36 that reported declines in physical and mental health with increasing age (e.g. Chandola, Ferie, Sacker, & Marmot, 2007; Hopman et al., 2006; Sacker, Head, Gimneo, & Bartley, 2009). For example, Chandola and colleagues (2007) used a sample of men and women aged 35 to 55 at baseline from the Whitehall II Study to examine long-term changes in the physical and mental health summary scores up to 18 years and found negative linear changes over age for both health dimensions. Our study adds to these earlier reports by placing their results in an adult lifespan perspective using data from a large and nationally representative sample.

In addition, our results illustrate that the assumption of age convergence in accelerated longitudinal designs may not always be accurate. Here, when the current 20- to 30-year-old participants reach old age, they will not necessarily develop into the 70- to 80-year-old participants in our study. For example, as depicted in the bottom panel of Figure 1, mental health appears to decline more in older age groups, yet older adults have greater levels of mental health at the start of the study than younger adults. If mental health takes a downturn in adulthood at some point, then it would be impossible for the younger adults in the study to be on the same trajectory in late life as the older adults in the study (i.e., the younger adults could not have greater levels of mental health in late life). Among the reasons contributing to non-convergence are birth cohort differences and selection effects (see Sliwinski, Hoffman, & Hofer, 2010). For the mental health example presented, it is plausible that the older adults who participated in the study are healthier and happier than those who did not participate. Simply by surviving to the last stage of life, these people may be a more select group of individuals than the younger people in the study.

Personality correlates of changes in physical and mental health

Our results also revealed that personality factors moderate changes in perceived health across adulthood. All of the Big Five personality dimensions were associated with between-person differences in age-related perceived health trajectories. Consistent with many reports (Bolger & Schilling, 1991; Costa & McCrae, 1987; Lahey, 2009; Neeleman et al., 2004), people higher in neuroticism tended to report poorer physical and mental health. These differences in health may reflect the effects of poor coping strategies in anticipation of or reaction to stressors, somatic complaints, and emotional instability that accompany neuroticism (Mroczek & Almeida, 2004; Watson & Hubbard, 1996). For example, when faced with a challenge, people high in neuroticism may use less effective coping strategies (e.g. rumination), which in turn results in poorer health outcomes relative to people low in neuroticism. In addition, it has been suggested that high levels of neuroticism are linked to reporting more health problems, and such a bias may contribute to the neuroticism-health association found in our study (e.g. Watson & Pennebaker, 1989). Participants higher in conscientiousness and extraversion each reported better physical and mental health, and more extraverted individuals perceived shallower physical health declines. Conscientious individuals tend to engage in health-promoting behaviours such as exercise and less in health-harming behaviours such as smoking (Boggs & Roberts, 2004), whereas the health implications of extraversion appear to be primarily mediated by social activities (e.g. utilizing resources from one's social network in times of need; Wilson et al., 2005).

We also found that openness was associated with poorer mental health in young adulthood but not in old age. We note that this result is somewhat at odds with previously published work suggesting that openness relates to better mental health (e.g. Duberstein et al., 2003; Jerram & Coleman, 1999; for a null finding, see Turiano et al., 2012). We can only speculate about possible reasons underlying these discrepant findings. For example, we used an adjective checklist to measure openness, whereas other studies have used 60+ item scales such as the NEO-FFI. It is possible that the seven adjectives used in our study thus do not capture all the openness aspects the scale measures and potentially all the aspects of the other personality traits. Substantively, this finding may reflect a biased health perception in that individuals who live an active and engaged life may perceive a given health loss more negatively and be more detrimentally affected than people who live a less active life, especially in young adulthood when being active is more the norm. Further, openness has been discussed as a key predictor in theoretical accounts of personality growth, which, for example, includes the process of developing wisdom and individualized morals that transcend social norms (Staudinger & Kunzmann, 2005). Being more open to experience is related to moving forward on the difficult path of personality growth, and this journey is often filled with challenges and stress. To achieve personal growth and self-fulfilment, individuals must experience difficult situations which they cope with and ultimately learn from. Thus, being more open can expose individuals to stressful situations (though the outcome may be good), which in turn can relate to poorer levels of mental health. Further studies are needed to replicate and explore the underlying mechanisms of this openness–mental health association. Taken together, our longitudinal study adds to earlier cross-sectional reports of personality–health associations (e.g., using the SF-36: Duberstein et al., 2003; Jerram & Coleman, 1999; Lockenhoff et al., 2008) by demonstrating that a number of personality characteristics are important factors in shaping how perceptions of one's health change across adult life.

Our results also revealed that the health implications of personality did not differ by age for physical health, whereas some personality effects for mental health were less pronounced in older ages (e.g. openness). Importantly, many of the examined personality correlates' relationships with health were not moderated by age suggesting that the relationships do not differ based on age. Despite this, future work should further explore interactions of personality and other variables with age because doing so can provide information about which characteristics of individuals to target for health interventions. The characteristics of individuals that have greater health implications with age should be targeted to ideally lessen the health problems that will become exacerbated with increasing age. For example, in our study openness was found to have negative health implications in young adulthood but not in old age. Thus, targeting openness for mental health interventions may not be very worthwhile because of this tendency to improve with age regardless.

Limitations and outlook

We note several limitations of our study. First, as with most large-sample studies the specific measures available have some shortcomings. For example, health is a multidimensional construct including

objective indicators such as medical diagnoses and subjective indices such as self-ratings. With only moderate overlap among these indices (Steinhagen-Thiessen & Borchelt, 1999), our findings based on changes in self-ratings may not generalize to more objective markers of health. Specifically, we note that the SF-36 may not be an ideal measure of mental and physical health because it is geared towards primarily assessing negative health aspects rather than positive ones such as well-being (e.g. emotional well-being, life satisfaction). In a similar vein, personality was measured only once in the HILDA, thereby not allowing us to examine how changes in personality and more broadly, psychological factors, are linked to changes in health (Infurna, Ram, & Gerstorf, in press; Mroczek & Spiro, 2007; Turiano et al., 2012). Following the same "trait" assumption underlying the single-occasion measurement of personality, we used a single-occasion measure of negative life events, a decision that precluded examining how fluctuations in experience of negative life events may affect health trajectories. In some cases, the response scale was also limited. For example, the measure of disability was dichotomous, and thus did not distinguish severity of disability or allow for examining how severity was related to health. Second, although our study describes how personality and age are related to adults' health trajectories, we have not drilled into or explored the specific mechanisms through which these factors influence health. Further studies addressing such pathways are warranted, including examination of how health behaviours, physiological arousal, or social support mediate the effects noted here. Third, the relatively low number (only 10) and frequency (only yearly) of within-person assessments did not permit modeling of discrete shifts and change points in individual-level health trajectories. More closely spaced assessments would allow for a wider variety of change models (non-linear trajectories with many changes in direction), potential identification of individual-level timing of onset of health declines (e.g. second analysis in Gerstorf et al., 2008), and better opportunity to examine the interplay between physical and mental health, to identify time-varying predictors and to examine time-varying effects. Fourth, the data used here, obtained from a nationally representative sample of the population, certainly improves upon the predominantly cross-sectional studies on this topic, but an ideal study would follow individuals over a much longer time period and thoroughly track individual-level development across large parts of adult life. Finally, although the effects were small ($R^2 < .005$), differences were found between participants providing more data (e.g. 6+ waves) compared to participants who provided less data (e.g. 5 or less waves). As a consequence, selective attrition of people in worse health needs to be taken into account when interpreting our findings.

To conclude, our study represents an effort to better understand the vastly different long-term change trajectories of self-rated physical and mental health across adulthood and old age. Data from a national sample in a highly developed nation indicate that typical declines in perceived physical health are apparent throughout adulthood, whereas typical mental health remains relatively stable across adulthood. By more precisely understanding the health changes occurring in adulthood, we can better know when to intervene, and better inform public policy and programs as to when and how resources would be most needed to improve the health and well-being of individuals. We have also shown that personality factors may serve as protective factors against or risk factors for health declines. Of particular note is that some of these associations differ with age and this helps us to know which characteristics of individuals to target for health interventions (e.g. the ones that have greater health implications with age). Our study thus provides further impetus for research targeting the underlying pathways and processes involved in the emergence of health disparities during adulthood.

Funding

The first author was supported by a fellowship from the ISSBD (International Society for the Study of Behavioural Development-Jacobs Foundation Mentored Fellowship for Early Career Scholars). The authors are grateful for the support provided by the National Institute on Aging (Grants RC1 AG035645, R21-AG032379 and R21-AG033109). The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

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