ORIGINAL ARTICLE

Frequency of stressful life events and associations with mental health and general subjective health in the general population

Ana Nanette Tibubos[1] [ID] · Juliane Burghardt[1] · Eva M. Klein[1] · Elmar Brähler[1] · Claus Jünger[1,2] · Matthias Michal[1,3] · Jörg Wiltink[1] · Philipp S. Wild[3,4,5] · Thomas Münzel[2] · Susanne Singer[6] · Norbert Pfeiffer[7] · Manfred E. Beutel[1]

Abstract

Aim We aim to determine the frequency of stressful life events (SLEs) and investigate the association of single and aggregated SLEs with mental health and general subjective health, which has not been reported for an aging representative sample to date.

Subjects and methods A total of 12,947 participants (35–74 years old) of the Gutenberg Health Study (GHS) in Germany were analyzed. SLEs were analyzed at the item and aggregated level with unweighted and weighted sum scores. Additionally, the survey included measures of mental health, general subjective health and demographics. Descriptive analyses were stratified by sex, age and socioeconomic status.

Results Multivariate analyses of variance with SLE at the item level revealed large main effects for sex ($\eta_p^2 = 0.30$) and age ($\eta_p^2 = 0.30$); a moderate effect was found for socioeconomic status ($\eta_p^2 = 0.08$). Interaction effects of sex with age and SES were also significant, but with negligible effect sizes. Regression analyses revealed similar results for unweighted and weighted SLE sum scores controlling for sociodemographic variables, supporting the detrimental relations among cumulated SLEs, depression ($\beta = 0.18/0.19$) and anxiety ($\beta = 0.17/0.17$), but not general health. Mental health indicators showed the highest correlations with single SLEs such as change of sleep habits or personal finances. Severe SLEs according to proposed weight scores showed no or only weak associations with mental health.

Conclusion Representative data support a more distinct impact of SLEs on mental health than on general health. Single SLEs show strong associations with mental health outcome (e.g., change of sleep habits). The low associations between severe single SLEs and mental health merit further attention.

Keywords Life events · Mental health · Depression · Anxiety · Stress · General health

✉ Ana Nanette Tibubos
AnaNanette.Tibubos@unimedizin-mainz.de

Juliane Burghardt
Jburghar@uni-mainz.de

Eva M. Klein
Eva.Klein@unimedizin-mainz.de

Elmar Brähler
Elmar.Braehler@medizin.uni-leipzig.de

Claus Jünger
Claus.Juenger@unimedizin-mainz.de

Matthias Michal
michal@uni-mainz.de

Jörg Wiltink
wiltink@uni-mainz.de

Philipp S. Wild
Philipp.Wild@unimedizin-mainz.de

Thomas Münzel
tmuenzel@uni-mainz.de

Susanne Singer
singers@uni-mainz.de

Norbert Pfeiffer
norbert.pfeiffer@unimedizin-mainz.de

Manfred E. Beutel
Manfred.Beutel@unimedizin-mainz.de

Extended author information available on the last page of the article

Background

Life events are significant occurrences, often with far-reaching consequences. They take place with or necessitate changes in behavioral patterns (Filipp 1995; Holmes and Rahe 1967). Diverse forms of life events, such as social, physical and biological events, can be classified as normative or non-normative (Wrzus et al. 2013). Normative life events comprise puberty, marriage, relocation, parenthood, entering the labor market, retirement or the death of the parents. They are expected or of a high probability for most people at a certain age. In contrast, non-normative life events are often unexpected and occur at any time during the lifespan. Examples of non-normative life events are death of a spouse, divorce or unemployment. While non-normative life events have a moderate occurrence probability, normative life events are more likely (Filipp 1995). Thus, most studies focus on normative life events.

Life events and sociodemographic variables

Socioeconomic status was shown to have an impact on life events and other stressors (Lantz et al. 2005; Hobson et al. 1998). Higher financial stress was associated with moderate-to-severe functional limitations and poor-to-fair self-rated health. Differential exposure to stress and negative life events based on socioeconomic disparities may be one determinant for socioeconomic inequalities in health. Gender also determines the risk of exposure to stress (Landrine et al. 1995; Thomas et al. 2008). Gender has been found to influence the predictive role of stressful life events (SLEs) for the risk of major depressive episodes over a long-term period of 25 years (Assari and Lankarani 2016). The predictive role of SLEs for depression was stronger in men than women. However, these findings may be due to gender differences in the threshold of reporting stress, perceiving risks or use of coping strategies (Harris et al. 2006).

Relationship of life events with health-related variables

Health is defined as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity," according to the World Health Organization (WHO). A meta-analysis by Kraaij, Arensman and Spinhoven (Kraaij et al. 2002) revealed that almost all negative life events appeared to have a modest but significant relationship with depression. For instance, the total numbers of negative life events and of daily hassles had the strongest relationships with depression. Furthermore, longitudinal data from a 10-year follow-up health survey were analyzed including life events as stressors and morbidity years of ten chronic conditions (Hsu 2011). Accordingly, loss of offspring increased the risk for impaired physical health, psychological health and life satisfaction. Being newly widowed was related to depressive symptoms, whereas being newly divorced increased the risk of poor social support. There is also longitudinal evidence for life events related to the development of anxiety disorders (Jonker et al. 2017). With reference to morbidity years, increased failure of successful aging was observed, especially after medical illness such as stroke (Kornerup et al. 2010), respiratory system disease (Lietzén et al. 2011), cancer (Lillberg et al. 2003), diabetes and visceral adiposity (Mooy et al. 2000). Chronic inflammatory diseases of the central nervous system such as multiple sclerosis have also been linked to SLEs (Mohr et al. 2004). There is evidence for gene-environment correlations with regard to SLEs and psychotic experiences (Shakoor et al. 2016). The nature and extent of the association between life event exposure and stress reactivity in young adults depended on the valence of the events together with the sex of the individual and their social network size (Phillips et al. 2005). To provide a theoretical framework, Schwarzer and Schulz (2003) proposed a model suggesting different mediating pathways with regard to the association of stressful life events and illness indicators. The potential mediators were health-compromising behaviors (e.g., smoking, alcohol consumption, physical inactivity), physiological changes and negative affect.

Assessment of life events

Originally, according to Holmes and Rahe, critical life events were supposed to be associated with stress experience regardless of the valence of a certain life event (Holmes and Rahe 1967). This means that important life changes, whether negative, such as the death of a close friend, or positive, such as marriage, all induce stress. This theoretical framework implies that life events require the individual to adapt and regain stability. The Social Readjustment Rating Scale [SRRS; (Holmes and Rahe 1967)] is a widely used checklist for the occurrence of stressful life events (SLEs) (Scully et al. 2000). The authors suggested scores reflecting the severity of the impact of the life event for each item, which refer to the past year. The scores called "life-changing units" range from 11 to 100. Stress is operationalized as a cumulative psychological construct and estimated from the summed frequency of life events. Higher sum scores correspond to higher stress levels. There are modified English versions of the SRRS (Hobson et al. 1998; Hobson and Delunas 2001; Miller and Rahe 1997); some are based on specific populations (Goldberg and Comstock 1980; Lüdtke et al. 2011). In summary, checklists are still the most popular assessment methods for stressful life events (Hobson and Delunas 2001; Cleary 1980) although interview methods have been introduced [e.g., (Paykel 1997; Wittchen et al. 1989)]. As criticized by some researchers (Hobson and Delunas 2001), the life event items contain both

discrete events (e.g., sustained injury or disease) and possible symptoms or consequences of stress (e.g., change of sleep patterns). Additionally, critical life events vary in their valence, ranging from positive to negative, e.g., marriage and death of a spouse. Also, it is not clear whether and how operationalization of a stress score improves the predictive value of life events with regard to mental or general health (Cooper et al. 1985).

Objectives of the study

First, we aimed to present the frequency of stressful life events for a large representative sample of the German population. Thus, we wanted to provide data on the frequency of life events depending on age, sex and socioeconomic status. This allows for cross-national comparison and for the investigation of cultural differences. Second, we further wanted to determine which of the SLEs are of interest for epidemiological research in terms of psychological distress (depression and anxiety) and subjective health. Highly stressful life events (based on the SRRS guidelines) are assumed to have a negative impact on health resulting in higher distress (depression, anxiety) and lower self-reported general health. Finally, we tested whether weighted, as suggested by the original authors (Holmes and Rahe 1967), or unweighted SLE scores of life events predict distress and subjective health taking sociodemographic variables into account. We expected stronger covariations of SLE with indicators of psychological distress compared with the more abstract variable of subjective general health in terms of convergent and discriminant validity.

Methods

Baseline data of the Gutenberg Health Study (GHS) were used in the current study. The first wave provided cross-sectional data of $N = 12,947$ participants enrolled from April 2007 to April 2012. The GHS is a population-based, prospective, observational single-center cohort study in western mid-Germany (Rhein-Main region). The main objective of the GHS is prevention of cardiovascular, metabolic, ophthalmological and mental disorders in the general population of the region by improving disease prediction by considering lifestyle, psychosocial and environmental risk factors, protein patterns, genetic variants and subclinical disease. Previous studies based on the GHS dealing with psychosomatic issues have been published identifying risk factors of, for instance, mental (Tibubos et al. 2019a; Tibubos et al. 2019b) and somatic ill health (Beutel et al. 2019; Michal et al. 2014; Ernst et al. 2019). The study design and procedure have been described in detail elsewhere (Wild et al. 2012; Höhn et al. 2015).

Participants

Prior to enrollment, participants signed written informed consent. The study and its procedure were approved by the ethics committee of the Statutory Physician Board of the State of Rhineland-Palatinate and controlled by the local and federal data safety commissioners. The GHS sample was drawn randomly from the local registry of the city of Mainz and the district of Mainz-Bingen. The sample was stratified 1:1 for gender and residence and in equal strata for decades of age. Participants between the ages of 35 to 74 years were included. Individuals with insufficient knowledge of the German language, or physical or mental inability to participate, were excluded; 5.2% were excluded based on these exclusion criteria. The response rate (defined as the recruitment efficacy proportion, i.e., the number of persons participating in the baseline examination divided by the sum of the number of persons participating in the baseline examination plus those who refused and those who could not be contacted) was 55.5%. The sample is described in detail in the supplement material (Table S2a and Table Sb) separately for men and women. Mean age was 55.0 (SD = 11.1) years; 49.4% were female.

Measures and assessment

Data were collected during a 5-h examination in the study center. They included evaluations of classic cardiovascular risk factors, laboratory examinations, a computer-assisted personal interview and anthropometric measurements. In the computer-assisted personal interview, participants were asked questions about sociodemographic variables and completed questionnaires. All examinations were performed according to standard operating procedures by certified medical technical assistants.

The Social Readjustment Rating Scale (SRRS) (Holmes and Rahe 1967) is a widely used checklist for stressful life events (Scully et al. 2000; Hobson and Delunas 2001). It provides a standardized measure of the impact of a wide range of common stressors. The original version includes 43 items. An adapted German version with 36 items was administered in the GHS (Cronbach's alpha = 0.81). Seven items were excluded because of partially overlapping content and time constraints. In line with the original scale, the GHS version of the SRRS used four response categories (0 = never occurred; 1 = occurred in the last year; 2 = occurred 2 to 5 years ago; 3 = occurred > 5 years ago). Response categories 2 and 3 were combined as "occurred > 1 year" in the descriptive statistics based on single SLEs stratified for sociodemographic variables (see supplement material Table S1, Table S2, Table S2a and Table S2b). Since weighted scores indicating the severity of stress for each life event were only available for SLE regarding the past year (Miller and Rahe 1997), we accordingly used only the categories 0 and 1 in multiple

regression analyses with SLE sum scores as dependent variables to compare unweighted and weighted sum scores of the SRRS items. Death of the spouse or a close family member, divorce or marital separation, and jail terms were regarded as the most severe SLEs.

Depression was measured by the Patient Health Questionnaire (PHQ-9) (Kroenke and Spitzer 2002), which quantifies the frequency of being bothered by each of the nine diagnostic criteria of major depression over the past 2 weeks. The items were rated on a 4-point Likert scale, 0 = not at all to 3 = nearly every day. Responses are summed to create a score between 0 and 27 points.

Generalized anxiety (GAD) was identified by the GAD-2 screener derived from the anxiety module of the PHQ (Kroenke et al. 2007). Participants answered the two GAD items "Feeling nervous, anxious or on edge" and "Not being able to stop or control worrying" on a 4-point Likert scale, 0 = not at all to 3 = nearly every day.

General subjective health was measured by the item "How do you rate your health in general on a 5-point Likert scale ranging from 1 = "very good" to 5 = "bad"? (Brähler et al. 1979). To ease the interpretation, we recoded this variable so that a high score indicated better health.

Sociodemographic variables used in this study were: sex, age, socioeconomic status (SES), partnership and income. Sex and partnership were dichotomous variables. Age was measured as a continuous variable for descriptive statistics, and subsequent analysis of variance categories were calculated based on 10-year intervals. SES was defined according to Lampert and Kroll's scores of SES with a range from 3 to 21: 3 indicates the lowest SES and 21 the highest. Subsequently, we generated three SES categories (low, moderate, high) based on Lampert et al.'s (Lampert and Kroll 2009) recommendation for descriptive analyses and analyses of variance. Following the Organisation for Economic Co-operation and Development [OECD (OECD 2011)], we estimated equivalence income by dividing net household income by the square root of the number of people living permanently in a household.

Statistical analysis

Descriptive statistics were calculated for each SRRS item. Group-specific statistics were provided, such as sex, age and socioeconomic status. To test group differences, univariate and multivariate analyses of variance were subsequently performed. Spearman correlation analyses (SLE at the item and aggregated level) and multiple hierarchical regression analyses (SLE at the aggregated level) with the enter method were used to investigate the association of stressful life events with health-related variables. We did not estimate missing data for inference statistical analyses because they can be systematic, for instance, because of sex (e.g., pregnancy), age (e.g.,

school-related questions, retirement) and other determinants. For multivariate analyses (i.e., variance and regression analyses), listwise deletion was used. Multiple regression models with SLE on the item level were not conducted because of the detrimental reduction of the sample size and lack of variance for many single SLE item predictors. In the first block of the regression analyses at the aggregated level, sociodemographic variables were controlled. The second block included the aggregated SLE sum score (unweighted or weighted). Due to the big baseline sample, p values should be treated with caution and are primarily given for descriptive reasons; they correspond to two-tailed tests. Statistical analyses were conducted using SPSS for Windows 23. Correlation and regression coefficients were interpreted based on Cohen (Cohen 1988).

Results

Descriptive statistics for all items of the SRRS are displayed in Table S1 (see supplement material) for all participants referring to the frequency of live events which occurred in the past year. Detailed data reporting frequencies with regard to all response categories ["never," "occurred in the past year" and "> 1–5 years (lifetime)"] are presented as supplement material (Table S2 overall, Table S2a female, Table S2b male).

In the past year, having been on vacation was reported most frequently by a total of 68.6%, followed by personal injury or illness (23.7%), outstanding personal achievements (19.2%), changed health status of a family member (17.7%), change of personal habits (16.2%), conflicts with the boss (13.5%), change in financial state (12.8%), change in sleeping habits (12.4%), change in recreation and change in responsibilities at work (11.3% each), reconciliation with a partner (11.2%) and death of a close family member (9.6%), business readjustment, change to a different line of work and death of a close friend (8.8% each). Patterns were similar for women and men; however, men reported more than twice as many minor law violations (19.7%) as women (8.9%). Regarding lifetime incidences, the majority of participants reported life events such as marriage, pregnancy (women), death of a close family member, moving, and vocational and educational changes. Women reported the death of a spouse more frequently (9.6%) than men (1.4%). Table S2a and S2b shows the SLE items according to age and SES for females and males, respectively.

Multivariate analyses of variance with SLE at the item level as dependent variable revealed large main effects for sex (Wilks' $\lambda = 0.70$, $F(36, 8466) = 99.30$, $p < 0.001$, $\eta_p^2 = 0.30$) and age (Wilks' $\lambda = 0.42$, $F(108, 25{,}355) = 79.79$, $p < 0.001$, $\eta_p^2 = 0.25$). A moderate effect was found for SES (Wilks' $\lambda = 0.85$, $F(72, 16{,}932) = 20.26$, $p < 0.001$, $\eta_p^2 = 0.08$). Interaction effects of sex × age (Wilks' $\lambda = 0.96$, $F(108, 25{,}355) = 3.19$, $p < 0.001$, $\eta_p^2 = 0.01$), sex × SES (Wilks' $\lambda = 0.98$, $F(72,$

16,932) = 2.88, $p < 0.001$, $\eta_p^2 = 0.01$), age × SES (Wilks' λ = 0.95, $F(216, 50,205) = 2.18$, $p < 0.001$, $\eta_p^2 = 0.01$) were also significant, but with neglectable effect sizes. No significant effect was found for the triple interaction among the three independent variables (Wilks' λ = 0.97, $F(216, 50,205) = 1.16$, $p = 0.06$, $\eta_p^2 = 0.01$). Correlations between weighted and unweighted SLE sum scores were r = 0.96. Overall, almost identical findings were observed for unweighted scores because of the high correlation of weighted and unweighted scores. Therefore, only the results for weighted SLE sum scores are reported. As depicted in Fig. 1, the cumulated SLE increased with SES, but decreased with age in males and females. Compared with SLE analyses at item level, univariate analyses of variance with the aggregated SLE score (unweighted and weighted) revealed significant main effects with a rather small effect size for age ($F(3,12,913) = 310.69$, $p < 0.001$, $\eta_p^2 = 0.07$) and SES ($F(2, 12,913) = 44.08$, $p < 0.001$, $\eta_p^2 = 0.01$), but not for sex ($F(1, 12,913) = 0.03$, $p = 0.88$, $\eta_p^2 = 0.00$). None of the interaction terms turned out to be significant.

With regard to the association of mental and general subjective health with stressful life events, unweighted and weighted aggregated SLEs were significantly correlated with depression (r = 0.17 and 0.18, $p < 0.001$) and anxiety (r = 0.16 and 0.17, $p < 0.001$). There was only a very weak association of the unweighted SLE sum score with general subjective health (r = −0.04, $p < 0.001$), but none of the weighted SLE sum score (r = −0.01, n.s.). The differences of correlation coefficients referring to the unweighted SLE sum score were significant between general health and depression (z = 14.26, $p < 0.001$) or anxiety (z = 7.37, $p < 0.001$), respectively, indicating a larger effect on mental distress compared with general health. Table 1 depicts correlations between SLEs and depression, anxiety and general health. While SLEs such as personal injury or illness and sexual difficulties are similarly detrimental for general and mental health, change in responsibilities at work increases mental distress, but is also linked to better general health. Higher detrimental associations with mental health compard with general health were found for change in different areas such as living conditions, recreation, sleeping habits, personal habits, financial state, health status of a family member or line of work. Having trouble with the boss is primarily linked with mental distress, not with general health.

Regression analyses showed that unweighted and weighted aggregated SLEs significantly predicted depression (β = 0.18 and 0.19, $p < 0.001$) and anxiety (β = 0.17 and 0.18, $p < 0.001$) and to a lesser degree lower subjective health (β = −0.09 and −0.10, $p < 0.001$) controlling for sociodemographic factors. With regard to mental health, especially female sex and lower income, and to a neglectable amount absent partnership, lower SES and lower age additionally predicted depression. A similar pattern was observed for anxiety, but age and SES did not reach significance. Referring to general health, especially lower age and higher SES, but also employment and income were significant sociodemographic factors. The explained variance for all models ranged from 6% to 7% (Table 2).

Discussion

Our study provided frequencies of SLEs (Holmes and Rahe 1967; Hobson and Delunas 2001; Miller and Rahe 1997) for a large sample from the German population. We reported associations of stressful life events in terms of Holmes and Rahe's stress definition with mental health for a population-based German sample which had not been available to date.
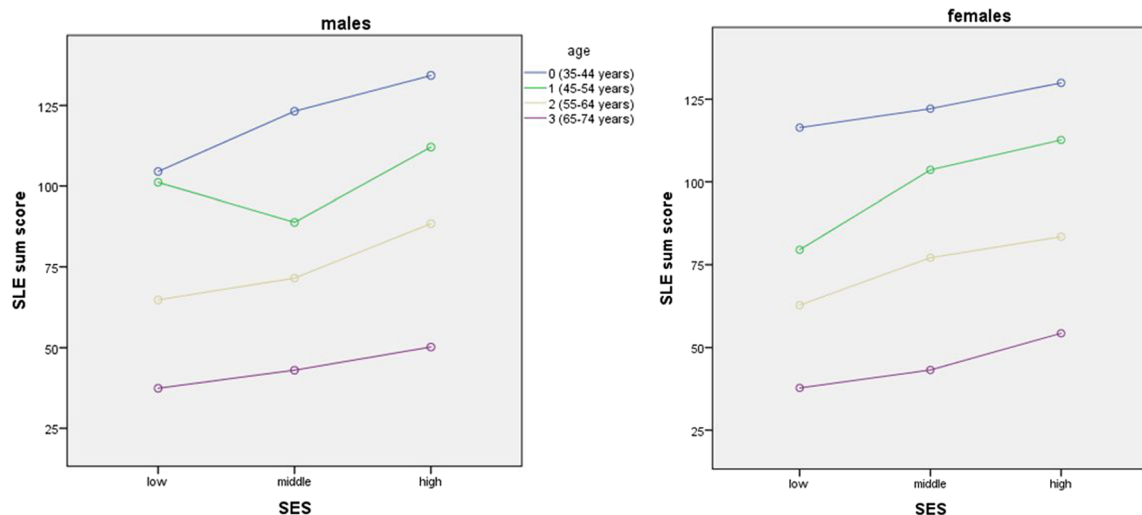

Fig. 1 Aggregated stressful life events (SLE) for men and women stratified by age and socioeconomic status (SES) in a German representative sample (N = 12,947)

Table 1 Bivariate correlation of stressful life events (SLE) with mental health in a German representative sample (N = 12,947)

Stressful life events (SLEs)	Depression N = 12,916	Anxiety N = 12,856	General health N = 11,566
1. Marriage	−0.02	0.01	−0.02
2. Fired at work	0.09***	0.07***	−0.04***
3. Retirement	−0.02*	−0.03***	−0.04***
4. Business readjustment	0.07***	0.09***	0.06***
5. Change in responsibilities at work	0.08***	**0.10***	**0.11***
6. Son or daughter leaving home	0.03*	0.04**	0.01
7. Trouble with in-laws	0.08***	0.08***	0.00
8. Change in residence	0.08***	0.08***	0.06**
9. Change in recreation	**0.16***	**0.14***	−0.01
10. Vacation	−0.02*	0.02*	0.08***
11. Minor violations of law	0.03**	0.02*	0.03**
12. Change in sleeping habits	**0.28***	**0.21***	**−0.10***
13. Change in financial state	**0.22***	**0.21***	−0.06***
14. Christmas alone	**0.12***	0.06***	−0.05***
15. Divorce	0.05***	0.06***	0.00
16. Death of Spouse	0.04***	0.02**	−0.03**
17. Personal injury or illness	**0.17***	**0.15***	**−0.18***
18. Marital reconciliation	0.08***	0.08***	0.02*
19. Pregnancy	−0.01	0.00	0.06***
20. Change to a different line of work	**0.16***	**0.15***	0.05**
21. Trouble with boss	**0.19***	**0.19***	−0.03*
22. Change in church activities	0.04***	0.05***	0.00
23. Begin or end school	0.06**	0.04*	0.03
24. Change in living conditions	**0.11***	**0.12***	0.04*
25. Marital separation	0.07***	0.07***	0.01
26. Death of close family member	**0.11***	0.08***	−0.08***
27. Change in schools	−0.01	−0.00	0.01
28. Outstanding personal achievement	0.05***	0.09***	0.09***
29. Change of personal habits	**0.18***	**0.18***	−0.03*
30. Spouse begins or stops work	0.02	0.02*	−0.01
31. Foreclosure on mortgage or loan	0.04***	0.03**	−0.01
32. Jail term	0.01	0.02*	0.00
33. Change in health of family member	**0.18***	**0.20***	−0.08***
34. Sex difficulties	**0.18***	**0.14***	**−0.11***
35. Gain of new family member	0.05***	0.04***	0.00
36. Death of close friend	0.07***	0.06***	−0.05***
SLE sum score unweighted	**0.17***	**0.16***	−0.04***
SLE sum score weighted	**0.18***	**0.17***	−0.01

Note: significant correlations with Bonferroni correction at *p < 0.05., **p < 0.01.,0 and ***p < 0.001. Bold-typed correlation coefficients are r ≥ 0.10

Comparisons with international data using the SRRS are now possible with a reliable data set from Germany allowing cross-cultural insights (Assari and Lankarani 2016). Based on the large and representative data set, we further provided reliable data without common selection bias for specific subpopulations, which is necessary for target-oriented public health services.

In the past year, having been on vacation as a normative life event was reported by the majority. Frequent health-related issues referring to the person were personal injury or illness or to the social network were changed health status of a family member, death of a close family member and death of a close friend. Changes of habits or health behaviors included: change of personal habits, change in recreation and change in sleeping

Table 2 Prediction of distress (depression, anxiety) and general health by stressful life events (SLE) at aggregated level controlling for sociodemographic variables in a German representative sample ($N = 12,947$)

	Depression		Anxiety		General health	
	Beta	T	Beta	T	Beta	T
Sociodemographic variables						
Sex	**0.10***/0.10*****	11.27/11.2	**0.13***/0.13*****	13.87/13.90	0.03**/0.03**	3.1/3.11
Age	−0.03**/−0.04**	−2.74/−2.96	−0.01/−0.01	−0.51/−0.8	**−0.15***/−0.15*****	−10.92/-11.27
SES	−0.06***/−0.06***	−5.45/−5.18	0.01/0.02	1.1/1.39	**0.11***/0.11*****	9.1/9.06
Partnership	−0.04***/−0.04***	−4.1/−04.10	−0.02*/−0.02*	−2.72/ −2.73	0.01/0.01	1.37/1.33
Employment	−0.02/−0.01	−1.21/−01.01	0.02/0.02	1.35/1.54	0.04**/0.04**	3.09/3.04
Equivalence income	**−0.10***/−0.10*****	−8.81/−7.77	**−0.09***/−0.09*****	−8.1/−8.04	0.08***/0.08***	6.98/6.97
Stressful life events						
SLE sum score	**0.18***/0.19*****	18.16/ 19.46	**0.17***/0.18*****	17.4/18.25	**−0.08***/−0.10*****	−7.91/−8.73
R^2, F-value (111897)	0.07, 417.65***/0.07, 466.8***		0.06, 369.46***/0.06, 399.56***		0.06, 173.58***/0.07, 205.64***	

Note: Results when using the unweighted SLE sum score are presented on the left side; for the weighted SLE results are displayed on the right side. SES = socioeconomic status. Bold-typed standardized regression coefficients ≥ 0.10.*$p < 0.015$. **$p < 0.01$. ***$p < 0.001$

habits. Vocational changes included trouble with the boss, change in financial state, change in responsibilities at work, change to a different line of work and business readjustment. Additional changes included personal achievements and reconciliation with the partner. Patterns were similar for women and men; however, men reported more than twice as many minor law violations as women and had more sexual problems than women.

Regarding lifetime incidences, the majority reported life events such as death of a close family member and normative events such as marriage, moving, and vocational and educational changes. Referring to reported single life events, there were some differences for men and women. In line with statistics of a higher mortality rate for men than women (Bundesamt 2016), for instance, women reported the death of a spouse more frequently than men. As was expected, women also reported a high lifetime frequency of pregnancy. Surprisingly, also men described pregnancy as a personal life event, albeit with a lower frequency for lifetime incidence, but to a similar amount for the past year. Thus, cognitive effects based on proximity in time and probably also on cohort effects seem to be relevant for this finding. Interestingly, the incidence of life events significantly decreased with age. A descriptive trend for higher SLE incidence rates was found for increasing social status: The youngest participants with the highest social status reported the highest sum of life events. A high SES, as evidenced by education, vocational status and income, is also likely to require flexibility and mobility. Adults from 35 to 44 years old are in an important phase of their family building and career advancement, so many SLEs can be expected.

At the bivariate level, many significant correlations of single SLEs with mental health were observed. Change of sleep habits and sexual difficulties can be taken as precursors or signs of depression. Conflicts with the boss, lack of personal achievement, and having an injury or disease are known predictors of mental distress (Kraaij et al. 2002); having spent Christmas alone can be taken as an indicator of social isolation. Conflicts with the boss, changes of personal finances and changed health status of a family member may indicate loss of security, a potential cause of anxiety and sexual difficulties. Both are more frequent in women. Conversely, general health has been associated with absence of personal illness, personal achievement, constant sleep patterns and vacationing along with younger age and higher SES.

Surprisingly, SLEs that are considered to be extremely stressful according to proposed scoring weights (death of the spouse or a close family member, divorce or marital separation, and jail term) were not linked to mental health at all or only weakly for both. An explanation for the lack of association between severe SLEs and mental health is mediating processes that are not included in our statistical models. For instance, Schwarzer and Schulz (2003) proposed the mediating role of health behavior and coping strategies to explain the link between SLEs and illness indicators. Another potential explanation is crucial moderating variables that have not been taken into account. Irrespective of different scoring suggestions of SLEs, further investigation of moderating variables for severe life events [e.g., for death of a spouse, see (Specht et al. 2011)] is required to understand these effects. Potential moderating variables are interindividual differences, especially psychological traits, as well as structural and social factors, such as generational and societal differences. The death of a beloved person after a long struggle with illness together with

the psychological and financial burden is likely to result in a decrease of distress compared with a sudden unexpected loss. Also, the theory of SLEs proposed by Holmes and Rahe (1967), which is the theoretical foundation of the SRRS, assumes that valence of a life event is irrelevant. However, the subjective valence of an experienced life event has been found to vary interindividually (Cooper et al. 1985). Finally, a third potential explanation might be associated with the outcome variables used in our study. Depressive symptoms and anxiety represent internalizing disorders. Individuals who were former prison inmates were more likely to express mental distress in externalizing symptoms, e.g., anger disorders (Rohrmann et al. 2013).

Bivariate correlation and multiple regression analyses revealed the effect of SLE on depression, anxiety and general health controlling for sociodemographic variables. In line with other studies (Spinhoven et al. 2010; Vardaxi et al. 2018; Kessler 1997), aggregated SLEs in terms of SLE sum scores were significant and consistent positive predictors of both indicators of mental distress. Weaker or no effects were found between cumulated SLEs and general health. Our findings emphasize the larger impact of cumulated SLEs on mental health compared with general health representing a more abstract concept including mental, physical and social health. As assumed before, the manifestation of life event effects is supposed to be reflected predominantly in mental health before affecting overall health comprising many domains. Also, findings at the item level revealed stronger relations between mental health and most SRRS items. Only a few items such as those including somatic health content (e.g., personal illness and sleep patterns) showed a significant association with general health. From a psychometric point of view, this result can be interpreted as validation for SLE scores in terms of convergent and discriminant validity. In our study, which refers to a large and representative sample, similar results were observed regardless of the use of weighted or unweighted sum scores. Thus, the scoring debate of life event checklists is not relevant for data interpretation of the current study compared with studies with small study populations and a higher likelihood of sample bias [cf. (Hobson et al. 1998)]. Self-reported general health revealed a stronger association with cumulated SLEs when sociodemographic variables were controlled. Overall, however, the proportion of explained variance of mental distress and general health was only 6% to 7%.

Positive bivariate relations of vacation and outstanding personality achievements were also observed in general health. Interestingly, a change in responsibilities at work was linked to better general health, but also to higher anxiety levels that might arise along with more novel and thus uncertain circumstances. In multivariate analyses, personal outstanding achievements were linked to lower depression and better general health. Overall, results were quite heterogeneous, not allowing the identification of SLE categories, such as

normative vs. non-normative, health-related, social or vocational, that might affect mental health more than others. For epidemiological studies among adults, SLEs with low incidence rates such as a jail term or change in schools can be regarded as less relevant.

Large interindividual differences are inherent with regard to effects of life events on health-related outcomes (Schwarzer and Schulz 2003). Stress caused by a particular stressor varies from one person to another because of the variability of circumstances, appraisal processes and many other personality-related characteristics such as goals, values, coping strategies and resources. In summary, although the SRRS is well researched, the results are only a rough approximation at best. A scale development of life event checklists is beyond the scope of this report, but data derived from the current study provide helpful information to do so. To interpret the results as causal effects of SLEs on mental health, a clear distinction of the chronical occurrence of SLEs and symptoms of depression and anxiety is pivotal. An overlap of the chronical appearance of the independent and dependent variables has not been controlled in the current study design. For a better understanding of the underlying mechanisms, the observation of trajectories of health-related variables and single SLEs in specific populations (i.e., in terms of sex-sensitive analyses) and in defined domains (e.g., vocational, family, individual) taking the corresponding circumstances and the interindividual emotional valence of an SLE into account will be a first step.

ensure scientific analyses on the highest level. Therefore, data are not made available for the scientific community outside the established and controlled workflows and algorithms.

To meet the general idea of verification and reproducibility of scientific findings, we offer access to data at the local database in accordance with the ethics vote upon request at any time. The GHS steering committee, which comprises a member of each involved department and the head of the Gutenberg Health Study (PSW), convenes once a month. The steering committee decides on internal and external access of researchers and use of the data and biomaterials based on a research proposal to be supplied by the researcher. Interested researchers make their requests to the head of the Gutenberg Health Study (Philipp S. Wild; philipp.wild@unimedizin-mainz.de). More detailed contact information is available at the homepages of the GHS (German: www.gutenberghealthstudy.org; English: http://www.gutenberghealthstudy.org/ghs/overview.html?L=1).

Compliance with ethical standards

Ethics approval and consent to participate The GHS and its procedure, including the present analyses, were approved by the ethics committee of the Statutory Physician Board of Rhineland-Palatinate, Germany (reference no. 837.020.07; original vote: 22.3.2007, latest update: 20.10.2015) and controlled by the local and federal data safety commissioners. Participation was voluntary, and written informed consent was obtained from each subject upon entry into the study.

Consent for publication Not applicable.

Disclosure statement The authors declare that they have no competing interests.

References

Assari S, Lankarani MM (2016) Stressful life events and risk of depression 25 years later: race and gender differences. Front Public Health 4

Beutel ME, Wiltink J, Ghaemi Kerahrodi J, Tibubos AN, Brähler E, Schulz A et al (2019) Somatic symptom load in men and women from middle to high age in the Gutenberg health study - association with psychosocial and somatic factors. Sci Rep 9:4610

Brähler E, Köhl A, Lademann H (1979) Aspekte des Krankheitsverhaltens in der Bundesrepublik Deutschland. Empirische Daten aus einer repräsentativen Bevölkerungsbefragung. Die Medizinische Welt 30:723–726

Bundesamt D-S (2016) Statistisches Jahrbuch Deutschland und Internationales 2016. Statistisches Bundesamt, Wiesbaden

Cleary PJ (1980) A checklist for life event research. J Psychosom Res 24:199–207

Cohen J (1988) Statistical power analysis for the behavioral sciences. 2. Ed. ed. Erlbaum, Hillsdale, NJ

Cooper CL, Cooper R, Faragher B (1985) Stress and life event methodology. Stress Health 1:287–289

Ernst M, Wiltink J, Tibubos AN, Brähler E, Schulz A, Wild PS et al (2019) Linking cancer and mental health in men and women in a representative community sample. J Psychosom Res 124:109760

Filipp S (1995) Ein allgemeines Modell für die Analyse kritischer Lebensereignisse. S. 3–52. S-H Filipp. Psychologie Verlags Union, Kritische Lebensereignisse Weinheim

Goldberg EL, Comstock GW (1980) Epidemiology of life events: frequency in general populations. Am J Epidemiol 111:736–752

Harris CR, Jenkins M, Glaser D (2006) Gender differences in risk assessment: why do women take fewer risks than men? Judgm Decis Mak 1:48

Hobson CJ, Delunas L (2001) National norms and life-event frequencies for the revised social readjustment rating scale. Int J Stress Manag 8:299–314

Hobson CJ, Kamen J, Szostek J, Nethercut CM, Tiedmann JW, Wojnarowicz S (1998) Stressful life events: a revision and update of the social readjustment rating scale. Int J Stress Manag 5:1–23

Höhn R, Kottler U, Peto T, Blettner M, Münzel T, Blankenberg S et al (2015) The ophthalmic branch of the Gutenberg health study: study design, cohort profile and self-reported diseases. PLoS One 10:e0120476

Holmes TH, Rahe RH (1967) The social readjustment rating scale. J Psychosom Res 11:213–218

Hsu H-C (2011) Impact of morbidity and life events on successful aging. Asia Pac J Public Health 23:458–469

Jonker I, Rosmalen J, Schoevers R (2017) Childhood life events, immune activation and the development of mood and anxiety disorders: the TRAILS study. Transl Psychiatry 7:e1112

Kessler RC (1997) The effects of stressful life events on depression. Annu Rev Psychol 48:191–214

Kornerup H, Osler M, Boysen G, Barefoot J, Schnohr P, Prescott E (2010) Major life events increase the risk of stroke but not of myocardial infarction: results from the Copenhagen City heart study. Eur J Cardiovasc Prev Rehabil 17:113–118

Kraaij V, Arensman E, Spinhoven P (2002) Negative life events and depression in elderly persons: a meta-analysis. J Gerontol Ser B Psychol Sci Soc Sci 57:P87–P94

Kroenke K, Spitzer RL (2002) The PHQ-9: a new depression diagnostic and severity measure. Psychiatr Ann 32:509–515

Kroenke K, Spitzer RL, Williams JB, Monahan PO, Löwe B (2007) Anxiety disorders in primary care: prevalence, impairment, comorbidity, and detection. Ann Intern Med 146:317–325

Lampert T, Kroll LE (2009) Die Messung des sozioökonomischen Status in sozialepidemiologischen Studien. In: Richter M, Hurrelmann K (eds) Gesundheitliche Ungleichheit. VS Verlag für Sozialwissenschaften, Wiesbaden, pp 309–334

Landrine H, Klonoff EA, Gibbs J, Manning V, Lund M (1995) Physical and psychiatric correlates of gender discrimination. Psychol Women Q 19:473–492

Lantz PM, House JS, Mero RP, Williams DR (2005) Stress, life events, and socioeconomic disparities in health: results from the Americans' changing lives study. J Health Soc Behav 46:274–288

Lietzén R, Virtanen P, Kivimäki M, Sillanmäki L, Vahtera J, Koskenvuo M (2011) Stressful life events and the onset of asthma. Eur Respir J 37:1360–1365

Lillberg K, Verkasalo PK, Kaprio J, Teppo L, Helenius H, Koskenvuo M (2003) Stressful life events and risk of breast cancer in 10,808 women: a cohort study. Am J Epidemiol 157:415–423

Lüdtke O, Roberts BW, Trautwein U, Nagy G (2011) A random walk down university avenue: life paths, life events, and personality trait

change at the transition to university life. J Pers Soc Psychol 101: 620

Michal M, Wiltink J, Kirschner Y, Schneider A, Wild PS, Münzel T, et al. Complaints of sleep disturbances are associated with cardiovascular disease: results from the Gutenberg health study. 2014

Miller MA, Rahe RH (1997) Life changes scaling for the 1990s. J Psychosom Res 43:279–292

Mohr DC, Hart SL, Julian L, Cox D, Pelletier D (2004) Association between stressful life events and exacerbation in multiple sclerosis: a meta-analysis. Bmj. 328:731

Mooy JM, De Vries H, Grootenhuis PA, Bouter LM, Heine RJ (2000) Major stressful life events in relation to prevalence of undetected type 2 diabetes: the Hoorn study. Diabetes Care 23:197–201

OECD (2011) Divided We Stand – Why Inequality Keeps Rising. Paris2011 [updated Paris]

Paykel E (1997) The interview for recent life events. Psychol Med 27: 301–310

Phillips AC, Carroll D, Ring C, Sweeting H, West P (2005) Life events and acute cardiovascular reactions to mental stress: a cohort study. Psychosom Med 67:384–392

Rohrmann S, Hodapp V, Schnell K, Tibubos A, Schwenkmezger P (2013) Das State-Trait-Ärgerausdrucks-Inventar–2 (STAXI-2). Deutschsprachige Adaptation des State-Trait Anger Expression Inventory-2 (STAXI-2) von Charles D. Spielberger. Hans Huber, Bern

Schwarzer R, Schulz U (2003) Stressful life events. Handb Psychol

Scully JA, Tosi H, Banning K (2000) Life event checklists: revisiting the social readjustment rating scale after 30 years. Educ Psychol Meas 60:864–876

Shakoor S, Zavos HM, Haworth CM, McGuire P, Cardno AG, Freeman D et al (2016) Association between stressful life events and psychotic experiences in adolescence: evidence for gene–environment correlations. Br J Psychiatry:bjp. bp. 114.159079

Specht J, Egloff B, Schmukle SC (2011) The benefits of believing in chance or fate: external locus of control as a protective factor for coping with the death of a spouse. Soc Psychol Personal Sci 2:132–137

Spinhoven P, Elzinga BM, Hovens JG, Roelofs K, Zitman FG, van Oppen P et al (2010) The specificity of childhood adversities and negative life events across the life span to anxiety and depressive disorders. J Affect Disord 126:103–112

Thomas AJ, Witherspoon KM, Speight SL (2008) Gendered racism, psychological distress, and coping styles of African American women. Cult Divers Ethn Minor Psychol 14:307

Tibubos AN, Brähler E, Ernst M, Baumgarten C, Wiltink J, Burghardt J et al (2019a) Course of depressive symptoms in men and women: differential effects of social, psychological, behavioral and somatic predictors. Sci Rep 9:1–10

Tibubos AN, Brähler E, Ernst M, Baumgarten C, Wiltink J, Burghardt J et al (2019b) Course of depressive symptoms in men and women: differential effects of social, psychological, behavioral and somatic predictors. Sci Rep 9:18929

Vardaxi CC, Gonda X, Fountoulakis KN (2018) Life events in schizoaffective disorder: a systematic review. J Affect Disord 227: 563–570

Wild P, Zeller T, Beutel M, Blettner M, Dugi K, Lackner K et al (2012) [The Gutenberg Health Study]. Bundesgesundheitsblatt, Gesundheitsforschung. Gesundheitsschutz. 55:824–829

Wittchen H-U, Essau CA, Hecht H, Teder W, Pfister H (1989) Reliability of life event assessments: test—retest reliability and fall-off effects of the Munich interview for the assessment of life events and conditions. J Affect Disord 16:77–91

Wrzus C, Hänel M, Wagner J, Neyer FJ (2013) Social network changes and life events across the life span: a meta-analysis. Psychol Bull 139:53

Affiliations

Ana Nanette Tibubos[1] • Juliane Burghardt[1] • Eva M. Klein[1] • Elmar Brähler[1] • Claus Jünger[1,2] • Matthias Michal[1,3] • Jörg Wiltink[1] • Philipp S. Wild[3,4,5] • Thomas Münzel[2] • Susanne Singer[6] • Norbert Pfeiffer[7] • Manfred E. Beutel[1]

[1]   Department of Psychosomatic Medicine and Psychotherapy, University Medical Center of the Johannes Gutenberg University Mainz, Zahlbacher Str. 8, 55131 Mainz, Germany

[2]   Center of Cardiology, University Medical Center of the Johannes Gutenberg University Mainz, Mainz, Germany

[3]   DZHK (German Center for Cardiovascular Research), partner site RhineMain, Mainz, Germany

[4]   Center for Thrombosis and Hemostasis, University Medical Center of the Johannes Gutenberg University Mainz, Mainz, Germany

[5]   Preventive Cardiology and Preventive Medicine, Center for Cardiology, University Medical Center of the Johannes Gutenberg University Mainz, Mainz, Germany

[6]   Institute of Medical Biostatistics, Epidemiology and Informatics, University Medical Center of the Johannes Gutenberg University Mainz, Mainz, Germany

[7]   Department of Ophthalmology, University Medical Center of the Johannes Gutenberg University Mainz, Mainz, Germany