Trends in Disability Trajectories and Subsequent Mortality: A study based on the German Socio-Economic Panel for the periods 1984-1987 and 1995-1998 with a three year mortality follow-up.

Gabriele Doblhammer[+*], Uta Ziegler[*+]

+: Rostock Center for the Study of Demographic Change
Konrad-Zuse-Str.1
18057 Rostock
Germany
doblhammer@rostockerzentrum.de

*: Insitute for Sociology and Demography
University of Rostock
Ulmenstr. 69
18057 Rostock
Germany
ziegler@rostockerzentrum.de

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Introduction

Over the past three decades gains in life expectancy have primarily arisen from reductions of mortality among the old and oldest old (Thatcher et al. 1998) while starting with the early 1980s and continuing into the 1990s the percentage of elderly with limitations in ADL or IADL has been decreasing (Freedman et al. 2002, Manton and Gu 2001). Overall trends in healthy life expectancy and disability–free life expectancy support the theory of dynamic equilibrium (Robine et al. 2003). Over the last several years various longitudinal studies conducted in the United States, Europe, and other developed countries concluded that there was a significant reduction in the rate of functional decline over the last three decades. (Cutler 2001, Freedman et al. 2002, Robine et al. 2003). In terms of active life expectancy Crimmins et al. (1989, 1994, 1997) found that between 1970 and 1980 most additional years gained in life expectancy were disabled years while most of the increase between 1980 and 1990 was in years free of disability. Researchers estimated that a mortality reduction of approximately 1% per year was accompanied by at least a 2% reduction of disability (Manton and Gu 2001).

However, these trends do not take into account that one cannot use morbidity and disability interchangeably. The presence of different disease may have quite different effects on mortality, hospitalization, disability, und functional impairment (Mor 2005, Verbrugge and Patrick 1995). In France and the US the prevalence of disabling chronic diseases increased while the severity of disability decreased (Crimmins and Saito 2001; Robine et al. 1998) which may be attributed to a weakened link between chronic disease and disability (Freedman and Martin 2000). A study of Swedish oldest old shows increasing health problems between 1992 and 2002 that include self-reported diseases, symptoms, as well as objective tests of physical capacity, lung function, vision, and cognition. Surprisingly no significant differences in the activities of daily living limitations were found (Parker et al. 2005). These findings are supported by Parker et al. (2007) who report improvements in disability measures while there is simultaneous increase in chronic disease and functional impairments. In their words, “an expansion of other health problems may accompany a compression of disability”.

Studies of compression or expansion of disability typically use prevalences of disability in the context of the Sullivan Method (Sullivan 1971) or the incidence of health transitions in combination with multi-state life tables (e.g. for one of the most recent studies see Cai & Lubitz (2007). During the last two decades a series of studies analyzed courses of health and disability by exploring individual-level trajectories of functional impairment and disability (Maddox and Clark 1992; Verbrugge and Jette 1994; Li et al. 2000; Liang et al. 2003; Deeg 2005; Nusselder et al. 2006), physical symptoms (Aldwin et al. 2001) and health trajectories (Clipp et al. 1992; Liang et al. 2005; McDonough and Berglund 2003). Liang et al. (2007) combine courses of functional status and subjective health while Taylor and Lynch (2004) explore trajectories of impairment in relation to depressive symptoms later in life. The concept of individual-life trajectories, however, has not been used so far to study changes in disability and functional impairment over time.

The objectives of this study are twofold. First, we will explore whether in the 1990s as compared to the 1980s the frequency of individual-level disability trajectories has changed taking into account changes in the age-structure and the socioeconomic structure of the population. Based on the existing literature we expect an increase in trajectories involving moderate disability. The shift towards moderate disability should result from a decrease in severe and probably also from a decrease in healthy trajectories. Second, we will analyze the relationship between specific disability trajectories and sub-sequent mortality and whether this relationship has changed over time. Over this period life expectancy in West Germany has increased by 2.8 years for females and 3.6 years for males (1984 until 1999, Human Mortality Database). It is unclear whether all health groups have profited proportionally from these additional years.

Data

We use data from the German Socio-Economic Panel (GSOEP) and restrict our analysis to West Germany. The GSOEP includes a variety of health and disability questions that were asked over different time periods. In the years 1984 to 1987, 1992 and 1995 to 2001 self-perceived disability was asked using the question: “not

regarding occasional illnesses, is the fulfillment of everyday activities, e.g. in the household, your job or education hindered by your condition of health, and to what extent?" with the categories not at all, slightly, to a great extent.

We chose this variable because it comes closest to the meaning of disability, e. g. defined by Robine and Michel (2004) as "measured through activity restricition in daily life, such as 'hampered in the daily life'". Furthermore the variable is used for a long period of time without interruption or changes in the wording. This means that the disability score used in the following analysis originally has three discrete levels ranging from 1 to 3. We distinguish two periods: 1984 to 1987 and 1995 to 1998. Since before 1990 no information for East Germany, then the German Democratic Republic, is available in the GSOEP we restrict our analysis to West Germany (1995 to 1998) and the Federal Republic of Germany (1984 to 1987). The GSOEP study started in 1984 in West Germany with 5,921 households in which 12,290 people above age 16 were surveyed. The data consist of seven samples. The original samples that exist since the start of the survey are sample A "residents in the FRG" and sample B "foreigners in the FRG". For this analysis sample A is used.

Two time periods 1984-1987 and 1995-1998 are analysed, which means that we can follow health trajectories of individual respondents over two four-year periods. In 1984 3,414 persons in the SOEP were aged 50+ with at least one information on disability, in 1995 the number decreases increases to 2805 (only West Germany). In each of the two periods these respondents are divided into three groups: respondents who survived until the end of the period and have information about their disability level for four years (1984: 2329 persons; 1995: 2011 persons). 398 (232) persons are excluded who were present in 1984 (1995) and survive to 1987 (1999) but have at least one missing information about their disability level. The second group consists of those who died (1984-1987: 251 persons, 1995-1998: 267 persons), and the third of those who were lost to follow-up (1984-1987: 436 persons, 1995-1998: 295 persons).

The follow-up study of the survivors spans over the period 1988-1990 and 1999-2001. Out of the 2329 survivors of the 1984-1987 period 94 died within the next three years and there were 203 cases of attrition. After the second period (1995-1998) there occurred 123 deaths and 222 cases of attrition.

Method

This research relies heavily on the methods developed in the two articles by Deeg (2005) and Nusselder et al. (2006). A three step procedure is followed in order to identify similar trajectories of disability among individuals. First step: For each respondent the level and time course of disability is characterized by four aspects: the level, direction, the concavity/convexity and the variability of the trajectory. We use separate linear regression to asses the four aspects for each individual. The level of disability is defined as the intercept of a linear regression model that regresses the year on the disability outcome. The slope of the model is used to indicate the direction of the change. A positive slope indicates deterioration, a negative an improvement of disability. Concavity/convexity of the time trend is measured by adding a quadratic term to the equation and measuring the distance between the quadratic regression curve and the straight linear regression line. A positive difference indicates a convex shape, a negative a concave shape. All three measures are estimated for the middle of the time period that the individual lives through. The fourth aspect, the variability of the trajectory, is measured by the root mean square error of the quadratic function. Second step: The four aspects are the input variables for a cluster analysis that groups individuals with similar levels and time courses into separate clusters. In order to assure that each of the four aspects influences the cluster analysis equally, we standardize them using their mean and standard deviation. We perform hierarchical agglomerative complete linkage cluster analysis based on Euclidian distances. The number of clusters is decided on the basis of the Calinski-Harabasz pseudo-F statistic. Contrary to earlier studies (Deeg 2005; Nusselder et al. 2006) we treat the stable disability trajectories (stable healthy, stable moderate disability, stable severe disability) separately and do not include them in the cluster analysis. Differently from the study by Nusselder et al. (2006) we use cluster analysis also to identify disability trajectories among the deceased.

Results

Two independent cluster analyses identify four identical disability trajectories in the two periods, in addition to the three stable trajectories (Figure 1 and Table 1). In both periods the trajectory "healthy, continuous decline" is the most frequent one (each 20% in both periods). In the first period the two trajectories "moderate disability improving" and "severe disability, improving" rank second with each amounting to 15%. In the second period these two trajectories become less common (together 26%). The proportion of the "stable healthy" trajectory increases between the two periods, particularly for males (1984-1987: 15% and 1995-1998: 18%). The proportion of the deceased increases slightly in the second period while attrition due to loss of follow-up decreases. Since the age structure of the population has changed between the 1980s and 1990s changes in the frequencies of trajectories can only be interpreted after adjusting for the age structure.

Table 2 shows that in all age groups with the exception of the oldest (80+) significant changes in the relative frequency of health trajectories exist. Changes, however, differ between age groups. In the two youngest age groups (50-59 and 60-69) the proportion of "stable healthy" and "stable moderate disability" increase, while all other trajectories decrease or remain unchanged. In age group 70-79 "stable moderate disability" increase, but also more disadvantaged trajectories such "stable severe disability". In the oldest age group "stable severe disability" decrease while more advantaged trajectories increase. It is important to note that the proportion of attrition changes between the two periods and becomes generally smaller over time. This trend is particularly strong in the oldest age group. Together with the changing age structure this may explain, why the proportion of the deceased increases over time in the GSOEP despite mortality improvements in Germany.

Figure 2 presents the probabilities of the eight possible outcomes (6 different disability trajectories, death, and attrition) for the two periods estimated by a multinomial logistic regression model. In addition to the period factor the model corrects for age in 10-year age groups, education, and marital status. The regression is weighted by the 1984 and 1995 sample weights in order to correct for sample design

and to account for attrition. For both sexes we find a trend towards the stable disability trajectory at a moderate level: for females the probability increases from 0.08 to 0.15 and for males from 0.05 to 0.10. This shift is accompanied by a reduction of disadvantaged disability trajectories regardless whether they are stable or involve changes in the disability status. This latter trend, albeit not significant, is stronger for males than females. For both sexes the risk of attrition is lower in the second than in the first period while no significant improvements in mortality exist in the GSOEP.

Table 3 presents the last reported health status of the respondents lost to follow-up (attrition) and of the deceased during the two time periods. Despite the fact that attrition became less over time the distribution according to the last health status of those lost to follow-up remained unchanged. None of the small differences between the two time periods are significant. Thus, attrition is independent from changes in the health status between the two time periods and the increase in the "stable moderate disability trajectory" is not the result of the healthier remaining in the sample to a larger extent in the second period than in the first.

Table 4 shows for the survivors of each period the odds ratios to die within the next three years depending on their disability trajectory. In both periods females who experienced stable severe disability have the highest risk to die: as compared to the healthy it is 4.29 (p=0.04) times as high in the first, and 6.48 (p=0.01) in the second period. In the first period the second highest mortality is observed for women who start healthy but experience a continuous decline (OR=4.26, p=0.02). In the second period the extent of the excess mortality of this trajectory is reduced to OR=2.92 and not significant at a conventional significance level (p=0.13). Among males, both in the first and second period those experiencing a stable severe disability trajectory have almost three times the mortality of the healthy (1st period: OR=2.67; p=0.05; 2nd period: OR=2.86; p=0.08). Compared to females, however, the excess mortality is much lower, probably reflecting the higher mortality of the healthy. In the second period, also those men who start healthy but continuously deteriorate in their health experience significantly higher mortality than the healthy (OR=2.79, p=0.07). The extent of the excess mortality is comparable to females. For both sexes models including an interaction effect between period and disability trajectory (not shown) do not find significant changes in the trajectory-specific mortality risk over time.

Discussion

The analysis of health trajectories in the GSOEP provides evidence that the health status of the elderly has been improving over time and supports the hypothesis of a dynamic equilibrium (Manton 1982). From the 1980s to the 1990s there is a significant shift towards health trajectories that involve stable moderate disability. There is no significant change in the relationship between disability trajectories and subsequent mortality over time. In other words, the relative excess mortality of the disabled remains unchanged while a larger proportion belongs to those with stable moderate disability pathways.

For males this shift towards stable moderate disability pathways is accompanied by a reduction of the unfavorable health trajectories, for females by a reduction in panel attrition. In both time periods those lost to follow-up have a similar istribution according to their last-measured health status. This implies that the shift towards the stable moderate disability trajectory is not the result of more individuals with moderate disability remaining in the survey sample.

Individuals who experience stable severe disability over a period of four years have the highest mortality risk, followed by those who start healthy but experience a continuous health decline. It is interesting to note that in the operationalization of limitation/disability used in the GSOEP those with moderate disability do not experience any excess mortality as compared to the healthy. This shift towards stable moderate disability trajectories that are non-fatal is in accordance with a large number of studies in the US and Europe. These studies show that in the past the shift towards moderate disability was accompanied by an increase in morbidity (Crimmins et al. 2001; Robine et al. 2003; Parker et al. 2005).

A series of underlying causes of the positive health trends have been discussed with a general consensus that the reasons seem to be multifactorial. First, significant contributions may have come from a promotion of good health habits which have an extremely large effect on subsequent disability (Vita et al. 1998; Hubert et al. 2002). There are a series of studies that show that health habits have generally improved over

time with the exception of obesity. Second, medical advances, such as better treatment of "hypertension, diabetes, coronary heart disease, rheumatoid arthritis, total joint replacements; medical preventive measures, such as colon cancer screening, influenza and pneumococcal vaccines, and cardiac-dose aspirin" may also have contributed (Cutler 2001). Third, survival after the incidence of cardiovascular disease has improved and disability declined through the use of appropriate therapies, including pharmaceuticals such as beta-blockers, aspirin, and ace-inhibitors, and invasive procedures (Cutler et al. 2006a). Fourth, raising educational levels may have contributed by influencing life-style, and raising awareness (Bandura 2000). Fifth, some of the improvement may be due to improvement in the built environment which helps elderly people to function independently even when their physical capacity has not changed (Spillman 2004).

Concerning future trends the impact of obesity is generally discussed as a thread to future improvements (Lakdawalla et al. 2004, Peeters et al. 2003, Sturm et al. 2004, Olshanksy et al. 2005). In the US, despite substantial increases in obesity, the general health profile of the population seems to be better than in the past. The largest contributions came from a reduction in smoking and the better control of blood pressure (Cutler et al. 2007). However, it has been estimated that about a third of the behavioral improvements witnessed over the past three decades might be offset by trends in obesity (Cutler et al. 2007). This discussion reinforces the importance of promoting better and active lifestyles and low-risk health habits and thus postponing disability through primary prevention into health care systems. Although this approach is most promising it has not been systematically implemented yet (Fries 2005). A need for systematic studies of specific primary interventions has been expressed (Fries 2005) in order to identify those population-based approaches which are most effective and most cost-efficient.

Recent research indicates that US Baby Boomers at the verge of retirement are in poorer health than their counterparts twelve years before. They indicate that they have relatively more difficulty with a range of everyday physical tasks, experience more pain, more chronic conditions, more drinking and psychiatric problems (Soldo et al. 2006). Thus, reducing disability from non-fatal diseases, such as osteoarthritis, rheumatoid arthritis, depression, isolation, but also Alzheimer disease will have

positive effects on future disability levels. For example, recent studies suggest that the progression of early Alzheimer disease can be slowed significantly by timely and adequate medical treatment (Hock et al. 2003).

Once that functional and cognitive limitations have occurred new assistive technologies implemented into smart homes will help people to function independently in their own environment for a longer period of time and thus, postpone disability. Raising levels of education will improve the ability of the elderly to cope with limitations. Research shows that better educated people use substantially more assistive technology (Cutler et al. 2006b).

The strength of this study lies in the longitudinal design of the survey which allows the analysis of individual disability trajectories together with a mortality follow-up conditional on past disability trajectories. Nevertheless, the study has two major limitations. First, similar to many other socioeconomic surveys the GSOEP is restricted to private households. In theory respondents are followed into institutions once they are in the panel, however, the proportion reported living in institutions in the GSOEP is too small (0.17% age 16+ in 1999) as compared to the German figure (0.61% age 15+ (0.70% total) in 1999, Statistical Office Germany 2001). Thus, most of the transitions into institutions are reported as panel attrition. Panel attrition reduced considerably between the two time periods, particularly among females. This is also one explanation for the offsetting trends in female panel attrition and the "stable moderate disability" trajectory. In the second period the improved health status of the females allowed them to continue living at home rather than to enter an institution. Males have a lower institutionalization rate and therefore are less prone to panel attrition. Thus, the higher probability of the male "stable moderate disability trajectory" in the second period is primarily reflected in a decrease of the unfavorable health trajectories.

The lack of the institutionalized population affects the frequency distribution of trajectories. Unfavorable trajectories are underreported either because they result in panel attrition or because they have been excluded already at baseline due to the restriction to private households. The proportion of people in institutions, however, has only changed slightly between the 1980s and the 1990s and increased from about

27.3% in 1991 (Felderer 1992), to 28.4% in 1999 (Statistical Office Germany, 2001) (both proportions are for West- and East Germany). Changes in the frequency distribution should therefore be undistorted.

Second, the GSOEP does not distinguish between disability and morbidity. Thus we cannot investigate what type of morbidity accompanies the shift towards stable moderate disability. The operationalization of the health question used in the GSOEP is very broad and most probably includes disability as well as complaints about chronic conditions and morbidity in a wider sense.

The GSOEP contains two more objective variables of related to obesity, namely doctor visits and hospitalization. A first comparison of doctor visits (not included here) between the two periods shows an increasing trend in the proportion of people who visited the doctor at least once within the last three month prior to the interview. The increase is particularly stronger for respondents following a stable health trajectory. One explanation is that they visit the doctor because of prevention: people stay healthy because they go to check-ups more regularly. Another possibility is, that a regular treatment of chronic diseases causes less disability in daily activities and people therefore feel healthy. Also the second objective measure, hospital stays, changes between 1984-1987 and 1995-1998. We observe a considerable decrease of respondents who do not report any stay in hospital and a shift towards more frequent hospitalization. This increase is less pronounced for respondents with “stable healthy” and “stable moderate disability” trajectories. Again, regular doctor visits could increase the handling of chronic diseases and therefore decrease the hospitalization risk. These results show that we need a better understanding of the correlation between subjective and objective morbidity measures and to what extent they are connected to functional limitations and disability.

Table 1: Relative frequency of the disability trajectories in 1984-1987 and 1995-1998 by sex

Trajectories	Males	Females	total	
1984-1987*	%	%	%	N
Stable healthy	15	12	13	387
Healthy, continuous decline	19	21	20	607
Moderate disability, improving	15	15	15	477
Stable moderate disability	5	7	6	180
Severe disability, improving	15	14	15	450
Stable severe disability	9	6	7	228
Death	9	8	9	251
Attrition	13	16	15	436
Total	100	100	100	3016
1995-1998**				
Stable healthy	18	11	14	417
Healthy, continuous decline	19	20	20	484
Moderate disability, improving	10	14	12	312
Stable moderate disability	11	12	12	299
Severe disability, improving	15	14	14	341
Stable severe disability	6	7	7	158
Death	10	10	10	267
Attrition	11	12	11	295
Total	100	100	100	2573

* weighted by 1984 survey-weights; ** weighted by 1995 survey-weights

Table 2: Relative frequencies of the disability trajetories in 1984-1987 and 1995-1998 by ten-year age groups

	Periods			Periods	
Trajectories	1984-1987*	1995-1998**	Total	1984-1987	1995-1998
Age 50-59	%	%	%	N	N
Stable healthy	19	23	21	231	254
Healthy, continuous decline	20	21	21	257	213
Moderate disability, improving	16	13	14	204	130
Stable moderate disability	7	11	9	81	117
Severe disability, improving	15	12	13	198	120
Stable severe disability	5	5	5	75	37
Death	3	2	2	35	21
Attrition	15	13	14	194	141
Total	100	100	100	1,275	1,033
Likelihood Ratio Test p=0.00					
Age 60-69					
Stable healthy	11	13	12	93	107
Healthy, continuous decline	20	18	18	166	143
Moderate disability, improving	19	14	16	175	108
Stable moderate disability	7	15	11	57	104
Severe disability, improving	16	16	16	137	117
Stable severe disability	**10**	**6**	**8**	**84**	**45**
Death	**4**	**8**	**6**	**43**	**71**
Attrition	14	11	13	125	78
Total	100	100	100	880	773
Likelihood Ratio Test p=0.00					
Age 70-79					
Stable healthy	10	8	9	56	50
Healthy, continuous decline	23	20	22	154	94
Moderate disability, improving	12	11	12	80	52
Stable moderate disability	5	12	8	34	61
Severe disability, improving	17	18	18	100	84
Stable severe disability	7	10	8	44	55
Death	14	11	12	98	69
Attrition	12	9	11	76	49
Total	100	100	100	642	514
Likelihood Ratio Test p=0.00					
Age 80+					
Stable healthy	4	2	2	7	6
Healthy, continuous decline	14	18	17	30	34
Moderate disability,,improving	8	8	8	18	22
Stable moderate disability	3	6	5	8	17
Severe disability, improving	6	9	8	15	20
Stable severe disability	**13**	**10**	11	25	21
Death	32	38	36	75	106
Attrition	20	10	14	41	27
Total	100	100	100	219	253

* weighted by 1984 survey-weights; ** weighted by 1995 survey-weights

Table 3: Last reported health status of the deceased and of the respondents lost to follow-up in 1984-1987 and 1995-1998

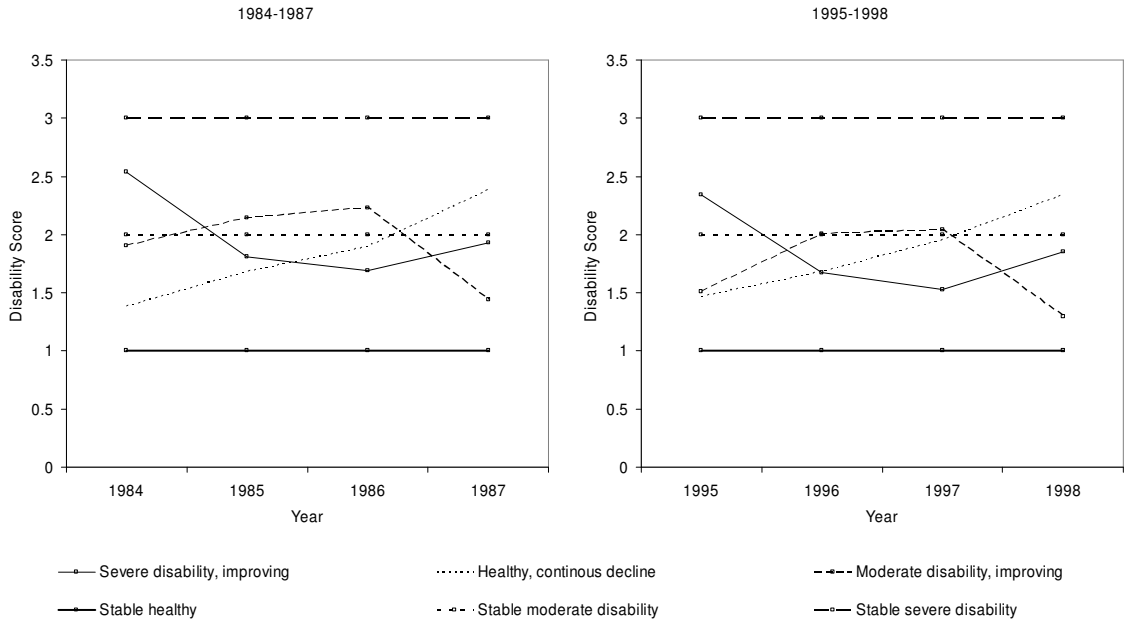
	Deaths			Attrition		
1984-1987	%	LCI	UCI	%	LCI	UCI
Healthy	14	9	18	36	32	41
Moderate disability	25	20	31	40	35	44
Severe disability	61	55	67	24	20	28
1995-1998						
Healthy	13	9	17	39	33	44
Moderate disability	29	24	35	39	33	44
Severe disability	58	33	44	22	17	27

Table 4: Odds ratios of three-year mortality for the survivors of the periods 1984-1987 and 1995-1998

Risk factor	Reference group	1984-1987		1995-1998	
Females		OR	p-value	OR	p-value
Severe disability, improving	Healthy, stable	1,59	0,49	1,14	0,86
Healthy, continuous decline		*4,26*	*0,02*	2,92	0,13
Moderate disability, improving		1,61	0,48	3,27	0,10
Moderate disability, stable		1,34	0,71	2,01	0,37
Severe disability, stable		*4,29*	*0,04*	*6,48*	*0,01*
60-69	50-59	2,28	0,06	1,59	0,43
70-79		5,93	0,00	11,07	0,00
80+		34,31	0,00	16,72	0,00
High education	Low education	0,62	0,43	0,40	0,32
Not married	Married	1,35	0,27	0,96	0,92
Constant		0,01	0,00	0,01	0,00
Males					
Severe disability, improving	Healthy, stable	1,30	0,63	0,95	0,94
Healthy, continuous decline		1,17	0,75	*2,79*	*0,07*
Moderate disability, improving		1,09	0,88	0,63	0,48
Moderate disability, stable		0,79	0,74	0,29	0,11
Severe disability, stable		*2,67*	*0,05*	*2,86*	*0,08*
60-69	50-59	1,18	0,68	2,99	0,04
70-79		3,86	0,00	4,68	0,00
80+		6,40	0,00	7,82	0,00
High education	Low education	0,81	0,69	0,32	0,08
Not married	Married	2,02	0,04	1,71	0,22
Constant		0,05	0,00	0,03	0,00

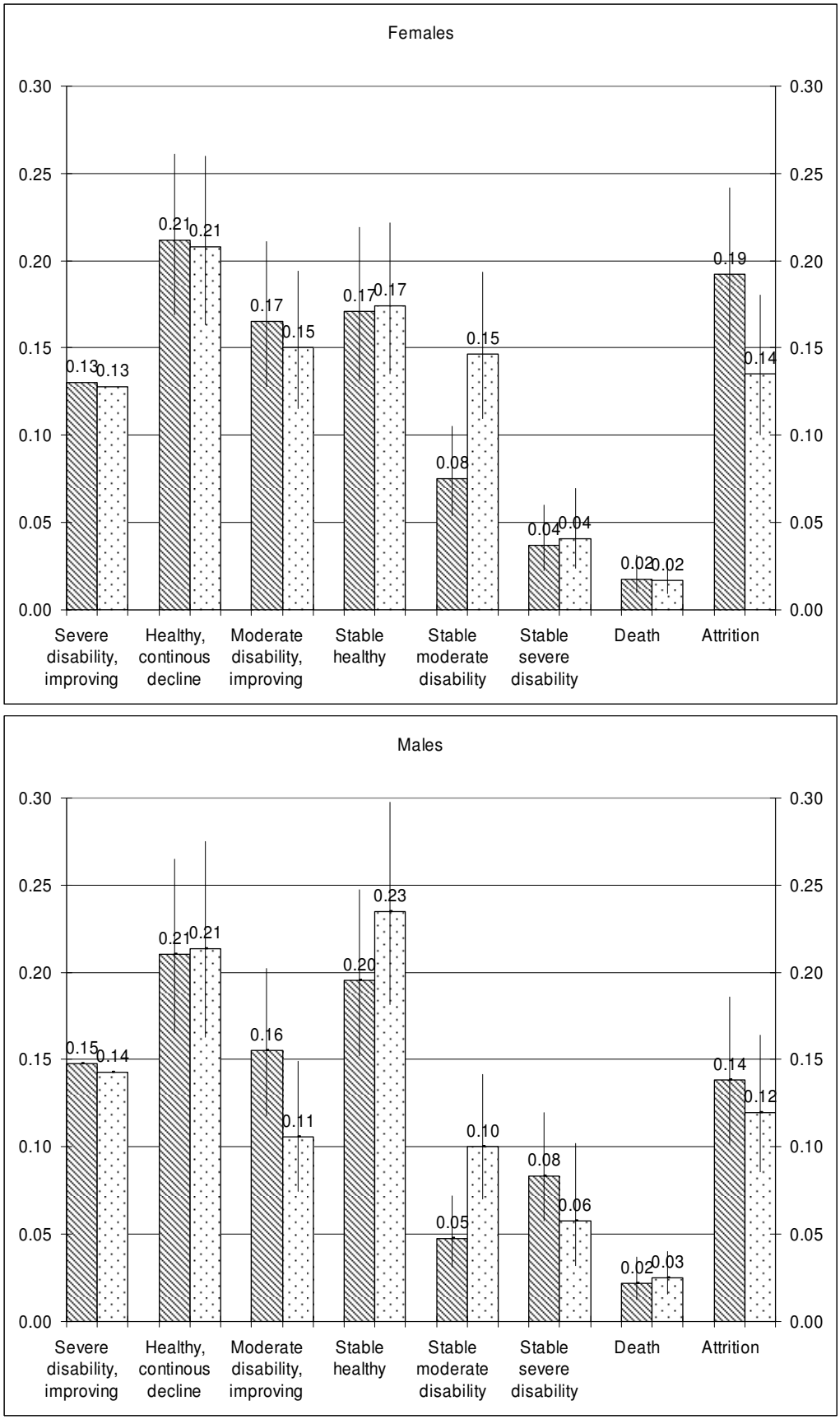
Weighted by 1984 and 1995 survey weights.

Figure 1: Trajectories of disability in the periods 1984-1987 and 1995-1998, West Germany



Source: GSOEP

Figure 2: Probabilities and confidence intervals of disability trajectories for the period 1995-1998 as compared to 1984-1987



Source: GSOEP

Bibliography

- Aldwin, C.M.; Spiro 3rd, A.; Levenson, M.R.; Cupertino, A.P. (2001). Longitudinal findings from the Normative Aging Study: III. Personality, individual health trajectories, and mortality. Psychol Aging. 16(3): 450-465

Bandura, A. (2000). Health Promotion from the Perspective of Social Cognitive Theory. In: Norman, P.; Abraham, C.; Connor, M. (eds.). Understanding and Changing Health and Behaviour. Reading, United Kingdom: Harwood: 299-339

- Cai, L.; Lubitz, J. (2007). Was there Compression of Disability for Older Americans from 1992 to 2003? Demography. Volume 44-Number 3, August 2007:479-495

- Clipp, E.C.; Pavalko, E.K.; Elder, G.H. (1992). Trajectories of health: In concept and empirical pattern. Behavior, Health, and Aging. 2(3): 159–179

- Crimmins, E.M.; Hayard, M.D. et al. (1994). Changing Mortality and Morbidity Rates and the Health Status and Life Expectancy of the Older Population. Demography. 31(1):159-175

- Crimmins, E.M.; Saito, Y. (2001). Trends in Healthy Life Expectancy in the United States, 1970-1990: Gender, Racial, and Educational Differences. Social Science and Medicine. 52:1629-1641

- Crimmins, E.M.; Saito, Y.; Ingegneri, D. (1989). Changes in Life Expectancy and Disability-Free Life Expectancy in the United States. Population and Development Review. 15:235-67

- Crimmins, E.M.; Saito, Y.; Ingegneri, D. (1997).Trends in Disability-Free Life Expectancy in the United States. Population and Development Review. 23:555-72

- Cutler, D.M. (2001). Declining Disability Among the Elderly. Health Affairs. 20:11-27

- Cutler, D.M.; Landrum, M.B.; Stewart, K.A. (2006a). Intensive Medical Care and Cardiovascular Disease Disability Reductions. NBER Working Paper. April 2006, No. 12184

- Cutler, D.M.; Landrum, M.B.; Stewart, K.A. (2006b). How Do the Better Educated Do It? Socioeconomic Status and the Ability to Cope with Underlying Impairment. NBER Working Paper. February 2006, No. 12040

- Cutler, D.M.; Glaeser, E.L., Rosen, A.B. (2007). Is The US population behaving healthier? NBER Working Paper. April 2007, No. 13013

- Deeg, D.J.H. (2005). Longitudinal characterization of course types of functional limitations. Vol. 27:253-261

- Felderer, B. (1992) Die langfristige Entwicklung einer gesetzlichen Pflegeversicherung. Ökonomische und demographische Perspektiven für die Bundesrepublik Deutschland. München: Bayerische Rückversicherung.

- Freedman, V.A.; Martin, L.G. (2000). Contribution of Chronic Conditions to Aggregate Changes in Old-Age Functioning. American Journal of Public Health. 90:1755-60

- Freedman, V.A.; Martin, L.G.; Schoeni, R.F. (2002). Recent Trends in Disability and Functioning Among Older Adults in the United States: A Systematic Review. Journal of American Medical Association. 288(24):3137-46

- Fries, J.F. (2005). Frailty, Disease, and Stroke. The Compression of Morbidity Paradigm. American Journal of Preventive Medicine. 29(5S1):164-168

- Hock, C.; Konietzko, U.; Streffer , J.R.; Tracy, J.; Signorell, A.; Müller-Tillmanns, B.; Lemke, U.; Henke, K.; Moritz, E.; Garcia, E.; Wollmer, M.A.; Umbricht, D.; De Quervain, D.J.; Hofmann, M.; Maddalena, A.; Papassotiropoulos, A.; Nitsch, R.M. (2003). Antibodies Against Beta-amyloid Slow Cognitive Decline in Alzheimer's Disease**.** *Neuron*. May 2003 22;38(4):547-54

- Hubert, H.B.; Bloch, D.A.; Oehlert, J.W.; et al. (2002). Lifestyle Habits and Compression of Morbidity. Journals of Gerontology: Biological Science and Medical Science. 57A:M347-M351

- Lakdawalla, D.N.; Bhattacharya, J.; Goldman, D.P. (2004). Are the Young Becoming more Disabled? Health Affairs. 23: 168-176

- Li, F.; Duncan, T.E.; McAuley, E.; Harmer, P.; Smolkowski, K. (2000). A Didactic Example of Latent Curve Analysis Applicable to the Study of Aging. Journal of Aging and Health. 12(3): 388-425

- Liang, J.; Shaw, B.A.; Krause, N.M.; Bennett, J.M.; Blaum, C.; Kobayashi, E.; et al. (2003). Changes in functional status among older adults in Japan: successful and usual aging. Psychol Aging. 18(4): 684-695

- Liang, J.; Shaw, B.A.; Krause, N.; Bennett, J.M.; Kobayashi, E.; Fukaya, T.; et al. (2005). How Does Self-Assessed Health Change With Age? A Study of Older Adults in Japan. J Gerontol B Psychol Sci Soc Sci. 60(4): S224-232

- Liang, J.; Shaw, B.A.; Bennett, J.M.; Krause, N.; Kobayashi, E.; Fukaya, T.; et al. (2007). Intertwining courses of functional status and subjective health among older Japanese. J Gerontol B Psychol Sci Soc Sci. 62(5): 340-348

- Maddox, G.L.; Clark, D.O. (1992). Trajectories of Functional Impairment in Later Life. Journal of Health and Social Behavior. 33(2): 114-125

- Manton, K. G. (1982). Changing Concepts of Morbidity and Mortality in the Elderly Population. Milbank Memorial Fund Quarterly / Health and Society 60 (2), 183–244

- Manton, K.G.; Gu, X. (2001). Changes in the Prevalence of Chronic Disability in the United Staes Black and NonblackPopulation Above 65 from 1982-1999. Proceedings of the National Academy of Sciences of the United States of America. 98:6354-6359

- McDonough, P.; Berglund, P. (2003). Histories of Poverty and Self-Rated Health Trajectories. Journal of Health and Social Behavior, 44(2): 198-214

- Mor, V. (2005). The Compressing of Morbidity Hypothesis: A Review of Research and Prospects for the Future. The American Geriatrics Society. 53:308-309

- Nusselder, W.J.; Looman, C.W.N.; Mackenbach, J.P. (2006). The level and time course of disability: Trajectories of disability in adults and young elderly. Disability and Rehabilitation. 28(16): 1015-1026

- Olshansky, S. J.; Passaro, D.; Hershow, R.; Layden, J.; Carnes, B. A.;Brody, J.; Hayflick, L.; Butler, R. N.; Allison, D. B.; Ludwig, D. S. (2005). A Potential Decline in Life Expectancy in the United States in the 21st Century. N. Engl. J. Med. 352, 1138-1145

- Parker, M.G.; Ahacic, K.; Thorslund, M. (2005). Health Changes Among Swedish Oldest Old Prevalence Rate From 1992 and 2002 Show Increasing Health Problems. Journal of Gerontology: Medical Sciences. Vol. 60A. No.10:1351-1355

- Parker, M.G.; Ahacic, K.; Thorslund, M. (2007). Health Trend in the Elderly Population: Getting Better and Getting Worse. Gerontologist. April 2007, 47(2):150-158

- Peeters, A.; Barendregt, J.J.; Willekins, F. et al. (2003). Obesity in Adulthood and Its Consequnces for Life Expectancy: A Life-Table Analysis. Annals of Internal Medicine. 138:24-32

- Robine, J.M.; Mormiche, P., Sermet, C. (1998). Examination of Causes and Mechanisms of the Increase in Disability-Free Life Expectancy. Journal of Aging and Health. 10:171-91

- Robine, J.M.; Jagger, C.Mathers, C.D.; Crimmins, E.; Suzmann, R. (2003). Determining Health Expectancies. Chichester, United Kingdom: John Wiley & Sons

- Robine, J.M., Michel, J.-P. (2004). Looking Forward to a General Theory on Population Aging. Journal of Gerontology: Medical Sciences

- Soldo, B.J.; Mitchell, O.S.; Tfaily, R.; McCabe, J.F. (2006). Cross-cohort differences in health on the verge of retirement. NBER Working Paper. December 2006, No. 12762

- Spillman, B. (2004). Changes in Elderly Disability Rates and the Implications for Health Care Utilization and Cost. The Milbank Quaterly. 82(1):157-94

- Statistical Office Germany (2001). Kurzbericht: Pflegestatistik 1999. Pflege im Rahmen der Pflegeversicherung, Deutschlandergebnisse. Statistisches Bundesamt, Bonn

Sturm, R.; Ringel, J.; Andreyeva, T. (2004). Increasing Obesity Rates and Disability Trends. Health Affairs. 23:199-205

- Sullivan, D. F. (1971). A Single Index of Mortality and Morbidity, in: HSMHA Health Reports, Vol. 86, April 1971, pp. 347-354

- Taylor, M.G.; Lynch, S.M. (2004). Trajectories of Impairment, Social Support, and Depressive Symptoms in Later Life. Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 59(4): 238-S246

- Thatcher, A. R.; Kannisto, V.; Vaupel, J. W. (1998). The force of mortality at ages 80 to 120 (1998) Odense: Odense University Press

- Verbrugge, L.M.; Jette, A.M. (1994). The disablement process. Social Sciences & Medicine. 38(1), 1-14

- Verbrugge, L.M.; Patrick, D.L. (1995). Seven Chronic Conditions. Their Impact on U.S. Adults' Activity Levels and Use of medical Services. American journal of public Health. 85:173-182

- Vita, A.J.; Terry, R.B.; Hubert, H.B.; Fries, J.F. (1998). Aging, Health Risks, and Cumulative Disability. New England Journal of Medicine. 338:1035-1041

- Human Mortality Database; www.mortality.org