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WWII trauma impacts physical and mental health in the oldest old: results from a German population-based study

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ABSTRACT

Introduction: Epidemiological studies in different traumatised samples indicate an increased risk for numerous physical and mental diseases. It is suspected that this is due to chronic changes in fundamental processes in the immune, nervous, and endocrine systems, which take years to manifest pathologically. Previous studies have considered intervals of a few decades. However, little is known about whether a link between trauma and physical and mental health can be established over very long periods of time and in the oldest old population.

Materials and methods: A total of 1,299 German citizens aged 80 and above were interviewed about on-going suffering from the effects of traumatic World War II (WWII) events as well as about physical and mental health. Multiple linear and logistic regression models were used to assess the impact of suffering from the effects of traumatic events on general health, several medical conditions, multimorbidity, pain, and depression.

Results: 43.94% of the oldest old were still suffering from the effects of traumatic events in connection with WWII. Participants who were still suffering from the effects of traumatic events were more likely to be treated for heart failure, blood diseases, bladder problems, back pain, respiratory or lung diseases, and sleep disorders. They also had poorer general health, higher multimorbidity, more pain, and higher depression scores.

Discussion: Findings suggest that chronic psychological suffering from the effects of traumatic events in early life is associated with impaired physical and mental health even seven decades after the events.

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World War II; morbidity; medical condition; depression; allostatic load

Introduction

Exposure to psychological trauma and subsequent chronic stress is associated with a variety of different medical conditions such as coronary heart disease, diabetes, chronic obstructive pulmonary disease (COPD), cancer, chronic widespread pain, depression, and may even accelerate the process of aging itself (Afari et al., 2014; Chung, Jones, Harding, & Campbell, 2016; Edmondson & von Känel, 2017; Kohn, Levav, Liphshitz, Barchana, & Keinan-Boker, 2014; Lohr et al., 2015; Strauss, Dapp, Anders, Von Renteln-Kruse, & Schmidt, 2011; Vaccarino et al., 2014; Williamson, Porges, Lamb, & Porges, 2015). There is additional evidence that adverse childhood experiences (e.g. emotional or physical abuse, witnessing domestic violence) are related to cancer, COPD, ischemic heart diseases, liver diseases, headaches and depression in later life (Anda et al., 2008; Anda, Tietjen, Schulman, Felitti, & Croft, 2010; Brown, Thacker, & Cohen, 2013; Chapman et al., 2004; Dong, Dube, Felitti, Giles, & Anda, 2003; Dong et al., 2004; Dube et al., 2009). The adverse impact of traumatic experiences on health can be attributed to chronic changes in core biological systems (McEwen & Wingfield, 2003) and often becomes visible only years after the traumatic event (Danese & McEwen, 2012). A population naturally affected by more and severe medical conditions is the oldest old ($\geq$ 80 years). At the same time, this population is more likely to have experienced traumatic events throughout their lifetime (Glaesmer, Gunzelmann, Braehler, Forstmeier, & Maercker, 2010). Yet the connection between trauma and physical and mental health in the oldest old general population has scarcely been investigated due to challenging recruitment (e.g. cognitive decline, hospitalisation, full inpatient care). This study seeks to fill this gap by investigating the effects of traumatic childhood and adolescence experiences on late-life health in the oldest old population.

Allostatic load theory (McEwen & Stellar, 1993) has emerged as an influential theoretical framework to examine the adverse impacts of traumatic experiences on health in older age. Allostasis is defined as the ability of the body to adapt to changing environmental or internal factors in order to maintain stability of physiological key variables. The process of adaption relies on the flexibility of the nervous, endocrine, and immune system. Chronic overactivation (e.g. chronic stress after exposure to psychological trauma) of these systems is called allostatic load. As Danese and McEwen (2012) suggest, chronic stress during childhood interferes with the development of the above-mentioned physiological systems, leading to negative long-term consequences and potentially accelerating physical decline in older age.

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The most traumatic event experienced by many of the oldest old around the globe was probably the Second World War (WWII). WWII was a terrible catastrophe, claiming over 60 million lives, including six million Jews who were murdered by the Nazi regime. Millions of people worldwide served in the armed forces or the medical sector and even more were affected by the war as civilians. Many war survivors experienced severe traumatic events, such as combat, wounding, bombing, displacement, famine, and rape. Negative effects of WWII trauma on mental and physical health, which persist even decades after the war, are well studied with a focus on Jewish survivors of the Holocaust (e.g. Barel, Van IJzendoorn, Sagi-Schwartz, & Bakermans-Kranenburg, 2010) and veterans of the anti-Nazi coalition (e.g. Elder, Clipp, Brown, Martin, & Friedman, 2009). In Germany, there are only a few studies on long-term consequences of WWII trauma in the general population (e.g. Glaesmer, Braehler, Riedel-Heller, Freyberger, & Kuwert, 2011; Glaesmer et al., 2010; Glaesmer, Kaiser, Braehler, Freyberger, & Kuwert, 2012). Epidemiological studies show high prevalence of Post-Traumatic Stress Disorder (PTSD) in different samples of German older adults, ranging from 1% in former child soldiers (Kuwert, Spitzer, Rosenthal, & Freyberger, 2008) to 42% in former displaced children (Strauss et al., 2011). According to German population-based studies, around 3% of the German population aged 60 and above fulfil the criteria for PTSD (e.g. Glaesmer et al., 2010). Compared with 0.7% in Switzerland (Maercker et al., 2008) or 0.9% in the Netherlands (Van Zelst, De Beurs, Beekman, Deeg, & Van Dyck, 2003), this indicates a rather high prevalence.

Even though older adults with a history of traumatic experiences have higher health care utilisation (Lamoureux-Lamarche, Vasiliadis, Préville, & Berbiche, 2016), the post-traumatic symptomatology is often overlooked by general practitioners (Kuwert, Hornung, Freyberger, Glaesmer, & Klauer, 2015). In order to provide adequate treatment, it is crucial to understand this hidden variable. Since the generation who experienced WWII as children or adolescents is reaching a critically high age, this study might be one of the last opportunities to examine adverse health effects of WWII-related traumatic events on the oldest old. As the very old population is expected to triple by 2050 (He, Goodkind, & Kowal, 2016), the results could provide useful insights for future generations. The present study explicitly does not focus on the effects of chronic PTSD on physical and mental health, but rather on the relationship between a state of subjective suffering under long-ago events and possible associations with physical and mental illnesses. Based on the aforementioned studies, we hypothesised that suffering from the effects of WWII events leads to higher prevalence of medical conditions as well as higher pain, poorer general health, and higher depression scores in the oldest old.

Materials and methods

Subjects

This study is based on data from the 'Survey on quality of life and subjective well-being of the very old in North Rhine-Westphalia (NRW80+)', a representative, cross-sectional survey among persons aged 80 and older living in the most populous federal state of Germany. North Rhine-Westphalia is often referred to as 'small Germany' because it reflects the social structure of the whole Federal Republic. The data acquisition was carefully planned, taking into account the special challenges of surveys among the oldest old (Wagner et al., 2018). The Federal State of North Rhine-Westphalia was divided into 120 sample points, representing 94 communities. Representative sampling was realised by using a multistage approach, including respondents in private households and institutional settings. Interviews with proxy persons were realised in case the target person was not able to answer the survey. The choice of possible proxy persons was not limited, but the proxies were required to be able to provide sufficient information on the target person. Thus, for example, (professional) nursing staff could also be considered as proxy persons. The study was approved by the Ethics Committee of the Medical Faculty of the University of Cologne (No. 17-169). Between August 2017 and February 2018, 8,040 persons were contacted with a total of 1,863 interviews being realised, including 176 proxy interviews. Informed consent was obtained from all participants or legal representatives. Cognitive status was screened with a standardised neuropsychological test battery (DemTect; Kalbe et al., 2004), except for proxy interviews. The results of the cognitive screening were corrected for non-feasibility of the subtest convert numbers. For this study, participants who were screened positively for dementia (i.e. DemTect Score <9; $n = 137$), refused cognitive screening ($n = 73$) or had missing values in one of the subtests of the cognitive battery ($n = 270$) were excluded. Participants born outside present-day Germany or former German territory ($n = 121$) were also excluded to ensure that participants lived through the war as citizens of the Reich. In total, we included $n = 1{,}299$ participants in the present study. Around 12.16% ($n = 158$) ot the interviews were realised with proxy informants. Of those proxy informants, 48.73% ($n = 77$) were sons or daughters, 22.15% ($n = 35$) wives or husbands, 8.23% ($n = 13$) professional nurses, 5.70% ($n = 9$) sons- or daughters-in-law, 4.43% ($n = 7$) legal guardians, 3.80% ($n = 6$) nieces or nephews, 1.90% ($n = 3$) friends, 1.90% ($n = 3$) grandchildren, 1.90% ($n = 3$) partners (not married), and 1.27% ($n = 2$) brother- or sister-in-law.

Instruments

Traumatic events list

Participants were asked about suffering from the effects of WWII-related and non-WWII-related events. Suffering from WWII trauma was assessed with the question: 'Were there any experiences or events in your life that still weigh on you today?' If affirmed, the participants were asked: 'Which event still weighs on you the most today?' The answer was then categorised as WWII-related or non-WWII-related by the interviewer. If the participants reported a non-WWII-related event, they were asked specifically for WWII-events ('Were there any experiences or events in connection with the Second World War that still weigh on you today?'). The most burdening event was then categorised by the interviewer according to a modified version of the German version of the Composite International Diagnostic Interview (CIDI) trauma list (Wittchen & Pfister, 1997; World Health

Organization, 1990). Categories were bombardment, displacement or flight, physical threat, attack, injury or torture, captivity, kidnapping or hostage-taking, death of parents, death of siblings, survived serious illness, death of partner, accident, death of child, rape, or other. Non-WWII-related events were also assessed with a modified version of the CIDI trauma list.

Physical and mental health

Physical health was measured with an extended version of the Self-Administered Comorbidity Questionnaire (SCQ; Sangha, Stucki, Liang, Fossel, & Katz, 2003). Participants were asked which out of 19 medical conditions they were currently in medicated or non-medicated treatment for. Multimorbidity was assessed as the total sum of medical conditions. Subjective general health was measured on a four-point item ('How would you generally describe your health status in the past four weeks?') with possible responses of 'very poor', 'somewhat poor', 'somewhat good' and 'very good'. Pain was measured on a five-point item ('If you felt pain, how severe was your pain in the past four weeks?') with possible responses of 'no pain', 'light', 'moderate', 'strong', and 'very strong'. Mental health was assessed twofold. Firstly, 'mental illness' was one medical condition in the SCQ. Secondly, depression scores were measured with a short form of the Depression in Old Age Scale (DIA-S4; Heidenblut & Zank, 2010, 2020). The DIA-S4 is a four-item scale that showed good diagnostic performance in a sample of 331 geriatric inpatients (Heidenblut & Zank, 2020). Items (e.g., 'I tend to worry a lot') can be answered 'yes' or 'no'. 'Yes' responses are coded 1, 'no' responses are coded 0. Item 3 ('I can enjoy my life, even when things are sometimes more difficult') is reverse coded.

Statistical analyses

Statistics were computed in SPSS 25.0 (IBM Corp., Armonk, NY). χ^2-tests were run to determine differences in gender, percentage of proxy interviews, full inpatient care, and family status. Ordinal data effects (education, household income) were tested via Mann–Whitney tests. The DIA-S4 was dichotomised, as suggested by the authors (Heidenblut & Zank, 2020). Scale values below 1.5 indicate no possible depressive disorder, while values above 1.5 indicate a possible depressive disorder. Self-rated health was also dichotomised, because few participants chose the extreme answers ('very poor' 6.24%, 'very good' 9.85%). Only 6.51% of the participants responded having experienced 'very strong' pain in the past four weeks. The 'strong' and 'very strong' categories were therefore collapsed to one category 'strong'. Logistic regressions (including age, gender, and traumatic non-WWII event as possible confounders) were run to assess the relationship between the suffering from effects of WWII events and medical conditions, depressive disorder, and self-rated health. An ordinal regression model (including age, gender, and traumatic non-WWII) was fitted to assess the influence of suffering from traumatic WWII events on pain. The proportional odds assumption was tested with the Brant test (Brant, 1990). The goodness of fit for logistic and ordinal regression models was tested against the baseline model, using Log-likelihoods (-2LL). Effects of WWII trauma on multimorbidity, general health, pain, and depression were tested with linear regressions, adjusting for age, gender, and traumatic non-WWII event. p value to reject the null hypothesis was set to below .05 in all tests. Because the use of proxies is controversial for psychologically sensitive data (e.g., mental health), separate logistic, ordinal and linear regression analyses were conducted without proxies ($n = 1141$). The results are not displayed in detail. Where the results without proxies differ from the results with proxies, this is indicated accordingly.

Results

Descriptive characteristics

Table 1 shows the descriptive characteristics of the sample. Participants' ages ranged from 80 to 102 years with a mean age of 86.16 years ($SD = 4.52$). Since the latest included date of birth was in July 1937, all participants were at least two years old at the beginning of WWII and at least seven years old by the time WWII ended. Participants suffering from a WWII trauma were older ($M = 86.48$, $SD = 4.55$) than people not suffering from a WWII trauma ($M = 85.91$, $SD = 4.49$). This difference was statistically significant ($t(1297) = 2.25$, $p = .02$), representing a small effect size ($d = 0.13$). The risk of suffering from the effects of an additional non-WWII event was 1.58 times higher for participants suffering from the effects of WWII events compared with those not suffering from the effects of WWII events ($\chi^2 = 52.62$, $p < .001$). Study groups did not differ in gender, cognitive status, proportion of proxy interviews, family status, education, and household income.

Traumatic WWII events

A total of 565 (43.49%) participants were still suffering from WWII trauma over 70 years after the war. Participants answered that they were suffering the most from the effects of bombardment (12.47%) and displacement or flight (8.70%), followed by physical threat, attack, injury or torture (4.77%), death of parents (2.93%), captivity, kidnapping or hostage taking (2.77%), death of siblings (2.54%), death of partner (0.77%), survived serious illness (0.46%), death of child (0.23%), and rape (0.23%). 7.62% reported to suffer the most from an event not specified in the list.

Impact of WWII trauma on physical and mental health

Hypertension was the most widespread disease with over 59% of the total sample currently in treatment, followed by joint or bone disease (43%) and congestive heart failure (37%). On average, the participants had 3.62 ($SD = 2.33$) medical conditions. Logistic regression models revealed associations between WWII trauma and several medical conditions (Table 2).

Participants suffering from the effects of WWII-related events were more often treated for back pain (OR = 1.51, 95% CI = 1.18-1.94, $p < .01$), bladder problems (OR = 1.47, 95% CI = 1.10-1.97, $p < .01$), blood diseases (OR = 2.62, 95% CI = 1.28-5.36, $p < .01$), congestive heart failure

Table 1. Descriptive characteristics of the sample.

	Total sample ($n = 1299$) *M* (*SD*)	Not suffering from WWII trauma ($n = 734$) *M* (*SD*)	Suffering from WWII trauma ($n = 565$) *M* (*SD*)	*T*
Age	86.16 (4.52)	85.91 (4.49)	86.48 (4.55)	2.25*
	n (%)	*n* (%)	*n* (%)	χ^2/ *U*
Female	664 (51.12)	372 (50.68)	292 (51.68)	0.13
Cognitive status				2.86
Normal	930 (71.59)	512 (69.75)	418 (73.98)	
MCI	211 (16.24)	128 (17.44)	83 (14.69)	
Not assessed (proxy)	158 (12.16)	94 (12.81)	64 (11.33)	
Suffering from effects of non-WWII event	565 (43.49)	255 (34.74)	310 (54.87)	52.62***
Proxy interview	158 (12.16)	94 (12.81)	64 (11.33)	0.65
Full inpatient care	115 (8.87)	70 (9.55)	45 (7.99)	0.96
Family status				5.87
married/living together	553 (42.58)	333 (45.37)	220 (38.94)	
married/living separate	12 (0.92)	7 (0.95)	5 (0.88)	
divorced	45 (3.46)	26 (3.54)	19 (3.36)	
widowed	649 (49.96)	346 (47.14)	303 (53.63)	
single	40 (3.08)	22 (3.00)	18 (3.19)	
Education				120.60
low	274 (21.87)	163 (23.02)	111 (20.37)	
middle	672 (53.63)	370 (52.26)	302 (55.41)	
high	307 (24.50)	175 (24.72)	132 (24.22)	
Household income				117.42
< 1.300€	170 (16.59)	96 (16.70)	74 (16.44)	
1.300€ to < 1.700€	180 (17.56)	91 (15.83)	89 (19.78)	
1.700€ to < 2.600€	345 (33.66)	189 (32.87)	156 (34.67)	
2.600€ to < 3.600€	199 (19.41)	131 (22.78)	68 (15.11)	
3.600€ to < 5.000€	80 (7.80)	41 (7.13)	39 (8.67)	
5.000€ to < 18.000€	50 (4.88)	27 (4.70)	23 (5.11)	
≥ 18.000€	1 (0.10)	0 (0.00)	1 (0.22)	

Note. $n = 1299$. *$p < .05$, *** $p < .001$.

Table 2. Logistic and ordinal regression analyses predicting medical conditions, self-rated health, and depression.

	Not suffering from effects of WWII event *n* (%)	Suffering from effects of WWII event *n* (%)	OR (95% CI)[1]	Modelfit χ^2
Depression[2] ($n = 1214$)	150 (21.83)	159 (30.17)	1.39 (1.07-1.82)*	36.56***
Poor self-rated health ($n = 1294$)	240 (32.83)	245 (43.52)	1.52 (1.21-1.92)***	19.30**
Pain ($n = 1290$)			1.36 (1.11-1.67)**	37.90***
No pain	229 (31.46)	151 (26.87)		
Low	158 (21.70)	103 (18.33)		
Moderate	205 (28.16)	151 (26.87)		
Strong	136 (18.68)	157 (27.94)		
Medical condition ($n = 1296$)				
Back pain	189 (25.85)	195 (34.51)	1.51 (1.18–1.94)**	32.87***
Bladder problems	114 (15.60)	122 (21.59)	1.47 (1.10–1.97)**	11.83*
Blood disease	12 (1.64)	24 (4.25)	2.62 (1.28–5.36)**	9.46*
Cancer	60 (8.21)	43 (7.61)	0.93 (0.61–1.42)	12.99*
Cardiac infarction	54 (7.39)	46 (8.14)	1.13 (0.74–1.74)	18.20**
Congestive heart failure	234 (32.01)	250 (44.25)	1.68 (1.33–2.12)***	31.76***
Diabetes	114 (15.60)	74 (13.10)	0.85 (0.62–1.18)	7.68
Ear disease or hearing loss	154 (21.07)	145 (25.66)	1.22 (0.93–1.59)	26.46***
Eye disease or visual impairment	211 (28.86)	185 (32.74)	1.14 (0.89–1.45)	8.34
Hypertension	425 (58.14)	347 (61.42)	1.17 (0.93–1.47)	4.01
Joint or bone disease	303 (41.45)	264 (46.73)	1.18 (0.94–1.48)	47.78***
Kidney disease	49 (6.70)	53 (9.38)	1.35 (0.89–2.05)	7.34
Liver disease	6 (0.82)	11 (1.95)	2.33 (0.84–6.50)	8.25
Mental illness	41 (5.61)	44 (7.79)	1.38 (0.88–2.17)	12.15*
Neurological disease	80 (10.94)	51 (9.03)	0.75 (0.51–1.09)	30.84***
Respiratory or lung disease	75 (10.26)	86 (15.22)	1.56 (1.11–2.20)*	7.52
Sleeping disorder	75 (10.26)	115 (20.35)	2.05 (1.48–2.83)***	44.86***
Stomach or intestinal disease	84 (11.49)	86 (15.22)	1.39 (1.00–1.94)	7.91
Stroke	56 (7.66)	45 (7.96)	1.11 (0.73–1.70)	5.03
Other chronical disease	88 (12.04)	76 (13.45)	1.12 (0.80–1.57)	5.55

Note. OR = odds ratio, CI = confidence interval. *$p<.05$, ** $p<.01$, *** $p<.001$. [1]Logistic regression models including age, gender, and traumatic non-WWII event. [2] Depression was defined as scale values of 2 and higher on the DIA-S4 (see instruments section for further information).

Table 3. Multiple regression analysis predicting multimorbidity

	Multimorbidity ($n = 1296$)	
	B (SE)	*β*
Constant	0.96 (1.22)	
Age	0.03 (0.01)	0.05
Gender	0.30 (0.13)	0.07*
Suffering from effects of critical life event	0.19 (0.13)	0.04
Suffering from effects of traumatic WWII event	0.63 (0.13)	0.14***

Note. R^2_{corr} multimorbidity = .03***. *$p < .05$, ***$p < .001$.

(OR = 1.68, 95% CI = 1.33-2.12, $p < .001$), respiratory or lung diseases (OR = 1.56, 95% CI = 1.11-2.20, $p < .05$), and sleeping disorders (OR = 2.05, 95% CI = 1.48-2.83, $p < .001$). No significant differences were found for the other medical conditions. Suffering from the effects of traumatic WWII-related events was also related to poorer self-rated health (OR = 1.52, 95% CI = 1.21-1.92, $p < .001$).

A proportional odds model was fitted to assess the association of suffering from the effects of WWII-traumatic events with pain (Table 2). The Brant test revealed no violations against the proportional odds assumption (all $p > .05$). For participants suffering from the effects of WWII-related traumatic events, the odds of experiencing more pain was 1.36 times (1.11-1.67, $p < .01$) that of participants not suffering from the effects of WWII-related traumatic events. With regard to mental health, suffering from the effects of WWII-related events was related to depression, as assessed with the DIA-S4 (OR = 1.39, 95% CI = 1.07-1.82, $p < .05$), but not with 'mental illness' as part of the SCQ. The multiple regression model (Table 3) showed higher multimorbidity for participants suffering from WWII trauma.

After excluding proxy informants, participants suffering from the effects of WWII-related traumatic events were also more often treated for stomach or intestinal disease (OR = 1.44; CI = 1.02-2.05, $p < .05$). No other differences were found, after excluding proxies.

Discussion

The purpose of this study was to broaden the understanding of two neglected aspects relating to the connection of trauma and health: firstly, the unique population of the oldest old (i.e. $\geq$ 80 years) was investigated, a rapidly growing population in many countries worldwide for which studies are still rare. Secondly, this study focuses on the effects of events that took place more than 70 years ago (i.e. WWII), while other studies mainly focus on shorter timeframes. Unlike other studies, the present study did not focus on chronic or reactivated PTSD, but on a state of subjective suffering from the effects of WWII-related traumatic events and its relation to physical and mental health. This cross-sectional study shows that over 43% of the German oldest old population are still burdened by traumatic events related to WWII. The events that cause the most suffering include, among others, bombardment, displacement, physical threat, and death of close relatives. As hypothesised, this study found higher prevalence of congestive heart failure, respiratory or lung diseases, back pain, blood diseases, bladder problems, and sleeping disorders in participants still suffering from the effects of traumatic events. Odds ratios ranged from 1.47 for bladder problems to 2.62 for blood diseases. Additionally, suffering from the effects of WWII-related events was associated with higher multimorbidity and pain as well as with poorer general health. With regard to mental health, participants suffering from the effects of traumatic WWII events were more often screened positively for depression using a newly developed self-report questionnaire (Heidenblut & Zank, 2020), but were not more likely to be treated for mental illnesses as assessed by self-report.

This study focused on traumatic experiences during WWII with an emphasis on the long-lasting effects of early childhood and adolescence trauma (the participants were two to 24 years old at the beginning of WWII). Studies on childhood maltreatment have shown that allostatic load can lead to diseases through chronic alteration of the highly connected nervous, endocrine, and immune system (Danese & McEwen, 2012). The present study found additional evidence to show that the adverse impact of traumatic childhood events is visible even 70 years after the traumatic experience. Yet it is important to mention that this study did not focus on the underlying biological mechanisms.

A recent review points to adverse effects of trauma on cardiovascular diseases (e.g. cardiac infarction, congestive heart failure, hypertension, stroke) (Edmondson & von Känel, 2017). The discussed biological pathways imply an overactivation of the sympathetic nervous system, reduced activation of the parasympathetic nervous system, altered HPA axis functionality, and higher inflammation levels. There is also strong evidence for behavioural risk factors such as smoking, physical inactivity, overweight, and non-adherence to treatment (Edmondson & von Känel, 2017). The results of the present study are consistent with this review with respect to cardiac insufficiency, whereas heart attack, hypertension, and stroke were not associated with traumatic WWII experiences. With regard to heart attacks, the findings of the present study are supported by a general population study (Spitzer et al., 2009), which did not find any differences between participants with and without traumatic experiences. However, a study on US veterans found higher prevalence in the trauma exposure group (El-Gabalawy, Blaney, Tsai, Sumner, & Pietrzak, 2018). This effect disappeared, though, after correcting for number of traumas, psychiatric disorders, drug and alcohol abuse, and nicotine dependence. With regard to hypertension, the majority of previous studies seem to indicate an association between trauma and hypertension, but comparability with this study is limited due to different samples (e.g. Kang, Bullman, & Taylor, 2006). One link between trauma and cardiovascular diseases in general might be sleeping disorders (Edmondson & von Känel, 2017). The present study supports this hypothesis as higher prevalence of sleeping disorders in participants suffering from the effects of traumatic experiences was found.

Older adults suffering from the effects of traumatic WWII experiences had higher prevalence of respiratory or lung diseases (e.g. Asthma, COPD) the present study. This result corresponds to the findings of other studies in older general and veteran populations (El-Gabalawy et al., 2018; Glaesmer, Brähler, Gündel, & Riedel-Heller et al., 2011). Traumatic WWII-related experiences were also associated with higher treatment rates for back pain and higher self-rated pain in this study. This is a well-documented finding in veteran (El-Gabalawy et al., 2018) and civilian samples (Glaesmer, Brähler, Gündel, et al., 2011). Discussed pathways imply an altered HPA axis response to stress as stated by allostatic load theory (McEwen & Stellar, 1993; McEwen & Wingfield, 2003) as well as attentional bias towards pain stimuli and misinterpretation of body signals (Sharp & Harvey, 2001). Empirical evidence of blood diseases (e.g. anaemia, leukaemia, lymphoma) following traumatic experiences is very limited. This study found higher incidence of blood diseases in older adults suffering from the effects of traumatic WWII experiences. Similar results were found for anaemia in another cross-sectional study on primary care patients with PTSD (Weisberg, Bruce, & Machan, 2002). Future studies should examine the underlying biological pathways more closely.

Linking psychological stress to bladder problems is a common finding in patients with interstitial cystitis and

overactive bladder (Lai, Gardner, Vetter, & Andriole, 2015). The present study, participants suffering from the effects of traumatic WWII experiences were treated more often for bladder problems compared with the non-suffering participants. This result was also found in studies on overactive bladder in female veterans (Bradley, Nygaard, Hillis, Torner, & Sadler, 2017). Again, altered HPA axis activity due to posttraumatic stress might be one possible pathway (Pierce et al., 2016).

The connection between traumatic stress and cancer seems to be less clear than the connection to cardiovascular diseases. The present study found no association between suffering from WWII-related traumatic events and cancer in the oldest old population. Contrary to the present study, US veterans with trauma exposure showed higher cancer prevalence in several studies (e.g. El-Gabalawy et al., 2018), which is supported by a recent community-sample study (Kaster, Sommer, Mota, Sareen, & El-Gabalawy, 2019). However, the authors of the latter point out that there are differences depending on the type of cancer. Particularly breast cancer seems unrelated to traumatic events. The present study did not differentiate between cancer types, which might explain the non-significant results of the present study.

Several studies suggest an association between posttraumatic stress and diabetes (e.g. Vaccarino et al., 2014). In the older population, diabetes was associated with traumatic experience, but not with PTSD (Glaesmer, Brähler, Gündel, et al., 2011). The present study found no evidence for the above-mentioned association in the oldest old population. Additional studies are required to further elaborate this contradiction. Joint or bone diseases (e.g. arthritis, rheumatoid arthritis, osteoporosis) were not associated with suffering from traumatic WWII experiences in the present study. Other studies found higher rates in US veterans exposed to trauma or with current PTSD (e.g. El-Gabalawy et al., 2018). This finding is further supported by general population studies (e.g. Glaesmer, Brähler, Gündel, et al., 2011). One possible explanation why joint and bone disease was not associated with suffering from WWII-related traumatic events in the present study could be that the prevalence of joint and bone diseases is generally high in the oldest old (Gheno, Cepparo, Rosca, & Cotten, 2012). The present study, over 43% were affected, with hypertension being the only disease that is more common. Thus, as the traumatised people reach a very high age, group differences might vanish. Longitudinal epidemiological studies might address this issue in the future. With regard to neurological diseases (e.g. Parkinson's disease [PD], epilepsy, multiple sclerosis, polyneuropathy, migraine), this study found no association with suffering from the effects of traumatic WWII events. However, in another study especially migraine seems to be associated with PTSD (e.g. El-Gabalawy et al., 2018). Evidence was also found with respect to PD in one longitudinal study (Chan et al., 2017). The present results can partly be explained by a higher mortality risk of PD patients as well as generally high dementia rates in PD patients (participants with low cognitive screening scores were excluded in the present study).

War is one major trigger for many mental illnesses like depression in the older population (Morina, Stam, Pollet, & Priebe, 2018). This study has shown traumatic experiences to influence mental health in a complex way. Treatment for mental illnesses in general seemed not to be influenced by the suffering from the effects of WWII events. However, participants that suffered from such effects had higher depression scores and were treated more frequently for sleep disorders, a common comorbidity of mental health issues. The results can partly be explained by the finding that many traumatised older adults express their mental illness through somatisation (Glaesmer et al., 2012), and older adults are often neglected regarding treatment for mental illnesses (Smith, Cook, Pietrzak, Hoff, & Harpaz-Rotem, 2016).

An important aspect for the interpretation of the present results is the general impact of traumatic experience on ageing and mortality. Behavioural explanations for altered mortality of traumatised persons include a heightened risk for developing alcohol use disorders (Norman, Haller, Hamblen, Southwick, & Pietrzak, 2018) as well as a heightened suicide risk (Gradus et al., 2010). A more biologically based approach to explaining the negative effects of traumatisation on ageing is the study of telomere length. Telomeres are chromatin structures that cap the chromosomal DNA end and protect it from damage. With ageing, telomere length decreases continuously (Blackburn, Epel, & Lin, 2015). Traumatic events like childhood trauma can fasten telomere shortening (Coimbra, Carvalho, Moretti, Mello, & Belangero, 2017). This effect was also found in former prisoners of war (Solomon et al., 2017) and civilian women with trauma (Roberts et al., 2017). Aggregating these findings, one might argue that the oldest old population represents only the most resilient WWII survivors, and many of those traumatised by WWII did not reach this very high age. This could at least partly explain some of the null results of the present study.

Most literature about the effects of traumatic experiences on physical and mental health focus either on pathologies like PTSD or concepts like Late Onset Stress Symptomatology (LOSS; Davison et al., 2006) and their associations with diseases. LOSS is defined as normative processes in aging combat veterans who did not develop stress-related disorders after war-exposure in the first place. However, after being confronted with the challenges of aging itself (e.g., retirement, loss of spouse, physical illness), veterans experience more war-related thoughts, memories, and feelings. Compared to PTSD, LOSS is associated less with psychopathology, but there might be commonalities with subthreshold PTSD (Potter et al., 2013). The present study, however, asked about ongoing personal suffering with a single item ('Were there any experiences or events in connection with the Second World War that still weigh on you today?'). It thus maps a widespread, subjective suffering from traumatic experiences in the distant past and can show that here, too, connections with impaired physical and mental health can be found. The question of possible overlaps with PTSD and LOSS, however, must remain unanswered at this point. Future studies could compare the present measure with established concepts such as PTSD and LOSS to explain possible correlations and differences.

Limitations

The present study benefits from its unique insight into the rapidly growing oldest old population. However, some

limitations should be mentioned. Despite the negative impact on representativeness, participants who were screened positive for dementia or had missing values in the cognitive battery were excluded. This was regarded as necessary to ensure reliability and validity of participants' answers. Possibly, more physiologically based assessments of posttraumatic suffering, like autonomic response to stressful stimuli (D'Andrea, Pole, DePierro, Freed, & Wallace, 2013), could overcome this issue in the future.

Proxy responses can help to conduct representative surveys among very old and impaired samples. Although it is difficult to compare proxy statements with the statements of those affected, some studies indicate that proxies systematically overestimate the physical and psychological burden of old people (Li, Harris, & Lu, 2015; Neumann, Araki, & Gutterman, 2000). The present study decided to include proxy responses because there were no systematic differences in the frequency distribution of proxy interviews between people suffering from the effects of WWII-related traumatic events and those not suffering from them. However, in order to account for possible biases, separate analyses were conducted without proxies. The exclusion of proxies led to significantly higher OR for stomach and intestinal diseases in participants suffering from the effects of WWII-related traumatic events. With proxies taken into account, this relationship was only close to statistical significance. Based on these results, it is rather unlikely that the inclusion of proxies in the present study led to a systematic bias of the results.

When interpreting this study, the limitations of the cross-sectional design regarding causality must be considered. In the investigation of traumatic events, ethical concerns prohibit the application of experimental study designs to human populations, This is especially relevant when discussing the direction of the observed WWII trauma – impaired health pathway. It could be argued that those who reported suffering from the effects of WWII-related traumatic events did so because of their currently impaired physical or mental health (e.g. depression, pain). This also applies to the observation of the present study that people who reported suffering from the effects of WWII-related traumatic events also reported suffering from additional non-WWII-related events more often. On the one hand, participants who suffered from WWII-related traumatic events could be more vulnerable to subsequent traumatic events, as suggested by cumulative disadvantage theory (Dannefer, 2003). On the other hand, attention and memory bias towards negative stimuli is often observed in depressed adults and adults with chronic pain (Gotlib & Joormann, 2010; Pincus & Morley, 2001). These attention and memory-related processes could lead to a negatively distorted evaluation of one's own past.

In this study, participants suffering from the effects of WWII-related traumatic events were significantly older than those who indicated no suffering. Despite the small effect size, this could bias the results in several ways. On the one hand, people who were older at the time of WWII may have stored the experiences more consciously and therefore have better access to conscious memory content today. On the other hand, WWII experiences may become more stressful with age, as they are reactivated by other experiences such as physical illness or loss of close relatives. At the same time, the age differences at the time of the traumatic events must also be taken into account. Literature suggests that traumatic experiences in early childhood have a more negative impact on psychopathology compared to older childhood or adolescence (Dunn, Nishimi, Powers, & Bradley, 2017). Again, the cross-sectional study design cannot account for such differences. Therefore, age was included in the statistical analyses, in order to account for possible bias. However, it cannot be ruled out that the observed age difference has an effect on the way traumatic events are remembered by the participants.

The present study examined the quality of life of very old people, but without fully surveying the individual life course. Drawing causal conclusions from traumatic events that occurred more than 70 years ago, thus, is inevitably associated with uncertainties. Individual resilience and vulnerability, and its life-long development can have important influences on the subjective suffering from traumatic WWII events at late-life. Future studies should use longitudinal study designs to resolve uncertainties about the underlying causal pathways and intraindividual development over the life course.

Implications

In sum, this study found evidence of a negative impact of traumatic experiences (and subsequent psychological burden) in early childhood and adolescence on physical and mental health over 70 years after the traumatic events. The present results underline the importance of screening for traumatic experiences in older patients since the population is neglected regarding treatment. As most studies on the underlying biological and behavioural mechanisms as well as treatments are based on younger participants, there is a special need for further research based on longitudinal designs.

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