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The course of subjective sleep quality in middle and old adulthood and its relation to physical health

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SOEP – The German Socio-Economic Panel Study at DIW Berlin

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Sakari Lemola and David Richter

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The course of subjective sleep quality in middle and old adulthood and its relation to physical health

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Abstract

Objective: Older adults more often complain about sleep disturbances compared to younger adults. However, it is not clear whether there is still a decline of sleep quality after age 60 and whether changes in sleep quality in old age are mere reflections of impaired physical health or whether they represent a normative age dependent development.

Method: Subjective sleep quality and perceived physical health were assessed in a large representative sample of 14,179 participants (52.7% females; age range 18-85) from the German Socio-Economic Panel Study across 4 yearly measurement time points.

Results: Subjective sleep quality linearly declined from young adulthood until age 60. After age 60 a transient increase in subjective sleep quality occurred that coincides with retirement. Physical health prospectively predicted subjective sleep quality and vice versa. These relations were similar for participants above and below age 60.

Discussion: Around retirement a transient increase in subjective sleep quality occurs, which may reflect a decrease in work related distress or an increase in flexibility to organize the day according to one's circadian preferences. Perceived physical health is important for subjective sleep quality in old adults, but not more important than at younger age.

Keywords: Sleep quality; Physical health; Old age; Retirement; German Socio-Economic Panel Study.

Introduction

Older adults more often complain about sleep disturbances such as difficulty initiating and maintaining sleep, waking up too early, and excessive daytime tiredness compared to young adults (Bixler, Kales, Soldats, Kales, & Hedley, 1979; Foley et al., 1995; Foley, Monjan, Simonsick, Wallace, & Blazer, 1999; Foley, Ancoli-Israel, Britz, & Walsh, 2004; Ganguli, Reynolds, & Gibley, 1996; Gislason, Reynisdottir, Kristbjarnarson, & Benediktsdottir, 1993; Middelkoop, Smilde-van den Doel, Neven, Kamphuisen, & Springer, 1996; Newman, Enright, Manolio, Haponik, & Wahl, 1997; Schubert et al., 2002). In a study on three large epidemiological samples of adults above age 65 more than half reported that they suffered from at least one of these symptoms most of the time (Foley et al. 1995). Around one third had symptoms of insomnia, around one in ten rarely or never felt rested after waking up in the morning, and only less than 20% rarely or never had any complaints. Older individuals also more often use prescribed hypnotics than young people although the effectiveness of these sleeping aids has been subject of debate (Glass, Lancot, Herrmann, Sproule, & Busto, 2005). Depending on the population which is studied percentages of those who use sleeping pills range between 5% (Aparasu, Mort, & Brandt, 2003) and 33% (Craig et al., 2003).

Poor sleep in old adults is often secondary to physical health problems. In their epidemiological study Foley et al. (1995) could show that sleep complaints were associated with a higher number of respiratory symptoms, physical disabilities, use of nonprescription medications, and poor self-reported health. Only 7% of the incidence of insomnia occurred in the absence of associated medical conditions (Foley et al., 1999). In the same line further studies on the comorbidity of sleep complaints suggest that the majority of geriatric sleep complaints are not the result of age *per se* but rather of medical and psychiatric disorders (Foley et al., 2004; Giron et al., 2002; McCrae et al., 2005; Taylor et al., 2007; Vitiello, Moe, & Prinz, 2002). Thus, the high prevalence in sleep complaints among older persons may

partially also reflect the age-related high prevalence in chronic diseases and other health problems during older age.

While there is high prevalence of sleep complaints in old age there is, however, debate on the question whether sleep quality further declines after age 60. In favor of a further decline of sleep quality after age 60, Phelan and coworkers (Phelan, Love, Ryff, Brown, & Heidrich, 2010) reported a decrease in reported sleep quality in women aged 67 at baseline across a follow-up period of 10 years. Applying growth mixture modeling they found evidence for two distinct sleep patterns, one of good but declining sleep quality and one of consistently poor sleep quality. In a related vein, studies by Middelkoop et al. (1996), Schubert et al. (2002), and Newman et al. (1997) reported an increase in night-time awakenings after age 60 based on cross-sectional data.

In contrast to the view that sleep quality continuously declines over the life-span Ohayon et al. (2004) put forward that this course is asymptotically shaped with a linear decline between 20 and 60 years of age which then reaches a low plateau level after the age of 60 years. Their conclusions were based on a meta-analysis of 65 polysomnographic studies of individuals aged between 5 and 102 years. Polysomnography is considered the gold standard of diagnosing sleep disorders (Brand & Kirov, 2011) and involves synchronous recording of the electrical activity of the brain (electroencephalogram, EEG), eye-movements (electrooculogram, EOG), and muscle activity during sleep (electromyogram, EMG). Analysis of the sleep EEG allows to distinguish between different sleep stages ranging from sleep stages 1 and 2 that reflect shallow sleep, slow wave sleep (SWS) that reflects deep sleep, and rapid eye movement (REM) sleep. SWS is the sleep state during which the individual is least susceptible to environmental stimuli (Zepelin, McDonald, & Zammit, 1984) and which is most important for the recuperative function of sleep (Borbely & Achermann, 1999). In their meta-analysis Ohayon and coworkers (2004) found a marked reduction in SWS between age 20 and 60 years but no evidence for a further decrease after age 60. In line

with these conclusions from polysomnographic studies, also several epidemiological survey studies found no further increases in sleep complaints after age 60: In the three epidemiological samples above age 65 studied by Foley et al. (1995) only in one sample sleep complaints increased with age. Moreover, this relation of age with sleep complaints disappeared after adjusting for differences in health status. Further, Ganguli et al. (1996) and Gislason et al. (1993) found no further increases in sleep complaints with age after 60 years and relatively high persistence of symptom reporting in a two year follow-up (Ganguli et al., 1996). A recent study applying polysomnography on a sample of more than 2600 participants showed no decrease of sleep efficiency after age 60 indicating no further increase of night-time awakenings and sleep onset latency (Redline et al., 2004). Based on the inconsistency in findings regarding the course of sleep quality after age 60, Vitiello (2006) concluded that there is need for further and more differentiated description of the developmental course of sleep quality in old age. A limitation of most of the prior studies on the development of sleep quality after age 60 is that sleep quality was only assessed cross-sectionally.

While there is a large body of evidence that poor physical health is a reason for sleep disturbances, research is also accumulating that poor or insufficient sleep has negative consequences for physical and mental health as well. Prospective studies show that insufficient and disturbed sleep is related to a variety of physical and psychological health problems such as coronary heart disease (Meisinger, Heier, Löwel, Schneider, & Döring 2007), hypertension (Stranges et al., 2010), premature death (Heslop, Smith, Metcalfe, Macleod, & Hart, 2002), depression and anxiety disorders (John, Meyer, Rumpf, & Hapke 2005; Kaneita et al., 2006; Roth et al., 2006) and lower psychological well-being (Groeger, Zijlstra, & Dijk, 2004, Phelan et al., 2010). Correspondingly, there is a large body of evidence from laboratory based studies that sleep plays a vital role for many somatic processes including metabolism, immunofunction, thermoregulation, and processes related to respiration and the cardiovascular system (Siegel, 2005). Moreover, many cognitive and

psychological processes including memory consolidation, attentional processes, insightfulness, and emotional processing depend on the role of sleep for neuronal plasticity and recuperation (Brand et al., 2011; Diekelmann & Born, 2010).

The present study has three goals: First, we aim at describing the course of subjective sleep quality across the life-span in a large nationally representative panel study, i.e., the German Socio-Economic Panel (SOEP). The panel design has the advantage that the development of several age groups can be described longitudinally, which allows to figure out whether cross-sectional differences between age groups reflect the longitudinal development. As there is evidence from the meta-analysis by Ohayon et al. (2004) that sleep quality decreases with until age 60 but does not further decrease thereafter, we specifically test the hypothesis that subjective sleep quality shows a decrease until age 60 but remains on approximately the same level at higher age. Second, we examine the relationship between subjective sleep quality and perceived physical health. There is evidence of both an influence of physical health on sleep as well as from sleep on physical health. We therefore test their interdependency in a longitudinal cross-lagged path-model across four time-points of measurement expecting both significant prediction of subjective sleep quality and perceived physical health by the respective other variable. As there is a large body of evidence of the importance of physical health problems for sleep after age 60 we test the model separately in individuals of more than 60 years and younger individuals. Finally, we explore the impact of the transition to retirement on subjective sleep quality as one major event during old age by specifically analyzing the sub-sample in the SOEP that experienced retirement between the assessment waves in year 2008 and 2011. Generally, the transition to retirement is described as a neutral life-event that involves positive as well as negative effects on personal well-being. While probably most retirees experience less work-related distress, have more free time for leisure and nonprofessional activities, and relationships with friends and their family, it also involves a loss in structure of the weekdays, less contact with work mates, and also a

reduction of income (Luhmann, Hofmann, Eid, & Lucas, 2012). In their meta-analysis of 12 prospective studies on the impact of retirement on affective and cognitive well-being Luhmann et al. (2012) showed that retirement has an initial negative effect on cognitive well-being which the authors explained by possible disappointment of exaggerated expectations towards retirement. No initial effect during the first months after retirement was found regarding affective well-being. Afterwards, both cognitive and affective well-being increase asymptotically over the course of the first few years after retirement. In a similar vein, retirement may have a favorable influence on subjective sleep quality as it involves a reduction of work related stress and offers independence in planning the day and choosing bed and wake times without daytime-work related constraints. On the other hand, retirement may also have a negative influence on subjective sleep quality due to decrease in structure and regularity of weekday activities, which imposed a regular sleep-wake schedule.

Method

Participants

The data was provided by the German Socio-Economic Panel Study (SOEP; Version 28) of the German Institute for Economic Research. The SOEP is an ongoing, nationally representative longitudinal study of private households in Germany (for details see Wagner, Frick, & Schupp, 2007). Since 1984, SOEP has provided multi-disciplinary panel data from large samples covering the life-span from adolescence to old age. The SOEP consists of multiple subsamples selected to be representative of the population of Germany using a multistage probability design (i.e. random route walk; Thompson, 2006). All members of the selected households aged 16 years and older were asked to participate in the yearly interviews. All data have been collected by a professional fieldwork organization (Infratest Social Research, Munich).

Starting in 2008, the measure of subjective sleep quality analyzed in this study was administered yearly. In 2008, a total of 19,646 participants (52.4% female) completed them.

In the subsequent years 17,620 (89.7% of the original sample; 52.4% female), 15,718 (80.0% of the original sample; 52.6% female), and 14,278 persons (72.7% of the original sample; 52.7% female) provided valid sleep quality information again. At all four measurement occasions, one half of the participants were personally interviewed and the other half completed the questionnaire on their own. For the present study, only participants with complete data were included. As the sample decreased in very old age, we followed the approach of Specht, Egloff, and Schmukle (2011a) and restricted our analyses to participants not older than 85 years ($Ns > 40$ per year).

The final longitudinal sample was comprised of 14,179 participants (52.7% female) with a mean age of 49.76 years in 2008 ($SD = 16.55$, range 18-85). Of these participants, 21.6% were single, 61.9% were married, 10.3% were separated or divorced, and 6.2% were widowed. As to educational background, 32.8% of the participants had graduated from the vocational track of the three-tier German secondary system, 36.7% had graduated from the intermediate track, and 22.3% had graduated from the academic track. The remaining 8.2% held any other type of qualification. Work status (41.8% full time, 16.9% part time, 41.3% not working) was heterogeneous, as well.

Compared with the final longitudinal sample, participants dropping out after the first measurement (noncontinuers) were younger ($M = 46.89$ years, $SD = 18.81$, $p < .001$), slightly less likely to be female (51.1 female, $p < .05$), slightly less educated (33.1% vocational, 33.1% intermediate track, 20.1% academic track, 13.7% any other type of qualification, $p < .001$), less likely to be married (54.8%; $p < .001$), or separated (8.6%, $p < .001$), and more likely to be single (30.7%, $p < .001$). Furthermore, noncontinuers were more likely to be unemployed (43.9%, $p < .001$) and less likely to be part-time working (14.7%, $p < .001$). In terms of the central constructs, noncontinuers reported slightly better health ($M = 3.29$ vs. $M = 3.19$, $p < .01$) and comparable subjective sleep quality ($M = 6.74$ vs. $M = 6.76$, $p = .634$).

Measures

To keep respondent burden for the participants of the SOEP to a minimum, measures have to be as short as possible. Consequently, subjective sleep quality was assessed via a single item indicator “How satisfied are you with your sleep?”. Responses were made on an eleven-point scale ranging from 0 (totally unsatisfied) to 10 (totally satisfied). Convergent validity of this measure with objective indicators of sleep quality from ambulatory accelerometry data is reported elsewhere (Wrzus et al., 2012). Self-reported health was measured with the item “How would you describe your current health?”. Responses were made on a five-point scale ranging from 1 (bad) to 5 (very good). In addition in each year, participants reported whether specific occupational changes occurred within the past year. For the analyses of the present study, we extracted information according to retirement in the years 2008 to 2011 and coded them dichotomously as 0 (retirement did not occur) or 1 (retirement did occur).

Analytical Strategy

All analyses were calculated with SPSS 19.0 (2011) and Mplus 6.11 (Muthén, L. K. & Muthén, 1998-2011). The data of the present study has a natural hierarchy as people are nested in households which may result in dependencies in the data. Therefore, we corrected for this nonindependence in all analyses and calculated robust standard errors by using the household number as a cluster variable (B. O. Muthén & Satorra, 1995).

To analyze the effects of age and time on sleep quality, we created seventeen 4-year age groups on the basis of participants’ age in 2008 (cf. Lucas & Donnellan, 2011). The youngest group ranged from 18 to 21 years and the oldest group ranged from 82 to 85 years. Sample sizes and gender breakdown are depicted in Table 1. Scores of subjective sleep quality over the 3 years of our study served as dependent variables. Within a structural equation modeling framework we fitted linear growth models to the data and tested whether the seventeen age groups differed in their cross-sectional means (intercept) as well as their longitudinal development (slope) over the three years of our study. To test the hypothesis that

subjective sleep quality decreases until age 60 but does not further decline thereafter, the intercept of the cohort, which was 58-61 years old in 2008, was used as the reference against which all other group intercepts were tested. All model parameters were standardized relative to the overall sleep quality scores at the first measurement in the year 2008 (i.e., the mean of the intercept was set to 0, and its variance was set to 1), and error variances of the manifest indicators of sleep quality were constrained to be equal across time points. Model fit was evaluated with reference to the chi-square and degrees of freedom, the root-mean-square error of approximation (RMSEA), the comparative fit index (CFI), and the standardized root mean residual (SRMR). We use the common guidelines that well-fitting models will have RMSEAs at or below .05, CFIs at or above .95, and SRMRs at or below .06.

(Insert Table 1 about here)

To analyze the interdependence of health and sleep quality, we conducted multi group cross-lagged path analyses within a structural equation modeling framework. By this mean we were able to identify reciprocal or feedback relations between respondents' health and their sleep quality. Scores of subjective sleep quality and self-reported health over the 3 years of our study served as dependent variables. Several competing models were tested. First, a model only including auto-regressions within variables over time (i.e., paths between the sleep quality in the years 2008 and 2009, as well as between health in the years 2008 and 2009) was fitted and regarded as the null model (Model 0). Then competing models were tested, including (1) forward paths (i.e., 2008's sleep quality to 2009's health, Model 1), (2) reverse paths (i.e., 2008's health to 2009's sleep quality, Model 2), and (3) reciprocal paths (both forward and reverse, i.e., paths from sleep quality in the year 2008 to health at follow-up as well as from health in the year 2008 to the sleep quality at the following years, Model 3). The models all allowed for within-time correlations (e.g., sleep quality in the year 2008 was correlated with health in the year 2008), and were adjusted for the covariates sex, age, age², and age³. In addition, participants' age served as a grouping variable and we calculated

different models for younger (18 to 59 years) and older participants (60 to 85 years). Error variances of the manifest indicators of sleep quality as well as health were constrained to be equal across time points. The χ^2 difference test was used to determine which of the competing models provided the best fit to the data. Models 1-3 were all compared to the null model. Then, Model 3 was compared to the better-fitting of Models 1 and 2. Criteria for model fit and model comparison were used as described above.

To analyze the effects of retirement on sleep quality, we followed the approach of Lucas et al. (2003). First, we identified respondents who did not report retirement before the first year of our study (i.e. before the year 2008). Next, we restricted this sample to those respondents who experienced retirement at some point during the 3 year interval of the study. Among the respondents of our sample, 385 persons were identified. The data on sleep quality of these respondents were then centered on the yearly mean of the whole sample to account for average trends over time (cf. Lucas et al., 2003, Specht, Egloff, & Schmuckle, 2011b) and recorded relative to the year in which the retirement occurred. By using an unbalanced panel design and allowing missing data, we were able to model the 2 years prior and the 2 years following retirement with the four measurements of sleep quality available in the SOEP¹. Consequently, our sample sizes ranged from 186 to 385 respondents per year. We examined effects of retirement on sleep quality by fitting a latent growth model to the data. Scores of subjective sleep quality served as dependent variables. As the influence of many life events on people's subjective well-being seems to be characterized best by initial change followed by adaption (cf. Luhmann et al., 2012), and as people seem to report anticipatory changes in subjective well-being in the years before an event occurs (e.g. Lucas et al., 2003; Specht et al., 2011b), we calculated a quadratic growth model to account for nonlinearity, i.e. in addition to the intercept (reflecting the baseline level of sleep quality prior to retirement) and the linear slope a quadratic slope was estimated in our model. The error variances of the manifest indicators of sleep quality were constrained to be equal across time points.

Results

Effects of Age and Time on Sleep Quality

Cross-sectional means as well as longitudinal changes in mean levels were examined by plotting intercepts and slopes from the multi-group latent growth model (see Figure 1). Specifically, each individual line plots the mean for the year 2008 and the longitudinal development over the years 2008 to 2011 for one of the seventeen age cohorts. Consequently, the beginning of each line reflects the cross-sectional results for the year 2008, the end of each line reflects the cross-sectional results for the year 2011, and the slope of each line reflects longitudinal change for each cohort.

(Insert Figure 1 about here)

Figure 1 shows that the cross-sectional patterns are generally consistent with the longitudinal development as sleep quality is steadily decreasing across the adult life span until around age 60. The model fit for the unrestricted model (i.e., every age group was allowed to have individual intercept and slope values) was very good ($\chi^2(186) = 275.29, p < .001$, RMSEA = 0.02, CFI = 0.99, SRMR = 0.02). Comparison of age group specific intercepts to the intercept of the reference age group of 58-61 year old participants revealed significantly better subjective sleep quality ($p < 0.001$) for all age groups between 18 and 49 years. The age groups older than 49 years were not significantly different from the reference group except for the age group of the 62-65 year olds who reported significantly better subjective sleep quality than the younger reference group. This transient increase in subjective sleep quality is followed by a further moderate decrease which is reflected in a significantly negative slope of the 66-69 year old age group ($p < 0.01$). At age 85 subjective sleep quality arrives at a similar level as at age 60 (see also Table 1).

The Relationship between Health and Sleep Quality

In Table 2, fit statistics and model comparisons are presented for the competing models of sleep quality and health. According to the RMSEA, CFI, and SRMR fit statistics,

all models provided a good fit to the data. The χ^2 difference test of the competing models showed that the fit of Model 1 (with forward paths), Model 2 (with reverse paths), and Model 3 (with reciprocal paths) were significantly better than the fit of the null model. Further comparisons showed that Model 2 (with paths covering the influence of self-reported health on subjective sleep quality) fit the data slightly better than Model 1 (with paths of self-reported health on subjective sleep quality) and that Model 3 (with reciprocal paths) significantly better fit to the data than Model 1 and Model 2.

(Insert Table 2 about here)

Figure 2 presents the cross-lagged path analyses of self-reported health and subjective sleep quality. The residual correlations between respondents' sleep quality and health showed that higher sleep quality was concurrently related to better subjective health at all measurement occasions. The evaluation of the autoregressive pathways revealed that previous subjective sleep quality predicted subsequent sleep quality. Likewise, previous self-reported health predicted subsequent health. Cross-lagged associations revealed that higher levels of subjective sleep quality in preceding years were significantly associated with higher self-reported health later on. In turn, the cross-lagged associations of self-reported health on subjective sleep quality were also significant. Comparison of a model constraining paths to be equal between younger and older participants with a model without equality constraints between the two age groups showed a significant difference in model fit ($\chi^2(30) = 355.36, p < 0.001$; *model without equality constraints*: $\chi^2(60) = 750.40, p < .001$, RMSEA = 0.04, CFI = 0.99, SRMR = 0.04, *model with equality constraints*: $\chi^2(30) = 1105.76, p < .001$, RMSEA = 0.05, CFI = 0.98, SRMR = 0.04), although the model fit according to RMSEA, CFI, and SRMR was quite similar in both models. However, inspection of the path coefficients of the model without equality constraints reveals that the size of the coefficients was approximately similar for the younger and older group. To conclude, the analyses revealed that subjective

sleep quality and self-reported health were bidirectionally interrelated. These relations were approximately similar for the younger and older age group.

(Insert Figure 2 about here)

The association of sleep quality with retirement

The quadratic latent growth model fit the data very well ($\chi^2(9) = 17.62, p < .05$, RMSEA = 0.05, CFI = 0.97, SRMR = 0.06). Figure 3 shows the development of subjective sleep quality across retirement. Overall, participants reported an increase in subjective sleep quality of 0.59 points between sleep quality at the baseline level (2 years before retirement) and sleep quality at the peak of the curve one year after retirement. This increase corresponds to an effect size of $d = 0.24$ ($p < 0.001$).² Compared to the general age related decrease in sleep quality (see Figure 1), respondents reported a substantial increase in subjective sleep quality after their retirement.

(Insert Figure 3 about here)

Discussion

This study on a large representative panel sample aged between 18 and 85 years shows that subjective sleep quality linearly declines from young adulthood until age 60. After age 60 a transient increase in subjective sleep quality occurs that coincides with retirement. After the age of 66 subjective sleep quality begins to decrease again. Moreover, longitudinal analyses revealed that subjective sleep quality can be predicted by the perception of physical health one year before, while subjective sleep quality is also predictive of physical health. The predictive power of physical health was approximately similar in young as in old adults.

Our findings are consistent with a meta-analysis which shows that objectively assessed sleep indices such as sleep efficiency and the amount of SWS pronouncedly decrease between age 20 and age 60 but do not further decrease thereafter, thus resembling an asymptotic rather than a linear course (Ohayon et al., 2004). However, the findings are in contrast to the notion that sleep quality further deteriorates after age 60 as for instance assumed by epidemiological

studies by Schubert et al. (2002) and Newman et al. (1997). While we found a second decline in subjective sleep quality after age 66 until age 85—which is similar to recent longitudinal findings by Phelan et al. (2010), subjective sleep quality was transiently on the rise between 60 and 66 years.

According to Vitiello (2006) the conflicting evidence from polysomnographic research as summarized by Ohayon et al. (2004) on the one hand and from some of the epidemiological studies on the other hand (e.g., Newman et al., 1997; Schubert et al., 2002) may be reconciled by the point that the range in physical health is larger in the epidemiological studies. Thus, in samples with a larger range in physical health it is more probable to find further deterioration of sleep quality after age 60 due to decreasing physical health. The findings of the present study, however, are rather consistent with the view that subjective sleep quality is overall relatively stable after age 60 also in representative samples—while there is an increase after age 60, there is also a decrease after around age 66 compensating for the transient rise.

Our findings are further in line with the notion that physical health is predictive of subjective sleep quality (Foley et al., 1995; Vitiello, 2006). Poor health status may affect sleep; patients who suffer from obesity, cardiovascular, respiratory problems, physical disabilities, or chronic pain are known to report lower sleep quality than healthy individuals (Foley et al., 1995; Taylor et al., 2007). On the other hand, our findings are also consistent with a large body of evidence that indices of sleep quality are predictive of physical health (e.g., Heslop et al., 2002; Meisinger et al., 2007; Stranges et al., 2010). Good night sleep is beneficial for metabolism, thermoregulation, immunofunction, and processes related to respiration and the cardiovascular system (Siegel, 2005). Moreover, sleep plays a crucial role for psychosocial adjustment and cognitive function—in particular SWS is involved in learning and memory consolidation processes (Diekelmann et al., 2010). Maintaining an adequate sleep quality may therefore play a crucial role for successful aging. However, our results are

not in line with the expectation that physical health becomes more important for sleep quality during older age compared to how important it already was during younger adulthood.

Generally, the transition to retirement has been discussed as a neutral life event (Luhmann et al., 2012) exerting neither a negative nor a positive influence on subjective well-being. With regard to subjective sleep quality our findings indicate that retirement is rather a beneficial event. It is possible that a decrease in work related distress or the increase in flexibility to organize the day according to one's circadian preferences are mechanisms driving the transient increase in subjective sleep quality. On the other hand, it is also possible that the transient rise in subjective sleep quality at age 60 is partly promoted by the halt in the downward trend of the amount of SWS after age 60 in individuals who are in good health condition (Ohayon et al., 2004). Decreases in SWS are a driving force of deterioration of sleep continuity as lighter sleep stages are more prone to interferences from the environment as well as from inner somatic perceptions (Zepelin et al., 1984).

Limitations

In the SOEP subjective sleep quality was only assessed with a single item. It is possible that subjective sleep quality in older age does not reflect sleep disturbances as closely as in younger age groups because older individuals may adjust their evaluation in reference to their age: A 70 year old person would probably no longer expect the same sleep quality as with age 20. Therefore, it is possible that older persons can be quite satisfied with their sleep although they may have more sleep disturbances than younger individuals. In a similar line it is a limitation that no objective measures of sleep were assessed. As both subjective sleep quality and perceived physical health are assessed with self-report measures it is possible that their relationship is partly due to same-method variance.

Although the SOEP can be considered a representative study of the German population, it is acknowledged that the sample attrition of individuals after age 60 is nevertheless selective regarding health status. Participants who are in less good condition at

age 60 are less likely to participate 10 years later. It can therefore not be ruled out that selective drop out of participants with compromised health status is a driving force behind the transient rise/asymptotic course of subjective sleep quality in older age.

Conclusion

The decline in subjective sleep quality across the life span is not linear. Around retirement subjective sleep quality is temporally on the rise again. Subjective sleep quality and perception of physical health are bidirectionally related.

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Table 1. *Sample sizes of the 17 four-year age cohorts, percentage of women per cohort, and comparison of intercepts and slopes of age cohort specific growth curves.*

Age group	N	% women	χ^2 (df=1)		χ^2 (df=1)	
			intercept	p	slope	p
18 - 21	724	46.5	164.38	<0.001	9.90	0.002
22 - 25	607	52.9	76.25	<0.001	1.30	0.254
26 - 29	664	56.0	38.41	<0.001	1.56	0.211
30 - 33	683	56.2	30.32	<0.001	2.88	0.089
34 - 37	804	52.9	28.84	<0.001	6.06	0.014
38 - 41	1068	52.6	53.91	<0.001	7.02	0.008
42 - 45	1258	51.4	17.55	<0.001	8.50	0.004
46 - 49	1196	53.8	20.88	<0.001	13.78	<0.001
50 - 53	1173	53.8	2.37	0.124	18.48	<0.001
54 - 57	1103	55.9	0.65	0.420	8.61	0.003
58 - 61	1021	51.2	reference	-	0.95	0.328
62 - 65	876	48.4	11.97	<0.001	0.43	0.512
66 - 69	1104	50.5	3.79	0.052	7.97	0.005
70 - 73	866	51.3	3.19	0.074	4.68	0.031
74 - 77	496	52.6	0.46	0.499	0.78	0.377
78 - 81	350	54.9	1.15	0.284	4.17	0.041
82 - 85	186	69.4	2.05	0.153	0.19	0.662

Note. χ^2 -values refer to comparisons of intercepts and slopes of age group specific growth curves. Intercepts were tested against the reference group that was 58–61 years old at the first measurement in 2008.

Table 2. *Model fit for structural equation models of sleep quality in relation to health.*

Model	Model Fit					Model Comparison			
	df	χ^2	RMSEA	CFI	SRMR	Model	$\Delta \chi^2$	Model	$\Delta \chi^2$
Model 0	72	1929.99***	0.060	0.961	0.071				
Model 1 (Forward)	66	1306.20***	0.051	0.974	0.051	M1 vs M0	623.79***	M3 vs M1	555.80***
Model 2 (Reverse)	66	1247.92***	0.050	0.975	0.047	M2 vs M0	682.07***	M3 vs M2	497.52***
Model 3 (Reciprocal)	60	750.40 ***	0.040	0.986	0.036	M3 vs M0	1179.59***		

Note.

Analyses are controlled for sex, age, age², and age³.

df, degrees of freedom; RMSEA, root mean squared error of approximation; CFI, comparative fit index; SRMR, standardized root mean residual.

*** $p < 0.001$.

Caption/Legends:

Figure 1. Mean level change in subjective sleep quality for the 17 four-year age cohorts, controlled for sex.

Notes.

^a = Intercept different from the reference group (ages 58-61 years) as revealed by χ^2 difference test ($df=1$; $p < 0.01$).

^b = Slope different from 0 as revealed by Chi-squared difference test ($df=1$; $p < 0.01$).

Figure 2. Cross-lagged path analyses of self-reported health and subjective sleep quality.

Notes. Values in each first row represent coefficients for younger participants (18 to 59 years; $n = 9,812$), values in the respective second row represent coefficients for older participants (60 to 85 years; $n = 4,367$). All coefficients are significant at $p < .001$, except values with superscript a ($p < .01$).

Figure 3. Predicted changes in subjective sleep quality in the 2 years before and after retirement.

Notes. $N = 385$. Scores for subjective sleep quality are centered around the yearly mean to account for average trends over time.

Footnotes

¹ Our data even allows modeling 3 years prior and 3 years following retirement. However, we decided against this because only few respondents provided date for these time points (3 years before retirement: $N = 100$, 3 years after retirement: $N = 107$).

² The effect size was calculated using the standard deviation of sleep quality at the baseline level of 2.47 (cf. Specht et al., 2011b) and reflects the change of sleep quality relative to the variability in the respective population two years before retirement.

Figure 1.

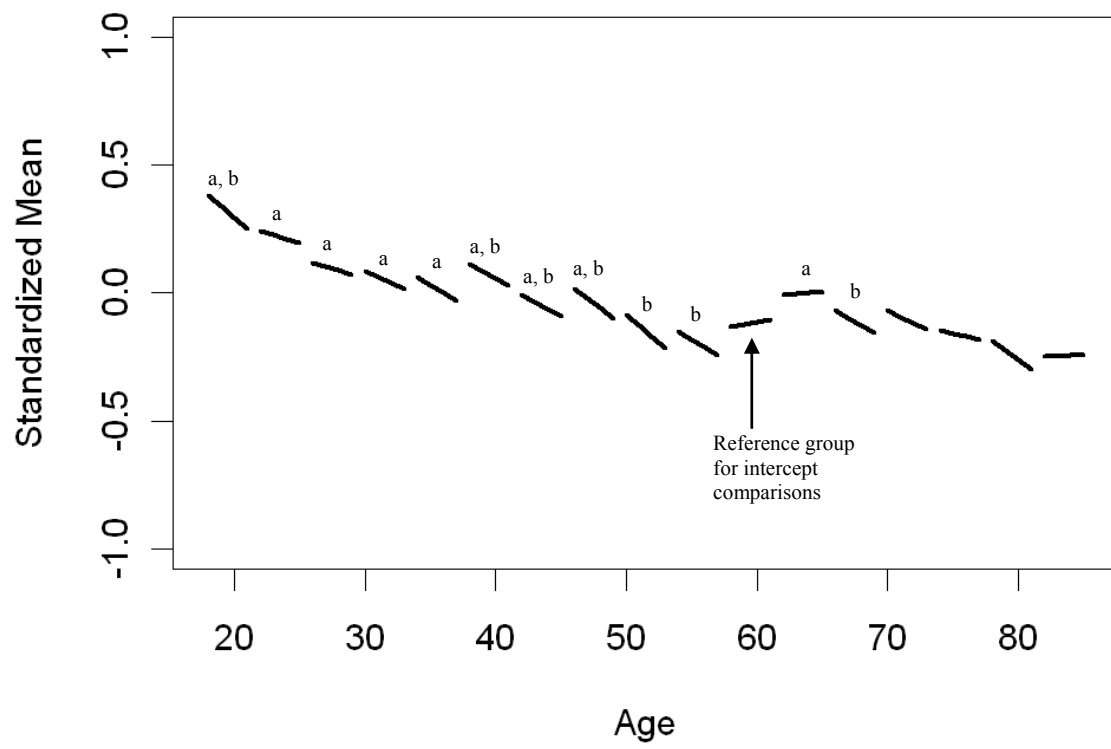


Figure 2.

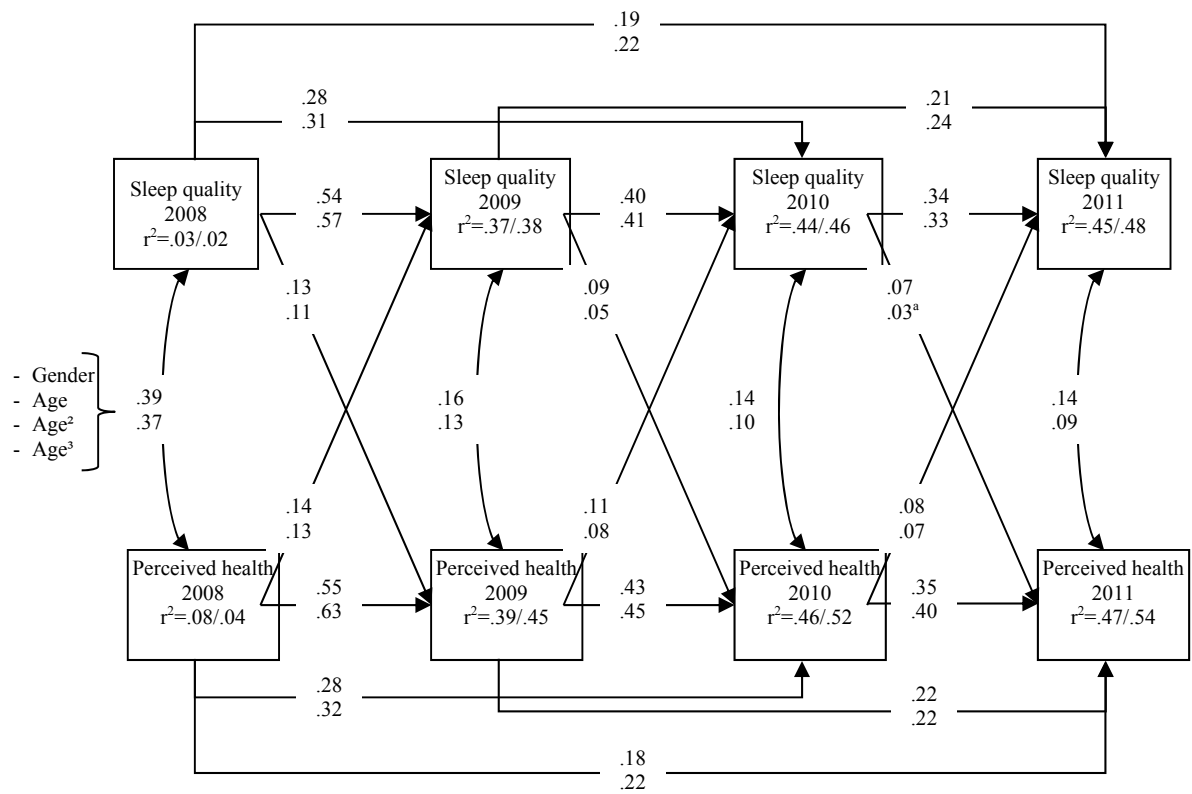


Figure 3.

