Resilience as a Factor of Longevity and Gender Differences in Its Effects*

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Abstract: Various explanations for longevity and mortality differences have been repeatedly tested and discussed in the context of worldwide population ageing. This study contributes to this field of research by testing the potential of resilience as a capacity to adapt in the face of adversity through individual and social resources and is the first European study to investigate how resilience predicts survival in later life. Panel data from the Survey of Health, Ageing and Retirement in Europe are used to determine the predictors of survival among people over the age of 75 between waves 1, 2, 4, and 5. The results of a multilevel logistic regression show that resilience is a strong predictor of survival among the oldest old and that this is true even when controlling for the amount and severity of adversity. Resilience is found on its own to be a stronger predictor of survival in women, while the amount and severity of adversity is more important in men. Resilience is therefore found to be an important factor in longevity and survival in later life and the stronger effect of resilience in women can partly explain the 'gender paradox'. To sum up, resilience is observed to be protective against decease, especially through the use of social resources, which are stronger among women and which are not measured in most traditionally used resilience scales.

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Introduction: increasing longevity and its explanations

Population ageing has become an increasingly relevant global issue, occurring at the level of both the individual and society. Despite some persisting inequalities in life expectancy and the prevalence of longevity across continents, countries, and social classes, the phenomenon of longevity has spread more and more throughout the world [Leeson 2014; Mathers et al. 2015]. Surviving to a higher age has changed from a very rare event to an almost universal human experience [Mayhew and Smith 2015]. Life expectancy at birth, which has approximately tripled in the course of human history, continues to grow and there is no indication that it will stop in the near future [Leeson 2014; Mathers et al. 2015; Mayhew and Smith 2015; Wilmoth 2000]. Theories of the 'biologically' maximum length of life, such as Fries' [1980] compression of morbidity theory, seem to fail. In longevity research, the research paradigm has changed in recent years from seeking explanations for why a death, given as natural, did not happen, to investigations into the predictors of longevity [Gilleard and Higgs 2000: 150]. Below we shall examine two principal areas of longevity research: the first concerns secular changes in late-life morbidity and mortality and the second the influence of structured inequalities on these parameters of bio-aging [ibid.].

Changes in life expectancy at the individual level have been accompanied by changes in the age structure of populations at the societal level. The proportion of older people in most countries has shown a constant increase, with the oldest age group representing the age group in the population that is growing most [Gwozdz and Sousa-Poza 2010]. The rapidly increasing number of people that belong in the 'oldest old' group—people approximately over the age of 80—has been followed by a growing field of research focused mostly on the quality of life of this age group and explanations for their remarkable longevity [Baltes and Smith 2004; Masui et al. 2006; Nygren et al. 2010]. Research on the quality of life of centenarians is also developing. Although the oldest old are often associated with dependency and disability, studies on longevity and centenarians have conclusively shown these associations to be faulty [Bishop et al. 2010; Kock et al. 2010].

Previous studies tested a wide range of factors to explain longevity and these factors differ across authors and disciplines. The main predictors of longevity according to medical research are the quality and quantity of health care [Lichtenberg 2011; Peters et al. 2015; Tyrovolas et al. 2011], lifestyle [Lichtenberg 2011], and genetic factors [Christensen, Johnson and Vaupel 2006]. On the other hand, studies in the field of the social sciences are focused especially on general personal traits [Law, Richmond and Kay-Lambkin 2014; Masui et al. 2006; Roberts et al. 2007; Terracciano et al. 2008], cognitive abilities [Anstey et al. 2001], socioeconomic status [Anstey et al. 2001; Roberts et al. 2007], and quality of life [Krause 2009; Netuveli et al. 2012], as well as factors from medical research as the main predictors of mortality. There is a general lack of research controlling for most of these factors while addressing their interconnections; these factors are situated in different areas of life in older ages and examined from different perspectives

[Masui et al. 2006; Roberts et al. 2007]. Furthermore, previous studies did not explain why some of the oldest old thrive and others succumb to disease under very similar conditions of hardship and very similar living conditions [Kern and Friedman 2010; van Kessel 2013]. One theoretically developed, but empirically not properly tested explanation for longevity and the different coping abilities of older people is resilience [Law, Richmond and Kay-Lambkin 2014; Martin et al. 2010; van Kessel 2013].

This paper investigates the effect of resilience on survival among the oldest old as a contribution to the studies of and explanations for longevity. We use the panel data from the Survey of Health, Retirement and Ageing in Europe (SHARE) to predict survival to the next wave on the basis of resilience while controlling the main confounders. We contribute to this underdeveloped research area by employing a cross-national European data set, using new categorisations of resilience and adversity and testing the potential of resilience to explain both longevity and gender differences in longevity. The results show that resilience strongly predicts survival even when some confounders are controlled for, but this is true mainly for women in the analysis of gender differences. Therefore, we conclude that resilience is more beneficial for women, especially given their more developed social resources. Possible implications and future research directions are discussed.

Resilience as a possible predictor of longevity

Resilience is a concept that was originally defined in developmental and child psychology to explain some individual, familial, and societal factors helping to adapt to risk and adversity in different stages of development [Cicchetti and Garmezy 1993]. Over time, this positive view of human development expanded to research on other life stages and especially to research on risk adaptation in later life [Fry and Keynes 2010; Wild, Wiles and Allen 2013]. The conceptualisation of resilience also changed over the course of the concept's development. Resilience shifted from being conceptualised as a psychology-based personal trait to being conceptualised as a process of adaptation to adversity through the use of personal, community, and social resources [Donnellan, Bennet and Soulsby 2015; Richardson 2002; Thetford et. al. 2015; Wild, Wiles and Allen 2013]. The specification reflecting the current content of the term resilience defines this concept as the process in which '[a]ssets and resources within the individual, their life and environment facilitate this capacity for adaptation and "bouncing back" in the face of adversity' [Windle 2011: 163]. More types of resilience have been recognised and defined, based on either the origin of the resources (individual, household, family, neighbourhood, community, and social resilience) or the area of application (psychological, mobility, financial, environmental, physical, social, and cultural resilience). All of these types are both interconnected and exist on their own at the same time; research has most often investigated individual resilience based on

personal resources and social resilience dependent on social network and structural factors [Martin et al. 2010; Wild, Wiles and Allen 2013; Wiles et al. 2012].

Many studies associate resilience with subjective quality of life [Blane et al. 2011; Hildon et al. 2008, 2010; Nalin and Franca 2015]. Subjective quality of life has been repeatedly associated with old-age mortality or longevity [Krause 2009; Netuveli et al. 2012; Pressman and Cohen 2005]. Therefore, it is reasonable to assume that resilience could be one of the important factors for surviving to a very old age. This idea is supported in theory by the argument that resilience helps to overcome health risks in older ages [van Kessel 2013; Wild, Wiles and Allen 2013] and by another argument that quality of life protects against mortality because it is one of the factors of resilience [Netuveli et al. 2012]. Martin and his colleagues even claim that 'longevity, resilience, and successful adaptation are immediately related, and it is likely that they share many of the common mechanisms and characteristics' [Martin et al. 2010: 214] at a very old age, since all people approaching a hundred years of age have had to adapt and cope with much adversity during their long lives.

Although the assumption that resilience is a factor that contributes to longevity is logical and theoretically grounded, this idea has not been thoroughly tested empirically. To the best of our knowledge, only one study from Australia and one from China have tested the impact of resilience on longevity. Law, Richmond and Kay-Lambkin [2014] compared some personality traits of 79 centenarians from Australia with population norms. The centenarians did not differ from the population norm in the amount of resilience. This study worked with the concept of resilience as a relatively stable personal coping ability, which we find an inappropriate conceptualisation, as we consider the concept of resilience changing over time to be more plausible, since its resources and challenges also change in time. This argument is supported by the evidence that resilience changes with changes in adversity [Hildon et al. 2008, 2010] and resources [Thetford et al. 2015; van Kessel 2013], while the very old generally deal with fewer resources and more adversity [Wild, Wiles and Allen 2013]. The second study addressing resilience as a possible predictor of longevity was conducted by Zeng and Shen [2010]. These authors used a Chinese longitudinal survey to test the effect of resilience measured in one wave on survival to the next wave, in which the respondents in the analysis had reached the age of a hundred years. Resilience appeared to be a very strong predictor of the odds for becoming a centenarian: resilient adults had a 43% higher likelihood of survival [Zeng and Shen 2010]. Despite the use of a quite improvised and self-made scale of resilience, with just a few items, this is the only research illustrating the utility of the resilience concept in the field of longevity research.

The evidence for resilience being dependent on adversity more specifically means that respondents with lower resilience and worse outcomes were facing more severe adversity [Blane et al. 2011; Hildon et al. 2008, 2010]. Hence, the amount and severity of adversity can have a mediating role in the association be-

tween resilience and positive outcomes. Nevertheless, studies of resilience have not yet controlled for adversity itself as a factor, so the possibility that people with greater resilience and better outcomes have just faced less serious hardships has not been tested.

Are there gender differences in the effect of resilience?

Ageing and longevity are highly feminised processes, as the proportion of women among centenarians is 79% worldwide and 82% in Europe [United Nations 2015]. On the other hand, women in general report worse subjective health than men. Geriatric deterioration begins earlier with women than men and occurs more rapidly [Kalvach et al. 2008: 112]. Furthermore, older women are frailer [Clegg et al. 2013], have poorer health and functional status [Vaupel 2009; Walter-Ginzburg et al. 2005], more of them are likely to have lost their life partner [Guiaux, Van Tilburg and Van Groenou 2007], and they are more likely to experience loneliness [Steptoe et al. 2012] than older men. Despite all this adversity, women have lower mortality rates than men in all age categories [Vaupel 2009] and across all causes of death [Austad 2006]. This phenomenon is often called the 'gender paradox' [Netuveli et al. 2008; Ory and Warner 1990; Walter-Ginzburg et al. 2005]. This health/survival paradox is a complex phenomenon that has many partial explanations, such as differences in biological risks, risks connected to social roles, and illness behaviour [Vaupel 2009], as well as in lifestyle in terms of smoking or physical activities [Walter-Ginzburg et al. 2005]. However, this paradox remains largely unexplained [Austad 2006; Vaupel 2009].

The concept of resilience has been omitted from explanations for the gender paradox, much like the way in which it has been largely omitted from factors explaining longevity. Netuveli et al. [2008] found greater resilience among women and claimed that the higher longevity among women despite greater adversity could also indicate greater resilience in older women. On the other hand, in thirteen studies using the most popular Resilience Scale for older adults, none found greater resilience among women than among men [Choowattanapakorn et al. 2010; Wagnild 2009]. This inconsistency can be tentatively explained by the different measurements used. The study by Netuveli et al. measured resilience through its outcomes and reported a high predictability of resilience in relation to social support [Netuveli et al. 2008], whereas the Resilience Scale used in the thirteen other studies, which was developed in 1993, measures individual resilience and omits family and community resources [Windle, Bennett and Noyes 2011]. The assumption that the common measurement of resilience as an individual trait fails to detect the actual greater resilience of women seems to be supported by a paper by Hildon et al. [2010] measuring outcomes of resilience, which also found more resilient individuals among women.

It is reasonable to assume that older women have significantly greater social resilience than older men, as they are more involved in social activities [Doma-

jnko and Pahor 2015], have more social relations and more perceived social support [Stephens et al. 2011], are more likely to get support from their social network [MacDonald 2007], have larger [McLaughlin et al. 2010] and denser social networks, have greater contact with network members, and feel closer to network members [Cornwell, Laumann and Schumm 2008]. Thus, women can have greater social resilience, which is not usually measured in empirical studies [Wagnild 2009], and as a consequence they can have greater resilience generally.

It is possible that the greater social resilience of women does not explain the greater ability of women to survive adversity in later life. The amount of resilience may not be the important factor in this issue; it could be the efficiency of the resilience itself. According to Nygren and colleagues [2005], resilience is associated with mental health only among women. Other studies found stronger effects of concepts closely tied to resilience among women: social relationships [Kendler, Myers and Prescott 2005], social support [Lyyra and Heikkonen 2006], and subjective quality of life [Netuveli et al. 2012] are more protective against mortality and other harmful outcomes among women than among men. This indirect evidence for resilience as a more important factor of longevity in women, which has not yet been empirically verified, is considered in this study.

The concept of resilience has been largely omitted from research of longevity and its predictors, although resilience can be a very important factor according to the literature. This paper aims to contribute to studies of longevity and reaching very old age by testing resilience as a predictor of longevity and survival in the European context. We hypothesise that resilience in very old age strongly predicts survival and helps older people to live even longer. We argue that the amount and severity of adversity people experience should be included in research on the outcomes of resilience, and we expect that the effect of resilience can be partly explained by different 'loads' of adversity. Further, resilience is tested as the explanatory factor for the higher survival rates of very old women than very old men. We hypothesise that the 'gender paradox' can be explained by (a) a greater resilience among women and/or (b) resilience in women as a more protective process against mortality.

Data, measurement and methods

Data

Data from the Survey of Health, Ageing and Retirement in Europe (SHARE) are used to test our hypotheses. SHARE is a unique cross-national panel project focused on populations over the age of 50 and their partners. This project employs computer-assisted personal interviews and encompasses a wide range of topics, such as employment, health, social support, family, financial situation, and quality of life. Respondents from participating countries are repeatedly interviewed every two years. This paper draws on waves 1, 2, 4, and 5 (wave 3 asked a differ-

ent set of questions), which were conducted between 2004 and 2013, to follow respondents over time [Börsch-Supan 2013, 2015]. A total of 15 countries participated in at least two waves of data collection.[1]

The data set of this study contains only respondents who were included in at least two waves—either as alive (in both) or as deceased in a later wave. This study focuses on the populations of the oldest old, and thus only respondents of at least 75 years of age[2] were kept for the analysis. Further, the sample does not contain respondents with missing values or respondents with no adversity (26.6% of respondents of the defined sample had no adversity), because at least one adversity is required in order to indicate the level of resilience [Hildon et al. 2010; Netuveli et al. 2008]. Additionally, respondents in the household other than the primary respondent who fulfilled the required criteria were excluded from the analysis. Otherwise, the independence of the observations would have been undermined by the overrepresentation of younger and married respondents, as co-residing older people had a higher chance of being in the probability sample of households.

Some respondents in the sample fulfilled all the above-indicated criteria in two waves and some of them in three or four waves, and this needs to be incorporated into the data structure. Since this study utilises a panel dimension with the dependent variable deceased/alive measured in later waves and all explanatory and control variables measured in previous waves, the unit of analysis is the observation between two consecutive waves. We therefore use a multilevel data structure with 8924 observations between waves as level-1 observations nested in 7591 respondents aged 75+ as level-2 observations. The second part of the analysis is conducted for men and women separately: these two sub-samples contain 3777 observations nested in 3210 men respondents and 5147 observations nested in 4381 women respondents.

The dependent variable

The only dependent variable in the empirical analysis is the information about whether the respondent was alive at the time of the later wave of data collection. This is one of the first pieces of information obtained from members of the household at the beginning of the longitudinal version of the interviewing process, and it is also the only outcome of the later of the two waves of observation used in the analysis, since all the predictors are accessible from the data collection of

[1] These are Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Greece, Italy, the Netherlands, Poland, Slovenia, Spain, Sweden, and Switzerland.

[2] A more common cut-off age of the oldest old group is 80 years. However, the cutoff age of 75 seems appropriate, especially with older cohorts from post-communist countries in the sample [United Nations 2013; Zaidi 2010].

the earlier wave. This outcome, coded as deceased/alive, takes the form of a dichotomous variable and thus multilevel binary logistic regression is employed as a method of analysis.

The main explanatory variable

Resilience is the main explanatory variable of this study, as our focus is on the question of the explanatory power of this factor in the area of longevity and survival among the oldest old. Two methods are frequently used to operationalise resilience in the social sciences. The first method is measurement using some of the scales specially developed for measuring resilience (for a review, see Windle, Bennett and Noyes [2011]). These scales are used in psychological research to measure personal traits and require a special resilience questionnaire for data collection [Eley et al. 2013; Fry and Debats 2010; Lamond et al. 2008; Nalin and Franca 2015; Nygren et al. 2010; Zeng and Shen 2010]. The second method of operationalisation is measuring resilience through two indirect indicators: adversity and adaptation to adversity. Adversity in older age is defined as functional limitations or other health problems, financial problems [Blane et al. 2011; Hildon et al. 2008 2010; Netuveli et al. 2008], bereavement [Hildon et al. 2010; Netuveli et al. 2008], and stress or worsening general living circumstances [Hildon et al. 2008, 2010]. Adaptation is defined as a high or stable subjective quality of life [Blane et al. 2011; Hildon et al. 2008, 2010], mental health [Netuveli et al. 2008], or subjective health [Domajnko and Pahor 2015] in the face of at least one adversity. This second means of measurement fulfils the definitions of resilience and, additionally, makes it possible to construct an indicator of resilience in all surveys containing information about adversity and quality of life.

Our analysis here uses an indirect measurement of resilience based on the standard definition of resilience as the capacity to adapt in the face of adversity [Rowe 2010; Windle 2011]. Resilience is indicated in the same way as in some previous studies [Blane et al. 2011; Hildon et al. 2010; Netuveli et al. 2008]: by a higher quality of life in the presence of at least one adversity. This operationalisation was performed in three steps. First, three types of adversity crucial for the group of the oldest old were indicated in the data and respondents with at least one adversity were kept in the final sample. Second, a multidimensional scale of quality of life in later life was used to evaluate how good the life of respondents was under such adversity. Third, respondents were sorted into four categories based on the level of their quality of life, i.e. based on the degree to which they are able to adapt to adversity.

We use basically the same types of adversity among the oldest old as previous research [Blane et al. 2011; Hildon et al. 2010; Netuveli et al. 2008] and define them in the areas of health, financial security, and partnership. First, adversity in the area of *health* is measured with the item 'For the past six months at least,

to what extent have you been limited because of a health problem in activities people usually do?', with the answers 'severely limited' and 'limited, but not severely'. Second, *financial problems* are indicated by the answers 'with great difficulty' and 'with some difficulty' to the question 'Thinking of your household's total monthly income, would you say that your household is able to make ends meet...'. Third, adversity in the area of *partnership* is measured with the question 'In which year did you become a widow/er?' and was defined as the death of a spouse in the last four years (this is the approximate length of bereavement after this loss, see Parkes and Prigerson [2010] or Stroebe, Schut and Stroebe [2007]). The presence of any such adversity was taken as grounds to evaluate the resilience of the respondents in terms of their quality of life.

The quality of life of respondents who had experienced some type of adversity is indicated on a CASP-12 scale. This scale, which is a shortened form of the longer CASP-19 and CASP-15 versions of the scale, was developed as a theoretically based and empirically valid measurement of quality of life in early old age. CASP-12 measures the domains of control, autonomy, self-realisation, and pleasure, which sociological theory considers to be the essential domains of quality of life for the group of younger old [Higgs et al. 2003]. Each domain is measured with four items and each item is evaluated on a 4-point scale, which after all the times are summed yields values between 12 and 48. CASP-12 is used as the indicator of quality of life for the group of oldest old [Gjonca et al. 2010; Jivraj et al. 2014; Zaninotto, Falaschetti and Sacker 2009], even though it was originally developed for a younger age group. This seems justifiable, as the CASP domains remain important for quality of life even in very old age [Baltes and Smith 2004; Krause 2007].

Previous studies identified resilient respondents as those with at least one adversity and a higher quality of life—respondents with CASP values higher than the median value [Hildon et al. 2008, 2010] or in the highest quartile [Blane et al. 2011] were defined as resilient. We argue that this transformation of a continuous scale into a dichotomous variable results in a loss of information. Furthermore, this step prevents the nature of the effect of resilience from being determined. Therefore, the respondents were divided into four categories based on their CASP index quartiles: a higher CASP value means higher resilience. These four groups are labelled as very vulnerable, quite vulnerable, quite resilient, and very resilient individuals.

The control variables

The first and the most innovative control variable in this study is the variable indicating the amount and severity of adversity. The variable representing adversity was constructed from basically the same variables and values as the indicator of resilience. It is represented by the sum of the numerical values assigned to the responses as follows (where the maximum possible score is 6 and the minimum

is 1): being limited in everyday activities is coded as 1, being limited severely in these activities is coded as 2; having some difficulty making ends meet is coded as 1, having great difficulty with this is assigned a 2; having lost one's partner in the last four years is coded as 1, and as 2 if the loss occurred in the last year. For each of these variables the absence of adversity is coded as 0. The higher the adversity score summed from the above, the higher the amount and/or severity of adversity the person has experienced.[3] This variable significantly correlates with the CASP (Pearson's $r = –0.39$ and Spearman's rho = –0.38) and is considered to be highly relevant for this study.

Other control variables cover characteristics of the respondent that are theoretically or empirically relevant for survival but were not used to construct the resilience indicator. We control for the categorical variables *gender* (male/female), *country*, *partner in the household* (no/yes), and *education level* (using the ISCED scale divided into three categories: 0–1, 2–4, and 5–6; this categorisation is the most meaningful one according to the International Standard Classification of Occupations [2012]). Continuous variables employed in the analysis are *age*, *net household assets*, number of *health conditions* diagnosed by doctors, and *gap between two data collections* in months. The top 0.5% and bottom 0.5% of the values indicating net household assets were coded as the next closest value in the direction of the mean value in order to eliminate the effect of outliers. Also, the currency units of this variable were converted into millions of Euros, because in the case of lower-order units the coefficient did not show the direction of the relationship (this means that the coefficient was 0.00 even though it was significant). All continuous effects were estimated as linear, since there was no theoretical argument or empirical findings indicating that they are of a non-linear nature [Hildon et al. 2010; Zeng and Shen 2010].

Results

We present the empirical findings in this section. First, we describe some of the main characteristics of the sample and the distributions of the variables used in the analysis. Second, the effect of resilience on survival to the next wave is tested on the whole sample with and without the control of the amount and severity of

[3] We checked the robustness of the findings and the results are generally robust to various sample definitions in terms of different waves and countries included: substantively identical results can be produced for each wave separately (robustness in time) as well as for a sample in which the countries with the highest number of respondents are not present (geographical robustness). The findings are also robust to various categorisations of resilience (measured as a continuum, on a two-, three-, and four-point scale) and to various categorisations of adversity (measured as scores on the complete six-point scale of the amount and severity of adversity, the three-point scale of the amount of adversity, and the six-point scale broken down into a set of three variables).

adversity. This is meant to determine the potential of resilience to explain longevity and the possibility that this effect can be mediated by adversity. Finally, the same models of multilevel binary logistic regression are conducted on the sub-samples sorted by sex to examine gender differences in the investigated effect. This final part of the analysis tests the potential contribution of resilience to research on gender differences in morbidity and mortality.

Descriptive statistics

The characteristics of the level-1 observations between two waves are presented in Table 1.[4] The number of observations and distributions across categories enables us to reconstruct the number of respondents placed in each category. Overall, 8.0% of the respondents included in two consecutive data collections died during this approximately two-year gap—10.0% of the male sample and 6.6% of the female sample. The number of deceased is sufficiently large for a valid estimation of the dependent variable.

There were very similar numbers of respondents (all statistics describe level-1 observations) in all four groups of the indicator of resilience, which is not surprising given the method used to construct this variable. The oldest-old age group has some specific qualities that are reflected in the distributions of other characteristics—about 58% of respondents were female, 11% had a tertiary education, age was positively skewed with a very low mean of just over 80 years, and 43% lived with their partner. It is worth noting the gender differences in some individual characteristics: 71.1% of men lived with their partner in the household, while 22.3% of women did. The proportion of men with tertiary education was 15.3%, whereas the proportion of women was 7.8%. Women also possessed a much smaller amount of total household assets and had more health conditions and adversities.

Overall, 82.6% units of analysis were limited or severely limited in everyday activities, 47.7% had at least some difficulty making ends meet, and 9.1% of them had experienced the death of a spouse in the last four years; these figures did not vary sharply across sexes. Most respondents faced one or two adversities, but the sample also contains respondents with more adversities, including approximately 5% of respondents who had faced a total of four, five, or even the maximum of six adversities—82% of these respondents were indicated as very vulnerable or quite vulnerable. The size of the national samples varied between 967 observations from Belgium and 235 observations from Slovenia due to differences in the numbers of waves and the size of the baseline and refreshment samples, and to differences in the response rate and the sample dropout rate [Malter and Börsch-Supan 2013].

[4] The distributions of the level-2 observations (respondents over the age of 75) are basically identical.

Table 1. Descriptive statistics of the panel sample of a total of 8924 respondents—3777 men and 5147 women—observed in two consecutive waves used in the analysis—part one

Variable	Categories or range	Male (% or mean)	Female (% or mean)	Total (% or mean)
Respondent alive in the next wave	Deceased	10.0	6.6	8.0
	Alive	90.0	93.4	92.0
Resilience	Very vulnerable	19.8	25.5	23.1
	Quite vulnerable	25.8	26.6	26.3
	Quite resilient	23.5	21.3	22.2
	Very resilient	30.9	26.6	28.4
Age	75–102	80.1	80.9	80.5
Total household assets in millions (Euro)	0–1.50	0.24	0.16	0.20
Number of health conditions	0–9	1.92	2.35	2.17
Education (ISCED)	ISCED 0,1	42.1	50.3	46.8
	ISCED 2–4	42.6	41.9	42.2
	ISCED 5,6	15.3	7.8	11.0
Wave number	1	17.6	17.6	17.6
	2	36.3	32.0	33.8
	4	46.1	50.4	48.6
Partner in the household	No	28.9	77.7	57.0
	Yes	71.1	22.3	43.0
Gap between waves	11–39	24.7	24.9	24.8
Adversities	1–6	1.73	1.91	1.84
Health limitations	Not limited	18.9	16.3	17.4
	Limited	54.3	53.4	53.8
	Severely	26.8	30.3	28.8

Table 1. Descriptive statistics of the panel sample of a total of 8924 respondents—3777 men and 5147 women—observed in two consecutive waves used in the analysis—part two

Variable	Categories or range	Male (% or mean)	Female (% or mean)	Total (% or mean)
Able to make ends meet	Fairly easily or easily	55.2	50.2	52.3
	Some difficulty	34.7	36.7	35.9
	Great difficulty	10.1	13.1	11.8
Death of spouse	No	92.5	89.8	90.9
	1–4 years ago	4.5	6.1	5.5
	in the last year	3.0	4.1	3.6
Quality of life: CASP-12	13–48	35.0	33.9	34.4
Country	Austria	6.1	7.3	6.8
	Belgium	11.5	10.3	10.8
	Czech Republic	8.9	8.8	8.8
	Denmark	4.8	6.0	5.5
	Estonia	6.3	10.3	8.6
	France	8.0	9.1	8.7
	Germany	5.1	5.3	5.2
	Greece	6.8	5.4	6.0
	Italy	8.4	6.2	7.1
	Netherlands	6.0	5.2	5.6
	Poland	2.9	2.8	2.9
	Slovenia	2.5	2.8	2.6
	Spain	10.0	9.9	9.9
	Sweden	7.9	6.1	6.9
	Switzerland	4.8	4.5	4.6

Source: SHARE, waves 1, 2, 4, and 5; authors' calculations.

Multilevel binary logistic regression for the whole sample

The general ability of resilience to predict survival and longevity is tested in two models for the whole sample together. The results are presented in Table 2. Model 1 contains control variables already used in this area of research. Model 2 differs in the fact that the information about the amount and severity of adversity is also included. Comparing these two models enables us to distinguish the effect of resilience as the ability to react to a certain level of hardship from resilience as the misleading identification of resilience as actually experiencing less adversity than individuals identified as vulnerable.

Model 1, presenting the odds ratios of multilevel binary logistic regression, shows that each increase on the 4-point scale of resilience improves the odds of survival. All of the categories differ significantly from the group of very vulnerable individuals. The biggest difference is, as expected, between the very vulnerable group and the very resilient group. More specifically, being very resilient means having 2.10 times higher odds of surviving to the next wave. The effect of resilience shows very strong statistical and substantive significance, and resilience seems to be a strong predictor of survival in very old age. We test and discuss some alternative explanations further on.

The other strong predictors of survival of the oldest old that were identified are consistent with both intuitive assumptions and previous knowledge. The odds of survival are 2.17 times higher for women than for men and decrease rapidly with increasing age and increasing gaps between the two data collections. The country effects are not presented in Table 2 and further on in order to save space, as they are mostly not significant and an examination of country or regional differences is beyond the scope of this paper.

No other characteristics effectively predict survival to the next wave. Household assets, health conditions, and a partner in the household are significant variables at the lower level with respective *p*-values of 0.044, 0.040, and 0.085. The odds ratios for education, which are not even close to significant, could be partially explained by an additional analysis showing that people with a lower level of education tend to have slightly more severe limitations and much greater financial difficulties. Therefore, the effect of education may remain hidden if it is mediated by health or financial situation. We could tentatively explain the low odds ratios of household assets and health conditions in the same way and the weak effect of partnership could be associated with bereavement, as the data indicate that in the period of bereavement people generally do not live with a partner in the household. These possible explanations were tested in the models without possible mediators, and the effects of education, financial security, partnership, and health changed to become more positive, but the difference was not strong. We therefore tentatively interpret the results to indicate that position in social structure and partnership are less important than the ability to mobilise personal and/or social resources among the oldest old.

Table 2. Estimates of the odds ratios of survival to the next wave based on binary logistic regression

	Model 1	Model 2
Resilience		
Very vulnerable (reference category)		
Quite vulnerable	1.22+	1.12
Quite resilient	1.70***	1.50**
Very resilient	2.10***	1.79***
Gender		
Male (reference category)		
Female	2.17***	2.15***
Age	0.90***	0.90***
Total household assets in millions (Euro)	1.33*	1.32+
Number of health conditions	0.95*	0.96
Education		
ISCED 0–1 (reference category)		
ISCED 2–4	0.97	0.95
ISCED 5–6	1.02	0.98
Partner in the household		
No (reference category)		
Yes	1.18+	1.12
Gap between waves	0.96**	0.96**
Adversities		0.81***
Country effects not shown		
N	8924	8924

Source: SHARE, waves 1, 2, 4, and 5, authors' calculations.
Note: $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Model 2, with adversity as an additional control variable, does not differ substantively from Model 1. Nevertheless, the odds of survival are significantly reduced by a greater amount and/or greater severity of adversity and the effect of resilience in this model is not so strong. We can therefore ascribe part of the effect of resilience from Model 1 to the fact that individuals with greater indicated resilience usually face less adversity. However, the effect of resilience remains strong and approximately linear, even if we control for this source of possible distortion. Being in the category of very resilient individuals still increases the

odds of survival 1.79 times. The odds ratios for household assets, health conditions, and partner in the household are somewhat weaker and less significant (or even not significant). The rest of the variables in Model 2 have the same effect as in Model 1 and we can thus keep the conclusions from the previous paragraph.

Multilevel binary logistic regression for men and women separately

The analysis of gender differences in the effect of resilience on survival follows the same logic as the previous analysis of the whole sample. Table 3 depicts the results for the sub-samples of men and women without the control for adversity in Models 3 and 4, which is followed by Models 5 and 6, which control for the amount and/or severity of adversity. The differences between the results for these two sets of models are relevant both theoretically and empirically.

The odds ratios differ considerably between Models 3 and 4. The gender differences worth noting are (a) the positive effect of household assets on survival among women; (b) the 1.24 times higher odds of survival for men living with a partner; (c) the 0.08 times lower odds for men with one additional health condition; (d) the higher odds ratios for resilience for women. These differences make sense in the context of our data, as women possessed fewer household assets and men's survival was generally more dependent on the presence of a spouse. The relatively weak significance of these two effects indicates that co-residence and economic position predict survival in a different way across sexes, but the effects are not strong.

While the stronger negative effect of health conditions among men is empirically supported by previous research, this is not true for the higher effect of resilience among women. Yet, the more protective effect of resilience among women makes sense and the lack of empirical evidence may be explained both by a shortage of research on this topic and by inadequate measurement of resilience as a stable and individual characteristic. Therefore, the higher survival of women may be partially explained by their greater ability to use personal, community, and social resources, but the effect of resilience is also highly significant for men. The country effects are again mostly not significant and were omitted from Table 3 to save space.

The analysis of gender differences brings some new findings when we include the amount and/or severity of adversity in the regression (Models 5 and 6). The previously significant odds ratios for household assets, partner in the household, and health conditions became insignificant, even though the gender differences are still visible. Controlling for the amount and severity of adversity made the odds of survival 0.25 times lower for men and 0.15 times lower for women with every additional point on the scale, weakened the effects of resilience substantially, and made the gender difference even more pronounced. For instance, the difference in the odds of survival between very vulnerable and very resilient respondents is 59% with $p = 0.012$ among men and 97% with $p = 0.000$ among

Table 3. Estimates of the odds ratios of survival to the next wave based on binary logistic regression conducted separately for men and women

	Model 3	Model 4	Model 5	Model 6
	Male	Female	Male	Female
Resilience				
Very vulnerable (reference category)				
Quite vulnerable	1.11	1.32+	0.98	1.24
Quite resilient	1.58**	1.80**	1.34+	1.64**
Very resilient	1.99***	2.23***	1.59*	1.97**
Age	0.92***	0.89***	0.92***	0.89***
Total household assets in millions (Euro)	1.26	1.48+	1.24	1.47
Number of health conditions	0.92*	0.97	0.94	0.98
Education				
ISCED 0–1 (reference category)				
ISCED 2–4	0.96	0.96	0.92	0.95
ISCED 5–6	0.86	1.47	0.80	1.44
Partner in the household				
No (reference category)				
Yes	1.24+	1.13	1.16	1.09
Gap between waves	0.97*	0.96**	0.97+	0.96**
Adversities			0.75***	0.85*
Country effects not shown				
N	3777	5147	3777	5147

Source: SHARE, waves 1, 2, 4, and 5, authors' calculations.
Note: $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

women. Generally, the effect of resilience remains positive and linear for both sexes. However, it is much lower, less significant, and largely explained by the amount and severity of adversity for men, while it is less explained by adversity and is substantially stronger for women.

We can combine the findings from the descriptive statistics and regression models into the statement that women have generally higher odds of survival because of the stronger effect resilience has in women and not because women have a generally higher level of resilience. The gender difference in resilience is more in its structure or function than in its amount. This supports our argument that the gender paradox can partly be explained by the greater social resources of women.

Conclusion and discussion

This study investigated the effect of resilience on survival among men and women in the oldest-old age group and gender differences in this causal relationship. Data from waves 1, 2, 4, and 5 of the SHARE were used to investigate this topic. While most of the research uses other explanations for human longevity and mortality reduction—such as health care, genetic factors, personal traits, or socio-economic status, which are partly dependent on the field of study—there is still some unexplained variance that can be partly addressed by the concept of resilience. We argue that studying resilience as a process of adaptation to adversity through the use of personal, community, and social resources has the potential to contribute to the field of longevity research and we support our claim with the following findings.

First, we found that the level of resilience strongly predicts survival in very old age. Hildon et al. [2008] examined some of the beneficial effects of resilience on one British cohort, and Zeng and Shen [2010] analysed the effect of resilience on becoming a centenarian on a rather small Chinese sample, with results similar to ours. This paper methodologically contributes to previous studies in several ways: (a) a cross-national panel sample from 15 European countries was used to test the assumption on a broader geographical scale, and the results were robust to changes of the sample definition in terms of included waves and countries; (b) all the control variables that seemed relevant were employed to obtain the net effect of resilience while some potential confounders were kept constant, but only gender and age had a substantial effect among older people facing adversity; and (c) an ordinal measurement of resilience was used instead of the usual dichotomous version to prevent loss of information, and higher resilience was found to predict higher odds of survival at each step on the 4-point resilience scale.

Second, the effect of resilience remains strong even when controlling for the amount and/or severity of adversity, although the factor of adversity is significant and explains some part of the effect of resilience for both sexes. Some previous studies reflected that resilience is dependent on the amount and severity of adversity [Blane et al. 2011; Hildon et al. 2008], but did not control for this possible source of bias in the analyses of the outcomes of resilience. We argue that analyses of resilience should contain this factor, as resilience is context-dependent and should not be evaluated in the same way among individuals with very different loads of adversity.

Third, the effect of resilience is especially strong in older women, while it is weaker and to a greater extent explained by the smaller amount and/or lesser severity of adversity in more resilient older men. In fact, some of the unexplained aspects of the gender paradox [Austad 2006; Ory, Warner 1990; Vaupel 2009] can be attributed to this higher effect of resilience among women, which was not determined by previous research due to the indicator of adversity being omitted from the analysis [Choowattanapakorn et al. 2010; Wagnild 2009]. Additionally,

most papers did not include social support or contacts in their measurement of resilience despite the importance of these resources in later life [Netuveli et al. 2008; Wagnild 2009]. Therefore, we argue that the higher longevity of women can be partly explained by their more protective form of resilience, which is more based on social resources.

Fourth, the age of the respondent is the only strong predictor of survival from the remaining characteristics contained in this study. Variables other than age and gaps between data collections are significant only in a minority of models (apart from education, which is significant in none of the models). Although these findings can be somewhat distorted by the definition of the sample and the construction of indicators for resilience and adversity, it seems that primarily biological factors and resources for adapting to adversity are very important for survival. Furthermore, it seems that these factors to a large extent explain the effects of socio-economic structures and partnerships. The analysis of gender differences revealed weak positive effects of living with a partner for men and of household assets for women. We can hypothesise from these findings that men depend more on their partners as the primary caregiver and women are more at risk of financial insecurity in this age group.

There are some limitations to the chosen methods and procedures. First, the whole analysis is conducted on a sample of the oldest old facing adversity, thus the conclusions are not applicable to other age groups or individuals without adversity—the latter cannot be recognised as resilient by definition. Second, this outcome-based measurement of resilience partly overlaps with key personal characteristics of the oldest old. This information called into question the precise values of some odds ratios. Nevertheless, we believe this study is a relevant contribution to the existing research that has used either an outcome-based measurement of resilience or a reductionist psychological measurement of resilience as a personal trait. This limitation of the previous research should be further addressed by measuring resilience as a multi-dimensional capacity, while the contributions of specific dimensions should be elaborated. Then, new sources of data with different measurements of key variables have the potential to enable more precise conclusions in the future.

Some future directions of this area of research, such as confirmation of the results using alternative measurements of resilience and studies of different age groups, are indicated by the limitations of this paper. The most important direction for future research seems to be evaluating which resources of resilience are the most relevant for survival and the quality of life of older people and how it is possible to promote these resources using the tools of social policy and other initiatives.

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