American Psychological Association

Psychology and Aging

© 2021 American Psychological Association
ISSN: 0882-7974

2021, Vol. 36, No. 3, 322–337
https://doi.org/10.1037/pag0000608

Feeling Younger as a Stress Buffer: Subjective Age Moderates the Effect of Perceived Stress on Change in Functional Health

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Feeling younger than one's chronological age is associated with various beneficial health outcomes. However, apart from these direct health effects, little is known about the role of subjective age as a potential "buffer" and compensatory resource that might counteract the detrimental effect of health risk factors. We investigated whether the effect of perceived stress as a major health risk factor on change in functional health is smaller among individuals who feel younger. Additionally, we analyzed whether this "stress buffer effect" of subjective age varies by chronological age. Longitudinal data from the German Ageing Survey comprising 3 years (2014–2017) were used (N = 5,039; mean age at baseline: M = 63.91 years, SD = 10.80 years, range 40–95 years). Latent change score models revealed that, controlling for baseline functional health as well as for sociodemographic variables, greater perceived stress was associated with a steeper decline in functional health. This effect increased in size with advancing chronological age. Moreover, a younger subjective age was associated with a less steep decline in functional health. Subjective age additionally exhibited a stress buffer effect: Among individuals who felt younger, the association of greater perceived stress with steeper functional health decline was weaker. This stress buffer effect of subjective age became larger with increasing age. Our findings thus suggest that, particularly among older adults, a younger subjective age might help to buffer functional health decline, not only by directly affecting functional health, but also by compensating and counteracting the detrimental effect of stress on functional health.

Keywords: midlife, old age, stressors, perceived age, age identity

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Most adults in middle adulthood and later life feel younger than they are (Barak, 2009; Barrett & Montepare, 2015; Kotter-Grühn et al., 2016; Stephan et al., 2018a; Uotinen et al., 2006; Westerhof & Barrett, 2005). When the divergence between chronological and subjective age is considered as a simple subtraction score, this discrepancy increases, according to some evidence, with advancing age (Kotter-Grühn et al., 2009; Montepare & Lachman, 1989; Westerhof et al., 2003). In contrast, when calculating the discrepancy relative to an individual's chronological age (i.e., proportional discrepancy = [subjective age—chronological age]/chronological age), such a discrepancy score remains more constant over chronological age, with individuals aged 40 and older feeling on average about 20% younger than their age (Rubin & Berntsen, 2006).

According to accumulating empirical evidence, feeling younger comes with various benefits for key developmental outcomes (Alonso Debreczeni & Bailey, 2021; Kotter-Grühn et al., 2016; Stephan et al., 2018a), including higher well-being (Brothers et al., 2017; Choi & DiNitto, 2014; Hajek & König, 2020; Keyes & Westerhof, 2012; Mock & Eibach, 2011; Spuling et al., 2013; Westerhof & Barrett, 2005), better cognitive and brain functioning (Kwak et al., 2018; Stephan et al., 2014, 2018), as well as favorable outcomes of physical health (Kotter-Grühn et al., 2009; Spuling et al., 2013; Uotinen et al., 2005; Westerhof et al., 2014; Westerhof & Wurm, 2015). Various mechanisms, including physiological, behavioral, and psychological-motivational pathways, seem to account for this association (Kotter-Grühn et al., 2016; Westerhof & Wurm, 2015). Subjective age thus seems to be "a meaningful alternative marker of aging" (Stephan et al., 2018a) as well as a "biopsychosocial marker of aging" (Stephan et al., 2018b).

So far, empirical findings and conceptual models regarding the theoretical nature of subjective age were mostly focused on the role of subjective age as a predictor of major developmental outcomes (e.g., Westerhof & Wurm, 2015). Such frameworks postulate various mediating mechanisms via which subjective age and other indicators of subjective aging (Dutt et al., 2018; Levy, 2009; Wurm et al., 2017) exert their impact outcomes such as health and well-being. However, another potential pathway leading from subjective age to health outcomes that has so far rarely been conceptually and empirically addressed is that subjective age might *indirectly* affect health by operating as a psychosocial compensatory resource that counteracts and buffers the detrimental effects of various health risk factors. In this study, we will address this assumption by focusing on stress, which is a crucial health risk

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The German Ageing Survey (DEAS) was funded under Grant 301-6083-05/003*2 by the German Federal Ministry for Family, Senior Citizens, Women, and Youth. The content is the sole responsibility of the authors. This contribution is part of the project "Health Trajectories into Old Age—Ways into Need for Long-Term Care" that is funded by the National Association of Statutory Health Insurance Funds (GKV-Spitzenverband).

The authors declare no conflict of interest.

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factor (Aldwin et al., 2011; Aldwin et al., in press; Schneiderman et al., 2005; Thoits, 2010). Specifically, we will investigate if subjective age moderates the association between perceived stress and functional health after 3 years in a sample of middle-aged and older adults. Moreover, we will explore whether this "stress buffer effect" varies by chronological age.

Subjective Age and Health

Assessing subjective age, which is sometimes also labeled "age identity" (e.g., Westerhof & Wurm, 2015) and represents "the most frequently used concept in the subjective aging literature" (Dutt et al., 2018), is simple and usually done based on a single-item question such as "How old do you feel?" (Kotter-Grühn et al., 2016). This simple assessment approach seems to be sufficient to meaningfully predict later health outcomes. Specifically, feeling younger than one's chronological age is associated with better physical and subjective health (Spuling et al., 2013; Stephan et al., 2012), higher grip strength (Stephan et al., 2013), and a lower risk of hospitalization (Stephan et al., 2016). Moreover, from a physiological perspective, subjective age is associated with markers of systemic inflammation, with individuals who feel younger revealing lower C-reactive protein (Stephan et al., 2015). Finally, the younger individuals feel compared to their actual age, the longer they tend to live (Kotter-Grühn et al., 2009; Markides & Pappas, 1982; Rippon & Steptoe, 2015; Stephan et al., 2018b; Uotinen et al., 2005; Westerhof et al., 2014).

These findings suggest that subjective age is an important psychosocial resource that has important implications for individuals' health and longevity. Different pathways have been suggested that explain the effects of subjective age on health and mortality. As Keyes and Westerhof (2012) discuss, feeling younger could be self-protective and represent a "self-enhancing strategy in cultures that stigmatize growing old" (p. 68), with a younger subjective age representing a coping mechanism against ageism (Chasteen & Cary, 2015) and preventing or at least buffering the negative health consequences of ageism and stigmatization phenomena. A younger subjective age might also lead to an "accumulation of subjective well-being" (Westerhof & Wurm, 2015, p. 149) and of other psychological resources that in turn promote health and functioning (Lyubomirsky et al., 2005; Pressman et al., 2019). Moreover, individuals' subjective age might affect the extent to which individuals perceive age-related changes, particularly losses, which are in turn associated with outcomes of health and functioning (Brothers et al., 2017). Feeling younger might also have beneficial motivational and behavioral consequences. Specifically, individuals with a younger subjective age might engage in certain everyday behaviors (such as personal, social, body-focused or trend activities; Montepare, 2019) and favorable health behaviors, such as regular physical activity (Caudroit et al., 2012; Stephan et al., 2014, 2015), to a larger extent than those feeling older. Finally, an additional potential mechanism that we assume and address in this study is that subjective age might also indirectly affect health by moderating and buffering the detrimental effect of major health risk factors such as stress.

Subjective Age as a Stress Buffer

Various empirical findings suggest that "experiencing high levels of stress over an extended period of time is one of the biggest risks for mental and physical health" (Klaperski, 2018, p. 244). Stress is an established risk factor for multiple outcomes of health and functioning (Chrousos, 2009), including cognitive abilities (McEwen, 2013; Neupert et al., 2006; Sapolsky, 1996), sensory functioning (Canlon et al., 2013; Sabel et al., 2018), health symptoms (Almeida et al., 2002; Ensel & Lin, 2000), and mortality (Aldwin et al., 2011; Jeong et al., 2016). Psychological as well as physiological and biological pathways account for these detrimental stress effects (Aldwin & Yancura, 2010; Kiecolt-Glaser et al., 2015; Rutters et al., 2014; Surachman & Almeida, 2018).

However, the health-detrimental role of stress is not deterministic, and "despite the indisputable fact that stress has adverse effects on health, it is by no means assured that stressed individuals will always get sick" (Aldwin & Yancura, 2010, p. 185). Specifically, the extent to which stress has a detrimental impact on well-being and health varies considerably according to individuals' characteristics, including their stress reactivity levels and their coping strategies when facing stressors (Almeida, 2005; Charles et al., 2013; Mroczek & Almeida, 2004; Piazza et al., 2013). Therefore, stress may not necessarily have a severe impact on health as long as individuals have sufficient compensatory resources, such as high levels of conscientiousness (Shanahan et al., 2014) or of mastery, self-esteem and social support (Thoits, 2010), available. We assume that subjective age is an additional compensatory resource that buffers the detrimental health effect of stress. As described above, feeling younger is associated with various psychosocial benefits such as higher well-being (Brothers et al., 2017; Choi & DiNitto, 2014; Keyes & Westerhof, 2012; Mock & Eibach, 2011; Spuling et al., 2013; Westerhof & Barrett, 2005), and these psychosocial benefits (e.g., positive affect as a stress buffer; Pressman & Cohen, 2005; Pressman et al., 2019) might in turn contribute to reducing the negative health consequences of stress. Additionally, individuals with a younger subjective age also engage more frequently in positive health and everyday behaviors such as physical activity (Caudroit et al., 2012; Montepare, 2019), which, according to accumulating evidence, is also an important stress buffer with regard to physical and mental health because it augments psychosocial resources and alleviates stress responses (Gerber & Pühse, 2009; Klaperski, 2018). In conclusion, subjective age has beneficial effects on various established "stress buffers," such as well-being (Pressman et al., 2019) or physical activity (Gerber & Pühse, 2009; Klaperski, 2018), and can therefore be assumed to operate as a stress-buffering psychosocial resource in itself.

This perspective that subjective age might interact with other factors regarding its impact on health and well-being is not entirely new, though empirical evidence is still very limited. Conceptual frameworks have so far mostly specified interaction effects between subjective age and other measures of subjective aging as predictors of health and well-being (Mock & Eibach, 2011; Wurm et al., 2017).

With regard to the specific interplay between stress and subjective age, there is some empirical evidence that supports the stress-buffering role of a younger subjective age (e.g., Stephan et al., 2018a). Shrira et al. (2014) found that a higher subjective closeness to death was associated with higher psychological distress among older adults, but this association was weaker among individuals feeling younger. In another study, Shrira et al. (2016) found that posttraumatic stress disorder symptoms were negatively associated with outcomes of successful aging among Israeli Jewish older adults exposed to missile attacks, but this association was buffered if

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individuals reported a younger subjective age. Moreover, it seems that older individuals with a posttraumatic stress disorder who feel older are more susceptible to physical decline (Shrira et al., 2018). Hoffman et al. (2015) investigated a sample of young adults and reported that individuals with a younger subjective age are less prone to the immediate effects of trauma in terms of acute stress disorder symptoms. The stress-buffering role of subjective age might thus not be limited to old age, but might already be manifest at younger ages. Also, a study based on Israeli older adults found that in March and April of this year—the first wave of the COVID-19 pandemic, which is a genuine stressor and a "multidimensional and potentially toxic stress factor" (Brakemeier et al., 2020) in itself—loneliness was less strongly associated with psychiatric symptoms among those older adults who reported feeling younger (Shrira et al., 2020). A younger subjective age as well as positive perceptions on aging in general (Cohn-Schwartz & Ayalon, 2020; Losada-Baltar et al., 2021) might thus be an important compensatory resource with a particularly protective effect against negative health outcomes and compromised well-being in times of heightened stress, such as the ongoing pandemic.

Additionally, considering subjective aging measures beyond subjective age, positive age stereotypes and positive self-stereotypes of aging have been found to reduce cardiovascular stress (Levy et al., 2000, 2008) and the stress biomarker cortisol, even when considered longitudinally over several decades (Levy et al., 2016). In contrast, negative aging attitudes seem to be associated with a greater emotional reactivity to daily stressors among older adults (Bellingtier & Neupert, 2016).

To conclude, we assume that the association between perceived stress and change in functional health is moderated by subjective age. More specifically, our prediction is that greater perceived stress is associated with a steeper 3-year decline in functional health, and that this association is less pronounced among individuals with a younger subjective age.

Subjective Age, Stress, and Health: The Role of Chronological Age

The extent to which subjective age and stress as well as their interaction predict change in functional health might additionally vary by chronological age. Regarding subjective age, "different age identities have different values and implications at different points in the life span" (Barrett & Montepare, 2015, p. 71). Specifically, feeling younger or older than one's actual age might get more relevant for various developmental outcomes as soon as individuals enter old age. For these older adults, whether they "feel" their age or not might make a crucial difference because if they do feel their age, they might—according to stereotype embodiment theory (Levy, 2009)—become targets of their own age stereotypes once they consider themselves as belonging to the group of older adults. Such stereotypes might thus become internalized and integrated in self-perceptions of aging that in turn can become a self-fulfilling prophecy and result in poorer health (Wurm et al., 2017, 2013).

Moreover, old age and particularly very old age are life phases that are characterized by a heightened level of vulnerability and a steeper decline in functional health (Baltes & Smith, 2003; Gerstorf & Ram, 2009; Wahl & Ehni, 2020; Wettstein et al., 2016; Wettstein, Spuling, et al., 2020) which might be counteracted to some extent by compensatory psychosocial resources such as a younger subjective age. In contrast, earlier in life, for example, in middle adulthood, most individuals are in good health (Lachman, 2004; Lachman et al., 2015) so how young or old individuals feel might be less health-relevant in this life phase. Regarding the mechanisms underlying the association between subjective age and health, the postulated process of well-being accumulation (Westerhof & Wurm, 2015) resulting from a younger subjective age as well as the health-protective effect of a younger subjective age via health behaviors might need time to reach their maximal impact on health. Consequently, also due to these mechanisms and their accumulating effects over time and age, stronger associations between subjective age and health can be expected with increasing chronological age. With regard to empirical evidence, several findings indeed suggest stronger associations between subjective age and health with advancing age (Bergland et al., 2014; Hubley & Russell, 2009; Stephan et al., 2012). Therefore, we assume that the association between a younger subjective age and less decline in functional health increases in size with advancing age.

Similarly, the health-detrimental effects of stress might change with advancing age (Ensel & Lin, 2000). Generally, the nature of stress changes across the life span (Aldwin et al., 1996), and there is also age-related change regarding the use of coping strategies when facing stressors (Aldwin et al., 2010; Brandtstädter, 2015; Schilling & Diehl, 2014). Additionally, as Umberson et al. (2008) discussed, "the impact of stress on health behavior may vary in magnitude, or even direction, at different points in the life course." Regarding physiological stress responses, the neuroendocrine and immune systems of older adults often need more time to return to normal after stress activation compared to younger adults (Aldwin, 2007). Moreover, according to the theoretical model of strength and vulnerability integration (SAVI; Charles, 2010), when encountering stress with sustained emotional arousal, older adults have greater problems and need more time returning to homeostasis. We thus expect that the detrimental effect of perceived stress on functional health change increases with older chronological age.

Finally, the expected role of chronological age as a magnifier regarding the effects of stress and subjective age on health changes might in turn also result in an age moderation effect when the interaction effect of stress and subjective age on health change is considered: That is, given both the higher stress vulnerability as well as the greater health relevance of subjective age with advancing chronological age, it is plausible that the role of a younger subjective age as a stress buffer also gets more crucial among chronologically older. A younger subjective age is thus expected to buffer the negative effect of perceived stress on change in functional health, and this stress buffer effect is assumed to increase in size with advancing chronological age.

The Role of Region (East vs. West Germany) as Additional Moderator

Finally, the stress buffer effect of subjective age might be of different strength for East versus West Germans. Generally, differences between East and West Germans in subjective and objective health have been reported (Martin et al., 2000; Schöllgen et al., 2010). Also, self-perceptions of aging and other psychosocial indicators differ between both groups (Schimmack et al., 2008; Wurm & Huxhold, 2012), with differences in favor of West Germans, though these differences might have diminished over time (N. Vogel et al., 2017).

However, the role of region for the effect of stress on functional health change or for the size of the "stress buffer effect" of subjective age has, to our knowledge, not yet been empirically addressed. Therefore, we will investigate the potentially moderating role of region of residence in an exploratory way.

Present Study

The aim of this study is to investigate the role of subjective age and perceived stress as well as their interaction as predictors of change in functional health. Additionally, the moderating role of chronological age in the described predictor effects will be addressed. Our expectations are as follows:

1. *Perceived stress, subjective age, and their interaction predict change in functional health:* We expect that controlling for baseline functional health as well as for sociodemographic characteristics, greater perceived stress and an older subjective age are associated with a steeper 3-year decline in functional health. Moreover, we expect a "stress buffer effect" of subjective age. Specifically, greater perceived stress is assumed to have a weaker negative association with change in functional health among individuals who feel younger.

2. *Chronological age moderates the predictor effects of perceived stress, subjective age, and of their interaction on change in functional health*: With regard to the role of chronological age, we expect both perceived stress and subjective age to be more strongly related to change in functional health among individuals with an older chronological age at baseline. Additionally, we assume that the described "stress buffer effect" of subjective age, that is, the moderating effect of subjective age on the association between perceived stress and functional health change, increases in magnitude with advancing chronological baseline age of the study participants.

We will also investigate, based on an exploratory approach, whether region of residence (West vs. East Germany) is a moderator of the association between perceived stress and change in functional health and if it also moderates the buffering effect of subjective age on the association between perceived stress and functional health change.

Method

Sample

Data of the German Ageing Survey were used for the following analyses. The German Ageing Survey is a cohort-sequential study, comprising samples of German community-dwelling adults who were aged 40 years and older at the time of their first study participation (C. Vogel et al., 2020). So far, six measurement occasions (T1: 1996, T2: 2002, T3: 2008, T4: 2011, T5: 2014; T6: 2017) have been completed. A new sample, drawn based on national probability sampling and systematically stratified by age, gender, and region of residence (i.e., West or East Germany), entered the survey every six years (1996, 2002, 2008, and 2014).

To be included for survey participation, individuals have to reside in Germany, and they need to be able to understand and speak German language. For the first two measurement waves (1996 and 2002), German citizenship was specified as a prerequisite for study participation. The vast majority of individuals who have participated so far (95.3%) have a German citizenship. Among those persons who were assessed in 2014, 2.46% had a non-German citizenship.

In this study, we included only study participants who took part in the measurement occasions in 2014 and 2017 because stress was not assessed prior to 2014. The sample size of individuals who participated at both occasions and provided valid information on the outcome and all included predictors, was $N = 5{,}039$. Sample characteristics are summarized in Table 1. Participants' mean age at baseline was 63.91 years ($SD = 10.80$ years). About 51% of the sample were female, and about one-third of the study sample lived in East Germany.

Table 1
Sample Description

Study Variables	$M \pm SD$ or n (%)
Age (2014), $M \pm SD$	63.91 ± 10.80
Female sex, n (%)	2,558 (50.8%)
Education:	
Low n (%)	253 (5.0%)
Medium n (%)	2,499 (49.6%)
Elevated n (%)	724 (14.4%)
High n (%)	1,563 (31.0%)
First Study Participation:	
1996 n (%)	398 (7.9%)
2002 n (%)	531 (10.5%)
2008 n (%)	1,623 (32.3%)
2014 n (%)	2,487 (49.4%)
Region of Residence:	
West Germany n (%)	3,376 (67.0%)
East Germany n (%)	1,663 (33.0%)
Functional Health (2014), $M \pm SD$	84.53 ± 19.63
Functional Health (2017), $M \pm SD$	82.27 ± 21.58
Perceived Stress (2014), $M \pm SD$	2.32 ± 0.64
Subjective Age (Proportional Discrepancy[a], 2014), $M \pm SD$	−0.13 ± 0.11

Note. M = mean; SD = standard deviation.
[a] Proportional discrepancy = [felt age—chronological age]/chronological age (see, Rubin & Berntsen, 2006).

Measures

Functional Health

Functional health was measured in 2014 and in 2017 using the physical functioning subscale of the SF-36 assessment instrument (Bullinger & Kirchberger, 1998). Study participants indicated their extent of limitation ("limited a lot," "limited a little," or "not limited at all") when executing 10 common everyday activities such as walking several blocks or bathing and dressing. Answers were aggregated and transformed according to the manual guidelines, resulting in a sum score that ranged from 0 to 100. Higher scores indicate a better functional health.

Subjective Age

Subjective age was assessed in 2014 by a single-item question ("How old do you feel?"), which is a very common assessment

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approach in subjective aging research (Kotter-Grühn et al., 2016). For a better interpretability of subjective age, a proportional discrepancy score between felt age and chronological age was computed (proportional discrepancy = [felt age—chronological age]/chronological age; Rubin & Berntsen, 2006). The resulting scores indicate the proportional extent to which individuals feel younger or older than their chronological age (e.g., a score of −.20 indicates that an individual feels 20% younger than he/she is, a score of +.20 indicates that an individual feels 20% older than he/she is, and a score of 0 indicates that subjective and chronological age are identical).[1]

Perceived Stress

For the assessment of perceived stress in 2014, the four-item short-form of the Perceived Stress Scale (Cohen et al., 1983) was used. Items (e.g., "In the last month, how often have you felt difficulties were piling so high that you could not overcome them?") were answered on a 5-point Likert scale, with a range from "never" to "very often" (Cronbach's α = .70).

Covariates

We controlled for baseline functional health (assessed in 2014) as well as for age, gender, region of residence (West vs. East Germany), education, and year of first study participation (i.e., 1996, 2002, 2008, or 2014). The assessment of education was based on the International Standard Classification of Education (ISCED) coding (UNESCO, 2012). Four levels of school and professional education (low, medium, elevated, and high) were distinguished.

Statistical Analyses

Using Mplus 8.4 (Muthén & Muthén, 2017), latent change score models (Kievit et al., 2018; McArdle, 2009) were computed. Change in functional health from 2014 to 2017 was modelled as a latent variable. In the unadjusted model, baseline functional health, age, perceived stress, and subjective age were specified as predictors of latent change in functional health. Predictors were specified as observed, nonlatent variables. Additionally, four (manifest) interaction terms were specified, including the interactions of perceived stress and of subjective age with chronological age (Stress × Chronological Age, Subjective Age × Chronological Age), the interaction between perceived stress and subjective age (Stress × Subjective Age), as well as a three-way interaction of perceived stress, subjective age, and chronological age (Stress × Subjective Age × Chronological Age). In the adjusted model including covariates, region (East vs. West Germany), education, gender, and year of first study participation were included as additional predictors of latent change in functional health. Missing data were handled using the FIML (full information maximum likelihood) estimation procedure.[2]

Results

Correlations between all study variables are shown in Table 2. Functional health revealed a high stability between 2014 and 2017 ($r = .70$), but the correlation was clearly below 1, thus indicating some interindividual variability in 3-year functional health changes. Among the strongest associations were the correlations of chronological age with functional health (2014: $r = -.24$; 2017: $r = -.30$). Moreover, a younger subjective age and lower perceived stress were significantly associated with a higher functional health both in 2014 and in 2017 (all r between −.17 and −.22).

Results of the latent change score models are displayed in Table 3. Both the model without covariates as well as the adjusted model including covariates achieved a good model fit.[3] Constraining the effects of all interaction terms (Stress × Age, Stress × Subjective Age, Subjective Age × Age, Stress × Subjective Age × Age) on latent change in functional health to 0 in the adjusted model resulted in a significant deterioration of model fit ($\Delta\chi^2(4) = 21.91$, $p < .000$). Therefore, the model without interaction terms was rejected. Proportions of variance accounted for in functional health change were $R^2 = .116$ in the model without covariates and $R^2 = .121$ in the model with covariates.

In both the model without covariates as well as in the model including covariates, the predictor effects of functional health (measured in 2014), chronological age, perceived stress, and subjective age on latent change in functional health were significant. Decline in functional health was steeper among those with better functional health in 2014 as well as among individuals who were older, who reported higher perceived stress and who felt older.

Also, with the exception of the interaction Subjective Age × Age, all interaction terms reached statistical significance: Higher perceived stress was associated with a steeper decline in functional health, and this association was stronger among individuals who were older (see Figure 1). Also, the association of perceived stress with decline in functional health increased in size with an older subjective age (see Figure 2). Stated differently, whereas an individual with a younger and older subjective age did only slightly differ with regard to change in functional health when both experienced low levels of stress, the difference between both in functional health change, in favor of the individual feeling younger, increased in size with increasing stress levels.

Finally, there was a significant three-way interaction of stress, age, and subjective age (see Figure 3): That is, the association of stress with change in functional health was not only stronger among individuals who were chronologically older and who felt older. The described stress buffer effect of subjective age was additionally moderated by subjective age and was stronger among individuals who were chronologically older. For instance, for two individuals aged 64.15 years, with one of them feeling 12% younger than

[1] Some outliers were detected for subjective age (e.g., a subjective age of 520 years). To avoid biased estimations due to such outliers, subjective age scores (computed as proportional discrepancy scores) that were more than 3 *SD* above or below the sample mean ($N = 10$) were coded as missing values.

[2] All individuals who provided at least one observation were included in the latent change score analyses ($N = 10{,}615$), although individuals with only one observation did not provide longitudinal, within-person change information. However, in order to avoid biased estimates due to sample selectivity, these individuals with only one study participation were not excluded from the analyses, but included in the FIML estimation.

[3] To increase model parsimony, additional model restrictions were set. Correlations between the covariates gender, region, and year of first study participation, which are of no particular theoretical interest and which were all found to be below $r = |.05|$, were set to 0. Additionally, the correlations between age and the interaction Stress × Subjective Age, between stress and the interaction Subjective Age × Age, and between subjective Age and the interaction Stress × Age were constrained to 0. These correlations were all below $r = |.05|$ in a model without these constraints. All other intercorrelations between covariates were freely estimated and not constrained.

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Table 2
Correlations Between Study Variables

Study Variables	1 Age	2 Gender[a]	3 Education	4 Study Entry[b]	5 Region[c]	6 Functional Health 2014	7 Functional Health 2017	8 Perceived Stress	9 Subjective Age[d]
1 Age	1.000	−.090***	−.051***	−.231***	.015	−.236***	−.303***	−.058***	.035*
2 Gender[a]		1.000	−.189***	−.033*	.016	−.091***	−.070***	.068***	−.066***
3 Education			1.000	.035*	.077***	.182***	.176***	−.165***	−.022
4 Study Entry[b]				1.000	−.019	.019	.030*	.019	−.044**
5 Region[c]					1.000	−.046**	−.033*	.012	.050***
6 F. Health 2014						1.000	.703***	−.215***	−.203***
7 F. Health 2017							1.000	−.177***	−.169***
8 Perceived Stress								1.000	.152***
9 Subjective Age[d]									1.000

Note. [a] 0 = male, 1 = female. [b] 0 = 1996, 1 = 2002, 2 = 2008, 3 = 2014. [c] 0 = West Germany, 1 = East Germany. [d] Proportional discrepancy = [felt age—chronological age]/chronological age (see Rubin & Berntsen, 2006).
* $p < .05$. ** $p < .01$. *** $p < .001$.

his/her age and the other one feeling approximately as old as he/she is, high stress (mean stress + 1 *SD*) leads to an additional functional health decline which is approximately 2–4 points higher—for both individuals—compared to low stress (mean stress – 1 *SD*). However, for two individuals aged 84.15 years, one of them feeling 12% younger and the other one feeling approximaltely as old as he/she is, the difference in functional health decline associated with low versus high perceived stress is four points versus more than seven points and thus more discrepant between these both individuals.

Additional Analyses

Comparison of the Moderating Effects of Subjective Age, Chronological Age, and Education

To compare the size of the moderation effect of subjective age on the association between perceived stress and functional health change with other potential sociodemographic moderators, we specified an additional model with all interaction terms as specified above as well as an additional interaction between stress and education. First, we compared the sizes of Stress × Subjective Age interaction and of the Stress × Age interaction.[4] The two interactions were statistically different from each other ($\Delta z = 2.34$, $p < .05$). The moderating effect of subjective age is thus larger than the one of chronological age. Education was not a significant moderator of the association between perceived stress and change in functional health ($\beta_{(\text{Stress} \times \text{Education})} = .02$, $SE = 0.03$, $p = .42$), and its interaction was also significantly smaller than the interaction of stress with subjective age ($\Delta z = 2.1$, $p < .05$).

Investigation of the Role of Region (East vs. West Germany)

We computed a latent change score model in which we additionally specified interactions of region with perceived stress as well as with the Stress × Subjective Age interaction term. In this model, the interaction terms Stress × Age, Stress × Subjective Age, and Stress × Subjective Age × Age remained significant; these effects were thus robust, independent of and not confounded by region. Moreover, we did not find evidence for differences between East and West Germans with regard to the effect of perceived stress on change in functional health and with regard to the stress-buffering effect of subjective age: Both interaction terms, Stress × Region ($\beta = .01$, $SE = .01$, $p = .457$) and Stress × Subjective Age × Region ($\beta = .00$, $SE = .02$, $p = .995$), did not reach statistical significance.

Discussion

In this study, we investigated, based on latent change score models, the role of perceived stress and subjective age as predictors of change in functional health in a sample of middle-aged and older adults. We also analyzed whether subjective age acts as a stress buffer, with a younger subjective age being associated with a weaker negative association between perceived stress and functional health change. With this approach, we broadened existing conceptualizations on the theoretical nature of subjective age, which has so far mostly been considered as a direct predictor of various developmental outcomes. However, its role as a compensatory psychosocial resource that might operate *indirectly* by buffering the detrimental effects of health risk factors has so far only rarely been considered. Finally, we explored the role of chronological age as a potential moderator of the predictor effects of perceived stress, subjective age, and their interaction on functional health changes. In the following, we will summarize the major findings of our study as well as their implications and limitations.

Stress and Change in Functional Health

Our assumption of a detrimental role of perceived stress for change in functional health was confirmed by our findings, even when controlling for subjective age, as well as for various sociodemographic measures. This finding is in line with previous evidence demonstrating a health-detrimental role of stress (e.g., Aldwin et al., 2011; Chrousos, 2009; Schneiderman et al., 2005; Thoits, 2010). Additionally, the effect of perceived stress on 3-year change in

[4] This difference was tested by following the approach as described by Kunzmann (2008): "$\Delta z = \beta_{(1)}–\beta_{(2)}$/square root $[(SE_{(1)}{}^2 + SE_{(2)}{}^2/2]$. Note that $\beta_{(1)}$ and $\beta_{(2)}$ are the two estimated paths to be compared; $SE_{(1)}$ and $SE_{(2)}$ are their respective standard errors" (p. 270).

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Table 3
Predictors of Change in Functional Health

Predictors	Model 1		Model 2	
	B (*SE*)	β	*B* (*SE*)	β
Functional Health (2014)	−0.26*** (0.01)	−.37***	−0.27*** (0.01)	−.38***
Age (2014)	−0.32*** (0.02)	−.22***	−0.33*** (0.02)	−.23***
Year of First Study Participation[a]			−.48* (0.23)	−.03*
Stress (2014)	−1.72*** (0.36)	−.07***	−1.48*** (0.36)	−.06***
Stress (2014) × Age (2014)	−0.07* (0.03)	−.03*	−0.07* (0.03)	−.03*
Subjective Age (2014)[b]	−0.05** (0.02)	−.04**	−0.06** (0.02)	−.04**
Subjective Age (2014) × Age (2014)	0.00 (0.00)	.00	0.00 (0.00)	.00
Stress (2014) × Subjective Age (2014)	−0.12*** (0.03)	−.06***	−.12*** (0.03)	−.06***
Stress (2014) × Subjective Age (2014) × Age (2014)	−0.01* (0.00)	−.03*	−.01* (0.00)	−.03*
Region[c]			−0.16 (0.44)	−.01
Education			0.96*** (0.22)	.06***
Gender[d]			−0.78 (0.42)	−.02
R^2		.116		.121

Note. Unstandardized (B) and standardized (β) coefficients are displayed in the table. *SE* = standard error. Model 1 = unadjusted model without covariates; Model 2 = adjusted model with covariates. Fit indices Model 1: $\chi^2(3) = 32.05$, $p = .000$; CFI = .994; RMSEA = .030, p not significant; fit indices Model 2: $\chi^2(6) = 38.90$, $p = .000$; CFI = .993; RMSEA = .023, p = not significant.
[a] First study participation in 1996, 2002, 2008, or 2014. [b] Proportional discrepancy = [felt age—chronological age]/chronological age (see Rubin & Berntsen, 2006). [c] 0 = West Germany, 1 = East Germany. [d] 0 = male, 1 = female.
* $p < .05$. ** $p < .01$. *** $p < .001$.

functional health was moderated by chronological age. That is, with increasing baseline age, the negative association between perceived stress and change in functional health became stronger. Older adults thus seem to be more vulnerable to stressors compared to middle-aged adults, at least when functional health change is considered as stress consequence. This result is in agreement with the predictions from the theoretical model of strength and vulnerability integration (SAVI; Charles, 2010) as well as with empirical evidence (e.g., Aldwin, 2007). Our finding of an age-related increase in the association between perceived stress and functional health change also supports the assumption that stress "may partially account for the increase in individual health differences in later life" (Aldwin & Yancura, 2010, p. 185). Particularly older adults' functional health might thus benefit from intervention programs to promote stress avoidance or to improve stress management, whereas functional health in midlife, a life phase in which the ability to handle stress might reach its peak (Lachman et al., 1994), generally seems to be less prone to decline (Lachman, 2004; Lachman et al., 2015) and also, according to our findings, less affected by the occurrence of stress.

However, it is important to point out that the age moderation effect on the association between perceived stress and functional health change that we identified in this study does of course not imply that older adults are necessarily more susceptible to *all* detrimental consequences of stress. For instance, in contrast to the physiological impact of stress, the *psychological* impact of stressors and the general affective stress reactivity might decrease with advancing age (Aldwin & Yancura, 2010; Schilling & Diehl, 2014; Schilling & Diehl, 2015; Stawski et al., 2019) due to improved emotional self-regulation and coping as well as, according to the SAVI model, "age-related enhancement in the use of strategies that serve to avoid or limit exposure to negative stimuli" (Charles, 2010, p. 1068). Therefore, future research should further investigate the role of chronological age regarding stress effects by contrasting physiological versus psychological stress consequences.

Subjective Age and Change in Functional Health

Another predictor of change in functional health was subjective age, which corresponds with other empirical findings that demonstrated the health relevance of subjective age (Kotter-Grühn et al., 2009, 2016; Spuling et al., 2013; Stephan et al., 2018a; Uotinen et al., 2005; Westerhof et al., 2014; Westerhof & Wurm, 2015). For an evaluation of the total effect of subjective age on functional health, this direct effect of subjective age needs to be considered in addition to the indirect effect of subjective age as a stress buffer that will be discussed below.

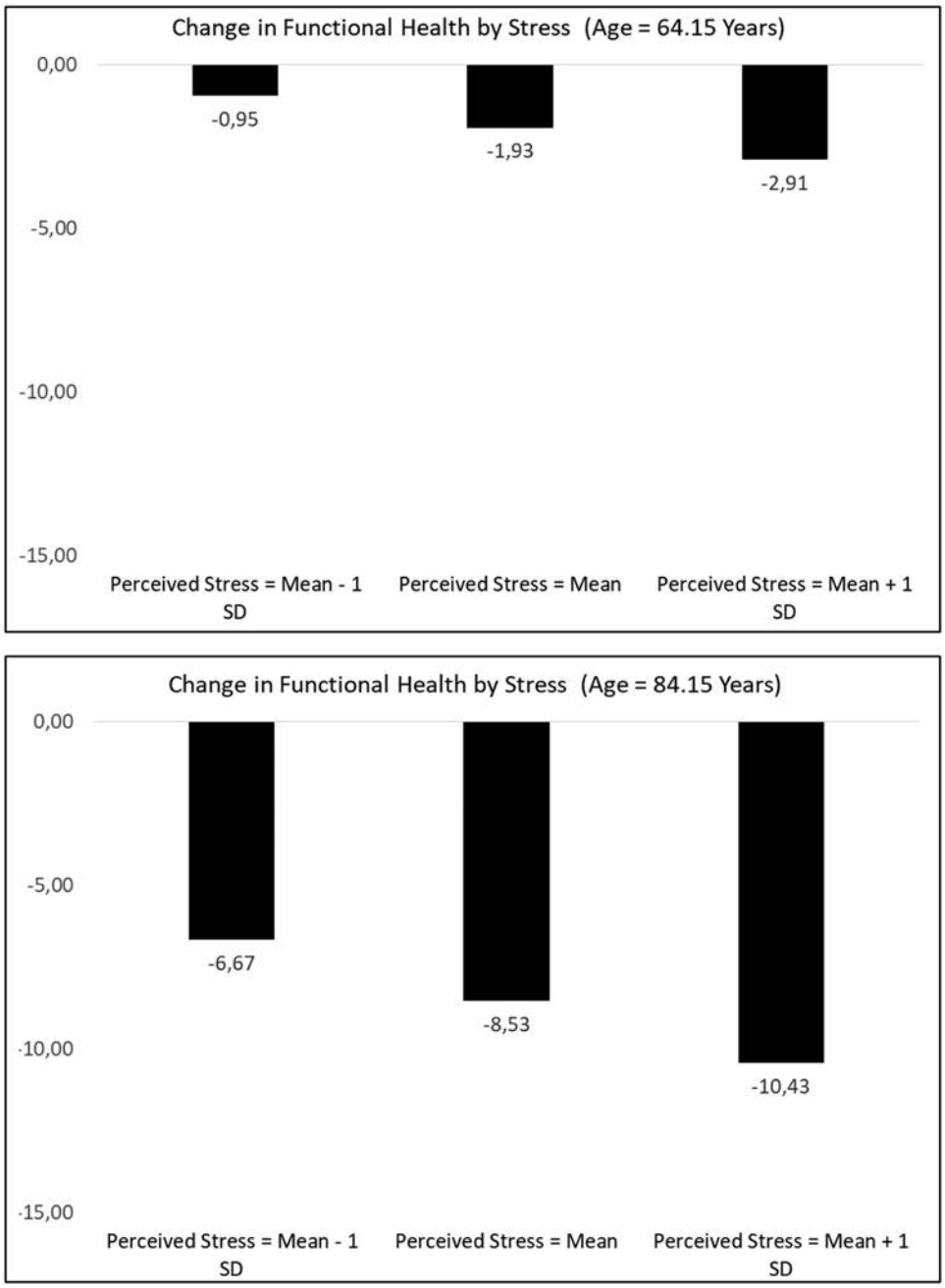
As subjective age might exert its influence on health via accumulation of psychosocial resources (Westerhof & Wurm, 2015) and via health and everyday behaviors such as physical activity (Caudroit et al., 2012; Montepare, 2019; Stephan et al., 2014, 2015), both mechanisms may need time to reach their maximal impact on health. Therefore, stronger effects of subjective age on functional health changes might have been found if an observation period comprising more than three years had been available.

Surprisingly, we found no significant moderating effect of chronological age on the association between subjective age and change in functional health. The health-protective effect of subjective age was thus similar at any chronological age over the second half of life, although other studies—though not all (e.g., Spuling et al., 2013; Westerhof et al., 2014)—reported an age-related increase in the effects of subjective age on health (Bergland et al., 2014; Hubley & Russell, 2009; Stephan et al., 2012), which would also be the prediction from stereotype embodiment theory (Levy, 2009). Again, functional health change over that rather

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Figure 1

The Association Between Perceived Stress and Change in Functional Health by Age



Note. y-axis: mean (unstandardized) change in functional health; score range in functional health: 0–100. *SD* = standard deviation. Higher perceived stress and older age are associated with a steeper decline in functional health. Moreover, the negative association between perceived stress and change in functional health increases with advancing chronological age. Top figure: Mean change in functional health by stress for an individual aged 64.15 years (which corresponds to the grand mean age). Bottom figure: Mean change in functional health by perceived stress for an individual aged 84.15 years (i.e., 20 years above the grand mean age).

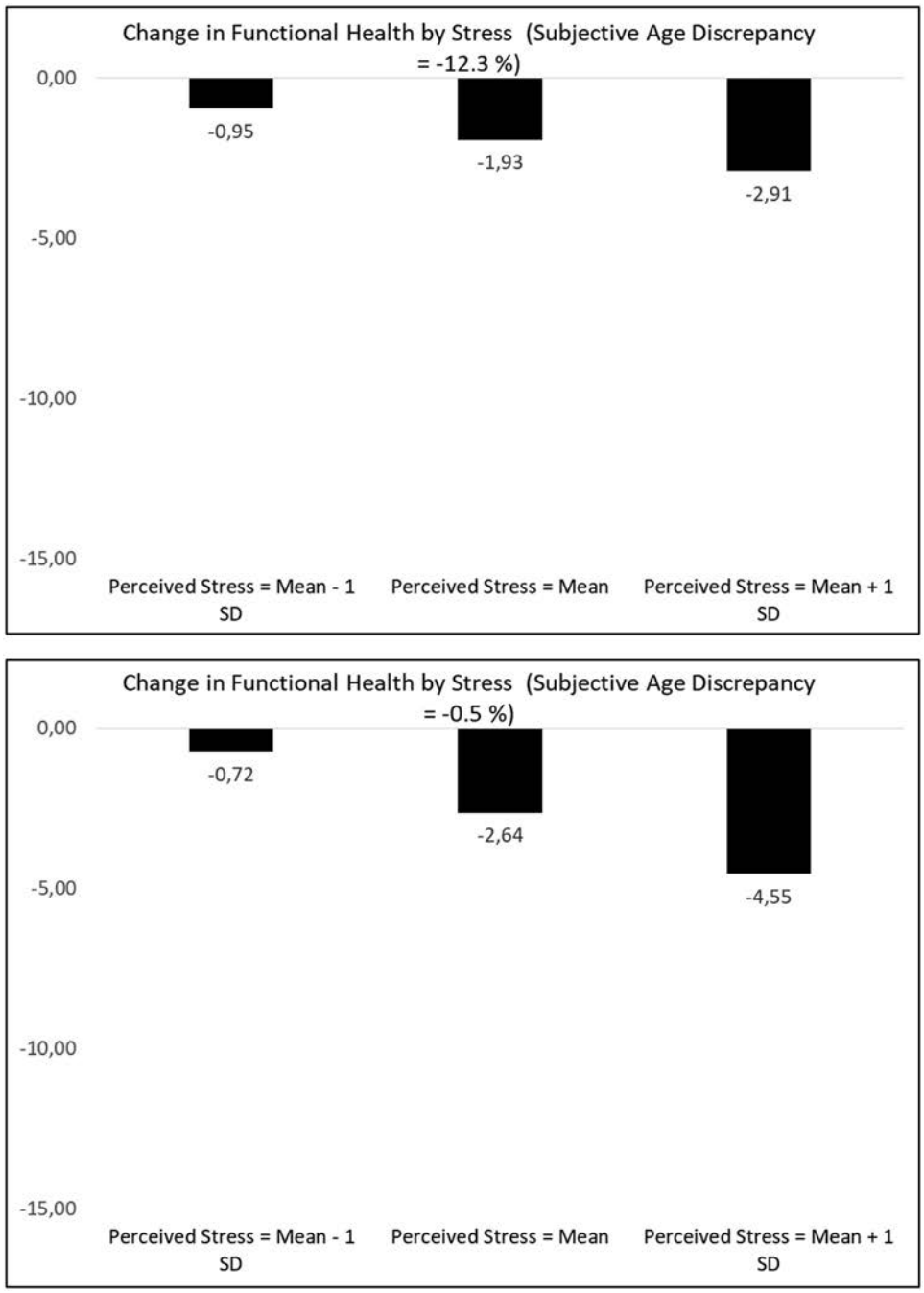
limited 3-year period may not be sufficiently long to observe meaningful age differences in the role and health relevance of subjective age. Alternatively, it may be health outcomes other than functional health, such as self-rated health (Stephan et al., 2012), that are increasingly strongly affected by subjective age when individuals get older.

Our finding that a younger subjective age has a positive effect on change in functional health regardless of chronological age also

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Figure 2

The Association Between Perceived Stress and Change in Functional Health by Subjective Age

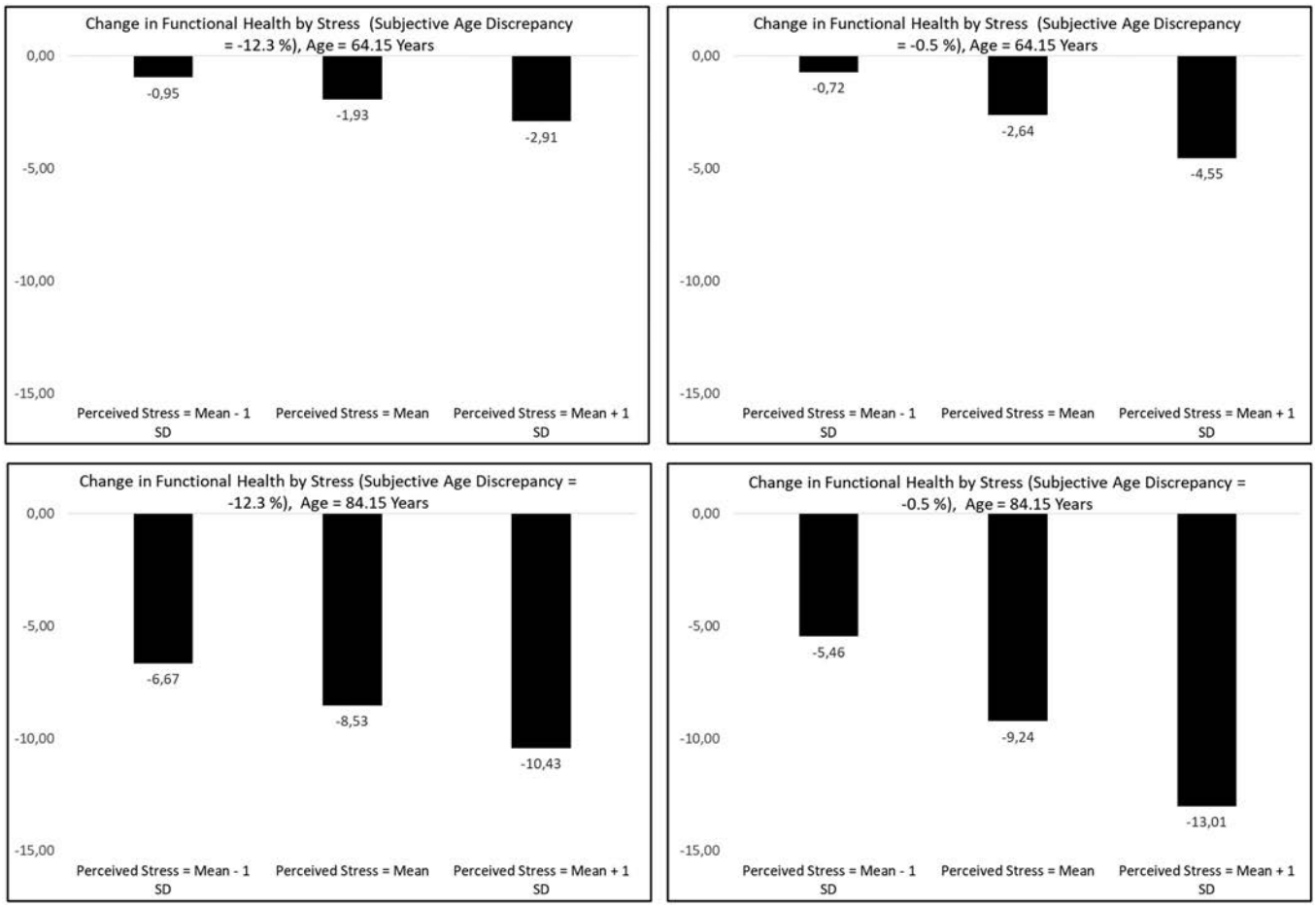


Note. y-axis: mean (unstandardized) change in functional health; score range in functional health: 0–100. *SD* = standard deviation. Higher stress and an older subjective age are associated with a steeper decline in functional health. Moreover, the negative association between perceived stress and change in functional health decreases with a younger subjective age. Top figure: Mean change in functional health by perceived stress for an individual feeling 12.3% younger than his/her chronological age (which corresponds to the grand mean of subjective age). Bottom figure: Mean change in functional health by perceived stress for an individual feeling approximately as old as he/she is (0.5% younger, which is one standard deviation above the grand mean of subjective age).

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Figure 3

The Association Between Perceived Stress and Change in Functional Health by Subjective Age and Age



Note. y-axis: mean (unstandardized) change in functional health; score range in functional health: 0–100. *SD* = standard deviation. With increasing chronological age, the moderating effect of subjective age on the association between perceived stress and change in functional health gets larger. Top figures: Mean change in functional health by perceived stress for an individual aged 64.15 years feeling 12.3% younger than his/her chronological age (which corresponds to the grand mean of subjective age; left figure) and for an individual of the same age years feeling approximately as old as he/she is (0.5% younger, which is one standard deviation above the grand mean of subjective age; right figure). Bottom: Mean change in functional health by perceived stress for an individual aged 84.15 years feeling 12.3% younger than his/her chronological age (which corresponds to the grand mean of subjective age; left figure) and for an individual of the same age feeling approximately as old as he/she is (0.5% younger, which is one standard deviation above the grand mean of subjective age; right figure).

implies that both middle-aged and older adults' health could equally benefit from interventions that promote a younger subjective age. Given that older adults are more susceptible to decline in functional health than middle-aged individuals, such interventions might be of a higher importance and necessity in this age group. According to recent evidence, negative self-perceptions of aging have a global detrimental impact on health (Chang et al., 2020) and cause considerable health care costs (Levy et al., 2020). Short-term interventions could demonstrate that subjective age is indeed plastic and changeable, for example, by eliciting certain mood states (Dutt & Wahl, 2017) or by providing positive feedback on an individual's physical or cognitive performance (Shao et al., 2020; Stephan et al., 2013). This "feedback intervention" even found a positive effect of manipulating subjective age on subsequent grip strength, which can be considered as a marker of functional health (Stephan et al., 2013). However, evidence for sustainable and lasting effects of subjective age interventions is still lacking, although there are already some promising findings regarding effects of interventions that focused on changing self-perceptions of aging in general (Beyer et al., 2019; Brothers & Diehl, 2017; Klusmann et al., 2012). These self-perceptions have in turn an impact on how old or young individuals feel (Bodner et al., 2017; Wurm et al., 2017).

Also, feeling younger than one's chronological age might not necessarily be adaptive and functional under all circumstances and for all outcomes. There might be an "ideal discrepancy" between subjective age and chronological age which is associated with favorable outcomes, whereas "feeling too young" could be associated with negative developmental outcomes. For instance, Blöchl et al. (2020) investigated associations between subjective age and life satisfaction in an adult sample and reported that "people who

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feel younger by a certain amount, but not more, have the highest levels of life satisfaction." Barrett and Montepare (2015) discuss that a younger versus older age identity might have different implications and a different desirability at different age phases: "the positive value ascribed to an older age identity by younger adults, and the appeal of a younger age identity to older adults, may be intervening factors impacting individuals' willingness to assume particular age identities at particular life stages" (p. 64). Moreover, going beyond subjective age, perceptions on aging in general might no longer promote positive developmental outcomes if they are "over-optimistic" and illusory: As Kornadt et al. (2020) discuss, views on aging "that one-sidedly emphasize the gains, strengths and potentials of old age/ageing might be counterproductive in different regards for example whenever they obstruct self-care or coping with contextual obstacles or complaints." This could also explain why older adults with a more favorable attitude toward their own aging were found to experience a steeper increase in self-reported problems with vision over time (Wettstein, Wahl, et al., 2020) and why negative self-perceptions of aging might be helpful for a short-term adjustment to serious health events, whereas they become rather dysfunctional when a long-term perspective is taken (Wolff et al., 2017). Therefore, before deriving interventions to promote a younger subjective age, more needs to be known about the "most adaptive" discrepancy between subjective age and chronological age, which might vary according to many factors such as age or the specific outcome domain considered. Kotter-Grühn (2015) points out with regard to the potential and prerequisites of interventions targeting views on aging: "Promoting more positive self-perceptions of aging may be a viable option if we were sure that the effects are universally positive (at a societal and personal level), if we had a relatively easy strategy which works for everybody and was accessible to everybody (who is interested), and if we knew about the long-term consequences of such strategies" (p. 181).

Subjective Age as a Stress Buffer

Besides the direct effect of subjective age on change in functional health, we also found, as expected, evidence of an indirect effect. Specifically, the detrimental effect of perceived stress on change in functional health was smaller among individuals who felt younger. This stress buffer effect of subjective age has been reported before with regard to functional health (Shrira et al., 2018) and other outcomes (Bodner et al., 2017; Hoffman et al., 2015; Shrira et al., 2014, 2016), including also recent evidence on the protective role of subjective age in this very stressful period of the COVID-19 pandemic (Shrira et al., 2020). Notably, our finding that a younger subjective age has a stress-buffering role also implies that an older subjective age "is a vulnerability factor that exacerbates the risk of poor physical and mental health from stressful situations" (Stephan et al., 2018a).

Future conceptualizations addressing the theoretical nature of subjective age should therefore be broadened, and they should not only consider subjective age as a direct predictor of developmental outcomes. Rather, subjective age is also a compensatory resource that interacts with other protective and risk factors, not only within the domain of subjective aging (Mock & Eibach, 2011; Wurm et al., 2017), but also with psychosocial factors such as stress. Given its role as a stress-buffering factor, subjective age can thus be seen in line with other established "stress buffers," such as positive affect (Pressman et al., 2019) or physical activity (Gerber & Pühse, 2009; Klaperski, 2018). With regard to practical implications, promoting a younger subjective age by means of interventions might thus help individuals to minimize the detrimental impact of stress on health, though this assumption requires more research.

In contrast to the direct association between subjective age and change in functional health that was not moderated by chronological age, the stress buffer effect of subjective age was age-dependent, indicating that particularly for older adults functional health change was less strongly affected by greater perceived stress if they had a younger subjective age. This effect also indicates that stress had a stronger negative association with change in functional health among older adults with an older subjective age than among younger adults with an older subjective age. The assumption of a greater importance of subjective age for health with advancing chronological age, as postulated by the stereotype embodiment theory (Levy, 2009) and as supported by some empirical studies (Bergland et al., 2014; Hubley & Russell, 2009; Stephan et al., 2012), was thus confirmed by our data when its role as a stress buffer was considered, although its direct effect on functional health change, independent of perceived stress, was not found to vary by chronological age.

This "double impact" of a younger subjective age on change in functional health, both via a direct positive impact on functional health trajectories and via a buffering effect on the negative impact of stress on functional health change, underlines once again that interventions to make individuals feel younger (Dutt & Wahl, 2017; Stephan et al., 2013) might be a promising approach to foster individuals' functional health. Given that old and very old adults are more susceptible to health declines (Baltes & Smith, 2003; Wahl & Ehni, 2020; Wettstein et al., 2016) and may also be more prone to the health-detrimental effects of stress (Aldwin, 2007; Charles, 2010) than younger or middle-aged individuals, and given that they seem to benefit more from a younger subjective age as a stress buffer than younger age groups, they might be primarily targeted for such interventions. However, as pointed out before, more needs to be known at first regarding the sustainability of such intervention effects and regarding the "ideal" subjective age that should be promoted to obtain the most beneficial health and well-being consequences before deriving and applying specific intervention formats.

Also, future research should investigate whether the identified "stress buffer" effect can also be observed when other domains of subjective age views, such as self-perceptions of aging or awareness of age-related change (Diehl et al., 2014), are considered. On the one hand, different subjective aging concepts are unique and distinguishable, they differ with regard to their associations with everyday behaviors (Montepare, 2019), health, and well-being (Spuling et al., 2020), so that the stress-buffering role might be unique to subjective age. However, on the other hand, there is some evidence supporting also a moderating role of perceptions on aging and age stereotypes on associations of stress with health or well-being (Bellingtier & Neupert, 2016; Cohn-Schwartz & Ayalon, 2020; Levy et al., 2000, 2016; Levy et al., 2008; Losada-Baltar et al., 2021). Different concepts of subjective aging might also influence and interact with each other (Bodner et al., 2017) with regard to their associations with health and well-being (Brothers et al., 2017; Mock & Eibach, 2011; Wurm et al., 2017), so that the stress-buffering effect of one subjective aging domain might be augmented or mediated by another. Such a potentially complex

interplay between multiple dimensions of subjective aging requires further research.

Limitations

This study has several limitations. Perceived stress has so far only been assessed on two measurement occasions in the German Ageing Survey, so that our options of statistical analyses were restricted, and predicting change in functional health across an extended observational period comprising more than two measurement occasions and 3 years was not possible.

Moreover, although the four-item short-form of the Perceived Stress Scale (Cohen et al., 1983) is frequently applied and has good psychometric properties, its focus is on perceived stress during the last month. It can thus not distinguish between acute and chronic stressors. However, chronic stress might actually be particularly detrimental for health outcomes (Schneiderman et al., 2005), so that larger effects of stress on change in functional health might have resulted if exclusively chronic stress had been assessed. Additionally, *change* in perceived stress over time and "stressor pile-up" (Schilling & Diehl, 2014) might drive changes in functional health to a larger extent than perceived stress measured at only one point in time. Therefore, future research should consider the dynamic character of stress and study stress as a time-varying determinant of health and of change in health.

Subjective age was assessed by a single-item question, namely "How old do you feel?." Although this is a common approach to assess subjective age (Kotter-Grühn et al., 2016), it has been criticized because it might elicit reports of an older subjective age. For instance Gendron et al. (2018) claim that "operationalizing subjective age in this manner contributes to the dominant societal view of aging as decline by perpetuating the use of the term 'old' as an undesirable state" (p. 618). Therefore, alternative item formulations that do not include the word "old," such as "what age do you feel?," have been proposed and used in other studies (Mock & Eibach, 2011; Rubin & Berntsen, 2006).

Finally, functional health was assessed based on the SF-36 physical functioning subscale (Bullinger & Kirchberger, 1998). This assessment instrument has good psychometric characteristics and is frequently used in research. However, it is a self-report instrument, and stronger effects of stress on health are usually found when objective, biomedical health indicators are considered (Aldwin, 2007). The estimated effect of perceived stress on change in functional health from this study might therefore be conservative.

Conclusion

In this study, we found that greater perceived stress predicts steeper decline in functional health in middle-aged and particularly in older adults. In contrast, a younger subjective age was a significant predictor of a less steep decline in functional health. Additionally, among individuals feeling younger, the detrimental effect of perceived stress on functional health change was weaker. This stress buffer effect of subjective age increased in size with chronological age.

Our findings support the role of stress as a risk factor for functional health decline, particularly among older individuals, as well as the health-supporting and stress-buffering role of a younger subjective age. Existing conceptions of subjective age might thus need refinement and extension, as a younger subjective age is not only a direct protective determinant of health, it also seems to operate indirectly as a compensatory psychosocial moderator and a stress-buffering resource. According to Thoits (2010), "coping and social support interventions that most effectively buffer the effects of stress should be identified" (p. 47). Therefore, with regard to practical implications, interventions that promote positive self-perceptions of aging, including a younger subjective age, might provide such an effective stress buffer, and functional health of older adults in particular might benefit from such an approach.

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Received September 10, 2020
Revision received February 17, 2021
Accepted March 2, 2021 ■

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