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Can time heal all wounds? An empirical assessment of adaptation to functional limitations in an older population

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ABSTRACT

Chronic diseases and functional limitations may have serious and persistent consequences for one's quality of life (QoL). Over time, however, their negative impact on QoL may diminish because of adaptation. Understanding how much people adapt helps to correctly separate the effects attributable to interventions from those arising from adaptation and thus facilitates a better estimation of the effects of disease and treatment on QoL. To date, however, there is little empirical evidence on adaptation in older populations. In particular, it is unclear to which extent dimensions of QoL like health and overall experience with life are influenced by adaptation. This paper studies adaptation to functional limitations in 5000 respondents of the Survey of Health, Ageing and Retirement in Europe (SHARE) who develop disabilities during the span of the 5 waves of data collection between 2004 and 2015. To examine the association between time since the onset of functional limitations and self-perceived health and life satisfaction, a fixed effects ordered logit model is used. We found evidence supporting adaptation in life satisfaction, corresponding to a return to pre-onset levels of life satisfaction. Also in the self-perceived health dimension, adaptation does occur, but it does not occur fast enough to offset the negative changes in underlying health. This means that observational studies that measure one of these two outcome measures should be aware that part or all of the effects found are due to adaptation.

1. Introduction

In health care, improving quality of life (QoL) of patients is an important objective and QoL is considered an outcome to assess quality of care and effectiveness of interventions. Changes in QoL are not necessarily caused by interventions: the negative impact of the disease on quality-of-life can diminish over time because of adaptation. While adaptation may be seen as a remarkable display of human resilience, it is often considered a problem from a measurement perspective because it might lead to biased estimates of the impact of disease and interventions on QoL, and potentially causes misleading conclusions. This may especially occur in unrandomized trials and observational studies when the end-point of interest is (i) measured over a prolonged period (ii) self-reported and (iii) focusses on how one feels in general or with respect to limitations caused by the disease.

As a result, adaptation has been used as an argument against using patient-reported outcomes as the maximand in economic evaluations (cf. Versteegh and Brouwer (2016) and Brazier et al. (2017)), which are a key instrument for priority setting in public health care resource allocation in some countries. Empirical evidence on whether and how much patients adapt could inform standards detailing the required level of evidence on effectiveness of treatments targeting QoL-related end-points. Moreover, if adaptation to certain conditions takes place, this raises the difficult but unavoidable question if resource allocation decisions should take this into account as decision-makers may choose to prioritize conditions for which adaptation is less likely achieved.

While adaptation would have important consequences, so far there is limited agreement on (i) through which dimensions adaptation occurs and (ii) to what extent. Moreover, the research on adaptation to health-related problems (Brickman et al. (1978), Lucas (2007), Oswald and Powdthavee (2008), Powdthavee (2009), McNamee and Mendolia (2014) and Cubi-Molla, Jofre-Bonet, & Serra-Sastre (2016)) is up to this point on adults with disabilities which is a very limited and particular group, studies a limited number of outcomes (Powdthavee (2009) is an exception), and has limited statistical power.

This paper quantifies the size and timing of adaptation of older respondents with functional limitations. To facilitate the choice of outcomes and to improve the interpretation of the results, it applies the conceptual framework of the Quality of Life Expert Group (EG) (2017). An understanding of how much people adapt on each of the dimensions

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of QoL helps to correctly separate the effects attributable to interventions from those arising from adaptation and thus facilitates a better interpretation of studies on the effects of disease and treatment on QoL.

Prior studies do not provide unambiguous support for the occurrence or level of adaptation to ill-health. A pioneer study by Brickman et al. (1978) finds that happiness of paraplegic accident victims was well above what would have been expected given their circumstances. Some longitudinal studies followed suit that had the added benefit of controlling for individual heterogeneity. Lucas (2007) does not find any adaptation of life satisfaction to disability in two large panel surveys of the general population while Oswald and Powdthavee (2008) find a considerable level of adaptation using one of these data sets but a different econometric specification. Using a similar econometric specification as Oswald and Powdthavee (2008) applied, McNamee and Mendolia (2014) observe some adaptation to chronic pain for women in the general population, but none for men. Cubi-Molla et al. (2016) provide evidence for adaptation after a relatively long duration of 20 years in self-assessed health, making use of a fixed effects probit model.

These differences might occur because of the way the effect of adaptation was measured (i.e. the econometric strategy) but could also be caused by a difference in the response variable used. This is a matter that has received relatively little attention in the literature. One exception is a study by Powdthavee (2009), who adopts a model proposed by Van Praag, Frijters, and Ferrer-i-Carbonell (2003) to study the effect of mild and severe disability on several areas of life, including satisfaction with health, income and housing. Disability is found to have the most impact on the health dimension, where adaptation was incomplete for the severely disabled. Incomplete adaptation is defined as a recovery in subjective health that is not equal to pre-onset levels of health. Still, complete adaptation was found for all subdomains in the mildly disabled category. Powdthavee (2009) proceeds by modelling life satisfaction on the subdomains to determine the importance of these domains for overall satisfaction with life. Because adaptation in life satisfaction in this study is based on the adaptation in the weighted domains (including health), it is not surprising that there appears to be complete adaptation in the mild condition, but not in the severely disabled group.

This paper contributes to this literature in four ways. First, it examines the incidence and magnitude of adaptation for older people, as it uses an older sample rather than a sample of the general population. Adaptation of the elderly to functional limitation is of interest because this is a large and growing part of the population and because a big part of the health care budget is allocated to this group and the conditions causing such limitations. This group is also of interest because the extent or level of adaptation among the elderly might differ significantly from younger counterparts because (i) older individuals value different things when valuing life compared to the general population (Netuveli and Blane, 2008) and (ii) have been shown to be more resilient than younger adults (Goodin et al., 2012; Terrill et al., 2014).

Second, this paper contributes by analysing adaptation in multiple dimensions of QoL to address part of the ambiguity surrounding adaptation results from prior studies. We adopt the framework proposed by the Quality of Life Expert Group (2017), describing nine dimensions of QoL. Of these, we examine adaptation in the two dimensions that are expected to be most affected, either directly or indirectly, by functional limitations: life satisfaction and self-perceived health. In doing so, we use a different approach from Powdthavee (2009), who models self-perceived health as a subdomain of life satisfaction. Our framework acknowledges that life satisfaction is part of QoL rather than fully comprising all QoL domains, which aids the interpretation.

The third contribution of this paper is that it is the first adaptation study to make use of the multi-country SHARE database, which increases the external validity of our results (Clark, 2018). Fourth, this is the first paper to use a long-standing functional limitations scale as an indicator of ill-health: the Instrumental Activities of Daily Living (IADL) measure. The main advantage of using IADL compared to the (medically) diagnosed chronic illness (used by Cubi-Molla et al. (2016)) is that one is more likely to adapt to the functional limitations caused by chronic illness than to "the feeling of being chronically ill". The two main advantages of using the IADL scale instead of more simple questions about disability (Lucas, 2007; Oswald and Powdthavee, 2008; Powdthavee, 2009) is that the IADL scale is less prone to justification bias and can give an indication of the severity of the functional limitations.

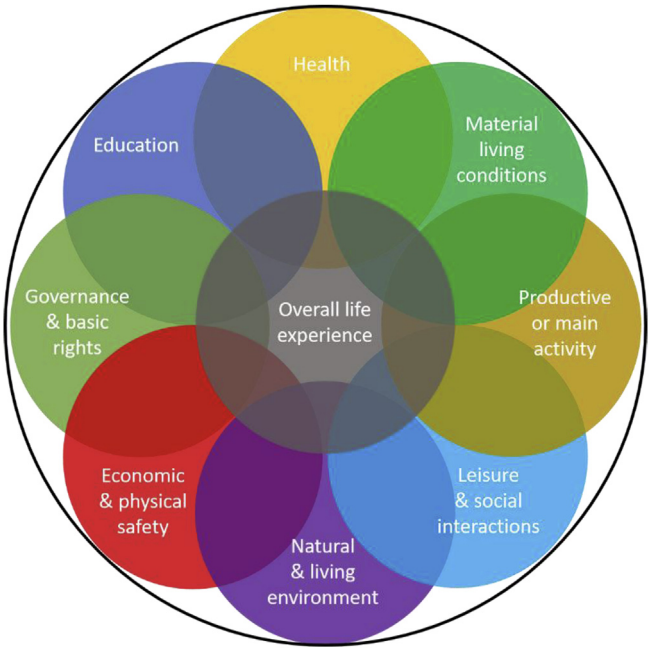

Fig. 1. Quality of life dimensions.
Source: own adaptation of EG (2017)

2. Conceptual framework

Fig. 1 provides a simplified overview of the adopted QoL framework. The important contribution of the EG (2017) framework is that it highlights that QoL is a multidimensional concept – they distinguish nine dimensions – and that no single measure is able to capture all these dimensions. Of these dimensions, the first is about life as a whole. It is closely related to the subjective well-being literature as life satisfaction is the headline indicator on this dimension. Particularly life satisfaction is believed to be influenced by many if not all of the other dimensions. Yet, valuing QoL goes beyond subjective reports of well-being and should also include measures of people's functioning and freedom. The additional eight dimensions of the QoL framework adopted by the EG (2017) are rooted in the capabilities approach. They present objective features that have been proven to affect quality of life.

For this study on adaptation to functional limitation, we focus on the dimensions for health (self-perceived health) and overall life experience (life satisfaction), since we believe these two domains to be most affected by developing functional limitations. Solely focusing on life satisfaction could erroneously result in decision-makers thinking that QoL in a certain population is high, when that is actually an artifact of adaptation and hides underlying differences in opportunity or capability due to disease. Similarly, a focus on objective health would neglect potential effects in other domains.

3. Data

We use data from the Survey of Health, Ageing and Retirement in Europe (SHARE). We use data from 17 European countries and Israel and all 5 regular waves between 2004 and 2015 (i.e. excluding wave 3,

which was about the respondent's life history). Individuals of 50 years and over at the time of sampling were asked to participate, whereas their spouse was asked to participate regardless of his or her age. Ethics approval has been obtained by the SHARE team and therefore no further ethical approval was required.

The total number of observations in these five waves is 260,244. Of these, we select individuals who (i) had no IADL limitations when they were first interviewed, (ii) subsequently developed one or more IADL limitations, (iii) remained disabled and iv) reported having a chronic illness at any point during and (if applicable) before the onset of the limitations. This leaves us with 15,826 (6.1%) observations for the main analysis of life satisfaction and self-perceived health.

3.1. Variables

Life satisfaction is measured by the question: "*On a scale from 0 to 10 where 0 means completely dissatisfied and 10 means completely satisfied, how satisfied are you with your life?*" which was asked in waves 2, 4, 5 and 6. The question on self-perceived health is posed as "how would you describe your health in general?", with five answer categories: Poor, Fair, Good, Very good and Excellent. Wave 3 did not contain this information and is excluded.

The information on chronic illness is obtained through the question: "*Some people suffer from chronic or long-term health problems. By chronic or long-term we mean it has troubled you over a period of time or is likely to affect you over a period of time. Do you have any such health problems, illness, disability or infirmity?*".

We measure functional limitations through the validated IADL scale (Graf, 2007). The IADL limitations are a good objective health measure because they measure a wide range of limitations that occur frequently among the elderly and that are essential for living independently. The activities included in IADL are listed in Table 2. The number of times somebody reports to have any difficulty with one of the activities can be added into a sum score ranging from 0 (no difficulty with any activities) to 9 (limited functionality in all 9 activities).

The three main independent variables are (i) an indicator of having at least one IADL limitation, (ii) the number of IADL limitations and (iii) the duration: the time since the onset of these limitations. We measure duration as follows. If an individual reports to have (i) IADL limitations in a particular wave, but not in the preceding wave(s) and (ii) a chronic illness in the current wave and/or preceding wave(s), the duration is approximated by the time in years between the current wave and preceding wave divided by two (see Table 1). For example, if an individual reports limitations in wave 4, but not in wave 2, the duration at wave 4 will be set to 2 years. If the individual has already reported (i) IADL limitations in the preceding wave(s) since onset and (ii) a chronic illness in the preceding wave(s) since onset, the full length in years between the current and preceding wave(s) is added to the previously recorded duration. These calculations are presented in Table 1.

Subsequently, duration is split up in four dummy variables, since the effect of duration may be nonlinear. The dummy categories are (i) no functional limitations, (ii) the onset of the limitations is reported within the past 2 years (1 wave), (iii) between 2.1 and 5.5 years (2 waves) or (iv) more than 5.5 years ago (more than 2 waves). This division is chosen because it roughly corresponds to the number of waves spent with limitations.

The fixed effects in our specification absorb the impact of characteristics and circumstances that do not change in the short run for an elderly population, including personality traits, level of education, the number of children and the country in which the respondent lives. Hence, we only need to control for *time-variant* characteristics that may be correlated with and affect an individual's life satisfaction and health. Following Clark, D'Ambrosio, and Ghislandi (2016), Cubi-Molla et al. (2016) and Ferrer-i-Carbonell and Frijters (2004), we control for marital status, employment status and household income. We add time dummies to control for exogenous shocks to the life satisfaction and self-perceived health that all respondents experience. The time dummies also capture ageing effects and therefore function as an additional proxy for underlying health (see Frijters, Haisken-DeNew, and Shields (2004)). Following McNamee and Mendolia (2014) and Frijters et al. (2004) we do not control for both age and time simultaneously. Moreover, we do not control for variables on healthcare use, which may be "bad controls" as they may (in part) be affected by the functional limitations. Despite these controls and the fixed effects, there may be other random, time varying shocks that have a lasting effect on the outcomes cause a bias in the estimates if the frequency with which they occur is correlated with the duration since the onset of the respondent's functional limitation. The subset of life events for which this is the case and their importance is however most likely limited.

3.2. Descriptive statistics

Figs. 2 and 3 depict the concentration of life satisfaction and self-reported health for four subgroups of respondents ranked by duration of IADL limitations. These two figures highlight that (i) there are relatively few people in the lowest categories of life satisfaction and in the highest categories of self-perceived health for all subgroups, (ii) those with IADL limitations score lower than those who have no IADL limitations yet, but (iii) those with enduring IADL limitations appear to return to pre-onset levels for life satisfaction but not for self-reported health. Note that this does not indicate adaptation or the lack thereof per se. Particularly, for the self-perceived health scores this might also mean that health is deteriorating over time and adaptation simply does not happen fast enough to offset this negative effect.

In about half of the selected observations, the individual has developed functional limitations and 83% has developed a chronic illness (Table 2). The frequency at which each subcategory of the IADL measure is chosen varies, with doing work around the house or garden being the most frequent. Yet, cross tabulation of the subcategories with self-perceived health shows that there are no categories that are markedly more severe than others. This aids the interpretation of the sum IADL score resulting in the number of limitations, combining categories that more or less represent the same level of severity per functional limitation. The average number of limitations with IADL is

Table 1
Construction of the duration variable.

	Wave 1	Wave 2	Wave 3 (omitted)	Wave 4	Wave 5	Wave 6
	2004/06	2006/10	-	2010/12	2013	2015
Median time in years between waves	-	3	4	2	2	-
Onset limitations in wave 2	0	1.5	-	5.5	7.5	9.5
Onset limitations in wave 4	0	0	-	2	4	6
Onset limitations in wave 5	0	0	-	0	1	3
Onset limitations in wave 6	0	0	-	0	0	1

Table 2
Descriptive statistics independent variables.

Variable	Definition	Mean	Standard deviation
Prevalence of IADL limitations	Total	0.451	
Prevalence of IADL limitations per subcategory (for respondents reporting at least 1 limitation)	Using a map to figure out how to get around in a strange place	0.400	
	Preparing a hot meal	0.229	
	Shopping for groceries	0.363	
	Making telephone calls	0.118	
	Taking medications	0.123	
	Doing work around the house or garden	0.698	
	Managing money, such as paying bills and keeping track of expenses	0.232	
	Leaving the house independently and accessing transportation services	0.160	
	Doing personal laundry	0.111	
Incidence of chronic illness		0.832	
Number of IADL limitations		2.432	2.020
Duration of functional limitations		2.000	1.655
Marital status	0 = Married/registered partnership (reference category)	0.618	
	1 = Not married	0.382	
Employment	1 = Retired (reference category)	0.711	
	2 = Employed	0.088	
	3 = Unemployed	0.023	
	4 = Inactive	0.178	
Log household income[a]	Logarithm of household income	9.566	1.490
Number of subjects	5322		
Number of observations	15760		

[a] For household income, the imputed values are presented, since it is scarcely reported in the original data set.

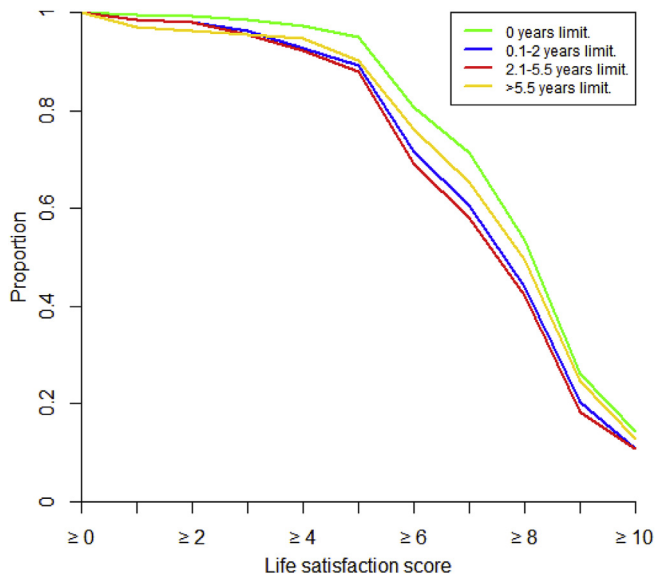

Fig. 2. Life satisfaction scores displayed for different durations of functional limitations.

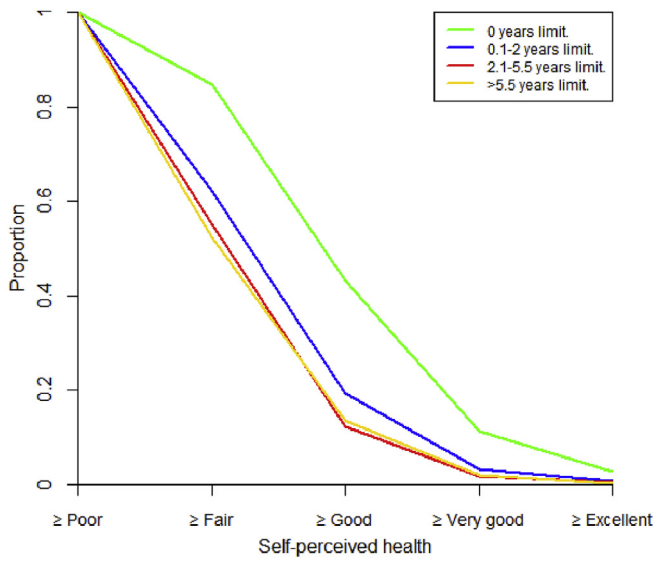

Fig. 3. Self-perceived health displayed for different durations of functional limitations.

2.4 and the average duration of having IADL limitations is 2 years. Furthermore, approximately 59% of the observations is for a female respondent, 62% is married and 70% is retired; the mean age is 72 years.

4. Methods

4.1. Estimation

We estimate the effect of duration on life satisfaction and self-perceived health using a fixed effects ordered logit specification which models a latent response variable according to the "blow-up and cluster" (BUC) estimator (Baetschmann et al., 2015). The ordered logit specification assumes the existence of a latent response variable according to:

$$Y_{it}^{*} = C_{it}'\theta + D_{it}'\delta + IADL_{it}\gamma + \alpha_i + \varepsilon_{it}, \quad i = 1, \ldots, N, \quad t = 1, \ldots, T. \tag{1}$$

Y_{it}^{*} is respondent i's latent self-perceived health or life satisfaction at time t, $IADL_{it}$ the number of IADL limitations, D_{it} a vector with dummy variables capturing the time since the onset of the functional limitations and C_{it} a vector with the covariates controlling for time-variant characteristics that could affect life satisfaction or self-perceived health. Lastly, α_i is the individual specific fixed effect and ε_{it} the error term, which follows a logistic distribution. The observed self-perceived health or life satisfaction, denoted by Y_{it}, is constructed from Y_{it}^{*} as follows

$$Y_{it} = k \cdot if \cdot \tau_{ik-1} < Y_{it}^{*} \leq \tau_{ik}, \; k = 1, \ldots, K \tag{3}$$

The thresholds between categories $k-1$ and k can be individual specific, with $\tau_{i0} = -\infty$ and $\tau_{iK} = \infty$, and $\tau_{ik-1} \leq \tau_{ik}$ for all k. For further

details on the estimation procedure, see Baetschmann et al. (2015). In the Results section, we focus on the marginal effects; the procedure for estimating these is outlined in appendix file A.

4.2. Interpretation

The measurement of adaptation is not straightforward and the complexities start with the definition of adaptation itself. The literature distinguishes between a true change in subjective QoL and scale recalibration (Ubel et al., 2010), where scale recalibration refers to a change in the interpretation of the scale on which QoL is measured over time. Particularly in the context of health economic decision making, scale recalibration can be considered bias that has to be excluded from treatment effect, since only a true change in subjective QoL is of interest.

A true change in subjective QoL and scale recalibration are also jointly referred to as response shift or the effect of adaptation (Peeters and Stiggelbout, 2013; Sprangers and Schwartz, 1999). While we acknowledge the meaningful distinction between these constituents of response shift, we here refer to adaptation as the umbrella term for the cause of reporting higher QoL levels as we do not have the means to identify scale recalibration separately within this study.

4.3. Robustness checks

In addition to the main analysis, we perform five sets of additional analyses in order to assess the robustness of our results with respect to model features and attrition issues that have raised concern in previous studies. First, to check the claim of Frijters et al. (2004) that time dummies will include age effects, we perform two additional analyses where the time dummies are replaced by age dummies. Next, analyses are performed for a linear model specification. We do this to address concerns raised by Bond and Lang (2018) regarding rank order identification for ordinal data, by assuming a continuous scale for the response variables. Third, we test the results for robustness to the definition of the duration variable by using a continuous duration variable as opposed to the dummy specification. Fourth, to ensure that the results are not driven by respondents who have only been observed living with IADL limitations for a relatively short period of time and to test for selective attrition, one analysis is executed for a smaller sample of individuals *who have had IADL limitations* for three or four consecutive waves. Fifth, in order to assess adaptation through different functional limitation measures, we perform two additional regressions with ADL and mobility as the functional limitation measure. The ADL scale, which measures more severe (and rarer) limitations than the IADL scale, includes activities like dressing and walking across a room. The mobility scale is the sum of 10 mobility items measured in SHARE, including categories like walking 100 m and sitting for about 2 h. Lastly, to make sure that the imputations are not affecting the conclusions, we perform an analysis on the subset of the data that has complete observations on the response variables for all observed waves.

5. Results

5.1. Main results

The regression results reveal that respondents who developed functional limitations less than 2 years ago (reference category) experience a lower life satisfaction than those living without functional limitations (Table 3). That is, as expected, developing functional limitations has a negative effect on satisfaction with life. This is further confirmed by the negative coefficient for the number of IADL limitations: a higher number of limitations is related to a lower life satisfaction.

However, individuals who have lived with functional limitations for longer than 5.5 years have higher levels of life satisfaction than the reference group (which has had limitations for 0.1–2 years): the coefficient for having limitations for more than 5.5 years of IADL limitations is significant and positive. This finding supports the adaptation hypothesis. However, note that the magnitudes of the coefficients cannot directly be compared because of the non-linear regression specification.

The wave dummies are added to capture the effect of ageing on life satisfaction, but may also capture the effect of other time shocks on life satisfaction or self-perceived health that are common to all respondents. The fifth wave has a significant negative effect on life satisfaction compared to the first observed wave (second wave), which might be caused by the Great Recession striking at this time. The other wave dummies do not show a significant effect, implying that the effect of age on life satisfaction as captured by the wave dummies is minor. Lastly, the employed respondents are more satisfied with their lives than the retired.

Experiencing IADL limitations for the first time and the number of IADL limitations also have a significant negative effect on self-perceived health. We find adaptation for this QoL dimension too, with the coefficients for a duration of 2.1–5.5 years and more than 5.5 years being positive and significant compared to having a limitation for the first time.

Furthermore, the wave dummies all have a significant negative effect compared to the first observed wave (wave 1). This clearly

Table 3
FE ordered logit regression for life satisfaction and self-perceived health.

	Life satisfaction	Self-perceived health
Duration		
0 years (NO) IADL limitations	0.302***	0.723***
	(0.081)	(0.083)
0.1–2 years IADL limitations (reference category)	–	–
2.1–5.5 years IADL limitations	0.128	0.222*
	(0.083)	(0.087)
> 5.5 years IADL limitations	0.409*	0.704***
	(0.184)	(0.173)
Number of IADL limitations		
Number of IADL limitations	−0.091***	−0.191***
	(0.019)	(0.022)
Wave		
Wave 1 (reference category self-perceived health)	–	–
Wave 2 (reference category life satisfaction)	–	−0.580***
	–	(0.073)
Wave 4	0.095	−1.321***
	(0.073)	(0.100)
Wave 5	−0.316***	−1.580***
	(0.095)	(0.116)
Wave 6	0.135	−1.658***
	(0.145)	(0.162)
Marital status (Reference category: Married)		
Not married	−0.127	0.163
	(0.149)	(0.152)
Employment status (Reference category: Retired)		
Employed	0.450***	0.444***
	(0.136)	(0.143)
Unemployed	−0.391	−0.0162
	(0.212)	(0.221)
Inactive	−0.043	−0.133
	(0.090)	(0.096)
Household income		
Log household income	0.036	0.021
	(0.022)	(0.020)
Number of subjects	5322	5322
Number of observations	15760	14087

Note. Ref. stands for reference category. *** indicates $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Standard errors are reported underneath the regression estimates within parentheses. Standard errors are obtained by means of cluster robust variance estimation.

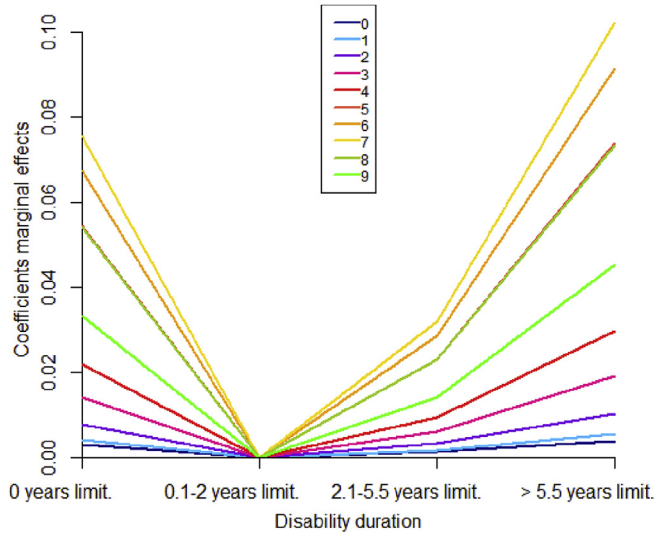

Fig. 4. Average marginal effects for duration of functional limitations on the probability of reporting $Y > k$ for life satisfaction.

indicates that ageing as measured through the wave dummies has a negative effect on self-perceived health. Finally, employed respondents have a significantly higher self-reported health than retired respondents, probably in part because being in good health enables someone to continue to work.

To better understand the magnitude of the adaptation to functional limitations, we calculate average marginal effects (see appendix A for details and appendix tables B1 and B2 for the full results, including Krinsky and Robb (1986, 1990) standard errors). The average marginal effects for the duration of IADL limitations on the probability of reporting a higher life satisfaction category than category *k* are displayed in Fig. 4 for categories 0 to 9. Fig. 4 shows for instance that the probability of reporting a life satisfaction score higher than 7 (on the 0 to 10 scale, where higher is better) is about 7.5 percentage point higher for those not experiencing any IADL limitations than for the reference category consisting of respondents who developed functional limitations in the past 2 years. Respondents who have had IADL limitations for 2.1–5.5 years are 3 percent more likely than the reference category to report a life satisfaction score larger than 7. Surprisingly, respondents who have had IADL limitations for at least 5.5 years (i.e. 3 waves) have

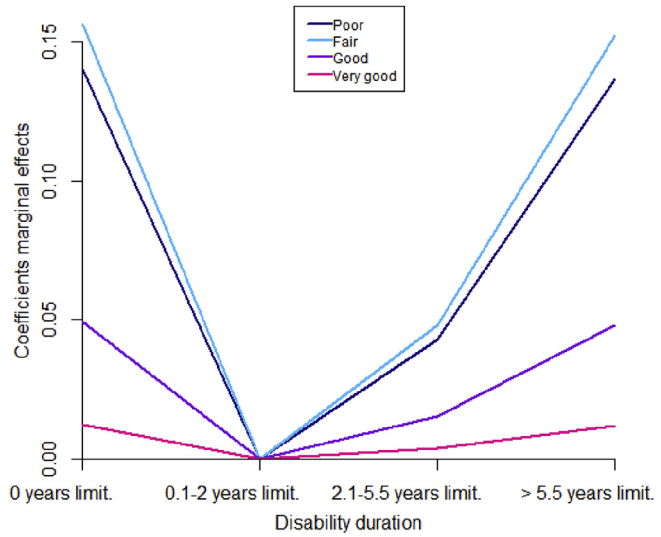

Fig. 5. Average marginal effects for duration of functional limitations the probability of reporting $Y > k$ for self-reported health.

the highest probability of all four subgroups of reporting a score of higher than 7 – about 10 percentage points higher than the reference category. All effects are positive, meaning that for all the displayed duration categories and across the entire distribution, the probability of reporting a higher life satisfaction category is larger than that for the first observed period living with functional limitations.

The average marginal effects for duration in the regression with self-perceived health show a large effect of having no IADL limitations on the probability of being in the three highest categories (16 percentage point) and the four highest categories (14 percentage point) of the self-reported health measure compared to having IADL limitations for 0.1–2 years (Fig. 5). Here, the effects for all self-perceived health categories are also positive for 2.1–5.5 years and more than 5.5 years of IADL limitations. This means that, on average, respondents who have experienced IADL limitations for a longer period have a higher likelihood of reporting higher self-perceived health compared to respondents who experience living with functional limitations for the first time.

5.2. Robustness checks

The first robustness check regards the replacement of the time dummies by age dummies to check the statement made by Frijters et al. (2004) that time dummies will contain age effects. The results can be found in appendix table B3. We see that the analyses with age dummies are indeed similar to those with time dummies. The results for the remaining robustness checks with life satisfaction can be found in appendix table B4, those for self-perceived health in appendix table B5. The results of the analysis with self-perceived health are robust to a change from a nonlinear FE ordered logit specification to a linear FE specification. The analysis with life satisfaction is less conclusive, since the coefficients on duration are not significant, yet the effects are in the same direction as in the main specification.

For the analysis with a continuous duration variable as opposed to the dummy specification outlined above, we find a significant positive effect of duration on life satisfaction and self-perceived health.

The analysis for the subsample of respondents living with IADL limitations for three or four consecutive waves shows the same pattern of results for both life satisfaction and self-perceived health, yet the duration coefficients for the life satisfaction analysis are not significant. This is likely explained by the fact that the sample size for this analysis is very small: 1249 observations which is merely 8.8% of the full study sample. This shows that the results are not driven by respondents with IADL limitations who exit the panel after being included in the sample for a very short period.

Two additional analyses with activities of daily living (ADL) and mobility as the functional limitations measure were also used to assess the effect of duration since the onset of functional limitations on self-reported life satisfaction and health. The results for self-perceived health and ADL agree with those from the analysis with IADL as functional limitation measure. The results from the other analyses are less in line with the main results. This might be due to the fact that the ADL and mobility measures consist of more severe items than the IADL measure and it might therefore be harder to adapt to these types of limitations. Alternatively, it could be caused by the reduction in sample size: these more severe limitations are rarer than IADL limitation and thus the sample size is smaller.

Finally, in order to assess the effect of the imputations on the results, an analysis was performed where only individuals that had complete observations for the response variable in all observed periods were included. The imputations do not affect the conclusions.

6. Discussion

Subjective assessment of the same objective health state may change within one individual over time if one is able to adapt to functional limitations. Empirical evidence on whether and how much patients

adapt could inform standards detailing the required level of evidence on effectiveness of treatments targeting QoL-related end-points. Moreover, if adaptation to certain conditions takes place, this raises the difficult but unavoidable question if resource allocation decisions should take this into account as decision-makers may choose to prioritize conditions for which adaptation is less likely achieved. However, there is little empirical evidence for the extent of adaptation for older people in self-reported measures that constitute QoL like life satisfaction and self-perceived health. This paper analyzed adaptation to functional limitations assessed through the effect of time since the onset of the limitations on both life satisfaction and self-perceived health for SHARE respondents aged 50 and over. We followed the definition of QoL of the Quality of Life Expert Group (2017) framework that describes health and overall evaluation of life as 2 out of 9 dimensions of QoL.

We find evidence supporting the adaptation hypothesis for IADL limitations in the life satisfaction data and for self-perceived health. Interestingly, this adaptation occurs while the health of the respondents deteriorates: the descriptive statistics for self-perceived health (Fig. 3) showed that respondents experiencing functional limitations for a longer duration do fall in lower self-perceived health categories. Moreover, there was a negative effect of ageing (used as a proxy for health deterioration) on self-perceived health. Consequently, the respondents' subjective health never returned to its pre-onset level. Yet, the evidence in support of adaptation suggests that these respondents report higher self-perceived health levels *given their deteriorating health*. Adaptation does occur, it simply does not occur fast enough to offset the negative changes in underlying health.

For the analysis with life satisfaction, there truly does seem to be a return to pre-onset levels of reported satisfaction with life. This is already apparent from the descriptive statistics (Fig. 2) that showed only a small difference between the distribution of life satisfaction scores for respondents experiencing no limitations compared to those living with functional limitations for over 5.5 years. This is a remarkable result. While health deteriorates, adaptation in life satisfaction is manifested to such an extent that it offsets the negative effect of a decrease in health. A reason for this could be that adaptation in life satisfaction occurs faster compared to that in self-perceived health since the construct of evaluation of life is more correlated with the other constituents of QoL like leisure and social interactions. A reweighting of these dimensions could then facilitate the response shift.

These results are different from Powdthavee's (2009) findings who only finds incomplete adaptation for the severely disabled; persons with self-reported disability and at least one functional limitation. A possible explanation is that Powdthavee (2009) focuses on the general population and this study focuses on older individuals (mean age 72). The adaptation process might be different for different age groups, since their day-to-day activities will be different and therefore their means to adapt. Moreover, older people have been shown to be more resilient than younger adults (Goodin et al., 2012; Terrill et al., 2014). As a consequence, they might more easily adapt to hardship. Alternatively, the chronic conditions prevalent in a different age group might be different to those reported by our sample and the adaptation process for these subsets of diseases could differ.

Another explanation could be the difference in conceptual framework. Powdthavee (2009) considers subjective health as a constituent of life satisfaction, where this paper considers both variables as components of QoL. This latter approach recognizes that two people can be happy but still unequal in terms of objective life circumstances. The changes we observe in life satisfaction might be driven by different factors than those explicitly modelled in Powdthavee's (2009) analysis. We strongly believe in the benefit of conceptualizing overall experience with life as the subjective well-being component of QoL in addition to objective components like health.

A limiting factor in the study of adaptation so far is that one cannot verify what mechanisms comprise the effect of adaptation: is it a true change in subjective QoL or a change in one's internal standards (i.e. scale recalibration)? Scale recalibration leads to a different interpretation of the subjective response scale, but not to a true change in life satisfaction or self-perceived health. This distinction is important because only the true change in these QoL dimensions is of potential interest to determine the level of evidence needed in effectiveness studies with QoL-related end-points. Both scale recalibration and a true change in QoL are of interest, however, in determining to what extent adaptation plays a role in resource allocation decisions. Future research should investigate how to separate the effects of scale recalibration and the other effects of adaptation. Still, in both cases, estimates of QoL effects of interventions will be biased.

The main implication of our findings is therefore that caution is needed in the interpretation of studies that attribute changes in the life satisfaction and self-perceived health components of QoL, since the natural course of life satisfaction and self-perceived health seems to be one of self-restoring after physical limitations have occurred in older people.

The results also have implications for health policy, where QoL – or a change therein – is used as an indication of the effectiveness of treatments or interventions in cost-utility analysis on which reimbursement decisions are based. In general, there is a meaningful distinction to be made with regard to QoL measurements that focus on 'adaptation sensitive domains' (i.e. life satisfaction and subjective health) and more objective measures such as IADL and ADL. Here, the instruments focusing on adaptation sensitive domains appear to be biased in assessing the effectiveness of interventions applied to (fully) adapted populations, in which case objective measures might be preferred.

In short, after the onset of functional limitations, older individuals show a relative recovery in self-perceived health despite health deterioration and return to previously reported life satisfaction, illustrating the remarkable human ability to adapt and learn from hardship but posing challenges for researchers.

Conflicts of interest

The authors have no conflict of interest.

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Appendix A. Supplementary data

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References

Baetschmann, G., Staub, K.E., Winkelmann, R., 2015. Consistent estimation of the fixed effects ordered logit model. J. Roy. Stat. Soc. 178 (3), 685–703.

Bond, T.N., Lang, K., 2018. The Sad Truth about Happiness Scales: Empirical Results. Retrieved from.

Brazier, J., Rowen, D., Karimi, M., Peasgood, T., Tsuchiya, A., Ratcliffe, J., 2017. Experience-based utility and own health state valuation for a health state classification system: why and how to do it. Eur. J. Health Econ. https://doi.org/10.1007/s10198-017-0931-5.

Brickman, P., Coates, D., Janoff-Bullman, R., 1978. Lottery winners and accident victims: is happiness relative? J. Pers. Soc. Psychol. 36, 917–927.

Clark, A.E., 2018. Four decades of the economics of happiness: where next? Rev. Income Wealth 64, 245–269.

Clark, A.E., D'Ambrosio, C., Ghislandi, S., 2016. Adaptation to poverty in long-run panel data. Rev. Econ. Stat. 98 (3), 591–600.

Cubi-Molla, P., Jofre-Bonet, M., Serra-Sastre, V., 2016. Adaptation to healthstates: sick yet better off? Health Econ. 1–18.

Ferrer-i-Carbonell, A., Frijters, P., 2004. How important is methodology for the estimates of the determinants of happiness? Econ. J. 114 (497), 641–659.

Frijters, P., Haisken-DeNew, J.P., Shields, M.A., 2004. Investigating the patterns and determinants of life satisfaction in Germany following reunification. J. Hum. Resour. 39 (3), 649–674.

Goodin, P.A., Hurst, A., Johnson, J., Tarrier, N., 2012. Psychological resilience in young and older adults. Int. J. Geriatr. Psychiatr. 27, 262–270.

Graf, C., 2007. The lawton instrumental activities of daily living (IADL) scale. Medsurg Nurs.: Official J. Acad. Med. Surg. Nurs. 18 (5), 315–316.

Krinsky, I., Robb, A.L., 1986. On approximating the statistical properties of elasticities. Rev. Econ. Stat. 68 (4), 715–719.

Krinsky, I., Robb, A.L., 1990. On approximating the statistical properties of elasticities: a correction. Rev. Econ. Stat. 72 (1), 189–190.

Lucas, R.E., 2007. Long-term disability is associated with lasting changes in subjective well-being: evidence from two nationally representative longitudinal studies. J. Pers. Soc. Psychol. 92, 717–730.

McNamee, P., Mendolia, S., 2014. The effect of chronic pain on life satisfaction: evidence from Australian data. Soc. Sci. Med. 121, 65–73.

Netuveli, G., Blane, D., 2008. Quality of life in older ages. Br. Med. Bull. 85, 113–126.

Oswald, A.J., Powdthavee, N., 2008. Does happiness adapt? A longitudinal study of disability with implications for economists and judges. J. Publ. Econ. 92, 1061–1077.

Peeters, Y., Stiggelbout, A.M., 2013. Anticipated adaptation or scale recalibration? Health Qual. Life Outcome 11 (171), 1–10.

Powdthavee, N., 2009. What happens to people before and after disability? Focusing effects, lead effects, and adaptation in different areas of life. Soc. Sci. Med. 69, 1834–1844.

Sprangers, M.A.G., Schwartz, C.E., 1999. Integrating response shift into health-related quality of life research: a theoretical model. Soc. Sci. Med. 48, 1507–1515.

Terrill, A.L., Molton, I.R., Ehde, D.M., Amtmann, D., Bombardier, C.H., Smith, A.E., Jensen, M.P., 2014. Resilience, age, and perceived symptoms in persons with long-term physical disabilities. J. Health Psychol. 21 (5), 640–649.

The Expert Group on Quality of Life Indicators, 2017. Final Report of the Expert Group on Quality of Life Indicators. Retrieved from Luxembourg.

Ubel, P.A., Peeters, Y., Smith, D., 2010. Abandoning the language of "response shift": a plea for conceptual clarity in distinguishing scale recalibration from true changes in quality of life. Qual. Life Res. 19 (4), 465–471.

Van Praag, B.M.S., Frijters, P., Ferrer-i-Carbonell, A., 2003. The anatomy of subjective well-being. J. Econ. Behav. Organ. 51, 29–49.

Versteegh, M.M., Brouwer, W.B.F., 2016. Patient and general public preferences for health states: a call to reconsider current guidelines. Soc. Sci. Med. 165, 66–74.