Does the Sense of Coherence Predict Health 10 and 20 Years Later? - Results From A Population-Based Longitudinal Study in Germany

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Abstract

Background

The sense of coherence (SOC) is reported to influence health, but health may also have an impact on SOC. The objective of this study was to examine the longitudinal associations between SOC and selected self-reported and physician-assessed health outcomes over a period of 10 and 20 years, and to determine the direction of the associations.

Methods

We conducted a population-based, longitudinal study, involving 392 participants (204 males; mean age 43.01 years) who were followed for a median of 10 and 18 years. Analyses of variance were carried out to examine the longitudinal associations between SOC at baseline and health outcomes (i.e., self-rated health status, SHS; physical health status assessed by physician, PHS; self-reported satisfaction with life, SWL) at follow-ups. The direction of associations was examined using a cross-lagged model on correlation coefficients, adjusted for sex and age at baseline.

Results

There were significant group effects for SOC at baseline on SWL at 10-year ($F = 11.91, p < .01, ηp² = .068$) and at 20-year follow-up ($F = 6.68, p = .002, ηp² = .057$). SHS ($r = .238, p < .01$), PHS ($r = -.140, p < .05$) and SWL ($r = .400, p < .01$) predicted SOC at 10-year follow-up stronger than vice versa. The direction of associations between SOC and health parameters at 20-year follow-up was less consistent.

Conclusions

The long-term associations between SOC and self-reported and physician-assessed health may be reciprocal in community-dwelling adults. More research is needed to examine the predictive power of health on SOC and whether interventions targeted at improving health parameters, may impact SOC.

Background

Already 40 years have passed since Antonovsky introduced a salutogenic model focusing on the origins of health and well-being [1]. This model seeks to explain why some individuals are capable of maintaining and even improving their health in stressful life situations. The main concept behind the salutogenic approach is the sense of coherence (SOC). Antonovsky described the SOC as a global orientation to view one’s own life as structured, manageable, and meaningful [2]. SOC can also be understood as the capacity of a person to cope with stressors in daily life by identifying and using their generalized resistance resources (GRR, e.g., intelligence, ego identity, social support, cultural and preventive health orientation) to maintain and strengthen their health [3, 4]. SOC is influenced by life experience whereas the GRRs provide an individual with sets of meaningful life prerequisites [5]. Antonovsky emphasized that the SOC concept is a dispositional orientation rather than a personality trait.
or a coping strategy [6]. Furthermore, the SOC represents a salutogenic factor, actively promoting and facilitating health [7].

Numerous empirical studies have shown that the SOC is associated with positive subjective wellbeing, mental health and quality of life [for recent systematic reviews, see 8–10]. Furthermore, the SOC is associated with lower severity of symptoms of anxiety and depression [3, 5, 11]. The correlation with health in general ranges from moderate to good, explaining up to 66% of the variance in SOC depending on the assessment tools used [12]. The remaining variance is accounted for by other factors such as age, social support and education. In addition, the SOC is also associated with physical health, but reported correlations are usually significantly lower and less consistent. This may indicate that the SOC mainly comprises an individual’s mental, social, and spiritual resources to cope with the challenges of life. Schumacher and colleagues also assumed that the SOC does not directly affect physical health, but only indirectly and mediated through coping behavior in stressful situations [13]. To date, only few longitudinal studies with an observation-time, which is sufficient to analyse the predictive associations of SOC on health and vice versa over the course of a lifespan exist [14–19]. The SOC appears to have a relatively high predictability, both in a short term (i.e., several months) and a long term (i.e., several years) perspective [8]. Länsimies and colleagues reported that a higher SOC in adolescents is a predictor of various health outcomes (e.g., quality of life, health behavior and mental health) in adulthood. [10]. However, conflicting results have been reported where SOC was not associated with health outcomes in adults. [3]. It has also been postulated that the relationship between SOC and health could rather be reciprocal, i.e. SOC potentially influences health, but health may also have an impact on SOC [2, 8].

The aims of the present study were to examine the longitudinal associations between SOC and various self-reported and physician-assessed health outcomes over a period of 10 as well as 20 years; and to untangle the direction of the associations between SOC and health outcomes in community-dwelling adults aged ≥ 33 years.

**Methods**

**Study population**

The study was conducted in the setting of a community-based, longitudinal research in southern Germany [20]. Data from five measurement waves carried out in 1992, 1997, 2002, 2010 and 2015 were used. Participants were randomly selected from the residents’ registration offices in Bad Schönborn, Germany. All participants gave written informed consent before taking part in the research. Participation was voluntary. The study was approved by a scientific advisory council, the Schettler Clinic, Bad Schönborn, Germany as well as the ethics committee of the Karlsruhe Institute of Technology (KIT). We strictly followed ethical guidelines from the German Psychological Society. All data was analysed anonymously.
The sample for the 10-year follow-up analysis on the associations between SOC and health outcomes consists of 349 individuals (166 females and 183 males) aged 33–67 years, whereas for the 20-year comparison, the sample consists of 240 individuals (113 females and 127 males) aged 33–62 years. The first ever participation of an individual in the study was considered the baseline measurement (i.e., 1992, 1997, 2002). If participants had valid data from study participation ten or twenty years after the baseline measurement then these data were considered for the 10- respectively 20-year analyses. Overall, 392 different individuals (188 females and 204 males) aged 33–67 years participated in this study. 152 persons were included only in the 10-year analyses, 43 persons were included only in the 20-year analyses, and 197 were included in both analyses. The response rate of the initial sample in 1992 was 56%. For the initial sample, individuals from five age strata (i.e., 35, 40, 45, 50, and 55 ± 2 years) were invited for participation. In each subsequent wave, new participants from 28 to 38 years of age were additionally recruited to compensate for dropouts [21].

Measures

Details on study procedures and measures have been published elsewhere [22]. In every study year, the data assessment took place between May and June.

**Sense of coherence (SOC).** The authorized German translation of the 13-item version of the Orientation to Life Questionnaire (SOC13) was used [2]. The answers are provided on a seven-point response scale ranging from 1 point to 7 points, with 1 and 7 indicating extreme feelings about questions (and statements) about how one's life is experienced (e.g., “when you talk to people, do you have the feeling that they do not understand you?” is scored from 1 = “never have this feeling” to 7 = “always have this feeling”). A total score for all 13 items of the SOC-13 was computed, ranging between 13 and 91 points. Higher values indicate a stronger SOC. The SOC-13 has proven to be a reliable, valid and cross-culturally applicable instrument that measures how individuals manage stressful situations and maintain their well-being [12, 13, 23, 24].

**Self-rated health status (SHS).** All participants were asked to rate their health status by answering following 5 questions: “how do you describe your health status?”, “how does your current health status affect your job performance?”, “how does your current health status affect your leisure activities?”, “how do you describe your health status compared to others of your age and gender?” and “has your health status changed in the last 5 years?”. Responses were given on a scale of 1 to 5 points, where 1 indicates a very low health status and 5 reflects a very high health status (e.g., “how do you describe your health status” is scored from 1 = “very poor” to 5 = “very good”). An overall score was calculated for the self-rated health status, ranging between 5 and 25 points with a higher score indicating a better self-rated health status.

**Physical health status (PHS).** Physical health status was assessed based on a thorough medical examination performed by a licensed physician. After the comprehensive examination, the physician made a diagnosis of 0 = “no limitations”, 1 = “minor limitations, not impacting daily life”, 2 = “limitations,
impacting daily life,” and 3 = “major limitations, heavily impacting daily life” with regard to orthopedic, neurological, and cardiovascular health. An overall score was created of the three diagnoses, ranging from 0 to 9 points. A higher score suggests more limitations.

**Satisfaction with life (SWL).** Satisfaction with life in general was measured by a single question “how satisfied are you with your life?”, with response options ranging from 1 = “very dissatisfied” to 5 = “very satisfied”

**Statistical analysis**

Demographics of the study samples at baseline were calculated separately for the 10-year and 20-year analyses. For categorical variables (e.g., sex, athletes), we calculated number (N) and percentage (%), for continuous variables (e.g., age, body mass index), we calculated means (M) and standard deviations (SD). Analyses of variance (ANOVA) were carried out to examine the longitudinal associations between SOC at baseline and the three different health outcomes (i.e., SHS, PHS and SWL) at 10 and 20 years of follow-up, respectively. For the ANOVA, the SOC variable at baseline was divided into three subgroups at the 20% and 80% percentiles. Participants with a score of 1354 points were considered as having a low SOC (i.e., 20% of participants with lowest SOC), 55–64 points indicated a moderate SOC and 6591 points indicated a high SOC (i.e., 20% of participants with highest SOC). These SOC groups were entered into the models as between-subjects factor whereas the repeated measures were considered as within-subjects factors.

In addition, a cross-lagged model on correlation coefficients to ascertain the direction of the associations between SOC and health outcomes was performed. Although cross-lagged designs should not be interpreted as definite proof of causality, they can be an indication of the predominant direction of effects over time [25–27]. In a crosslagged design two variables X and Y are measured at two time points, resulting in three types of relations: withintime or synchronous relations indicating the crosssectional association between X1 and Y1, or X2 and Y2; autoregressive or stability relations indicating the longitudinal prediction of X2 by X1, or Y2 by Y1; and cross-lagged relations indicating the longitudinal prediction of Y2 by X1, or X2 by Y1 [7]. Pearson’s product moment correlation coefficients were calculated for the analysis of the partial correlations. The effect sizes applied in this study follow Cohen’s recommendation for behavioural sciences: $r = .1$ small; $r = .3$, medium; and $r = .5$, large [28]. Sex and age at baseline were included in these models as covariates.

A p value < .05 was considered to be statistically significant. The data were analysed using SPSS for Windows, version 26 (Chicago, Illinois, USA).

**Results**

**Demographic characteristics**
Descriptive statistics of the samples at baseline for the 10- and 20-year follow-up analyses, as well as of SOC, SHS, PHS and SWL variables at baseline and follow-up are shown in Table 1. The distributions of sex, age, body mass index (BMI) and number of physically active persons are very similar in both study samples.

In the sample for the 10-year analyses, SOC total score showed a significant increase from baseline to follow-up ($p < .01$). Similarly, when comparing the SOC groups, the number of participants in low and medium SOC groups decreased from baseline to follow-up, whereas the number of participants in the high SOC group increased from baseline to follow-up. With regard to the different health-related outcomes, both SHS total score (i.e. subjective) and PHS total score (i.e. objective) showed a minimal decrease (SHS: $p = .014$; PHS: $p = .228$) from baseline to follow-up. However, in general, participants reported low limitations at both baseline and follow-up. Finally, participants reported a high SWL total score both at baseline and at follow-up. There was only a slight increase in mean scores from baseline to follow-up ($p = .478$).

In the sample for the 20-year analyses, SOC mean total score increased significantly from baseline to followup ($p < .01$). However, the health status of participants declined, i.e., SHS showed a small decrease ($p = .106$) between baseline and follow-up, whereas PHS increased significantly between baseline and follow-up ($p < .01$); and SWL mean total score increased slightly ($p = .207$).
Table 1
Demographics of the samples for 10- and 20-year follow-up analyses.

| Variables           | 10 years n = 349 | 20 years n = 240 |
|---------------------|------------------|------------------|
| Male sex, N (%)     | 183 (52)         | 127 (53)         |
| Age* in years, M (SD) | 43.00 (8.24)     | 42.54 (7.71)     |
| BMI* (kg/m^2), M (SD) | 25.45 (3.73)     | 25.23 (3.56)     |
| Athletes*, N (%)    | 223 (64.5)       | 166 (69.5)       |
| SOC total score, M (SD) | 59.90 (6.94)     | 68.56 (10.28)    |
| SOC groups, N (%)   |                  |                  |
| low                 | 68 (19.7)        | 31 (8.9)         |
| moderate            | 203 (58.7)       | 67 (19.3)        |
| high                | 75 (21.7)        | 250 (71.8)       |
| SHS total score, M (SD) | 17.35 (2.60)     | 16.94 (3.25)     |
| PHS total score, M (SD) | 1.60 (1.38)      | 1.35 (1.80)      |
| SWL total score, M (SD) | 4.11 (0.59)      | 4.12 (0.63)      |

Notes: SOC, sense of coherence: 1, extreme negative feeling to 7, extreme positive feeling, 13 items summed up; SHS, self-rated health status: 1, very bad to 5, very good; 5 items summed up; PHS, physical health status: 0, no limitations to 3, major limitations, 3 items summed up; SWL, satisfaction with life: 1, very dissatisfied to 5 very satisfied; * at baseline.

Longitudinal Associations Between Soc And Health Outcomes

The results of the ANOVA are shown in Table 2, separately for the 10-year and 20-year follow-up samples.

Self-rated health status (SHS): Participants reported lower SHS scores at follow-up compared to baseline across all SOC groups in the 10-year model. At baseline, the moderate SOC group had the highest SHS. SHS at 10-year follow-up was highest in participants with high SOC at baseline. However, no significant time, group or interaction effect could be found. The trend was similar in the 20-year model, i.e. participants with higher SOC at baseline reported higher SHS at both baseline and follow-up. Of note, mean SHS total score decreased between baseline and 20-year follow-up across all SOC groups, albeit no significant time, group or interaction effect was found.
Physical health status (PHS): Participants with moderate and high SOC at baseline and follow-up showed numerically higher mean PHS scores, albeit not significant. The results in the 20-year model differ from those in the 10-year model such that a significant time effect was found \( (F = 23.46, p < .01, \eta^2 = .096) \). Across all baseline SOC groups, PHS increased significantly from baseline to 20-year follow-up. No group or interaction effect was found.

Satisfaction with life (SWL): Participants with higher SOC at baseline reported higher SWL at baseline. At 10-year follow-up, participants with a moderate SOC at baseline had the highest SWL total score. SWL mean total score increased between baseline and 10-year follow-up in the low and moderate SOC group, and decreased in the high baseline SOC group. For the 10-year model, a significant group effect was observed \( (F = 11.91, p < .01, \eta^2 = .068) \). In the 20-year model, SWL mean total score increased between baseline and follow-up across all baseline SOC groups, and participants with a higher SOC reported a higher SWL at both baseline and 20-year follow-up. A significant group effect was found \( (F = 6.68, p = .002, \eta^2 = .057) \).
Table 2
ANOVA on longitudinal associations between SOC groups at baseline and SHS, PHS and SWL at 10- and 20-year follow-up

| SHS mean (SD) score | 10 years | 20 years |
|---------------------|----------|----------|
|                     | n        | baseline | follow-up | n        | baseline | follow-up |
| SOC                 |          |          |           |          |          |           |
| low                 | 56       | 16.77 (2.79) | 16.54 (3.38) | 35       | 16.34 (2.78) | 16.26 (2.99) |
| moderate            | 175      | 17.66 (2.37) | 16.83 (3.38) | 123      | 17.47 (2.57) | 16.92 (3.41) |
| high                | 66       | 17.53 (2.84) | 17.44 (2.75) | 37       | 17.70 (2.50) | 17.08 (2.17) |
| ∑                   | 297      | 17.46 (2.58) | 16.91 (3.22) | 195      | 17.31 (2.62) | 16.83 (3.14) |

| time                |          |           |           |          |           |           |
| F(1, 294) = 3.17, p = .076, ηp² = .011 | F(1, 192) = 2.37, p = .126, ηp² = .012 |

| group               |          |           |           |          |           |           |
| F(2, 294) = 1.90, p = .151, ηp² = .013 | F(2, 192) = 2.34, p = .099, ηp² = .024 |

| time*group          |          |           |           |          |           |           |
| F(2, 294) = 1.57, p = .211, ηp² = .011 | F(2, 192) = 0.32, p = .724, ηp² = .003 |

| PHS mean (SD) score | 10 years | 20 years |
|---------------------|----------|----------|
|                     | n        | baseline | follow-up | n        | baseline | follow-up |
| SOC                 |          |          |           |          |          |           |
| low                 | 54       | 1.33 (1.30) | 0.96 (1.50) | 42       | 1.29 (1.09) | 1.79 (1.76) |
| moderate            | 170      | 1.49 (1.35) | 1.51 (1.95) | 144      | 1.68 (1.39) | 2.23 (1.83) |
| high                | 62       | 1.53 (1.45) | 1.34 (1.65) | 38       | 1.61 (1.22) | 2.42 (1.72) |
| ∑                   | 286      | 1.47 (1.36) | 1.37 (1.82) | 224      | 1.59 (1.31) | 2.18 (1.81) |

| time                |          |           |           |          |           |           |
| F(1, 283) = 1.20, p = .139, ηp² = .008 | F(1, 221) = 23.46, p < .01, ηp² = .096 |

| group               |          |           |           |          |           |           |
| F(2, 283) = 1.45, p = .237, ηp² = .010 | F(2, 221) = 1.76, p = .174, ηp² = .016 |

| time*group          |          |           |           |          |           |           |
| F(2, 283) = 1.02, p = .361, ηp² = .007 | F(2, 221) = 0.49, p = .616, ηp² = .004 |

| SWL mean (SD) score | 10 years | 20 years |
|---------------------|----------|----------|
|                     | n        | baseline | follow-up | n        | baseline | follow-up |
| SOC                 |          |          |           |          |          |           |
| low                 | 63       | 3.78 (0.77) | 3.92 (0.68) | 42       | 3.90 (0.69) | 4.02 (0.64) |
| moderate            | 194      | 4.16 (0.48) | 4.19 (0.56) | 143      | 4.14 (0.48) | 4.17 (0.63) |
| high                | 73       | 4.25 (0.55) | 4.15 (0.74) | 40       | 4.30 (0.52) | 4.38 (0.54) |
| ∑                   | 330      | 4.11 (0.58) | 4.13 (0.64) | 225      | 4.12 (0.55) | 4.18 (0.62) |

| time                |          |           |           |          |           |           |
| F(1, 327) = 0.28, p = .597, ηp² = .001 | F(1, 222) = 1.87, p = .173, ηp² = .008 |

Notes: SOC, sense of coherence; SHS, self-rated health status; PHS, physical health status; SWL, satisfaction with life; ηp² = partial eta squared to indicate effect size; p indicates statistical significance
| SHS mean (SD) score | 10 years | 20 years |
|---------------------|----------|----------|
|                     | n baseline | follow-up | n baseline | follow-up |
| group               | $F(2, 327) = 11.91, p < .01, \eta^2 = .068$ | $F(2, 222) = 6.68, p = .002, \eta^2 = .057$ |
| time*group          | $F(2, 327) = 2.05, p = .130, \eta^2 = .012$ | $F(2, 222) = 0.31, p = .735, \eta^2 = .003$ |

Notes: SOC, sense of coherence; SHS, self-rated health status; PHS, physical health status; SWL, satisfaction with life; $\eta^2 = \text{partial eta squared to indicate effect size}; p \text{ indicates statistical significance}$

### Direction Of Associations Between Soc And Health Outcomes

All cross-lagged partial correlations with sex and age at baseline as covariates are presented in Figs. 1, 2 and 3.

The first cross-lagged model is linking SOC and SHS (Fig. 1). In the 10-year comparison, stability coefficients were moderate, ranging from .314 (SOC) to .377 (SHS). High levels of SOC at baseline positively predicted SHS at follow-up ($r = .142$), in turn, high levels of SHS at baseline positively predicted SOC at follow-up even stronger ($r = .238$). In the 20-year comparison, the stability relation was small regarding SOC ($r = .228$) and moderate regarding SHS ($r = .368$). Only a significant correlation between SOC at baseline and SHS at follow-up ($r = .209$) was found. Of note, within-time relations between SOC and SHS were small at baseline ($r = .214$) and moderate both at 10-year ($r = .366$) and 20-year follow-up ($r = .361$).

The second cross-lagged model describes the association between SOC and PHS (Fig. 2). Stability coefficients in the 10-year comparison ranged from .269 (PHS) to .314 (SOC). No significant relationship between SOC at baseline and PHS at follow-up was found. In turn, less limitation (i.e., lower PHS scores) at baseline positively predicted SOC at 10-year follow-up ($r = .140$). In the 20-year comparison, the stability relation was small regarding SOC ($r = .228$) and moderate regarding PHS ($r = .346$). No significant cross-lagged relation was found, whereas small within-time relations at all measurement times were observed.

Figure 3 is showing the third cross-lagged model linking SOC and SWL. In the 10-year comparison, moderate stability coefficients were found for both SOC ($r = .314$) and SWL ($r = .346$). High levels of SOC at baseline positively predicted SWL at follow-up ($r = .152$), in turn, high levels of SHS at baseline positively predicted SOC at follow-up even stronger ($r = .400$). In the 20-year comparison, stability coefficients ranged from .228 (SOC) to .315 (SWL). The cross-lagged correlations were small for both directions of effects, i.e. a high SOC at baseline positively predicted SWL at 20-year follow-up ($r = .209$), and a high SHS at baseline vice versa positively predicted SOC at 20-year follow-up ($r = .201$). Within-time coefficients were moderate at all measurement times, ranging from .134 (baseline) to .484 (10-year follow-up).
Discussion

With regard to the first research question, we observed that SOC total score increased significantly over 10 and 20 years of follow-up. In the 10-year model there was no significant change in health status (i.e., SHS, PHS and SWL), whereas in the 20-year model physical health status decreased significantly regardless of SOC at baseline. Antonovsky assumed SOC to be a health resource that was fundamentally acquired in early childhood and adolescence without any major changes after the age of 30 [1, 2]. According to our results and other studies, we assume that SOC develops positively along the entire lifetime [29]. Furthermore, our results showed that SOC at baseline appears to have a significant influence on SWL at 10- and 20-year follow-up, but not on SHS and PHS. These findings are somewhat in line and difference with previous longitudinal studies reporting that SOC is associated with positive subjective wellbeing, mental health and a lower number of subjective complaints and symptoms of illness [3, 5, 14–19]. This could be due to the different methods and study sample used, as well as the other longitudinal studies being based on much shorter follow-up times. Suominen and Lindström reported that people who have developed a strong SOC manage disease (i.e., mental, physical or social) better than those with a weak SOC [30]. This relation was also found among adolescents with congenital heart disease [7]. Furthermore, SOC is strongly related with self-rated health score and possession of health promoting resources that support the development of a positive subjective state of health [8]. Our study adds to the existing body of research by providing preliminary evidence of longitudinal associations between SOC at baseline and better SWL at both 10 and 20 years of follow-up. This relationship supports Antonovsky's view of the SOC as a global life orientation. He assumed that a strong SOC reduces the perceived strain of life [30].

Regarding the cross-sectional associations between SOC and health outcomes, we found positive correlations, ranging from small (i.e. PHS) to moderate (i.e. SHS and SWL). These findings are in line with a large body of previous cross-sectional research. For example, it was reported that the stronger the SOC, the better the perceived quality of life in general [9]. Furthermore, SOC seems to be connected with better health behavior, e.g. less use of alcohol, being a nonsmoker, better oral health care and better social competence [4, 31].

With regard to the direction of the associations between SOC and health outcomes, our data of the 10-year analyses showed that SHS, PHS and SWL at baseline predicted SOC at follow-up better than vice versa. This may indicate that the previously reported relationship between SOC and health is reciprocal. The results of the 20-year analyses revealed inconsistent associations between SOC and health outcomes. As of today, to the best of our knowledge, only the predictive effect of SOC on health and not vice versa has been examined, with several studies reporting that SOC seems to be a health resource promoting resilience and the development of a positive subjective state of health. Data from Suominen and colleagues confirmed that SOC predicts a positive subjective state of health in a Finnish population over a period of 4 years [5]. A 19-year register-based prospective study from Finland showed that a strong SOC at baseline was associated with reduced risk of psychiatric disorders 19 years later [17]. However, conflicting results have also been reported. For instance, Kivimäki and colleagues could not find a
predictive longitudinal relationship between SOC and health [16], and there was no difference in the development of health between individuals with a high SOC versus those with a moderate or low SOC.

Despite empirical findings supporting the importance and validity of the salutogenic theory, there is a lack of knowledge about how SOC develops over time, and how it could be strengthened. Suominen and Lindström assumed that there is a complex empowerment process characterized by both challenges and a certain willingness of an individual to solve problems [30]. Based on our data, we suggest that this empowerment process can be supported by good health status. In today's Western societies, economic status of the general population is at a relatively higher level compared to previous times. Therefore, individuals may have good internal healing resources, i.e., potential for active adaptation to new circumstances. This makes it possible for persons to maintain better health for longer periods of time, which in turn may influence the SOC itself over time. Antonovsky was aware of the impact of social conditions on peoples' health in a society, and he explicitly pointed out the responsibility of the society to create conditions that induce the strengths of coping. Furthermore, he emphasized focusing on structures supporting health rather than on specific risk factors. In addition to programs reducing such risk factors (e.g., obesity, high blood pressure or smoking), the attention should therefore also be on salutogenic structures of the society. By improving social support or reducing poverty, it is possible to reduce the risk of disease in the long term [32]. Therefore, the original definition of SOC as individual global orientation of the world should be broadened to wider levels like family and community coherence [33].

Our study should be interpreted in light of its strengths and limitations. The main strength of this study is the longitudinal, population-based design with a long follow-up of 20 years. As previous research has mainly utilized cross-sectional study designs, our study may be among the first to report the longitudinal associations between SOC and both self-reported (i.e., SHS, SWL) and objective health outcomes (i.e., PHS) assessed by a physician based on a medical examination. Main limitations of the study pertain to the use of questionnaires which may be prone to recall or social desirability bias, albeit all questionnaires used in this research are validated and have been used in large-scale research before. In addition, as in any observational study, we cannot draw any conclusion about cause and effect. However, by applying cross-lagged analysis, we were able to examine the predominant direction of effects over time, albeit keeping in mind that cross-lagged results should not be interpreted as proof of causality. Furthermore, there are other concepts contributing to a positive health development, e.g. resilience and empowerment which we did not consider in our analyses. It must be noted that these concepts may be related to SOC and our reported findings. Finally, our study was conducted in predominantly caucasian community in a rather wealthy town in South-Western Germany. Thus, findings may not be generalizable to predominantly urban areas or larger cities, as well as to communities with higher frequency of persons with migration background and/or less wealthy communities.

Conclusion

Overall, in conclusion, we provided evidence of reciprocal longitudinal associations between SOC and both self-reported and physician-assessed health in community-dwelling adults aged ≥ 33 years. More
research is needed to confirm our findings, and to further untangle the direction of associations between SOC and health in adults.

**Abbreviations**

GRR
generalized resistance resources; PHS: physical health status; SHS: self-rated health status; SOC: sense of coherence; SWL: satisfaction with life

**Declarations**

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Not applicable.

**Authors’ contributions**

AD, JKR and SCES analysed and interpreted the data. AD prepared the draft manuscript, while JKR, SCES, KB and AW provided the critical revisions. All authors approved the final version of the manuscript.

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**Availability of data and materials**

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

**Ethics approval and consent to participate**

The study was approved by a scientific advisory council, the Schettler Clinic, Bad Schönborn, Germany as well as the ethic committee of the Karlsruhe Institute of Technology (KIT).

**Consent for publication**

Not applicable.

**Competing interests**

All authors declare no conflicts of interest pertaining to this manuscript.

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