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Gender Differences in Trajectories of Health Limitations and Subsequent Mortality. A Study Based on the German Socioeconomic Panel 1995–2001 With a Mortality Follow-up 2002–2005

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Objectives. Although research on health limitations has investigated gender differences in health and mortality, gender differentials in individual-level trajectories have been studied less frequently. Moreover, there are no studies on the relationship between course types and subsequent mortality. We investigate course types, explore confounding by socioeconomic and demographic correlates, and pose the question of whether the gender gap in morbidity results from differences in the onset of, and/or survival with, health limitations.

Methods. Using the German Socioeconomic Panel, we identify individual trajectories of health limitations and use multinomial logistic regressions to explore confounding and the relationship with mortality.

Results. The frequency of stable trajectories without limitations is lower among women because they tend to experience courses that involve extended periods of limitations and deteriorating health. Women also experience more frequently improvement after deterioration. The female mortality advantage is particularly large after health deterioration.

Discussion. Health limitations do not make men and women more equal in the face of death. Our results are consistent with earlier studies showing that mortality selection and differences in chronic conditions may explain the gender gap in health and mortality. We extend previous research showing that the female health disadvantage is largely the result of their mortality advantage.

Key Words: Gender—Germany—Health limitations—Mortality—Trajectories.

GENDER differences in health and mortality have been of longstanding interest to researchers (for a recent review, see Oksuzyan, Juel, Vaupel, & Christensen, 2008). Why women live longer than men, but suffer from worse health, is, however, still an unsolved puzzle. Much of disability research in general, including research specifically in the area of gender differentials, has focused on the prevalence (e.g., Robine, Jagger, Mathers, Crimmins, & Suzman, 2002) or on the incidence (for a literature review, see Doblhammer, Hoffmann, Muth, Westphal, & Kruse, 2009). Yet in order to gain deeper insights into the gender-specific disablement process and its relationship with mortality, it is crucial to understand the heterogeneity of disabled persons by identifying distinct individual-level trajectories of disability.

A series of studies uses courses of health and disability to analyze functional impairment and disability (Li, Duncan, McAuley, Harmer, & Smolkowski, 2000; Liang 2007; Liang et al., 2003; Maddox & Clark, 1992; Taylor & Lynch, 2004; Verbrugge, Reoma, & Gruber-Baldini, 1994), physical symptoms (Aldwin, Spiro, Levenson, & Cupertino, 2001), and health trajectories (Clipp, Pavalko, & Elder, 1992; Liang et al., 2005; McDonough & Berglund, 2003).

Although our focus is on trajectories of health limitations, we also consider mortality and its predictors in our empirical analysis. We propose the combined analysis of trajectories of health limitations and, subsequent, mortality because the latter is an important final and "absorbing" status for the analysis of health changes, which creates selection biases if neglected.

Two recent Dutch studies came to different conclusions concerning gender differences in health trajectories: in Deeg (2005), gender was a predictive factor of health trajectories, whereas Nusselder, Looman, and Mackenbach (2006), similar to Maddox and Clark (1992), did not find an effect of gender. McDonough and Berglund (2003) reported worse initial self-rated health status among U.S. women; by contrast, Liang and colleagues (2003) found a lower risk of experiencing early onset of functional impairment among Japanese women compared with men.

The objectives of this study are (a) to identify different course types of health limitations in a representative sample of the Germany population, (b) to assess their relative frequency by gender, (c) to explore whether socioeconomic or demographic correlates explain gender differences in course types, and (d) to analyze the association of course types

Table 1. Sample Size and Number of Deaths and Attrition for 1995–2001 and Deaths and Attrition for the Follow-up Period of 2002–2005

Year	Attrition[a]/attrition with full information on limitation[b]	Deaths[a]/deaths with full information on limitation[b]	Persons alive 1995–2001/ persons alive 1995–2001 with full information on limitation
Trajectories 1995–2001			
1995		1/—	2,830/2,639
1996	72/69	93/91	2,830/2,639
1997	92/89	87/67	2,830/2,639
1998	131/123	86/77	2,830/2,639
1999	121/104	86/60	2,830/2,639
2000	92/82	75/54	2,830/2,639
2001	84/80	69/51	2,830/2,639
Total	592/547	497/400	2,830/2,639
2002–2005 follow-up of survivors			
Year	Attrition	Deaths	
2002	66	55	
2003	64	53	
2004	88	61	
2005	96	61	
Total	314	230	

Notes: [a] All cases.
[b] All cases with complete health information; health information does not exist for the follow-up.

with subsequent deaths in the 2002–2005 period, separately for men and women. In this way, we hope to gain a better understanding of whether women have an earlier onset of health limitations, a lower chance of recovery, and/or lower mortality once they are limited. This can contribute to the evaluation of two alternative explanations for why female morbidity is higher, while mortality is lower. According to the first explanation, the mortality selection effect leaves only the more robust men to survive, who are, in turn, relatively healthy, whereas the second explanation posits that differences are due to the prevalence of chronic diseases (e.g., Case & Paxson, 2005; Nusselder & Looman, 2004).

Turning from studies of prevalences and incidences to individual health trajectories, the question of "typical" health trajectories arises. Clipp and colleagues (1992) developed a typology of trajectories of physical health in a long-term perspective, which we apply to our setting of a health variable with three possible outcomes.

Data

The German Socioeconomic Panel (SOEP) Study was started in 1984 in West Germany. A total of 5,921 households, or 12,290 persons aged 16 and older, were surveyed annually. In 1990, East Germany was included into the panel, expanding it by 2,179 households and 4,453 persons. The data of the SOEP consist of seven samples. We limit our analysis to sample A, which was started in 1984 and includes residents in the Federal Republic of Germany, and sample C, which was drawn from German residents in the German Democratic Republic in 1990. Because the health of foreigners is too different from the health of Germans, they are excluded from this analysis.

In the years 1984–1987, 1992, and 1995–2001, self-perceived health limitations was asked using the question: "Disregarding occasional illnesses is the fulfilment of everyday activities, e.g., in the household, your job, or education, hindered by the state of your health, and to what extent?" The possible answers to this question were "not at all," "a little," and "many." This means that the limitation score used in the following analysis has three discrete levels, ranging from 1 (*non-limited*) to 3 (*many limitations*).

We chose this variable because it comes closest to the meaning of health limitations. Sometimes, the term disability is used for the health status "measured through activity restriction in daily life, such as 'hampered in daily life'," as, for example, defined by Robine and colleagues (2002). In the SOEP, however, the prevalences of answers "some" and "many" are too high to refer to it as disability. Within the paper, we interpret the variable as non-limited, some, and many limitations.

Because the question about self-perceived health limitations was not asked between 1992 and 1994, we look at the 1995–2001 period, which means that we follow individual trajectories of health limitations over a 6-year period, with seven points in time. The analysis is restricted to people aged 50 or older because health problems and death become more prevalent with increasing age. In 1995, a total of 3,919 persons in the SOEP were aged 50+ years. These respondents are divided into three groups: First, 2,830 respondents who survived between 1995 and 2001. From this group, 2,639 respondents have seven years of information about their health limitations, while 191 persons miss at least one year. The latter group is excluded from this analysis, but a different set of calculations in which these respondents were included produced similar results (data not shown here).

The second group consists of 497 individuals who died between 1995 and 2001. However, not all these individuals can be analyzed in full detail because only 400 of them provided information about their health limitations for each year between 1995 and their year of death. The third group consists of 592 persons who were present in 1995 and were lost to follow-up before the end of the observation period. Again, only 547 of them are part of this analysis because the others miss at least 1 year of information about their health limitations before their year of attrition. In the SOEP, death and attrition can be distinguished, and, for those remaining in the sample, death information can always be ascribed correctly. Table 1 gives an overview of the individuals included, of the persons lost to follow-up, and of the number of deaths.

We also have information on deaths and attrition for the 2002–2005 period. There were 230 deaths and 314 cases of attrition; these will be used to analyze the subsequent mortality and loss in the follow-up after the core observation period.

All socioeconomic and demographic correlates of trajectories of health limitations are taken from the beginning of the observation period, that is, the year 1995. For the variable gender, women are the risk group and men are the reference group. Age is measured in four age groups, starting with ages 50–59 and up to ages 80+ years. Education has two levels, first, respondents with a maximum of 9 years of schooling, including those with missing information and, second, those having 10 years and more. Respondents who are living with a partner in the same household are compared with those who live alone. Respondents residing in the area of the former German Democratic Republic are coded as East Germans, regardless of their place of birth. Marital status distinguishes the following four categories: married, single, widowed, and divorced.

Methods

We base our analysis on the archetypes of trajectories defined by Clipp, Pavalko, and Elder (1992). In the context of our study, these archetypes translate into the following seven trajectories that are characterized by their starting level and the direction of their change. (a) Non-limited individuals who remain so are included in the trajectory "non-limited, stable." This trajectory consists of respondents who reported being non-limited for seven consecutive years, together with those who reported limitations in only 1 of the 7 years. (b) Individuals who remain at the level of some limitations over the whole period or report some limitations in 6 out of the 7 years are placed in the trajectory "some limitations, stable." (c) Individuals who remain at the level of many limitations over the whole period, or report many limitations in 6 years, are grouped in the trajectory "many limitations, stable." (d) Respondents who are either non-limited or who suffer from some limitations in 1995, but who experience lasting deterioration of their health status and report worse health status in 2001, are placed in the trajectory "deterioration." (e) Respondents who start non-limited or with some limitations, experience at least 2 years of deterioration, but end with the same or a better health status in 2001 than in 1995 are grouped into the trajectory "deterioration, improvement." (f) Individuals who start with some or many limitations and report a better health status in 2001 than in 1995 are grouped into the trajectory "improvement." (g) Those who start with some or many limitations, experience improvement of at least 2 years, but end with the same or a worse health level are categorized as "improvement, deterioration." After assigning each individual trajectory to one of the seven categories, we display the shape of the trajectories by calculating in each group the average over all trajectories using the values 1= *non-limited*, 2 = *some limitations*, and 3= *many limitations*.

To assess gender differences in trajectories of limitations, we use multinomial logistic regression, modelling the trajectory groups as competing risks. For the mortality follow-up, we calculate age-standardized death rates (ASDRs) using the 1995 age structure of the survivors as the standard population. We use the age structure of the year 1995 as the standard population to remain consistent with the rest of the analyses, which is generally weighted by 1995 survey weights of the SOEP, which correct for the different sampling probabilities, as well as for attrition prior to 1995. Multinomial regression models with the competing risks of survival, death, and attrition are estimated to explore gender differences in relative mortality for each trajectory and by sex. For both sexes, the reference trajectory is the non-limited, stable pathway. To assess the significance of gender differences, an interaction term between sex and the type of trajectory is introduced into the model. To model the interaction term, we use discrete categories for each combination. In order to test whether the gender difference within one specific trajectory is statistically significant, we repeat the estimation of the model with changing reference groups in the interaction term: for example, to test whether the gender difference is significant in the deteriorating trajectory, the reference group is men experiencing this pathway. The software used for the calculations is Stata 10.1.

Results

The first three analyses explore gender differences in the risks faced by the 1995 study population of experiencing certain trajectories with the outcomes of survival, death, or attrition by 2001. The fourth analysis investigates gender differences in the mortality risk of dying between 2002 and 2005, depending on the type of trajectory experienced before.

Trajectories of Health Limitations Among the Survivors

Among all age groups, 14% of the men and 12% of the women died over the 1995–2001 observation period, 15% of the men and 19% of the women were lost in the follow-up, and 71% of the men and 69% of the women survived the period. The majority of the survivors experienced the stable non-limited pathway (Trajectory 1: men 18%, women 12%), followed by "some limitations, stable" (Trajectory 2: men 15%, women 15%), and deteriorating pathways (Trajectory 4: men 13%, women 15%). The least common pathways, experienced by between 5% and 8% of survivors, are in the category "many limitations, stable," "improving," or both "improving and deteriorating." Taking death and attrition into account, the main statistically significant gender difference lies in the "non-limited, stable" trajectory (Figure 1).

The different trajectory groups have different frequencies across age groups, as shown in Table 2. In the youngest age group, a considerably larger proportion of men than women follow the "non-limited, stable" trajectory, whereas more women follow the deteriorating pathway (men 13%, women 16%). In the age group 60–69 years, the gender differences

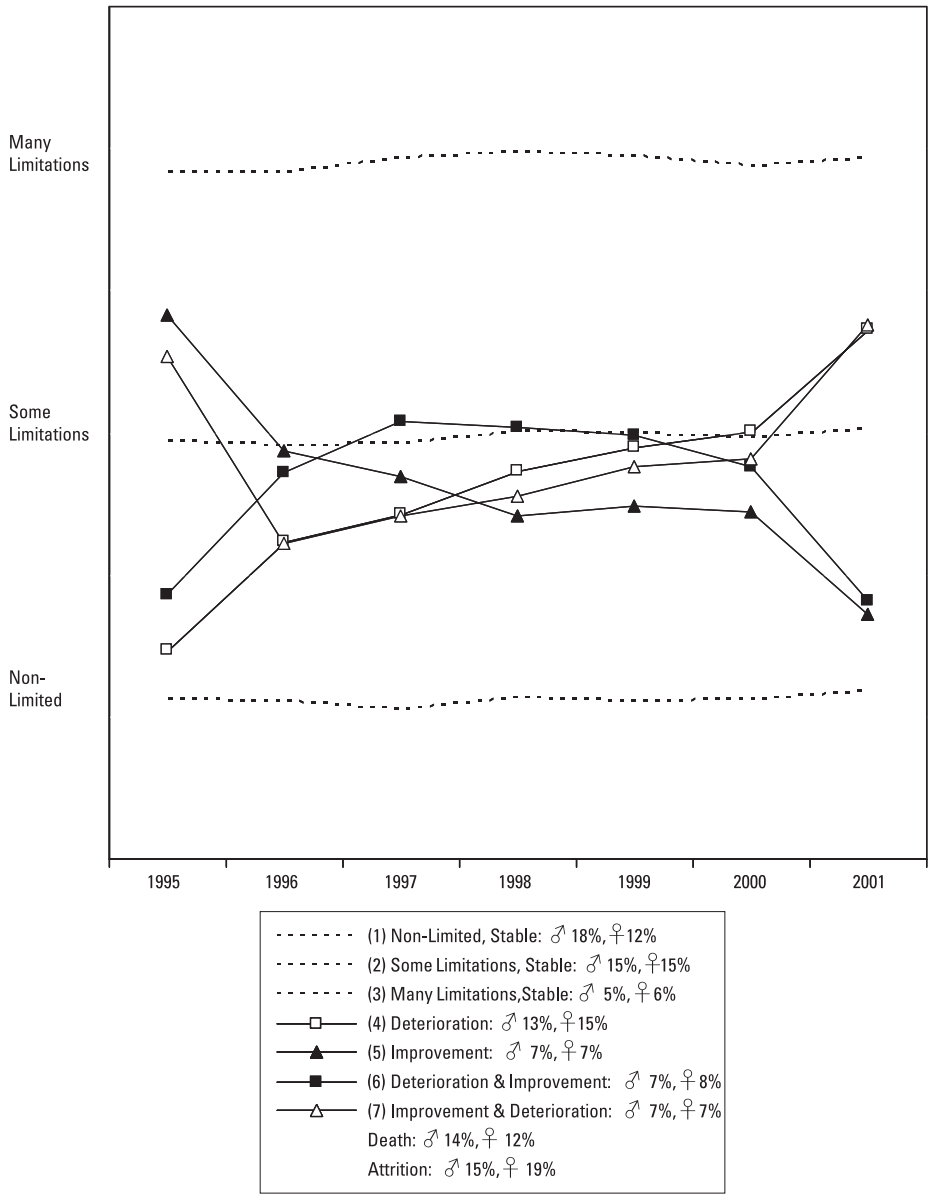

Figure 1. Trajectories of the survivors of the 1995–2001 period assigning the values 1 = *non-limited*, 2 = *some limitations*, and 3 = *many limitations*.

are best characterized by two features: First, among survivors who experience stable non-limited conditions, men report less limitations. Second, men are more likely to die, whereas women are more likely to survive but experience deteriorating trajectories. Similar patterns apply to the oldest age group of 70+ years. The gender differences are of borderline significance in the youngest age group (likelihood ratio test = 14.52, $p = .08$) and highly significant thereafter at $p = .01$.

Trajectories of Health Limitations Among the Deceased

In our study design, we observe the extent of health limitations among the deceased for different time periods: for example, for those who died in 1996, information is available for the year 1995, whereas for those who died in 2001, it is given in six consecutive years before death (1995–2000). In order to identify the trajectories according to the rules outlined earlier, we use at least 3 years and classify the trajectories into (a) stable trajectories without limitations, (b) some limitations, (c) many limitations, (d) deteriorating, and (e) improving. Due to small numbers, we do not distinguish the trajectories "deterioration, improvement" and "improvement, deterioration"; (f) individuals who died in 1996 and 1997 are included in the group "immediate death," without further consideration of their health limitations. A similar procedure is followed in the identification of trajectories among those lost to follow-up; however, results are not shown due to space restrictions.

Table 2. Proportions of the Trajectories in the Period 1995–2001 by Age and Gender

	Proportions of trajectories in each age group						*N*, all ages		
	Age 50–59 years		Age 60–69 years		Age 70+ years				
	Males	Females	Males	Females	Males	Females	Males	Females	Total
Total	100	100	100	100	100	100	1,620	1,965	3,585
Non-limited, stable	26	21	13	11	6	4	317	273	590
Some limitations, stable	10	12	15	15	11	7	228	300	528
Many limitations, stable	6	4	3	6	4	7	63	106	169
Deterioration	13	16	9	13	9	12	240	308	548
Improvement	6	6	5	5	3	3	118	134	252
Deterioration, improvement	11	11	9	13	4	10	115	161	276
Improvement, deterioration	9	10	14	15	14	9	119	157	276
Death	4	2	15	6	34	26	194	205	399
Attriton	14	19	18	16	14	21	226	321	547
Mean age	54.8	54.8	64.2	64.3	76.3	76.68			
N	1,575		1,111		899				
LR test	14.52*		31.92***		19.29***				

Notes: The proportions are weighted by 1995 survey weights. Maximum age range at ages 70+ years: males 70–94 years; females: 70–98 years. LR = likelihood ratio.

*p value ≤ .10; ***p value ≤ .01.

Looking at Figure 2, which depicts the trajectories among the deceased, we find that 5.5% of the men and 4.8% of the women present in 1995 die after the "non-limited, stable" trajectory. Because this would suggest that dying without limitations occurs most frequently, it should be noted that, due to the study design, the non-limited time span ranges from a minimum of 2 years to a maximum of 6 years. Therefore, it is less the rank of the trajectories by frequency but rather the sex difference that is of interest at this stage of the analysis (The issue of which trajectory is

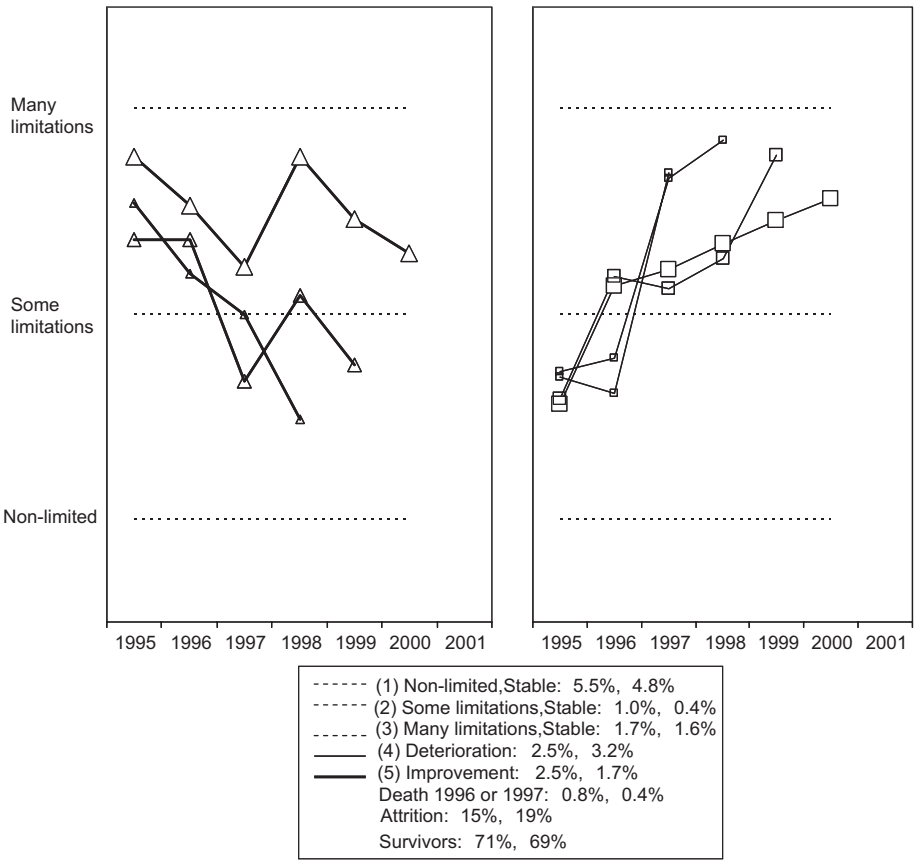

Figure 2. Trajectories of the deceased in the 1995–2001 period (the size of the markers indicate trajectories by death at a given wave) assigning the values 1 = *non-limited*, 2 = *some limitations*, and 3 = *many limitations*.

Table 3. ORs of Women to Experience a Trajectory (reference trajectory: non-limited, stable; reference group: males) (1995–2001)

		95%	
	OR	LCI	UCI
Survivors			
Non-limited, stable (reference trajectory)	1.00		
Some limitations, stable	1.41	1.00	1.99**
Many limitations, stable	1.40	0.65	2.05
Deterioration	1.41	1.03	1.94**
Improvement	1.25	0.86	1.83
Deterioration, improvement	1.32	0.91	1.91
Improvement, deterioration	1.09	0.71	1.65
Death			
Non-limited, stable	0.25	0.07	0.92**
Some limitations, stable	0.66	0.30	1.44
Many limitations, stable	0.89	0.50	1.56
Deterioration	0.57	0.26	1.23
Improvement	0.22	0.04	1.32*
Death 1996 or 1997	0.49	0.26	0.91**
Attrition			
Non-limited, stable	1.18	0.73	1.92
Some limitations, stable	1.54	0.90	2.64
Many limitations, stable	2.45	1.08	5.56
Deterioration	1.46	0.62	3.46
Improvement	5.25	1.96	14.08
Attrition 1996 or 1997	1.12	0.65	1.94
Pseudo Log Likelihood	−8748.92		
Pseudo R^2	.06		

Notes: Multinomial logistic regression model; the regression is weighted by 1995 survey weights. Adjusted for age (second-degree polynomial), education (high v. low), marital status (married, widowed, divorced, single), East/West Germany, and partnership status (partner yes/no). Reference trajectory: non-limited, stable; reference group: males. OR = odds ratio; LCI = lower confidence interval; UCI = upper confidence interval.

*p value ≤ .10; **p value ≤ .05; ***p value ≤ .01.

most frequently followed by death will be addressed in the mortality follow-up of the survivors). When gender differences are taken into account, it appears that a higher proportion of men die after more favorable trajectories, or experience immediate death in the first 2 years, whereas a higher proportion of women die after deteriorating trajectories. However, the differences are not statistically significant, and conclusions should only be derived after adjusting for the different age structures of the two sexes. This is done in the following analysis.

Sex Differences in Trajectories of Health Limitations of the Survivors, the Deceased, and Those Lost to Follow-up, Adjusted for Socioeconomic and Demographic Correlates

The following multinomial logistic regression integrates into one model the survivors, the deceased, and those lost to follow-up by calculating the odds ratios (ORs) for different trajectories (seven among survivors, six among the deceased, and six among attrition). The reference trajectory consists of persons who survived non-limited. In Table 3, we only display the ratios of women as compared with men experiencing a certain trajectory. The effects of age, education, marital status, East/West Germany, and partnership status will only be briefly discussed in the text because they mainly serve as control variables.

A clear pattern by gender emerges: instead of surviving non-limited, women have a higher risk of surviving with stable trajectories of some limitations (OR = 1.41, p = .05) or with deteriorating trajectories (OR = 1.41, p = .03). The disadvantage of men stems from mortality: women are only about one-quarter as likely as men to die non-limited (OR = 0.25, p = .04) or after improvement (OR = 0.22, p = .10) and face about half the risk (OR = 0.49, p = .02) of dying immediately in the first 2 years. Thus, even corrected for age and other confounding factors, men tend to experience death after comparatively favorable trajectories, as well as after deterioration. Meanwhile, women are more likely than men to experience limitations and survive.

There is a gender-specific pattern in attrition: instead of surviving non-limited, women have a higher risk of dropping out with some limitations (OR = 1.54, p = .12) or with many limitations (OR = 2.45, p = .03) and after improving trajectories (OR = 5.25, p = .00).

At this stage of the analysis, we are particularly interested in whether the health disadvantage of women among the survivors may result from attrition. We therefore combined the trajectories of those lost to follow-up with the respective trajectories of the survivors, assuming that they would have survived the full period had they stayed in the sample. Redoing the above analysis yielded basically the same results, which are not displayed due to space restrictions.

Regarding socioeconomic and demographic correlates of the trajectories of the survivors and the deceased, we find that the chance to survive non-limited declines with increasing age, and high education is associated with more favorable trajectories (results not shown). Individuals residing in East Germany experience less favorable trajectories than those in West Germany. Marital status and partnership do not have a significant affect on the trajectories.

Subsequent Mortality Between 2002 and 2005 of the Survivors

The following analysis explores the questions of which trajectories more frequently result in death and whether there are gender differences. We use additional SOEP waves for the persons who survived from 1995 to 2001, data that include subsequent death and attrition between 2002 and 2005. First, we explore gender differences in the trajectories, by calculating ASDR per 1,000 (Table 4). Among men, the death rate is highest for the deteriorating pathway (ASDR = 243), followed by the "many limitations, stable" (ASDR = 237) and the "improvement, deterioration" trajectories (ASDR = 226). Among women, the death rate is highest for the stable trajectory with many limitations (ASDR = 183); women with deteriorating trajectories experience a death rate of 107, which is more than twice the death rate of the

Table 4. ASDRs per 1,000 of the Mortality Follow-up 2002–2005 Based on the Trajectories of the Survivors of the 1995–2001 Period by Sex

	Number of deaths		ASDR	95%		ASDR	95%	
				LCI	UCI		LCI	UCI
	Males	Females	Males			Females		
Non-limited, stable	14	9	74	35	113	49	17	81
Some limitations, stable	18	15	68	37	99	75	37	113
Many limitations, stable	13	23	237	108	366	183	108	258
Deterioration	34	34	243	161	325	107	71	143
Improvement	7	7	95	25	165	128	33	223
Deterioration, improvement	11	8	146	60	232	62	19	105
Improvement, deterioration	19	18	226	124	328	106	57	155
Total	116	114						

Note: All calculations are weighted by 1995 survey weights. ASDR = age-standardized death rates. LCI = lower confidence interval; UCI = upper confidence interval.

non-limited (ASDR = 49), but almost half of those with stable trajectories of many limitations (ASDR = 183). Confidence intervals of the ASDR are generally overlapping between the sexes with the exception of the mortality following the deteriorating trajectory. Thus, in our sample, the main gender difference in mortality is that, among men, deteriorating health leads to death, whereas women die after long periods with more limitations.

We come to the same conclusion when we look at relative mortality in the form of ORs (Table 5). First, we estimate a multinomial logistic regression model for each sex separately with the competing risks of death and attrition as outcomes and adjust by age, education, marital status, East/West Germany, and partnership status. Among men, the risk of mortality is almost three times as high for individuals who experienced the trajectory "many limitations, stable" than for the non-limited (OR = 2.87, $p = .04$), and it is more than three times (OR = 3.01, $p = .01$) higher among those who followed a deteriorating pathway. In relative terms, the excess mortality of women with stable pathways of many limitations is even higher than that of men (OR = 4.33, $p = .01$). The mortality risk of those following a deteriorating pathway is, however, only twice that of the non-limited and statistically not significant (OR = 1.98, $p = .17$). Among women, it is the "improvement, deterioration" pathway that has the second highest mortality risk (OR = 2.70, $p = .05$).

It seems that men die when they experience deteriorating health for the first time, whereas women die when they experience repeated deterioration. Although one has to keep in mind that confidence intervals are overlapping between the two sexes.

Given the high excess mortality of individuals following a deteriorating trajectory of health limitations, the question arises whether there is a convergence of male–female mortality in this group. We introduced an interaction term between sex and the type of trajectory to test this possibility and found that the opposite is the case: differences in mortality between the sexes are particularly large for the deteriorating pathway (OR women = 0.34, $p = .00$). This finding is supported by the ASDR, which shows the highest absolute difference in the mortality of the two sexes for those

Table 5. Multinomial Logistic Regression Model of the Mortality Follow-up 2002–2005 by Trajectories of the Survivors of the 1995–2001 Period

	Males			Females			
		95%			95%		
	OR	LCI	UCI	OR	LCI	UCI	Interaction, OR females
Non-limited, stable	1 (RG)			1 (RG)			0.60
Some limitations, stable	0.70	0.29	1.65	1.63	0.41	6.51	1.11
Many limitations, stable	2.87**	1.08	7.63	4.33***	1.54	12.19	0.76
Deterioration	3.01***	1.37	6.59	1.98	0.74	5.29	0.34***
Improvement	0.77	0.28	2.14	1.59	0.47	5.45	1.10
Deterioration, improvement	2.00	0.73	5.48	1.18	0.37	3.77	0.33***
Improvement, deterioration	2.09*	0.88	4.93	2.70***	1.01	7.24	0.60
Pseudo Log Likelihood	−680.5			−900.25			−1596.3419
Pseudo R^2	.12			.10			.10

Notes: All calculations are weighted by 1995 survey weights. OR = odds ratio; LCI = lower confidence interval; UCI = upper confidence interval.

[a]Adjusted for age (second-degree polynomial), education (high v. low), marital status (married, widowed, divorced, single), East/West Germany, and partnership status (partner yes/no).

*p value ≤ .1; **p value ≤ .05; ***p value ≤ .01.

who experience the deteriorating trajectory. We do not find statistically significant differences for the other trajectories as well as for our control variables, albeit their effects generally follow the expected directions. We do not find significant differences in the risk of attrition depending on the previous trajectory.

Discussion

This study is the first analysis of German data that concentrates on individual-level trajectories of health limitations using a large data set (SOEP) that offers repeated measures of functional limitations. We find large gender differences in the trajectories of the different age groups. In the youngest age group (50–59 years), where mortality is still low for both sexes, surviving men tend to report the stable trajectory without limitations, whereas women report changing pathways of limitations, particularly deteriorating ones. At older ages (60+ years), when mortality starts to increase, women report deteriorating pathways, whereas men die. Among the survivors with stable trajectories, men tend to report better health levels. Age and education have an affect on trajectories and on mortality in the expected direction, whereas marital status and partnership only exert a negligible influence (results not shown). Individuals residing in East Germany experience worse trajectories of health limitations than West Germans. Gender differences in trajectories remain even when other socioeconomic and demographic characteristics are taken into account.

The mortality follow-up for the years 2002–2005 showed that the mortality advantage of women is particularly large for those who experienced a deteriorating pathway during the last 6 years: among this group, women have only a third of the mortality risk of men. This is also true for the deteriorating pathway that is followed by improvement. Our analysis shows that limitation pathways and mortality have to be analyzed together.

It is a fact that in all countries, women have lower mortality rates than men (Barford, Dorling, Smith, & Shaw, 2006) but worse health in terms of disability and functional limitations and a more complex pattern in terms of morbidity and illness (Oksuzyan et al., 2008). This could imply that they recover less easily from poor health than men; however, our results do not support this explanation. First, the improving trajectory is as frequent among women as among men. Second, deteriorating trajectories that are followed by improvement are even more frequent among women than among men, and this advantage of women increases with age.

As mentioned in the beginning, Liang and colleagues (2003) find that not women but men have an earlier onset of functional impairment. Possibly this inconsistency is due to their higher number of control variables in the regression model. In particular, controlling for self-rated health and cognitive impairment but not controlling for age might explain why they find a lower risk of an early onset for women. The fact that Tsuji, Sauvaget, and Hisamichi (2002), also using a Japanese sample, find an earlier onset of disability for men points at a second possible explanation, namely a difference between Japan and Germany, either in how men and women answer survey questions on health or in the real gender-specific timing of health limitations.

It is not yet known why women have a health disadvantage and a mortality advantage. One explanation involves biological differences (Oksuzyan et al., 2008). Another explanation posits that women assess their bodies differently than men. They perceive more problems, they have more pain, and they are more prone to depression (Delbès & Gaymu, 2002). As a result, they tend to report less serious ailments (Spiers, Jagger, Clarke, & Arthur, 2003). Women understand their bodies better, they admit to having illnesses more readily (Idler, 2003; Verbrugge, 1989), and in medical examinations, they rate their health lower than men. At the same time, however, women also pursue more medical treatments than men, and they generally exhibit better health behavior (Oksuzyan et al., 2008). The saying 'women suffer, men die' (Hoffmann, 2008) captures these gender differences. In this study, we cannot further examine the influence of subjective assessment, as we only use a single subjective health measure.

Here we come back to the two explanatory models for the male–female health and mortality paradox mentioned in the introduction: First, higher male mortality is the main underlying difference and it makes men more selected and therefore healthier and it makes women survive longer, even if they have the same disease as men (Crimmins, Kim, & Hagedorn, 2002). Consequently, this leads to more comorbidity and more severe illnesses among women (Oksuzyan et al., 2008). Second, different diseases might be the basic difference between the two sexes with men suffering more from mortal conditions, such as heart disease, whereas women have more morbid conditions, such as arthritis (Crimmins et al., 2002).

In our study, we cannot differentiate between diseases but between trajectories of limitations and subsequent survival. The mortality advantage of women is particularly large for the deteriorating trajectory. Once health deteriorates, the mortality risk increases more rapidly among men than among women. This is surprising because one understanding of the interplay between health limitations and mortality is that persons who have a higher level of health limitations over an extended period of time are more advanced in the process of disablement and are therefore closer to death. Other influencing factors, such as sex, should have less of an affect on mortality when a person is already limited. In other words, we would have expected that the gender gap in mortality narrows with growing limitations. However, we find that this is not the case.

One explanation is given earlier, namely that women tend to suffer from different chronic diseases than men (Case & Paxson 2005; Gold, Malmberg, McClearn, Pedersen,

& Berg, 2002; Nusselder & Looman, 2004). Nusselder and Looman decomposed differences in health expectancies by cause of death and by cause of disability. They showed that most of the additional years that women spend in disability are affected by disability arising from arthritis, followed by disability that is not attributable to diseases. These two types of diseases largely counterbalance the mortality advantage that women have in terms of heart disease and cancer. The finding is supported by Case and Paxson, who explained gender differences in self-reported health entirely by sex-specific differences in the distribution of chronic diseases.

To conclude our discussion of the two explanations for the male–female health and mortality paradox, we consider it plausible that both mechanisms are at work. We assume that women suffer from different kinds of diseases, which start earlier in life, and are more likely to lead to health limitations, but we cannot prove this assumption due to a lack of data on diseases. Furthermore, we assert that the age pattern of differences in the trajectories between men and women supports the hypothesized effect of mortality selection.

Our study has several limitations: First, we base our findings on a question with three levels of health limitation. This is very limited information and may be another explanation for discrepancies between our finding and those reported in earlier studies such as Liang and colleagues (2003) who base their study on disability trajectories on Activities of Daily Living and Instrumental Activities of Daily Living measures.

Second, we have only yearly data on limitations. Our analysis may therefore not capture changes or rapid short-term declines that precede death. Consequently, our results may overstate the proportion of people experiencing stable trajectories, as well as of those who are dying without limitations. If surviving men suffer more often from short-term deteriorations than women, then we are overestimating both the proportion of favorable trajectories among men and gender differences among survivors, particularly at younger ages. This may question our finding of an earlier onset of limitations among women. If the short-term health deterioration before death is more common among men than women, then the mortality disadvantage of men experiencing deteriorating trajectories may be overestimated. Despite these principle problems, annual information on limitations is probably near the available optimum, also compared with other studies that have 3-year intervals (Deeg, 2005; Liang et al. 2003, 2005, 2007).

Third, the small number of cases in the mortality follow-up limits our analysis of the relationship between course type and subsequent mortality and affects our significance tests. Thus, we have to be aware that nonsignificant differences between men and women in the sample do not necessarily imply that there are no gender differences in the population. This limitation calls for further studies with larger data sets and more cases in the mortality follow-up.

Finally, we decided to explore course types of trajectories starting from age 50 years, which implies that our sample consists to a large extent of younger ages. As can be seen from the age-specific analysis of the survivors, this choice of the starting age leads to a high proportion of individuals that follow a stable trajectory without limitations. Mortality selection certainly plays less of a role at the youngest ages; nevertheless, we decided to include these ages in order to test gender differences in the onset of health limitations. Future studies that are primarily interested in the mortality by course type and the question of mortality selection may consider starting at higher ages.

In summary, our study has explored for the first time trajectories of health limitations in Germany, and it is one of the few that focuses on gender differences in trajectories of health limitations in relation to mortality. In the German context, the health disadvantage of women stems from both an earlier onset of limitations and a lower mortality. Indeed, the health disadvantage of women seems to be primarily the result of a mortality advantage: instead of dying after experiencing deterioration or extended periods of many limitations, women survive, while coping with health limitations. Future research into the question of why women experience lower mortality, but worse health, should explore health trajectories in the context of causes of death and the underlying chronic conditions.

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