Accumulated life-course adversities and depressive symptoms in later life among older men and women in England: A longitudinal study

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Abstract

This paper investigates the association between accumulated major life-course adversities and later life depressive symptoms among older people in England, both at a single point in time (prevalence) and the onset over time during later life (incidence), using data from the English Longitudinal Study of Ageing. Using retrospective data on the experience of major life adversities from childhood onwards, five latent classes were identified: no/few life-course adversities (58.6 per cent), lost relationship (27.0 per cent), chained adversities (2.4 per cent), childhood adversities (6.3 per cent), and war-related adversities (5.7 per cent). Older people who had experienced 'chained adversities', 'childhood adversities' and 'a lost relationship' had higher odds of presenting current depressive symptoms in 2006, even after controlling for socio-demographic characteristics, health risk behaviours and social resources. Longitudinal analysis indicated that amongst respondents who were clear of depression in 2006, those older people who had experienced childhood adversities, a lost relationship and war-related adversities experienced a higher risk of having a new case of depressive symptoms. Results further indicate that women's mental health in later life is more sensitive to earlier life adversities than men's. The study shows that intervention earlier in the life-course may have benefits for the individual both contemporaneously and over the longer term.

Keywords: adversity, life-course, depression, England

Introduction

Depression is the most common mental disorder in later life, affecting people's quality of daily life and functioning. It can be experienced as a result of stress initiating cognitive and biological processes; with major life adversities, traumatic events or life-course adversities (terms often used interchangeably) being found to be amongst the best predictors of future onset of depression (Kraaij *et al*. 2002). Despite the fact that there are now more people in the UK aged 60 or over than aged under 18 (Office for National Statistics (ONS) 2017), and that by mid-2039 more than 1 in 12 of the population is projected to be aged 80 or over (ONS 2015), relatively few studies have examined the impact of major life- course adversities amongst the older population. Even fewer have taken a longitudinal approach, investigating the association between earlier life adversity with the onset or recurrence of depression in later life (*e.g.* Fiske *et al*. 2003), and there are none to our knowledge in the UK. This paper therefore adds to the literature in three important ways. Firstly, by taking a more holistic perspective of entire life-course adversities experience, it provides new evidence on the relationship between accumulated major life adversities and depressive symptoms amongst community-dwelling older people aged 50 and over in England at a single point in time (2006). Secondly, it provides new insights into the *persistent* effect of major life adversities as a risk factor for the onset of depression *during* later life, following older individuals who clear of depression at the baseline over an eight year period (2006-2014). Finally, it evidences the differences of such relationships by gender.

Depression in old age and gendered patterns

The level of depression in old age varies due to differences in diagnostic criteria and the population sampled between studies. Based on the estimation of the World Health Organization (2017), globally, the depression prevalence rate was 4.4 per cent in 2015 and

varied by age, peaking among those aged 55-74 years (above 7.5 per cent among females, and above 5.5 per cent among males). Blazer (2003) reviewed the existing evidence of depression in late life and reported that major depressive disorder occurs among up to 4 per cent of community-dwelling older adults aged 65 and above, and minor depression among between 8 to 16 per cent. In the UK, the 2014 Adult Psychiatric Morbidity Survey using the Clinical Interview Schedule – Revised (CIS-R) reported that among people aged 16, the prevalence of depression was 3.3 per cent, and that depression was more common in people aged 16 to 64 than in those aged 65 and above (McManus *et al*. 2014). Existing research shows that biological, psychological and social factors, such as medical illness, genetic susceptibility to mood disorders, endocrine changes, adverse life events and impaired social support, are all associated with later life depression (Blazer 2003).

Women are about twice as likely as men to develop depression during their lifetime, with a higher recorded prevalence in older women than in older men. Certain unique biological and social factors likely contribute to women's higher prevalence of depression (Nolen-Hoeksema 2001). Women have historically had less socio-economic power and status than men due to patterns of financial dependence or economic standing, and are also more likely to experience chronic strains, such as poverty and constrained choices (Stone *et al*. 2013). Moreover, women experience certain traumatic events, particularly sexual abuse, more often than men. A recent epidemiology survey of traumatic event exposure worldwide (Kessler *et al*. 2017) shows that most people (over 70 per cent) are exposed to traumas at some time in their life and nearly one-third were exposed to four or more traumas. In addition, men and women differ in the types of events they tend to experience, with men being more likely to report injuries, accidents and physical assault, and women more likely to report sexual assault. Even when women and men experience the same stressors, women may be more likely than men to develop depression (Breslau *et al*. 1997). Studies have found that gender roles and

psychological factors are more important than biological factors in explaining gender differences in stress responses (Nazroo *et al*. 1997; Lundberg 2005).

The impact of early-life adversities and health

Early-life adversity has been associated with a life-long increased risk for ill health. O'Rand and Halil-Luker (2005) found that early disadvantage and childhood illness have severe enduring effects and increase the risk for heart attack across the life-course. Friedman and colleagues (2015) reported an association between early life adversity such as childhood abuse and allostatic load, which is a marker of biological risk induced from inflammation, cardiovascular function, lipid metabolism and other indicators. A further recent study found that childhood abuse is linked to earlier all-cause mortality among women but not among men (Chen *et al*. 2016). Other studies have examined the effect of mediating factors such as personality traits and personal control, between early life events and later life health outcomes. For instance, Pitzer and Fingerman (2010) found that higher levels of personal control were associated with better physical and psychological functioning among adults who experienced abuse in childhood. However, such studies have focused solely on the effects of *early childhood* adversities, without exploring the full range of life-course adversities.

The association between major life adversities and depressive symptoms is now relatively well established. A number of studies among psychiatric patients and the general population have explored the long-term effects of traumatic stress on current adult depression, showing consistently that adults with depression report early traumatic adversities, such as experience of war (Landau and Litwin 2000), natural disasters (Briere and Elliot 2000), sexual assault (Zoellner *et al*. 2000), bereavement (Utz *et al*. 2012) and childhood traumas (Nurius *et al*. 2015). Several mechanisms have been proposed; for instance it is argued that stressful events may cause negative affective states such as feelings of anxiety, which in turn exert direct

effects on biological processes or behavioural patterns influencing disease risk (McEwen 1998). Over time, dysregulations across major biological regulatory systems (cumulative interacting adverse effects) may influence physiological and neuro-immunological pathways linking mental and physical health (Slavich and Irwin 2014).

Theoretical background and empirical studies of early-life adversities and later-life depression

The mechanisms between major adversities earlier in the life-course and health in later life are, however, less clear cut. Evidence of a causal link between two phenomena distant in time is more difficult to uncover due to the presence of multiple confounding factors in the intervening period, although the reciprocal effects of social, biological and psychological systems on each other are known to play an important role. Two inter-related theoretical approaches help to conceptually frame the experience of traumatic/ stressful lifetime events and their relationship with depressive symptoms in later life – the theory of 'stress proliferation' (Pearlin *et al*. 2005) and the 'cumulative inequality' theory (Ferraro and Shippee 2009).

Pearlin and colleagues (2005) put forward a conceptual framework regarding 'stress, health and the lifecourse', arguing that inequality rooted in social structure accumulates across an individual's life span, and that disadvantaged individuals have the greatest chance of exposure to health-related stressors. This is consistent with much of the literature on health inequalities, recognising that some groups have better opportunities for good health and longevity than others (Wilkinson and Pickett 2009). Importantly, for the purpose of this paper, and in addition to highlighting the potential health effects of single long-term stressors, such as poverty or discrimination, Pearlin *et al*. (2005) also put forward the notion of *stress proliferation* as a mechanism to explain how earlier life circumstances can affect later health

and well-being. They suggest that early traumas and off-time or out-of-sequence transitions (i.e. major life adversities), tend to give rise to additional, or secondary, stressors. Thus, those individuals who were exposed to a (early) serious adversity are at risk of experiencing a later exposure to additional adversities, which in turn cause cumulative, long-term harm to health (Horwitz *et al*. 2001).

The *cumulative inequality theory* adds a further dimension, contending that cumulative inequality interacts with one's ability to mobilize social, economic and psychological resources, shaping the individual's health and well-being in old age (Ferraro and Shippee 2009). Individuals with early life traumas are thus more likely to encounter and generate further stressful events throughout the later life stages, but with fewer personal and psychosocial resources to cope with them. Moreover, such individuals are more likely to amplify their biological and emotional response to any later emerged stressor and are predisposed to self-medicating behaviours like smoking, drug use and consumption of high-fat diets (Nusslock and Miller 2016). Together, these contributions to the literature provide a useful base to develop a conceptual framework which links the experience of stressful events at one stage of the life-course with adverse outcomes at a subsequent stage (Figure 1).

<Figure 1 here>

Some researchers argue that the consequences of prior adversities are better captured by considering one's exposure to multiple events rather than to one focal event only (Green *et al*. 2000), a position which is consistent with the concept of stress proliferation and lifetime cumulative adversity. A study analysing data from the Survey of Health, Ageing and Retirement in Europe (SHARE) found that respondents with more lifetime cumulative adversities were at a greater risk of high level of depressive symptoms and low quality of life (Shrira 2012). The association between cumulative adversities and mental health has also

been explored taking into account differences in the type of adversity and gender. For instance, studies found that self-oriented adversities (*i.e.* those reflecting trauma where the individual themselves was the target, *e.g.* being at risk of death due to accident or being a victim of assault or abuse) had a positive association with depressive symptoms, whereas other-oriented adversities (*i.e.* those where the trauma came from being exposed to actions targeting others e.g. witnessing people killed by violence) had either no association or an inverse association with depressive symptoms (Shmotkin and Litwin 2009). However, Palgi *et al*. (2012) showed that both self-oriented and other-oriented lifetime traumatic events were associated with perceived loneliness and depressive symptoms in the second half of individuals' life.

Research Hypotheses

Few studies have explored holistically the dimensions of entire life-course adversities experience (Pietrzak and Cook 2013), and whether such adversities continue to be associated with a later risk of depressive symptoms, either as a first onset or as an episode recurrence. This paper aims to (1) create and describe a taxonomy of the clustered life-course adversities among older men and women in England, and (2) investigate the association between these life-course adversities and mental health in later life. The first two hypotheses of this study are formulated as follows:

> H_1: the risk of suffering depressive symptoms in later life is higher amongst those who have suffered accumulated life-course adversities than those who have not (retrospective combined with cross-sectional analysis)
>
> H_2: this effect persists into later life (longitudinal analysis)

Moreover, our understanding of the association between major adversities during the life-course and their adverse impact on individuals' mental health in later life, cannot be isolated from gender differences permeating individuals' social and financial resources across the life-course (Pearlin *et al*. 2005). Women in particular in many societies experience a relative lack of social power, making them more vulnerable than men to specific traumas, which in turn may contribute to depression directly or indirectly by increasing women's reactivity to stress (Nolen-Hoeksema 2001). For instance, Pirkola *et al*. (2005) found that among a population sample aged 30-64 in Finland, there were marked sex differences in the associations between reported childhood experiences and environmental circumstances on the one hand, and adulthood mental disorders on the other. We therefore further hypothesise the sex differences in the associations as follows:

> H_3: women's mental health in later life is more sensitive to earlier life adversities than men's.

Method

Data

This study analysed data from the English Longitudinal Study of Ageing (ELSA), which started in 2002 and collects information on the physical and mental health, as well as the demographic and socio-economic circumstances, from a representative sample of the English population aged 50 years and over (Marmot *et al*. 2016). The sample has been followed up with an interview and medical examination every two and four years respectively (Steptoe *et al*. 2012). At Wave 3 in 2006, an additional module collecting retrospective life history data was fielded (Ward *et al*. 2009). Given this paper focuses on measures of lifetime adversities, the analyses were based on Wave 3 (2006) which was taken as the study baseline, with follow-up at Wave 4 (2008), Wave 5 (2010), Wave 6 (2012) and Wave 7 (2014).

Study sample

A total of 7,855 participants completed the ELSA (Wave 3) 2006 life history interviews. Of these, 7,048 were core study members and aged 50 and above. From this sample a total of 1,821 respondents were excluded from the analysis because of missing values (not mutually exclusive) on adversity events (N=1,807), childhood health (N = 7), housing wealth (N = 7), physical activity (N = 8) and depressive symptoms (N=29). Missing values for alcohol intake and social isolation were categorised as a missing group. The final analytical sample was 5,198 (Men=2,330, Women=2,868), which was classified into four age groups: 50-59 (29.6 per cent), 60-69 (33.5 per cent), 70-79 (25.8 per cent) and 80 and above (11.1 per cent). The majority of respondents (84.8 per cent) had intermediate or high education. More information about the sample (N=5,198) was provided in Table 1. This sample was used for the cross-sectional analysis. The analysis of the excluded participants shows that they were more likely to experience significant depressive symptoms (18.2 per cent v. 13.0 per cent, P=0.001) and were older than the analytical sample (mean age 67.2 vs. 66.3, P=0.001), but there were no gender differences (Supplementary Table 1).

<Table 1 here>

Cross-sectional analysis can only analyse multiple variables at a given time, however depressive symptoms might have occurred prior to some of the adversities. In order to avoid a possible reverse time order between the life-course adversity and depression, participants with current depressive symptoms at the baseline were excluded and 4,520 respondents who were clear of depressive symptoms in 2006 were selected to follow up in the longitudinal analysis. Among them, 479 participants who had missing information on the measurement of depressive symptoms in all of the follow-up surveys from Wave 4 (2008) to Wave 7 (2014) were excluded. Thus, the total analytical sample for the longitudinal analysis was 4,041.

Measurement

Current depressive symptoms. The Eight-Item Center for Epidemiologic Studies Depression Scale (CES-D) was used to measure depressive symptoms. The CES-D has been widely used in studies of later life depression, and has good psychometric properties for use in the UK population (Karim *et al*. 2015). A cut-off point of 4 has been found to produce comparable results to other depression scales (Steffick 2000), In the survey, in order to determine the presence of depressive symptoms, each respondent was asked the following questions, with the response options of 'yes' or 'no': 1) Much of the time during the past week, I felt depressed; 2) I felt everything I did was an effort; 3) My sleep was restless; 4) I was happy; 5) I felt lonely; 6) I enjoyed life; 7) I felt sad; and 8) I could not "get going". For each respondent, the total number of yes responses to questions 1, 2, 3, 5, 7, 8, and the "no" responses to questions 4 and 6 were summed to create a total depressive symptom score ranging from 0 to 8. If an individual was missing any of the eight items, they were excluded from the analyses. In this study, the report of current depressive symptoms equals 1 if the respondents' total depressive symptom score is greater than, or equal to, four at the baseline in 2006; and it equals 0 if not. This measurement was treated as the dependent variable for the cross-sectional logistic regression models.

Time until having a new case of depressive symptoms. This time-to-event measurement was used as the dependent variable for the longitudinal Cox regression models. A group of participants (N=4,041) who were clear of depression at the baseline in 2006 were asked the CES-D questions in each of the follow-up interviews between 2006 and 2014. The time until having a new case of depressive symptoms was measured as the period from the baseline survey in 2006 when respondents were clear of depression to the year when the respondents' depressive symptoms occurred (total depressive symptom score greater than, or equal to, four). The score equals 1 if the respondents had significant depressive symptoms at Wave 4

(2008). The corresponding time equals 2, 3 or 4 if the new case of depressive symptoms happened at Wave 5 (2010) or Wave 6 (2012) or Wave 7 (2014) respectively.

Accumulated life-course adversity. Sixteen life-course adversities listed in the ELSA life history questionnaire were used for the LCA method to generate the latent variable, reflecting the accumulation of major life-course adversities. Supplementary Table 2 presents a list of the questions and the prevalence of each adversity by gender. Significant gender differences were observed for the majority of single adversities. Four out of sixteen questions including the indication ‘‘aged<16’’ helped to understand the timing of when such adversities were first experienced in childhood: ‘‘Whether when aged<16 was physically abused by your parents; Whether when aged<16 parents argue or fight very often; Whether when aged<16 either parents was unemployed for over 6 months when wanted to work; Whether when aged<16 parents drunk/took drugs/had mental health problems’’. Other adversities such as ‘‘Ever fired a weapon in combat or been fired upon; Ever had a husband/wife/partner/child who has been addicted to drugs or alcohol’’ are likely to have been experienced during the respondents’ adulthood. Latent class analysis (LCA) was applied to identify latent classes (accumulated life-course adversity) for the next step of the statistical analysis.

Control variables. The multivariate analyses were performed after controlling for the effects of selected demographic, socio-economic status, risk behaviour and social resources variables, the selection of which was based on previous studies (Blazer 2003; Kessler *et al*. 1996; Fiske *et al*. 2003). These controls included age, gender, current marital status, childhood self-rated health, Activities of Daily Living (ADLs), education, National Statistics Socio-economic Classification (NS-SEC), housing wealth, smoking status, alcohol drinking status, working status, physical activity and social isolation.

Analytical plan

Latent class analysis (LCA) was applied to identify unobserved subgroups characterized by common life-course patterns of adversities experience. LCA is a model-based clustering method which produces the latent classes or latent clusters (terms used interchangeably) using a probabilistic model describing the distribution of data (Goodman 2002). In contrast to other clustering approaches finding sequence clusters with a chosen distance measure (*e.g.* Stone *et al*. 2015), LCA helps to compare models with differing numbers of latent classes in order to determine the best-fitting model. The categorical indicators used for the latent class analysis were sixteen reported single life-course adversity (Supplementary Table 2). We began with a two-class model and proceeded to test models with successively larger numbers of classes. The choice of the optimal number of classes was based on the comparison of various models using Akaike information criterion (AIC), Schwarz's Bayesian information criterion (BIC) and the sample-size-adjusted BIC (A-BIC), where a smaller AIC, BIC or A-BIC value indicates a better-fitted model. Further, we assessed the entropy of each model as an indicator for class separation, with higher entropy values being preferable, and performed Lo-Mendell-Rubin likelihood ratio test (LMR), Vuong-Lo-Mendell-Rubin likelihood ratio test (vLMR) and bootstrap likelihood-ratio test (bLRT) to test the significance of the difference in likelihoods of two models, where a non-significant p value indicates that the model with one or fewer classes is preferable. The authors' judgment of model interpretability were considered in the final decision.

Once the optimal number of classes was determined, a three-step procedure was applied for modelling LCA with distal outcomes (Asparouhov and Muthén 2014). Using a conventional regression model, treating the latent class membership as a directly-observable variable, may lead biased results because it ignores the classification uncertainty that is attached to the process of extracting the latent class membership given the probabilistic nature of this method. A three-step procedure was therefore adopted to avoid any potential bias. The first

step fitted a LCA model with the sixteen categorical indicators of single life-course adversity only and assigns respondents to their mostly likely latent class ‘N’. The second step determined the measurement error for ‘N’. The third step estimated the logistic or Cox regression models, where the latent class variable was measured by the most likely class variable ‘N’, and the measurement error was fixed and prespecified to the values obtained from step 2. Mplus 8 was used for the statistical analysis (Muthén and Muthén 2017).

In our analysis, there were two types of distal outcomes. The first was a binary variable - the current depressive symptoms at the baseline in 2006; the second was a ‘time to event’ variable -time to have a new depressive symptoms during the follow up 2006-2014. LCA models with distal outcomes were run first for females and males together, and then for females and males separately. For the binary distal outcome logistic regression was used, which uncovers relationships between life-course adversity and the prevalence of depression. Given the cross-sectional nature of all variables measured at a single point in time, it is possible that depressed older people are more likely to report life-course adversities. In order to address the possible reverse time sequence between depressive symptoms and life-course adversities, we then conducted Cox regression analysis to examine the time to have a new cases of depressive symptoms during the follow-up period from 2006 to 2014, taking the latent classes of the accumulated major life-course adversities into consideration. For this longitudinal analysis, older people with depression in the previous logistic regression were excluded and only those who were clear of depression at baseline in 2006 were included. Participants were right-censored at the end of observation in 2014 if they did not experience new case of depressive symptoms. Those with missing measurements of depressive symptoms were also right-censored at the time of dropout.

The ELSA has a relatively high sample attrition rate (Banks *et al*. 2011). In the longitudinal analysis for this paper, 1,689 out of the total 4,520 respondents who were clear of depression

at the baseline (Wave 3, 2006) only completed one, two or three rounds of the survey in the subsequent phases of data collection, and dropped out of the survey before 2014. As a result of such attrition, there may be possible selectivity affecting the validity of the results. There are two ways in which attrition can bias a sample (Ahern and Brocque 2005). Firstly, attrition may alter the characteristics of the sample, making it no longer representative of the original sample. Secondly, selective attrition can bias the longitudinal data by altering the covariance of variables. This occurs when the underrepresentation of some groups in the longitudinal sample leads to correlations between variables that are different than the true correlations in the original data. In order to explore the latter, survival analysis was run to investigate whether any of our study variables had been affected by attrition which in turn could change the true correlations in the study sample. Unlike logistic regression, survival analysis estimates the time until respondents drop out the survey, capturing the features of both earlier and later drop-offs. This method has been used in previous studies to reveal significant predictors of longitudinal sample attrition (Zethof *et al*. 2016). The results show that all selected variables were not statistically different between the study cases and the cases either lost to follow-up or with missing values, indicating that attrition was at random and did not require statistical adjustment in the analyses (Supplementary Table 3).

Results

Latent class analysis

A series of latent class models were explored, ranging from two to six latent classes. The AIC, BIC, A-BIC, p values for the Lo-Mendell-Rubin likelihood ratio test and Vuong-Lo-Mendell-Rubin likelihood ratio test indicated that the five-class model was statistically the most feasible model (Supplementary Table 4), though a 4-class solution might work better if p values of the Lo-Mendell-Rubin likelihood ratio test and Vuong-Lo-Mendell-Rubin

likelihood ratio test were set at 0.01. More importantly, the five-class model provided the most meaningful classifications of life-course accumulated adversities and thus was chosen for further analysis. [1]

The model-based (five-class model) predicted probabilities for each of the sixteen adversities by latent clusters were presented in Supplementary Table 5 and illustrated in Supplementary Figure 1. The results show very low probabilities of all adversities in Cluster 1; high probabilities of losing a very close friend/relative at risk of death/died due to illness/serious accident and providing long-term care in Cluster 2; high probabilities of childhood physical abuse, physical violence, sexual violence, natural disaster, life-threatening illness and financial difficulties in Cluster 3; high probabilities of childhood parents unemployment, drink/drug use and frequently fight in Cluster 4; and high probabilities of having ever witnessed the serious injury/death of someone in war or military action, ever fired a weapon in combat or been fired upon and ever lost a very close friend/relative in war or military service in Cluster 5.

Thus the created latent clusters were named as follows:

1. No/few life-course adversity (58.6 per cent);
2. Relationship lost (27.0 per cent);
3. Chained life-course adversities (2.4 per cent);
4. Childhood adversities (6.3 per cent); and
5. War-related adversities (5.7 per cent).

Classification and characteristics of latent clusters

Table 2 comprises a summary of the descriptive characteristics of the five clusters of the latent variable of accumulated life-course adversities. Cluster 1 (no/few life-course adversities) represented the largest group of older people (59 per cent) who had no or few life-course adversities. Cluster 2 (relationship lost) as described above characterised older people who had suffered bereavement and provided long-term informal care. Compared with the other clusters, this group (27 per cent) shows a significantly higher educational status and social class. Cluster 3 (chained life-course adversities) embodied a small group of people (2 per cent) who experienced multiple chained adversities through life. Compared to the other clusters, this group was relatively younger, female, more likely to be in a lower social class, currently smoking and had a low level of physical activity. Cluster 4 (childhood adversities) shows a group in which a substantial proportion were female and from a relatively lower social class. Cluster 5 (war-related adversities) included significant proportions of individuals who are of older age, male, with a lower education, former smokers and reporting low physical activity.

<Table 2 here>

The association of cumulative major life adversities and depressive symptoms

Table 1 shows the bivariate association between current depressive symptoms and a range of covariates, including the latent variable of accumulated life-course adversities. Overall, 13.0 per cent of the respondents reported depressive symptoms. Life-course adversities were associated with depressive symptoms, with the highest prevalence of depressive symptoms being observed among older people in cluster 3 (chained adversities), followed by cluster 4 (childhood adversities) and cluster 2 (relationship lost). Older people in cluster 1 (no/few adversities) and cluster 5 (war-related adversities) exhibited relatively lower prevalence of depression. In addition, being female, reporting poor childhood health, being divorced or

widowed, having lower education, lower occupational class, lower household wealth, experience of smoking, frequently drinking, reporting less physical activity and higher levels of social isolation were all found to be associated with depressive symptoms. A higher prevalence of current depressive symptoms was found amongst the younger old (50-59) and oldest old (80 and above) age groups.

Current depressive symptoms

The multivariate logistic regression results (Table 3) show that older people who experienced life-course adversities had higher odds of depressive symptoms, even after controlling for selected socio-demographic, health-risk behaviour and social support variables. Specifically, compared with older people who had no/few life-course adversities, those who experienced chained adversities had the highest chance of also experiencing depression, followed by those who experienced childhood adversities and those who suffered a lost relationship. Other factors which significantly predict depression included poor childhood self-rated health, lower housing wealth, smoking experience, lower physical activity and a higher level of social isolation. Gender was also significant, as is age, with being young and female both associated with higher odds of experiencing depressive symptoms. The separate models by gender show similar patterns although interestingly among older men, only one group - those with childhood adversities, had significantly higher odds of experiencing depression, while among older women, having experienced childhood adversities, a lost relationship, war-related adversities and chained adversities all led to higher odds of experiencing depressive symptoms.

<Table 3 here>

New case of depressive symptoms

Over the follow-up period of 8 years (2006-2014), there were 743 new cases of significant depressive symptoms out of 4,041 participants; an incident rate of 18.4 per cent. Figure 2 presents the Kaplan-Meier survival curves for the length of survival time after baseline (2006) until the occurrence of the significant depressive symptoms for men and women separately. The y-axis denoted the percentage of the sample who remain with no significant depressive symptoms, while the x-axis denotes observed time. Three points stood out. Firstly, among all older respondents who did not have any significant depressive symptoms at baseline, those with no or few major life adversities were more likely to continue in that situation (*i.e.* having a higher survival rate) than those experienced chained adversities, childhood adversities, war-related adversities and relationship lost. Secondly, compared to male elders, most female elders faced a higher risk of the onset of depression, with lower survival curves than men. Finally, men experienced chained adversities faced the highest risk of the onset of depression, while women experienced war-related adversities had the highest risk.

<Figure 2 here>

Table 4 shows that participants who experienced childhood adversities, a lost relationship and war-related adversities over the life-course had a higher hazard ratio of developing depressive symptoms, even after controlling for socio-demographic, health behaviour and social support variables. Older women were more likely (HR 1.67) to develop depressive symptoms during the eight-year follow-up period than their male counterparts. Other factors which significantly influence the likelihood of experiencing a new case of depressive symptoms included lower educational status, and low levels of physical activity.

<Table 4 here>

The separate Cox regression models show somewhat different results. For men, only those who experienced childhood adversities had a significantly higher hazard ratio for the onset of significant depressive symptoms; while among women, in addition, those who suffered a lost relationship, chained adversities and war-related adversities also had a higher risk of experiencing depressive symptoms. Moreover, higher education was a protective factor for depression among women and relatively better housing wealth was a protective factor for depression among men, while daily drinking and poor childhood health were risk factors for men.[2]

Discussion

This study characterised a typology of accumulated life-course adversities based on latent class analysis and investigated the associations between types of adversities and mental health in the later life. The findings address important aspects of life-course research by adopting a comprehensive approach which described one's entire life-course adversity experience (Pietrzak and Cook 2013), and considered conditions at earlier stages of the life-course in order to explain mental health in later life (Pearlin *et al*. 2005; Ferraro and Shippee 2009).

The results of this study suggest that five clustered major adversities experiences emerged over the life-course among older people and the corresponding socio-demographic correlates were not distributed randomly for these clusters. Older people with chained adversities and those with childhood adversities were more likely to be women and in relative disadvantage in terms of social conditions; while groups with war-related adversities were dominated more by men and relatively older persons. The social differences of adversity exposure were consistent with a previous study (Kessler *et al*. 2017). Compared to the conventional measurement of major adversities, i.e. simple counts of the total number of adversities or in one particular life period *e.g.* childhood adversity, the latent class analysis provided a more

holistic and detailed compositional dimension of exposure to adversity over one's entire life-course.

The findings further suggest that cumulative major life adversities were associated with both the prevalence and incidence of depressive symptoms among older age people in England. Broadly consistent with existing research (Shrira 2012; 2014), those who had experienced childhood adversities (OR 2.08, HR 2.35) and a lost relationship (OR1.98, HR1.89) faced a higher risk of having poor mental health outcomes in later life, even after controlling for socio-demographic characteristics, health risk behaviours and social support. These findings support our hypotheses that the risk of suffering depressive symptoms in later life w higher amongst those who have suffered accumulated life-course adversities than those who have not. In addition, this effect persists into later life. Interestingly, chained adversity was only associated with the prevalence of depression (OR 4.86), while war-related adversity was only significantly associated with the incidence of depression (HR 1.75). The possible explanation might be that respondents who have experienced chained adversity had a very high chance of earlier onset of depression (OR 4.86), and among this sub-group, those clear of depression for the longitudinal analysis may have much better resilience than other sub-groups. Future studies in this area would require more information about the respondents' stress coping resources and strategies in response to life-course adversities. In addition, war-related adversities might be linked with an advanced age at the onset of depression. Indeed, a previous study found that most of veterans aged 60 and above were psychologically resilient (Pietrzak and Cook 2013), while another study indicated mental health vulnerability among very old (aged 75 and above) Holocaust survivors (Landau and Litwin 2000).

Older women experienced higher odds of depressive symptoms and a higher hazard of reporting new such symptoms over an eight-year follow-up period. Cumulative major life adversities were positively associated with depressive symptoms among both older men and

women. However, more identified latent clusters of accumulated life-course adversities among women were significantly associated with both the prevalence and incidence of depression in later life. These findings were in line with the assumption that women's mental health in later life was more sensitive to earlier life adversities than men's. A number of factors can be put forward to explain these gender differences, including differences in the experience of adverse events themselves, as well as in biological responses to stress, mediated through the gendered nature of social roles (Taylor *et al.* 2000; Nazroo *et al*. 1997; Lundberg 2005). Notwithstanding the increase in women undertaking paid work roles alongside their caring obligations, nevertheless women's relative lack of social power may mean that women are more likely to encounter certain stressors, such as sexual assault, more often than men; this same lack of social power may then make them more vulnerable to developing depression in response to stress (Nolen-Hoeksema 2001; see also Supplementary Table 2). These results are in line with previous research findings that women were more vulnerable than men to develop depression and anxiety disorders, such as post-traumatic stress disorder even when they were threatened with similar stressors (Breslau *et al*. 1997).

Taken together, the findings in this study emphasise the long-term consequences of life-course adversities on mental health in later life, as well as the gender differences permeating such relationship. The study identifies a five categorical taxonomy of life-course adversities, namely the experience of a lost relationship, chained adversities, childhood adversities, war-related adversities and no/few adversities. Several types of early life exposures in childhood and early adulthood still operated as risk factors of late-onset depression, and there existed gender differences within such relationship. Life-course adversity exposures may create a vulnerable stress regulation system which continues into old age, and the nature of such vulnerability is likely to be specific to certain pattern of exposures. Our study has several strengths, including a large study sample, detailed life history data and the use of latent class

analyses with distal outcomes. However, our findings should be assessed in the light of the study limitations. The measurement of lifetime adversity was based on retrospective data, raising the prospect that the relationship between adversity and depression may be over- or under-estimated due to selective recall of these events as a function of current depression (Hardt and Rutter 2004). Such recall bias was partially mitigated here, in that the reports of lifetime adversity at baseline (2006) were made at a different time point to the reports of depressive symptoms during the follow-up period (2008-2014). Additionally, it was unclear from the data whether the current episode of depressive symptoms reflects the first onset or reoccurrence of these symptoms, and in both the logistic regression and Cox regression analysis, we could only establish the association between the life-course adversities and the first onset or recurrence of depression. However, a previous study found that a gender difference (with women at an increased risk) was revealed for the first onset of depression only (Wainwright and Surtees 2002), providing some support to the gender differentials found here being indicative of a first onset. Thirdly, it is important to recognise that other recent, unobserved, life events might also influence the outcome, although previous research has found that the effect of recent life events on depressive symptoms may be weaker and time limited (Kraaij *et al*. 2002). Finally, the very small class of "chained adversities" (2.4 per cent) might be associated with considerable uncertainty and classification error, pointing to the need for further research to explore the existence of this subgroup in other settings.

Notwithstanding these limitations, this study contributes to the literature on the link between clustered cumulative life adversities, and current and new depressive symptoms. Understanding this association is important not only in its own right, but also because poor mental health has been associated with an increased risk of morbidity and mortality in later life in various contexts, with depression being a particularly strong predictor of mortality in relation to cardiac and stroke (Pennix *et al*. 2001; House *et al*. 2001). An elevated risk of

depressive symptoms in later life is often associated with normative events as part of the process of ageing, such as retirement, widowhood and reduced ability to perform ADLs. Acknowledging that the current picture may be further complicated by the longer term and cumulative impact of early life adversities can help inform the design of future preventive interventions and treatments, and improve both current and future mental health among individuals.

Policy and practice implications

The paper's findings have important implications for the general population and the practice of health and social care professionals. The significant associations between early life adversities and the onset and prevalence of depression of old ages indicate a need to create broader public awareness and understanding about the effects of harmful stress from different types of adverse life-course experiences on the mental health across a wider population. Depression affects about 22 and 28 per cent of men and women over 65 respectively (HSE 2007), however previous research shows that fewer than one in six older people with depression discussing their symptoms with their GP, and among those, only half receiving adequate treatment (Chew Graham *et al.* 2011). In addition, the NHS England's National Director for Older People's Mental Health has highlighted that older people are a fifth as likely as younger age groups to have access to talking therapies but six times as likely to be on medication (Burns 2015). Developing mechanisms to encourage older people to share their life course experiences and symptoms of depression can effectively contribute to treating depression and promoting better mental health among the older population. The findings in this paper also relate to the UK government's recent efforts to raise awareness about social isolation and its link to, among a range of other factors, depression across the life course and in later life (HM Government 2018). Acknowledging the significant impact of life course adversities on older men's and women's risk of developing depression, and by

extension their risk of living in social isolation, is an important step in preventing and treating the negative effects associated with adverse mental health for individuals across socio-economic strata and with diverse demographic characteristics.

Future research

For future research, it would be interesting to add the precise timing dimension of these events within one's life-course into the latent class analysis. Life-course adversity may have a different impact depending on when and how adversities occur. Also, it would be ideal to lag the timing of depressive symptom onset in the multivariate analyses in order to allow for the control of prior conditions, especially the first onset of depression. Lastly, it would be important to repeat the analyses in other contexts including other European countries, the United States of America and China, where the similarly designed and structured survey data (the Survey of Health, Ageing and Retirement in Europe, the Health and Retirement Study and China Health and Retirement Longitudinal Study) are available.

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Notes

[1] It was noticed that the third subgroup of chained life-course adversities had a small sample size (2.4 per cent). Given this it was felt to be important to explore differences between the 5-class solution and 4-class solution. The category of chained life-course adversities in the 5-class solution was nearly all combined with that of childhood adversities in 4-class solution. , whilst the other three types remained largely unchanged. The class counts (proportions) for the 4-class of no/few chance of adversities, relationship lost, childhood adversity, war-related adversities were 3408 (65.6 per cent), 1068 (20.5 per cent), 436 (8.4 per cent) and 286 (5.5 per cent) respectively. Although the 4 class solution increased the sample size of the subgroup of childhood adversity, some relatively high probability events experienced by the subgroup of chained life-course adversities also became part of the feature of subgroup of childhood adversity, e.g. ever been a victim of sexual assault (including rape or harassment), ever been a victim of serious physical attack or assault, ever had a husband/wife/partner/child who has been addicted to drugs or alcohol and ever experienced severe financial hardship (data not shown). Given that we felt it important to distinguish the small group of people featured with chained adversities from those who *only* suffered from childhood adversities, the 5-class solution was chosen.

[2] We also ran multivariate models (both logistic regression and Cox-regression) using the 4-class solution and compared the results from the two solutions. The odds ratio (data not shown) of the respondents with Childhood adversities vs. those with no/few chance of adversities were slightly higher using the 4-class solution than that of using 5-class solution, reflecting the fact that in the 4-class solution, this subgroup of people also suffered from the chained life-course adversities which were very harmful to their mental health. Both were statistically significant, with $p<0.01$ in 5-class solution model and $p<0.001$ in 4-solution

model. We did the same comparisons for the Hazard ratios and found they were similar in terms of value of hazard ratios and the statistical significance (data not shown).

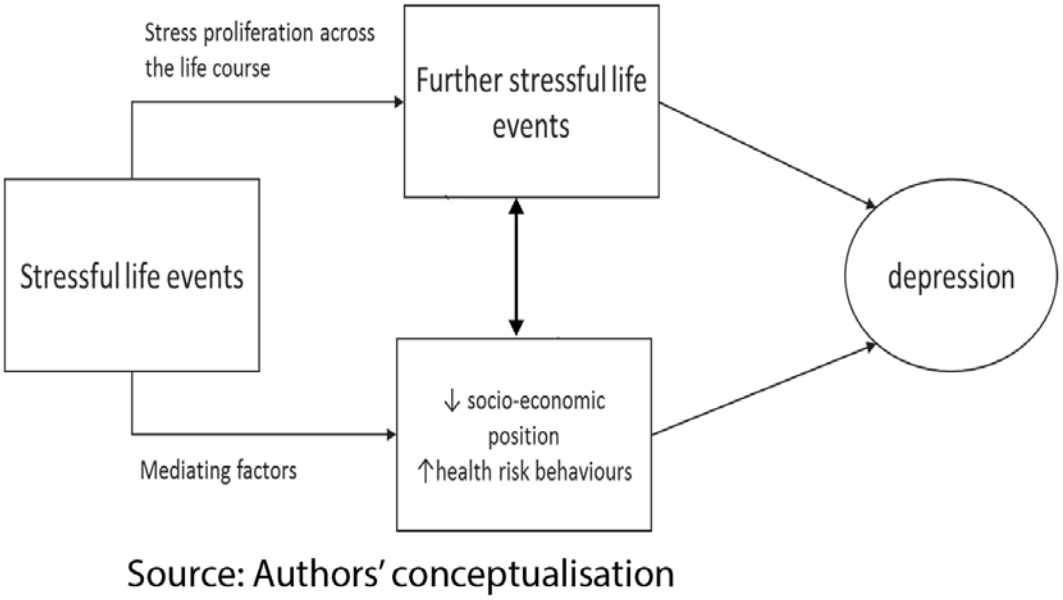
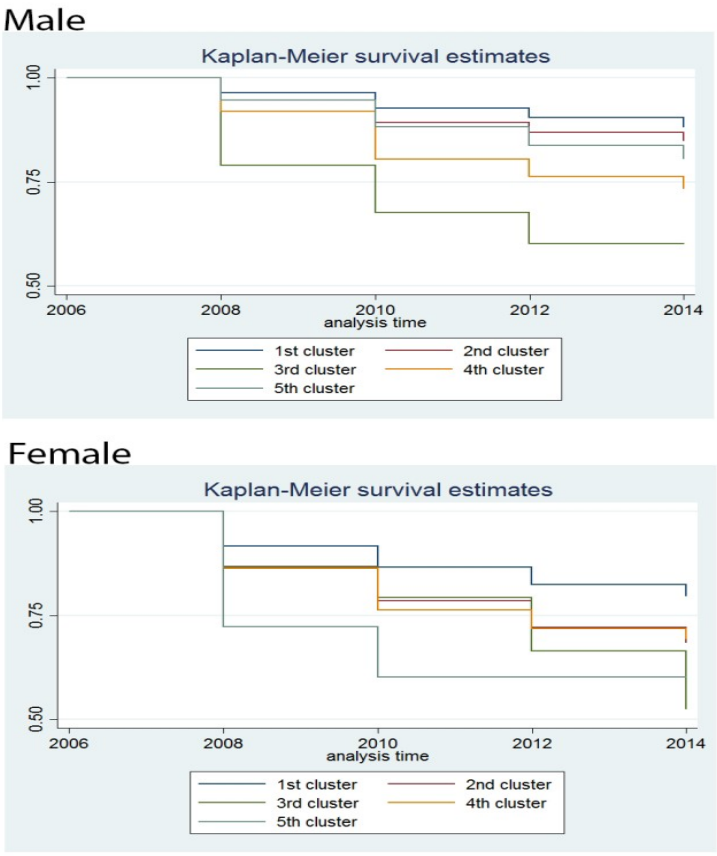


Figure 1. Conceptual framework of stress proliferation across the life-course



Source: Authors' analysis of ELSA, Wave 2006, 2008, 2010, 2012 and 2014
Legend 1st cluster=no/few adversities, 2nd cluster=relationship lost, 3rd cluster=chained adversities, 4th cluster=childhood adversities, 5th cluster=war-related adversities.

Figure 2: Kaplan-Meier survival estimate of depressive symptoms during the follow-up period (proportion of no depressive symptoms)

Table 1: Bivariate associations between selected covariates and depressive symptoms

Variables	Categories	% of significant depressive symptoms (depression)	P-value	Cases
Depressive symptoms	**Yes**	13.0		5,198
Life-course adversities	No/few chance of adversities	10.0	.000	3,044
	Relationship lost	16.0		1,404
	Chained adversities	40.0		125
	Childhood adversities	18.3		327
	War-related adversities	13.1		298
Age group	50-59	14.5	.016	1,539
	60-69	11.2		1,743
	70-79	12.9		1,341
	80 and above	15.1		575
Sex	Male	10.0	.000	2,330
	Female	15.5		2,868
Currently marital status	Never married	14.8	.000	277
	First marriage	9.0		2,929
	Remarried	9.4		608
	Divorced	23.5		544
	Widowed	22.4		840
Childhood self-rated health	Good	11.9	.000	4,578
	Fair/poor	21.5		620
ADL difficulties	None	9.5	.000	4,279
	1 item	23.2		499
	2 and more items	37.4		420
Education	Low (<=14 years)	17.0	.000	792
	Intermediate (15-16 years)	14.5		2,861
	High (>=17 years)	8.3		1,545
NS-SEC	Higher managerial/professional	8.5	.000	1,785
	Intermediate	12.7		1,358
	Routine/manual	17.3		1,997
	Long-term unemployed	15.5		58
Housing wealth	None	27.3	.000	812
	£1-£149,999	15.8		990
	£150,000-£299,999	10.1		2,166
	£300,000-£449,999	8.1		805
	£450,000+	3.8		425
Smoking status	Never smoked	11.2	.000	2,065
	Current smoker	22.1		670
	Former smoker	12.1		2,463
Drinking status	<Daily	8.2	.000	817
	Daily	13.0		3,903
	Missing	22.0		478
Physical activity	Low	21.9	.000	1,510
	Moderate	10.3		2,650
	High	7.2		1,038
Work status	Not retired	13.7	.216	2,481
	Retired	12.5		2,717
Social isolation	Low	7.1	.000	1,430
	Median	11.7		1,269
	High	22.8		534
	Missing	15.6		1,965

***p<0.001, **p<0.01, *p<0.05

Source: Authors' analysis of ELSA, Wave 2006. Total sample is 5,198.

Table 2: Cluster characteristics

	Life-course adversities cluster						
	1 No/few adversities	2 Relationship lost	3 Chained adversities	4 Childhood adversities	5 War-related adversities	Total	P value
Per cent of sample	58.6	27.0	2.4	6.3	5.7	100	-
Mean age	66.2	65.9	60.6	62.9	74.2	66.3	.000
Per cent of female	57.6	55.7	71.2	65.1	11.1	55.2	.000
Education							.000
Low education	14.5	13.5	10.4	10.1	38.9	15.2	
Intermediate education	56.1	53.1	57.6	64.5	41.6	55.0	
High education	29.4	33.4	32.0	25.4	19.5	29.7	
NS-SEC							.071
Higher managerial/professional	33.5	36.6	28.8	31.8	36.9	34.3	
Intermediate	26.6	26.2	26.4	22.6	24.2	26.2	
Routine/manual	38.7	35.8	44.0	45.3	38.6	38.5	
Long-term unemployed	1.1	1.4	0.8	0.3	0.3	1.1	
Smoking							.000
Never smoked	42.7	37.9	36.0	35.2	24.8	39.7	
Current smoker	11.2	14.0	23.2	19.6	12.8	12.9	
Former smoker	46.1	48.1	40.8	45.3	62.4	47.4	
Drinking							.021
<Daily drink	15.5	17.1	8.0	12.2	18.1	15.7	
Daily drink	75.4	74.1	77.6	79.5	70.5	75.1	
Missing value	9.1	8.8	14.4	8.3	11.4	9.2	
Physical activity							.009
Low	27.7	30.0	37.6	28.4	35.9	29.0	
Moderate	52.4	50.3	47.2	46.8	46.0	51.0	
High	19.9	19.7	15.2	24.8	18.1	20.0	
(N)	(3044)	(1404)	(125)	(327)	(298)	(5,198)	

Source: Authors' analysis of ELSA, Wave 2006. Total sample is 5,198.

Table 3: Odds ratios of depressive symptoms

Variables	Categories	Odds ratio	P	Odds ratio	P	Odds ratio	P
		Total		Male		Female	
Life-course adversities	No/few adversities						
	Relationship lost	1.98	***	1.49		2.29	**
	Chained adversities	4.86	***	1.75		3.61	***
	Childhood adversities	2.08	**	2.68	***	2.13	**
	War-related adversities	1.48		0.41		2.95	***
Age group	50-59						
	60-69	0.72	**	0.86		0.65	**
	70-79	0.65	**	0.87		0.57	***
	80 and above	0.55	***	0.93		0.45	***
Sex	Male						
	Female	1.28	*				
Current marital status	Never married						
	First marriage	0.86		0.80		0.89	
	Remarried	0.63	*	0.51	*	0.73	
	Divorced	1.34		1.31		1.38	
	Widowed	1.69		1.65		1.73	
Childhood self-rated health	Good						
	Fair/poor	1.58	**	2.11	**	1.42	***
ADL difficulties		1.45	***	1.56	***	1.42	***
Education	Low (<=14 years)						
	Intermediate (15-16 years)	1.08		1.53		0.90	
	High (>=17 years)	0.84		1.05		0.78	
NS-SEC	Higher managerial/professional						
	Intermediate	1.18		1.17		1.21	
	Routine/manual	1.27		1.23		1.34	
	Long-term unemployed	0.81		1.38		0.72	
Housing wealth	None						
	£1-£149,999	0.64	***	0.63	**	0.64	***
	£150,000-£299,999	0.56	***	0.62	**	0.52	***
	£300,000-£449,999	0.58	***	0.61	*	0.53	***
	£450,000+	0.30	***	0.30	***	0.27	***
Smoking status	Never smoker						
	Currently smoker	1.34		1.06		1.44	
	Former smoker	1.04		0.78		1.18	
Drinking status	<Daily						
	Daily	1.13		1.76		0.82	
	Missing	1.78	*	3.19	*	1.20	
Physical activity	Low						
	Moderate	0.68	***	0.62	**	0.68	**
	High	0.54	***	0.57	**	0.48	***
Work status	Not retired						
	Retired	0.99		0.93		1.04	
Social isolation	Low						
	Median	1.12		1.07		1.09	
	High	1.83	**	2.44	*	1.56	
	Missing	1.37		1.35		1.38	

***p<0.001, **p<0.01, *p<0.05

Source: Authors' analysis of ELSA, Wave 2006. Total sample is 5,198.

Table 4. Hazard ratios of depressive symptoms

Variables	Categories	Hazard ratio	P	Hazard ratio	P	Hazard ratio	P
		Total		Male		Female	
Life-course adversities	No/few adversities						
	Relationship lost	1.89	***	1.37		2.25	***
	Chained adversities	1.31		0.94		2.91	***
	Childhood adversities	2.35	***	2.87	***	1.97	***
	War-related adversities	1.75	*	1.49		1.79	**
Age at baseline	50-59(ref)						
	60-69	1.07		1.02		1.13	
	70-79	1.11		0.92		1.27	
	80 and above	1.52	*	1.60		1.50	*
Sex	Male(ref)						
	Female	1.76	***				
Marital status at baseline	Never married(ref)						
	First marriage	1.03		0.93		1.06	
	Remarried	1.17		1.14		1.13	
	Divorced	1.01		1.05		1.01	
	Widowed	0.99		0.89		1.01	
Childhood self-rated health	Good(ref)						
	Fair/poor	1.15		1.65	**	0.95	
ADL difficulties	Continuous variable	1.23	***	1.27	**	1.23	***
Education	Low (<=14 years) (ref)						
	Intermediate (15-16 years)	0.85		0.77		0.86	
	High (>=17 years)	0.78	*	0.91		0.69	*
NS-SEC	Higher managerial/professional(ref)						
	Intermediate	1.01		0.81		1.12	
	Routine/manual	0.97		0.80		1.05	
	Long-term unemployed	1.00		0.72		1.09	
Housing wealth	none(ref)						
	£1-£149 999	0.95		0.79		1.04	
	£150-£299 999	0.85		0.74		0.91	
	£300-£449 999	0.69	*	0.55	*	0.74	
	£450 000+	0.68	*	0.58		0.70	
Smoking status	Never smoked (ref)						
	Current smoker	1.24		1.44		1.14	
	Former smoker	1.07		1.11		1.06	
Drinking status	<Daily(ref)						
	Daily	1.13		1.50	*	0.93	
	Missing	0.98	*	1.22		0.84	
Physical activity	Low(ref)						
	Moderate	0.69	***	0.56	***	0.76	**
	High	0.70	**	0.67	*	0.72	*
Work status	Not retired(ref)	1.04		1.21		0.97	
Social isolation	Low(ref)						
	Median	1.18		0.96		1.26	
	High	1.05		1.02		1.09	
	Missing	1.22		1.50	*	1.10	

***p<0.001, **p<0.01, *p<0.05

Source: Authors' analysis of ELSA, Wave 2006, 2008, 2010, 2012 and 2014.
The total sample in Wave 2006 is 4,041 (1,861 males and 2,180 females).

Supplementary Table 1: Characteristics of selected sample (N=5,198) and excluded cases (N=1,850).

Variables	Categories	Total sample (7,048 cases)	Selected sample (5,198 cases)	Excluded sample (1,850 cases)	P-value (selected sample vs excluded one)
Depressive symptoms	Yes	14.3	13.0	18.2	0.000
	No	85.0	87.0	81.8	
Age group	50-59	30.4	29.6	32.5	0.000
	60-69	31.9	33.5	27.2	
	70-79	25.2	25.8	23.6	
	80 and above	12.5	11.1	16.6	
Sex	Male	44.5	44.8	43.6	0.371
	Female	55.5	55.2	56.4	
Current marital status	Never married	5.8	5.3	7.0	0.000
	First marriage	53.9	56.3	47.1	
	Remarried	11.4	11.7	10.7	
	Divorced	11.5	10.5	14.5	
	Widowed	17.3	16.2	20.6	
Childhood self-rated health	Good	87.8	88.1	87.5	0.493
	Fair/poor	12.1	11.9	12.5	
ADL difficulties	None	81.3	82.3	78.6	0.001
	1 item	10.0	9.6	11.1	
	2 and more items	8.7	8.1	10.3	
Education	Low (<=14 years)	16.5	15.2	20.2	0.000
	Intermediate (15-16 years)	54.9	55.0	54.6	
	High (>=17 years)	28.5	29.7	25.1	
NS-SEC	Higher managerial/professional	33.1	34.3	29.7	0.000
	Intermediate	25.3	26.1	23.0	
	Routine/manual	40.3	38.4	45.7	
	Long-term unemployed	1.2	1.1	1.6	
Housing wealth	None	17.6	15.6	23.2	0.000
	£1-£149,999	19.6	19.0	21.1	
	£150,000-£299,999	40.6	41.7	37.9	
	£300,000-£449,999	14.5	15.5	11.7	
	£450,000+	7.6	8.2	6.1	
Smoking status	Never smoked	39.2	39.7	37.8	0.000
	Current smoker	14.0	12.9	17.1	
	Former smoker	46.8	47.4	45.1	
Drinking status	<Daily	14.6	15.7	11.6	0.000
	Daily	71.5	75.1	61.2	
	Missing	13.9	9.2	27.2	
Physical activity	Low	30.7	29.0	35.4	0.000
	Moderate	50.0	51.0	47.2	
	High	19.3	20.0	17.4	
					.
Work status	Not retired	48.4	47.7	50.2	0.066
	Retired	51.6	52.3	49.8	
Social isolation	Low	25.2	27.5	18.9	0.000
	Median	22.9	24.4	18.8	
	High	10.3	10.3	10.5	
	Missing	41.5	37.8	51.8	

Source: Authors' analysis of ELSA, Wave 2006.

Supplementary Table 2: Gender differences on single reported adversity distribution

	Total	Male	Female	P
Had close friend/relative at risk of death/died due to illness/serious accident	63.3	61.8	64.5	*
Ever had a life-threatening illness or accident	26.7	30.9	23.3	***
Ever provided long-term care to disabled/impaired relative or friend	23.1	16.2	28.6	***
Ever experienced severe financial hardship	19.5	18.1	20.6	*
Whether when aged <16 parents argue or fight very often	19.1	17.2	20.7	***
Witnessed accident/violent act when person was killed/seriously wounded (not war)	13.8	21.7	7.4	***
Ever lost a very close friend/relative in war or military service	11.2	13.3	9.5	***
Ever experienced a major fire, flood, earthquake or other natural disaster	10.7	12.5	9.2	***
Whether when aged <16 either parents unemployed for over 6mths when wanted to work	7.3	7.9	6.8	
Ever been a victim of sexual assault (including rape or harassment)	5.8	2.6	8.4	***
Whether when aged <16 parents drunk/took drugs/had mental health problems	5.8	5.4	6.2	
Ever witnessed the serious injury/death of someone in war or military action?	5.8	11	1.6	***
Ever been a victim of serious physical attack or assault	5.7	6.8	4.9	**
Ever fired a weapon in combat or been fired upon	5.7	11.8	0.7	***
Ever had a husband/wife/partner/child who has been addicted to drugs or alcohol	4.7	2.5	6.6	***
Whether when aged <16 was physically abused by your parents	3.3	2.9	3.6	

Source: Authors' analysis of ELSA, Wave 2006.
Total sample size is 5,198.
***p<0.001, **p<0.01, *p<0.05

Supplementary Table 3: Hazard ratios of attrition

Variables	Categories	Hazard ratio	P
Life-course adversities	No/few adversities		
	Relationship lost	.97	
	Chained adversities	1.02	
	Childhood adversities	.95	
	War-related adversities	1.05	
Age group	50-59		
	60-69	.87	
	70-79	.89	
	80 and above	.93	
Sex	Male		
	Female	.98	
Current marital status	Never married		
	First marriage	.94	
	Remarried	1.07	
	Divorced	1.10	
	Widowed	.92	
Childhood self-rated health	Good		
	Fair/poor	.96	
Education	Low (<=14 years)		
	Intermediate (15-16 years)	.97	
	High (>=17 years)	.97	
NS-SEC	Higher managerial/professional		
	Intermediate	.99	
	Routine/manual	1.01	
	Long-term unemployed	1.04	
Housing wealth	None		
	£1-£149,999	.87	
	£150,000-£299,999	.93	
	£300,000-£449,999	.89	
	£450,000+	1.03	
Smoking status	Never smoked		
	Current smoker	1.03	
	Former smoker	1.02	
Drinking status	<Daily		
	Daily	1.05	
	Missing	1.05	
Physical activity	Low		
	Moderate	.97	
	High	.99	
Work	Not retired	0.96	
Childhood self-rated health	Good(ref)		
	Fair/poor	0.93	
ADL difficulties	Continuous variable	1.03	
Social isolation	Low		
	Median	.94	
	High	1.04	
	Missing	.97	

***p<0.001, **p<0.01, *p<0.05

Total sample size in Wave 2006 is 4,520, lost follow-up cases is 1,689 from Wave 2006 to Wave 2014.

Source: Authors' analysis of ELSA, Wave 2006, 2008, 2010, 2012 and 2014.

Supplementary Table 4. Goodness of fit and quality of classification measures of different class models.

	Number of latent classes				
	2	3	4	**5**	6
Akaike information criterion (AIC)	55738.481	54755.663	54451.403	**54339.647**	54254.363
Schwarz's Bayesian information criterion (BIC)	55954.830	55083.464	54890.657	**54890.353**	54916.522
Sample size adjusted BIC (A-BIC)	55849.966	54924.581	54677.753	**54623.429**	54595.577
P value for the Lo-Mendell-Rubin likelihood ratio test (LMR)	0.0000	0.0000	0.0000	**0.0309**	0.0478
P values for Vuong-Lo-Mendell-Rubin likelihood ratio test (vLMR)	0.0000	0.0000	0.0000	**0.0316**	0.0488
P values for bootstrap likelihood-ratio test (bLRT)	0.0000	0.0000	0.0000	**0.0000**	0.0000
Entropy	0.614	0.740	0.673	**0.678**	0.701

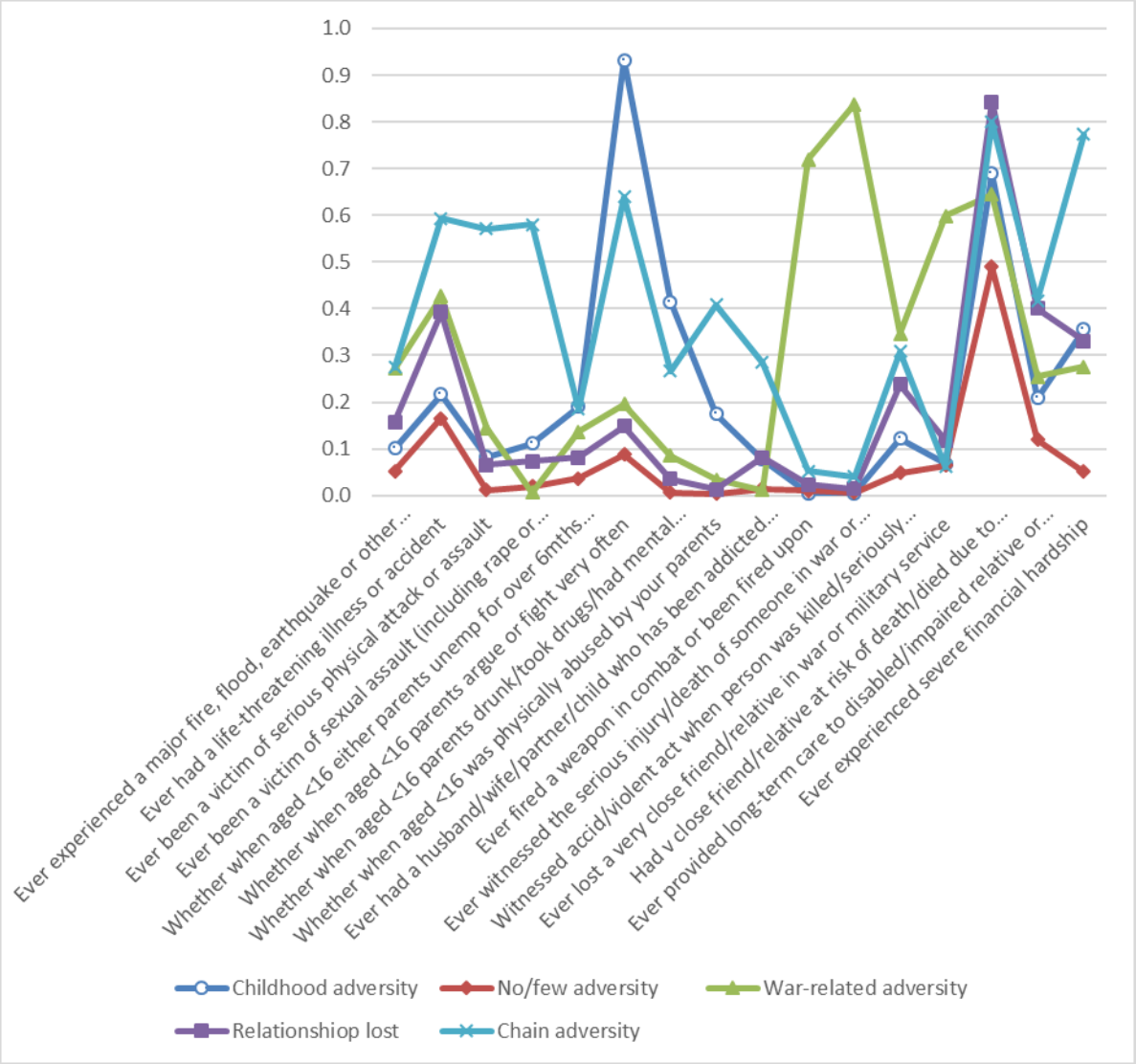
Source: Authors' analysis of ELSA, Wave 2006. Total sample is 5,198.

Supplementary Table 5. Class-specific marginal means for each life time adversity (5-cluster)

Adversities	Margin of life-course adversities cluster				
	1 No/few adversities	2 Relationship lost	3 Chained adversities	4 Childhood adversities	5 War-related adversities
Ever experienced a major fire, flood, earthquake or other natural disaster	0.052	0.157	0.274	0.101	0.272
Ever had a life-threatening illness or accident	0.165	0.392	0.594	0.216	0.427
Ever been a victim of serious physical attack or assault	0.012	0.065	0.571	0.083	0.145
Ever been a victim of sexual assault (including rape or harassment)	0.019	0.073	0.580	0.112	0.007
Whether when aged <16 either parents unemployed for over 6mths when wanted to work	0.037	0.082	0.185	0.190	0.136
Whether when aged <16 parents argue or fight very often	0.088	0.148	0.640	0.932	0.196
Whether when aged <16 parents drunk/took drugs/had mental health problems	0.006	0.036	0.267	0.415	0.085
Whether when aged <16 was physically abused by your parents	0.004	0.013	0.408	0.175	0.034
Ever had a husband/wife/partner/child who has been addicted to drugs or alcohol	0.015	0.081	0.285	0.078	0.012
Ever fired a weapon in combat or been fired upon	0.011	0.024	0.053	0.005	0.720
Ever witnessed the serious injury/death of someone in war or military action?	0.007	0.014	0.041	0.005	0.838
Witnessed accident/violent act when person was killed/seriously wounded (not war)	0.049	0.237	0.309	0.122	0.346
Ever lost a very close friend/relative in war or military service	0.064	0.118	0.062	0.068	0.599
Had close friend/relative at risk of death/died due to illness/serious accident	0.490	0.843	0.799	0.689	0.644
Ever provided long-term care to disabled/impaired relative or friend	0.120	0.401	0.418	0.209	0.255
Ever experienced severe financial hardship	0.051	0.331	0.773	0.356	0.276

Source: Authors' analysis of ELSA, Wave 2006. Total sample is 5,198.

Supplementary Figure 1. Class-specific marginal means for each life time adversity (5-class)



Source: Authors' analysis of ELSA, Wave 2006. Total sample is 5,198.