Temporal changes in health within five years before and after disability pension –the HUNT Study

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Abstract

Background: Health status has been reported to change before, during and after disability pension receipt. These associations might be subject to temporal changes according to changes in policy, incidence of disability pensions and other contextual factors. We compared the perceived health around time of disability retirement among persons receiving disability pension in the 1990s and 2000s in Norway.

Methods: We linked data from two consecutive cross-sectional population based Norwegian health surveys, HUNT2 (1995-97) and HUNT3 (2006-08), to national registries, identifying those who received disability pension within 5 years before or after participation in the survey (HUNT2: n=5362, HUNT3: n=4649). We used logistic regression to assess associations of time from receiving a disability pension with self-rated health, insomnia, depression and anxiety symptoms, and subsequently estimated adjusted prevalence over time.

Results: Prevalence of poor self-rated health peaked around time of receiving disability pension in both decades. For those aged 50+, prevalence the year before disability pension was slightly lower in 2006-08 (74%, 95% CI 70-79%) than in 1995-97 (83%, 95% CI 79-87%), whereas peak prevalence was similar between surveys for those younger than 50. Depression symptoms peaked more pronouncedly in 1995-97 than in 2006-08, whereas prevalence of anxiety symptoms was similar at time of receiving disability pension between surveys.

Conclusion: We found no strong evidence of differences in health selection to disability pension in the 2000s compared to the 1990s. However, we found indication of less depression symptoms around time of disability pension in the 2000s compared to the 1990s.

Keywords: work disability, health status, time trends

Introduction

High prevalence of disability pensions raise concern in many European countries, as does the emergence of mental illness as a leading cause of disability pension, often at a relatively young age.[1] Disease, illness and sickness are only partially overlapping concepts of ill health,[2] and there is a lack of knowledge on whether the associations of disease and illness with disability pensions have changed over time.

There is limited evidence of the reliability of medical evaluations of work disability[3], and there are several non-medical determinants of disability pensions.[4-6] For instance, social gradients in disability pension receipt[4, 7, 8] are only partially explained by differences in health, life-style and working conditions.[8] Financial downturns and unemployment tend to increase inflow to disability pension, suggesting temporal interchange between medical and non-medical benefit schemes.[9] The social gradient in disability pension tended to steepen in Sweden,[10] and data from UK indicate that the employment gap between healthy and unhealthy individuals increased more rapidly among lower social classes over the past decades.[11]The prevalence of disability pensions increased between the 1990s and 2000s in more than half of OECD countries, including Norway.[1] Simultaneously, the prevalence of self-reported poor health declined in Europe,[12] population educational attainment increased,[13] and more people were employed in service industries.[14] There are thus seemingly discrepancies between trends in disability pension receipt and its determinants.

In Norway, eligibility to disability pensions require a permanently reduced earning capacity by at least 50%, mainly due to medical causes.[15] Between 2004 and 2010, a time-limited disability pension was available for individuals with uncertain long-term earning incapacity. It was introduced as a policy instrument to reduce incidence of permanent disability pensions, but did not have the intended effect.[16] Revisions of vocational rehabilitation schemes have also failed to reduce incident disability pensions in Norway.[17]

Temporal changes in case handling by the welfare administration are thus plausible. Meanwhile, Norway experienced stable high employment and low unemployment in the 1990s and 2000s.[14]

When considering health trajectories before and after disability pension receipt, poor health might be both a cause and a consequence of disability pension receipt. There is evidence of a temporary reduction in self-rated health[18, 19] and deterioration of mental health[18, 20-23] in the years before disability pension receipt. Such associations could reflect stress related to a lengthy process[24] involving role transition, decreasing available resources and low control[25] and effects might be diagnose-specific. There is some indication that these associations are subject to temporal changes,[23] but this has rarely been addressed specifically. Changes in vocational rehabilitation, case handling by welfare authorities, prevalence of disability pensions and the composition of the group of disability pensioners might each manifest themselves as changes in health trajectories before and after disability pension.

The aims of the present study were to assess time trends in the association between poor health and disability pension, in particular whether disability pensions were granted to healthier individuals over time and whether the possible health effects of the transition to disability pensions had changed. We therefore compared the prevalence of reported poor health within five years before or after disability pension receipt in Norway in the 1990s and 2000s.

Methods

The HUNT Study

The HUNT Study is a total population based health study conducted in the county of Nord-Trøndelag in central Norway. We applied data from the second and third wave of the HUNT Study (HUNT2 in 1995-97 and HUNT3 in 2006-08) linked to registry data from Statistics Norway by an 11-digit personal identification number, which all Norwegian citizens have. At

each occasion, all inhabitants aged 20 years or older were invited and 70% participated in HUNT2 and 50% in HUNT3.[26]

Disability pensions

For each participant, we identified the first start date of full or graded, permanent or time-limited disability pensions in data collected from a social insurance database held by Statistics Norway, covering the entire population from January 1992 until December 2013. Information on primary diagnoses was available for disability pensions received before December 2007. Primary diagnoses were coded according to the International Classification of Disease (ICD) version 9 or 10. ICD-9 codes 290-319 and ICD-10 codes F00-F99 were classified as psychiatric diagnoses, ICD-9 codes 710-739 and ICD-10 codes M00-M99 were classified as musculoskeletal diagnoses and ICD-9 codes 390-459 and ICD-10 codes I00-I99 were classified as cardiovascular diagnoses. Further details about disability pension data can be found in the web appendix (Social security system).

Study sample

As accurate social insurance data was available only from 1992 to 2013, we restricted the time span to five years before or after participation in the HUNT Study. Five years before disability pension receipt will cover the rehabilitation period for most disability pensioners.[27]

We identified 5362 participants in HUNT2 (1995-97) and 4649 participants in HUNT3 (2006-08) who received a disability pension within five years before or after participation in the respective surveys. These two groups did not overlap, as no participants had a start date simultaneously within five years after participation in HUNT2 and within five years before HUNT3.

Dependent variables

Four different indicators of health and illness were used as dependent variables in the analyses. We thus treated indicators of health and illness as the dependent variable in our statistical model, whether measured before or after disability pension receipt. . *Self-rated*

health was assessed with the question "How is your health at the moment?" and dichotomised as good/very good vs fair/poor. *Symptoms of anxiety* and *depression* were assessed separately by the Hospital Anxiety Depression Scale, a validated instrument for mental symptoms in the general population.[28] We defined caseness depression and caseness anxiety as a score of 8 or more on the respective subscale.[28]

Participants who either reported difficulties falling asleep or waking too early without being able to go back to sleep were categorised as suffering from *insomnia*. Participants were asked about such problems the last month in HUNT2 and the last three months in HUNT3. In HUNT2 there were four response alternatives (never, sometimes, often or almost every night), the last two were considered as indicating insomnia. In HUNT3, there were three response alternatives (never, sometimes or several times a week), the latter was considered indicating insomnia.

Covariates

Information on highest level of education at the time of HUNT participation was collected from The National Education Database (Statistics Norway), and categorized to primary education or less, secondary education or college/university level education. Marital status was provided by Statistics Norway.

Statistical analyses

We calculated the time interval between participation in each wave of the HUNT Study and disability pension receipt and categorised these intervals as number of years before or after receiving a disability pension (from five years before to five years after disability pension). Thus, we ended up with ten non-overlapping groups of disability pensioners for each survey wave, each of these groups reflecting a different temporal relationship between the health measurements and disability pension. A similar approach was used by Øverland et al [18].

We estimated the predicted prevalence of poor self-rated health, insomnia, caseness depression and caseness anxiety for each of the one-year time intervals (from 5 years before to 5 years after disability pension) using complete cases and robust standard errors. Estimations were based on logistic regression analyses adjusted for sex, age, education, marital status and calendar time (average adjusted predictions, meaning predictions were made keeping covariates constant at their observed values). Age was centred, and a square term for age was included to allow for nonlinear age effects. We also estimated the predicted prevalence of each dependent variable for the entire HUNT population aged 67 or less (i.e. the time span of eligibility to disability pension, n= 51,614 in HUNT2, n=40,263 in HUNT3) using similar models, in order to make levels of ill health among disability pensioners visually comparable with the population average.

We included interaction terms between study wave and time before or after disability pension receipt. Statistical evidence of differences between calendar times were evaluated overall using a log-likelihood ratio test (LR test), but also for specific time points. Self-rated health was analysed separately for participants older or younger than 50 years of age, as the LR test indicated strong evidence of effect measure modification by age ($p<0.001$). We also assessed health by diagnostic categories of disability pensions (figure 2). As diagnostic information was available only until 2007, only results from HUNT2 (1995-97) are shown.

Statistical analyses were performed using Stata version 13 and 14.

Supplementary analyses

Analyses were also performed separately for participants in HUNT2 and HUNT3. We assessed patterns of missing data, performed multiple imputations and multilevel models to assess the impact of missing data on the results. We looked for effect measure modification by age (younger than 50 vs 50 years or older), sex and education. We assessed influence by administrative changes by including indicators of casework time and rehabilitation time as

covariates, by analysing self-rated health relative to onset of work disability and by restricting analyses to permanent disability pensions.

Please see appendix for further details.

Results

Descriptive statistics of the subsamples are presented in table 1.

Self-rated health

The prevalence of poor self-rated health was similar in the 1990s and 2000s (LR test of interaction p=0.5) among those younger than 50 years (figure 1). Prevalence peaked at 82% (95% CI 77-88%) the year before disability pension receipt in the 1990s compared to 79% (95% CI 72-85%) the year after disability pension receipt in the 2000s. The prevalence of poor self-rated health was, on the other hand, somewhat lower in the 2000s compared to the 1990s among those 50 years or older (LR test of interaction p=0.03). Peak prevalence in the older age group was 83% (95% CI 79-87%) in the 1990s compared to 75% (95% CI 70-79%) in the 2000s (p of difference =0.008), and the difference persisted until five years after disability pension receipt. However, the estimated population prevalence of poor self-rated health was also 4 percentage points lower in the 2000s than in the 1990s for those older than 50 years of age.

The prevalence of poor self-rated health remained high after disability pension receipt among those with a cardiovascular diagnose, whereas prevalence peaked around time of disability pension for those with a psychiatric or musculoskeletal diagnose (figure 2).

Insomnia

The prevalence of insomnia was 17% (95% CI 14-20%) five years before disability pension receipt compared to 33% (95% CI 0.29-0.37%) the year before disability pension receipt in the 1990s, with corresponding numbers 25% (95% CI 0.20-0.30) and 31% (95% CI 27%-36%) in the 2000s.

Insomnia was most prevalent among those with a psychiatric diagnose, however, the association with time since disability pension was stronger among those with a musculoskeletal diagnose (figure 2).

Mental symptoms

Overall, there was weak statistical evidence of differences in prevalence of caseness depression (LR-test p=0.1) and caseness anxiety (LR-test p=0.4), respectively, among those who received a disability pension in the 1990s compared to the 2000s. The prevalence of caseness depression five years prior to disability pension receipt was only three percentage points higher in the 1990s than in the 2000s, however, the year before disability pension receipt, the prevalence was 28% (95% CI 24-32%) in the 1990s compared to 16% (95% CI 12-19%) in the 2000s (p of difference <0.001). Estimated population prevalence of caseness depression was 10% in the 1990s compared to 8% in the 2000s.

Those who received a disability pension for a psychiatric diagnose had, as expected, markedly higher prevalence of caseness mental symptoms compared to those with musculoskeletal or cardiovascular diagnoses (figure 2).

Supplementary analyses

Separate analyses for the 1990s and 2000s showed similar results. We did not find statistical evidence of effect measure modification by sex or education. We did not find statistical evidence that missing data was associated with time before or after receiving a disability pension. Estimates from multiple imputation analyses as well as multilevel models were in line with estimates from complete case analyses (appendix – missing data).

Neither adjusting for administrative changes, nor restricting analyses to permanent disability pensions, substantially altered the results (appendix – social security system), but plotting self-rated health against onset of work disability (instead of receipt of disability

pension) indicated similar trajectories for younger versus older participants (supplementary figure S4).

Discussion

Overall, we found similar levels of poor health among individuals who received a disability pension in the 1990s and 2000s. Peak prevalence of poor health was also similar for the two decades, whereas peak prevalence of caseness depression was smaller in the 2000s.

The prevalence of poor self-rated health remained high five years after disability pension due to a cardiovascular diagnose, whereas it peaked the year before disability pension receipt for those with a psychiatric or musculoskeletal diagnose. The peak in prevalence of caseness depression the year before disability pension receipt was greatest among those who received a disability pension due to a mental diagnose.

Strengths and limitations

This study relied on cross-sectional health data linked to registry data on disability pension receipt. This enabled us to examine health both prior to and after disability pension receipt, among participants unaware of the research question of the present study. However, longitudinal data analyses would have been preferable when estimating health trajectories around time of disability pension.

As missing data on dependent variables seemed independent of time categories, complete case analyses should provide valid estimates of associations between time categories and health, whereas regression intercepts might still be biased.[29] Missing data on mental health warrants caution when comparing prevalence estimates during the ‘90s and ‘00s. Differently phrased questions about insomnia also preclude comparison between decades.

Non-participation might similarly bias the estimated prevalence of poor health. Non-participation in HUNT3 was associated with worse mental health and more frequent disability pension, .[30] and it is reasonable to expect similar mechanisms in HUNT2. Higher participation in HUNT2 than HUNT3 thus reduces comparability between study waves. Similar results between methods is a strength, still, prevalence in the 2000s might be underestimated due to stronger health selection to participation, as no method can fully compensate for missing data. Moreover, mortality as well as lower participation among disability pensioners could bias estimated prevalence of poor health after disability pension receipt. We could not examine degree of selection to participation empirically, but mortality within five years after disability pension is low and should not have a substantial impact on results. Furthermore, results from cause-specific analyses contradict increased selection as the main source of association.

Although self-rated health measured by a single question is rather unspecific and hard to define, it is strongly associated with mortality[31] and several other health outcomes.[32] Self-reported symptoms of anxiety, depression and insomnia are also subjective health measures that can be expected to be associated with stressful life events. The choice of dependent variables should thus assert the possibility of finding existing associations between time of disability pension and poor health. Compared to the criteria for insomnia, we did not include information on nightly awakenings or not feeling rested[33], as these were not available in HUNT2 (1995-97), we have thus not estimated prevalence according to clinical definitions for either of the dependent variables.

Health selection to disability pension

Although our results must be interpreted with caution, we found no indication of substantial changes in health selection to disability pension. Considering that self-rated health seemed to have improved among the old in the entire population, the tendency of improved self-rated

health among older disability pensioners could be interpreted as a stronger health selection to participation in the most recent health survey, but it could also be due to a cohort effect with better health among later cohorts. Selective participation might have led to underestimation of caseness depression in the 2000s.

The consistency of insomnia reports when asked to recall one versus three months is unfortunately unknown, but symptoms of insomnia fluctuate in the general population.[34] Transient episodes of insomnia are more likely triggered by stressors than chronic insomia,[35] and it is uncertain how these would be reported given three months recall. Prevalence of insomnia in the 1990s and 2000s should thus not be compared directly.

Health trajectories among disability pensioners

As poor health causes disability pension receipt after a rehabilitation period of unequal duration[24], an increase in prevalence of poor health leading up to time of disability pension receipt is to be expected. However, the decline in prevalence after disability pension receipt can be interpreted in several ways. A transient negative effect of disability pension receipt on health due to stress, and a subsequent positive effect on health related to absence of work strain and role adjustment is possible.[19, 25] Considering cause-specific disability pensions, cardiovascular diseases imply pathophysiological changes that may be less influenced by psychosocial stressors compared to musculoskeletal and psychiatric diagnoses. However, associations might not be causal.

As prevalence of caseness depression symptoms was comparable in the years before and after receiving a disability pension, we interpret the substantially lower peak prevalence of caseness depression in the ‘00s compared to the ‘90s as the disability process being less stressful in the later decade, rather than disability pension being granted to a population of better mental health. The results are thus compatible with a Swedish study finding higher rates of suicide attempts around time of disability pension in the 95-97 compared to 2005-06.[23]

There are gender differences in morbidity, working conditions and disability pension rates[38, 39], yet we did not find evidence of different associations with health before and after disability pension among men and women.

Conclusions

The present study did not find evidence of substantial changes in the health selection to disability pension over the past decades. Levels of depression symptoms do, however, seem to be somewhat less associated with the timing of the disability process, which might indicate less perceived stress related to receiving a disability pension over the last few decades. Results might be interpreted as supporting the existing social security system, despite concerns about high frequency and potential non-medical reasons for disability pensions.

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Conflicts of interest: GAAV is member of the Norwegian political party Centre Party. The authors report no other conflicts of interest.

Keypoints:

- Prevalence of poor health peaked around time of disability pension receipt in both the 1990s and 2000s. The peak in symptoms of depression was less pronounced in the 2000s compared to the 1990s.
- We did not find evidence of substantial changes in the health selection to disability pension over the past decades.
- Results might be interpreted as supporting the existing social security system, despite concerns about high frequency and potential non-medical reasons for disability pensions.

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Table 1 Descriptive statistics of participants who received a disability pension within 5 years before or after participation in the HUNT2 Survey (1995-97) or the HUNT3 Survey (2006-08).

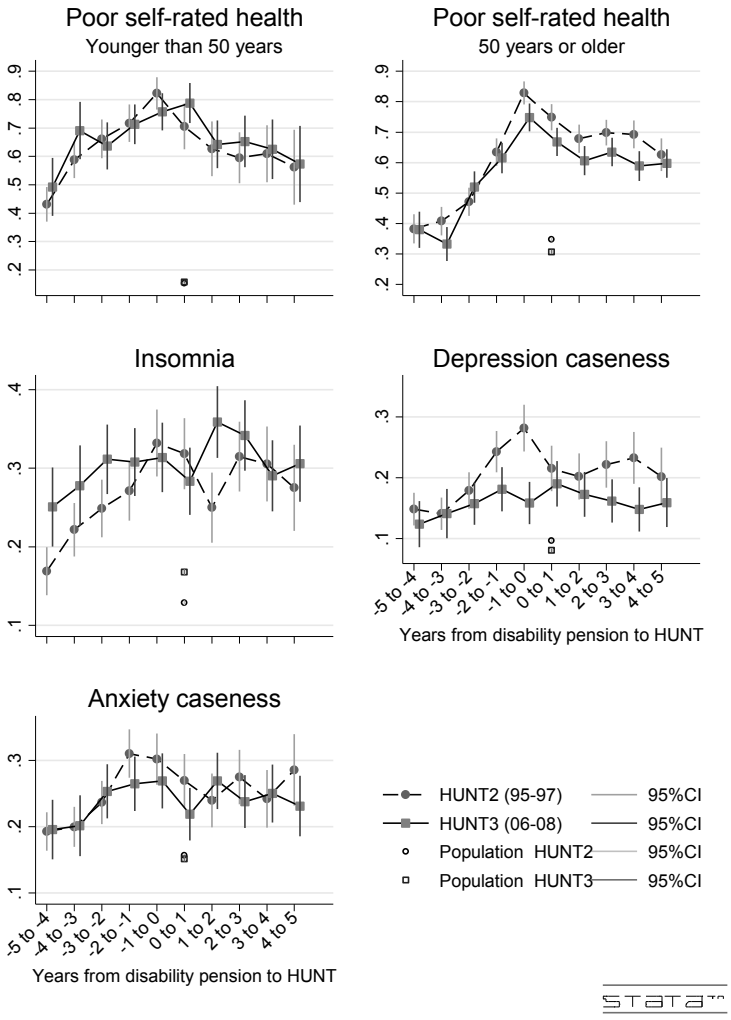
	HUNT2 (1995-97) (n=5362)		**HUNT3 (2006-08) (n=4649)**	
	N	**%**	**n**	**%**
Women	2890	53.9	2844	61.2
Age (mean/sd)	54.6	10.1	55.1	9.6
Poor self-rated health	3287	61.3	2708	58.3
Missing	52	1.0	159	3.4
Anxiety cases	1273	23.7	903	19.4
Missing	338	6.3	867	18.7
Depression case	1035	19.3	599	12.9
Missing	306	5.7	867	18.7
Insomnia	1175	21.9	1167	25.1
Missing	923	17.2	858	18.5
Education				
Primary	2306	43.0	1305	28.1
Secondary	2552	47.6	2616	56.3
College/ university	494	9.2	718	15.4
Missing	10	0.2	10	0.2
Marital status				
Unmarried	638	11.9	697	15.0
Married	3854	71.9	3029	65.2

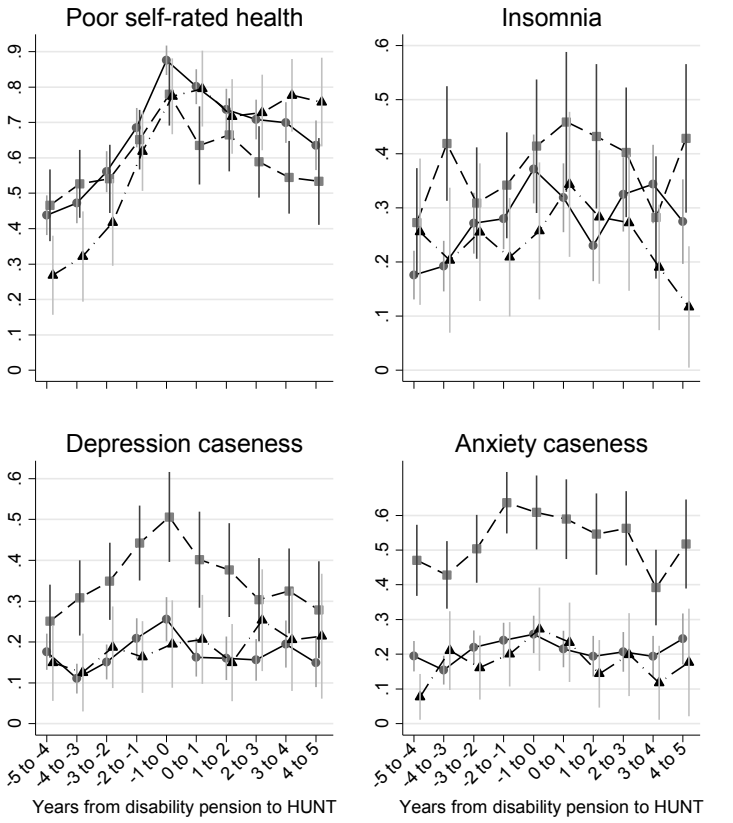
Widow(er)	257	4.8	194	4.2
Divorced/ separated	604	11.3	729	15.7
Missing	9	0.2	55.1	9.6

Figure legends:

Figure 1 Predicted prevalence of poor self-rated health, insomnia, depression and anxiety caseness according to time before or after disability pension for participants in HUNT2 (1995-97) and HUNT3 (2006-08). Predicted prevalence of poor self-rated health is stratified by age. Predicted prevalence for all participants age 20-67 years in HUNT2 and HUNT3 are included as reference values. Depression/anxiety caseness is defined as a score of 8 or more on the respective subscale of the Hospital Anxiety Depression Scale.

Figure 2 Predicted prevalence of poor self-rated health, insomnia, depression and anxiety caseness by time before or after disability pension, HUNT2 (1995-97), by diagnostic category. Depression/anxiety caseness is defined as a score of 8 or more on the respective subscale of the Hospital Anxiety Depression Scale.


Poor self-rated health
Younger than 50 years
Poor self-rated health
50 years or older
Insomnia
Depression caseness
Anxiety caseness
-5 to -4
-4 to -3
-3 to -2
-2 to -1
-1 to 0
0 to 1
1 to 2
2 to 3
3 to 4
4 to 5
Years from disability pension to HUNT
HUNT2 (95-97)
HUNT3 (06-08)
Population HUNT2
Population HUNT3
95%CI


Poor self-rated health
Insomnia
Depression caseness
Anxiety caseness
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
-5 to -4
-4 to -3
-3 to -2
-2 to -1
-1 to 0
0 to 1
1 to 2
2 to 3
3 to 4
4 to 5
Years from disability pension to HUNT
Years from disability pension to HUNT
Diagnostic category:
musculoskeletal
psychiatric
cardiovascular
95%CI
95%CI
95%CI

Supplementary material

Content:

List of tables and figures

Descriptives

Supplementary table S1. Descriptive statistics of participants who received a disability pension within 5 years before or after participation in the HUNT2 Survey (1995-97), by numbers of years between participation in the HUNT Study and disability pension receipt.

	5-3 yrs before (n=1256)		3-1 yrs before (n=1211)		1-0 yrs before (n=549)		0-1 yrs after (n=496)		1-3 yrs after (n=994)		3-5 yrs after (n=856)	
	n	%	n	%	n	%	n	%	N	%	n	%
Women	719	57.3	687	56.7	289	52.6	254	51.2	510	51.3	431	50.4
Age (mean/sd)	50.5	8.7	52.7	9.5	53.8	10.0	55.7	9.2	57.2	10.2	60.3	9.8
Poor self-rated health	601	47.9	747	61.7	454	82.7	365	73.6	634	63.8	486	56.8
Missing	12	1.0	12	1.0	6	1.1	4	0.8	11	1.1	7	0.8
Anxiety cases	276	22.0	340	28.1	160	29.1	121	24.4	215	21.6	161	18.8
Missing	57	4.5	60	5.0	33	6.0	33	6.7	76	7.7	79	9.2
Depression case	199	15.8	258	21.3	150	27.3	100	20.2	184	18.5	144	16.8
Missing	52	4.1	54	4.5	32	5.8	30	6.1	69	6.9	69	8.1
Insomnia	230	18.3	273	22.5	153	27.9	128	25.8	216	21.7	175	20.4
Missing	209	16.6	217	17.9	96	17.5	89	17.9	171	17.2	141	16.5

Education												
Primary	462	36.8	504	41.6	239	43.5	216	43.6	470	47.3	415	48.5
Secondary	676	53.8	556	45.9	255	46.5	233	47.0	448	45.1	384	44.9
College/ university	117	9.3	150	12.4	55	10.0	45	9.1	75	7.6	52	6.1
Missing	1	0.1	1	0.1	0	0.0	2	0.4	1	0.1	5	0.6
Marital status												
Unmarried	150	11.9	154	12.7	73	13.3	47	9.5	121	12.2	93	10.9
Married	882	70.2	877	72.4	392	71.4	366	73.8	713	71.7	624	72.9
Widow(er)	45	3.6	44	3.6	24	4.4	23	4.6	59	5.9	62	7.2
Divorced/ separated	176	14.0	133	11.0	59	10.8	59	11.9	100	10.1	77	9.0
Missing	3	0.2	3	0.3	1	0.2	1	0.2	1	0.1	0	0.0

Supplementary table S2. Descriptive statistics of participants who received a disability pension within 5 years before or after participation in the HUNT3 Survey (2006-08), by numbers of years between participation in the HUNT Study and disability pension receipt.

	5-3 yrs before (n=674)		**3-1 yrs before (n=1004)**		**1-0 yrs before (n=519)**		**0-1 yrs after (n=506)**		**1-3 yrs after (n=1014)**		**3-5 yrs after (n=932)**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**N**	**%**	**n**	**%**
Women	423	62.8	598	59.6	326	62.8	323	63.8	635	62.6	539	57.8
Age (mean/sd)	52.8	8.3	53.2	9.4	53.1	10.1	55.1	9.6	55.9	9.8	59.2	8.6
Poor self-rated health	296	43.9	606	60.4	380	73.2	339	67.0	592	58.4	495	53.1
Missing	13	1.9	32	3.2	19	3.7	18	3.6	50	4.9	27	2.9
Anxiety cases	114	16.9	224	22.3	116	22.4	90	17.8	204	20.1	155	16.6
Missing	149	22.1	189	18.8	107	20.6	91	18.0	179	17.7	152	16.3
Depression case	75	11.1	145	14.4	67	12.9	77	15.2	133	13.1	102	10.9
Missing	149	22.1	189	18.8	107	20.6	91	18.0	178	17.6	153	16.4
Insomnia	151	22.4	266	26.5	134	25.8	119	23.5	290	28.6	207	22.2
Missing	144	21.4	188	18.7	107	20.6	89	17.6	176	17.4	154	16.5
Education												
Primary	159	23.6	269	26.8	152	29.3	149	29.5	298	29.4	278	29.8

Secondary	379	56.2	557	55.5	285	54.9	287	56.7	580	57.2	528	56.7
College/ university	135	20.0	174	17.3	81.0	15.6	68	13.4	134.0	13.2	126	13.5
Missing	1	0.2	4	0.4	1	0.2	2	0.4	2	0.2	0	0.0
Marital status												
Unmarried	115	17.1	170	16.9	103	19.9	55	10.9	156	15.4	98	10.5
Married	424	62.9	643	64.0	313	60.3	340	67.2	655	64.6	654	70.2
Widow(er)	22	3.3	28	2.8	18	3.5	26	5.1	50	4.9	50	5.4
Divorced/ separated	113	16.8	163	16.2	85	16.4	85	16.8	153	15.1	130	14.0

Missing data

Assessing patterns of missing values

We lack information about individuals who received a disability pension due to either non-response to certain items by participant and non-participation. Because we had available information about participants in HUNT2 who received a disability pension within five years before or after median participation date in HUNT3, we were able to use information from HUNT2 to compare participants and non-participants among individuals who received a disability pension in the relevant period of time and thus should have been included in the study sample for HUNT3. The group of non-participants is, however, not complete, as we lacked information about those who did not participate in either HUNT2 or HUNT3.

We assessed the associations between education, sex, age, marital status (married, unmarried or divorced/separated/widowed), current smoking, and health (self-rated health, symptoms of depression, symptoms of anxiety and insomnia) measured in HUNT2 and participation in HUNT3. In univariate logistic regression, we found that primary education, male sex, current smoking, not being married, older age and having symptoms of anxiety was inversely associated with participation in HUNT3, among those who participated in HUNT2 and received a disability pension within five years before or after HUNT3. There was weak statistical evidence of lower participation in HUNT3 among those with caseness depression and insomnia, and about similar odds of participation among those with poor self-rated health in HUNT2.

Correspondingly, among those who participated in HUNT3, missing data on symptoms of anxiety and depression was associated with primary or secondary education (compared to college/university education), male sex, not being married and current smoking at HUNT3.

Assessing validity of complete case analyses

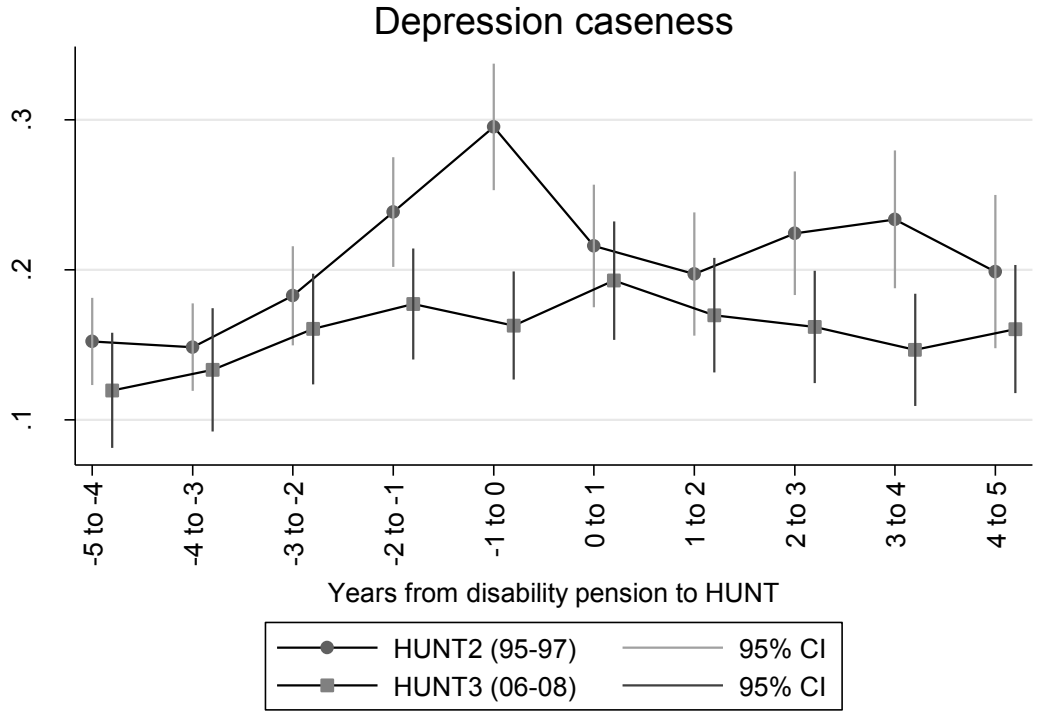
As the exposure of our analyses (i.e. time since disability pension) was fully observed for all participants in HUNT, the association between exposure and missing outcome data could be evaluated. If missing information about outcome is not associated with a fully observed exposure variable, complete case analyses should give valid estimates for associations with exposure, but there might be missing data bias in the regression intercept[1]. Logistic regression models, using an indicator of missing outcome data as outcome, did not give statistical evidence that "missingness" was associated with time since disability pension, whether time since disability pension was included as the ten indicators used in main analyses, or as only three indicators: before, around or after disability pension (p-values >0.1).

We also used information about disability pension receipt among participants in HUNT2 to evaluate the association between timing of disability pension receipt and participation in HUNT3. We generated an indicator for when a disability pension was received, 2001 to 2005 (i.e. before HUNT3 was conducted), 2006-2008 (i.e. during HUNT3) and 2009 to 2013 (i.e. after HUNT3), and assessed whether participation in HUNT3 and missing information about mental symptoms were associated with timing of disability pension receipt relative to timing of HUNT. Our results indicated similar chance of participating in HUNT3 whether a disability pension was received in the five years before, during or in the five years after HUNT3. Combining both non-participation and non-response, odds of having no information about mental symptoms from HUNT3 was higher for those who received a disability pension after HUNT3 (OR 1.17 (95% CI 1.05-1.30), but not during HUNT3 (OR 1.00 (95% CI 0.90-1.13) compared to those who received a disability pension before HUNT3.

Taken together, this supports validity of association estimates from logistic regression using complete cases only, as discussed in main paper. However, because responders and non-responders differed, the regression intercept and the estimated prevalence can be biased,

even though the association with time seems reasonable using complete cases. As missingness and non-response was found to be associated with factors also associated with poor health, non-response and missing data are more likely to have led to underestimation rather than overestimation of the prevalence in the source population. As both missing and non-participation is a more substantial problem in HUNT3, prevalence is likely more severely underestimated in HUNT3.

Supplementary figure S1. Predicted prevalence of depression symptoms depending on time since disability pension. Analyses restricted to participants who answered questionnaire 2 in the HUNT2 Study (1995-97)



Participants in the HUNT Study received a questionnaire (Q1) by mail, which they returned together with an informed consent form when attending for a clinical examination. They concurrently received a second questionnaire (Q2) to be returned by mail. The participation in questionnaire 1 (Q1) was higher than participation on questionnaire 2 (Q2) at each survey. To evaluate whether locating questions about mental health in Q2 in HUNT3 rather than in Q1 as in HUNT2 had caused any selection bias, we also restricted analyses of the association between time since disability pension and mental symptoms to participants

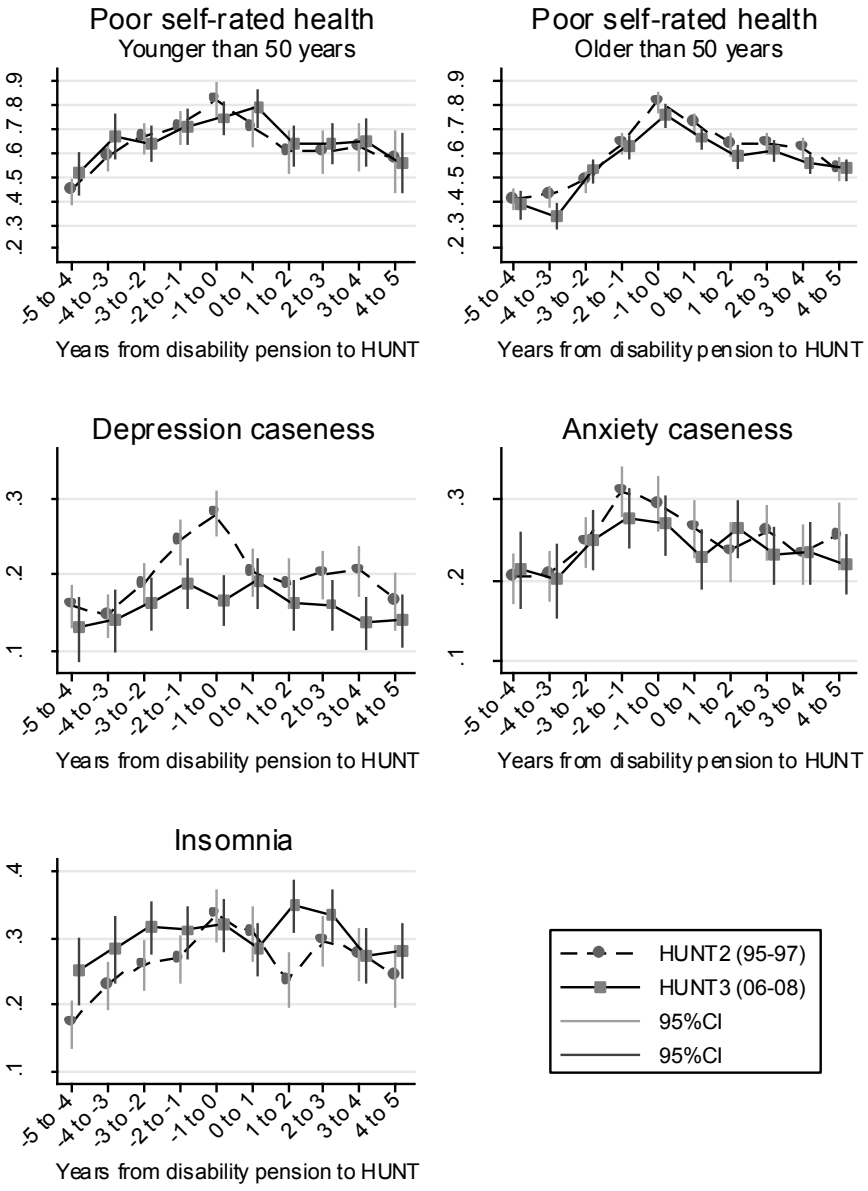
who also answered Q2. Results were similar (supplementary figure 1), suggesting the differential positioning of questions between HUNT2 and HUNT3 had not affected results.

Multiple imputations

Multiple imputations were performed as an additional analysis to evaluate the impact of missing data on insomnia and symptoms of depression and anxiety. We performed 500 imputations by chained equations, and included information from both study waves to impute missing values. In addition to variables included in the analysis models, we included information about long-standing limiting disease (dichotomous), current smoking and working class according to the Erikson Goldthorpe Portocarero scheme as auxiliary variables. Analyses of multiple imputed datasets provide valid estimates if data are missing at random, given the observed values of other included observations [1], an assumption that cannot be verified. Given the indications of higher participation among the more healthy parts of the population, prevalence of poor health in HUNT3 might be underestimated even in multiple imputed datasets.

We used postestimation commands to predict the prevalence of the dependent variables at different time intervals in our main analyses. Stata does not allow the margins command to be used after analyses of multiple imputed data, we therefore rather used the userwritten command mimrgns. Rather than applying margins on the final estimate, this command treats margins as the estimation command. A large set of imputations is required to reach asymptotic normality, which is an assumption for the summary of the estimates. As this assumption might not be appropriate for non-linear predictions, we used a linear regression model rather than a logistic model in the analyses of multiple imputed datasets. As the dependent variables were dichotomous, the results from linear regression correspond well with predictions based on a logistic model. Results from analyses of multiple imputed datasets were similar to complete case analyses (Supplementary figure S2).

Supplementary figure S2. Predicted prevalence of poor self-rated health, insomnia, depression and anxiety caseness according to time before or after disability pension for participants in HUNT2 (1995-97) and HUNT3 (2006-08), based on multiple imputed datasets. Predicted prevalence of poor self-rated health is stratified by age. Depression/anxiety caseness is defined as a score of 8 or more on the respective subscale of the Hospital Anxiety Depression Scale.

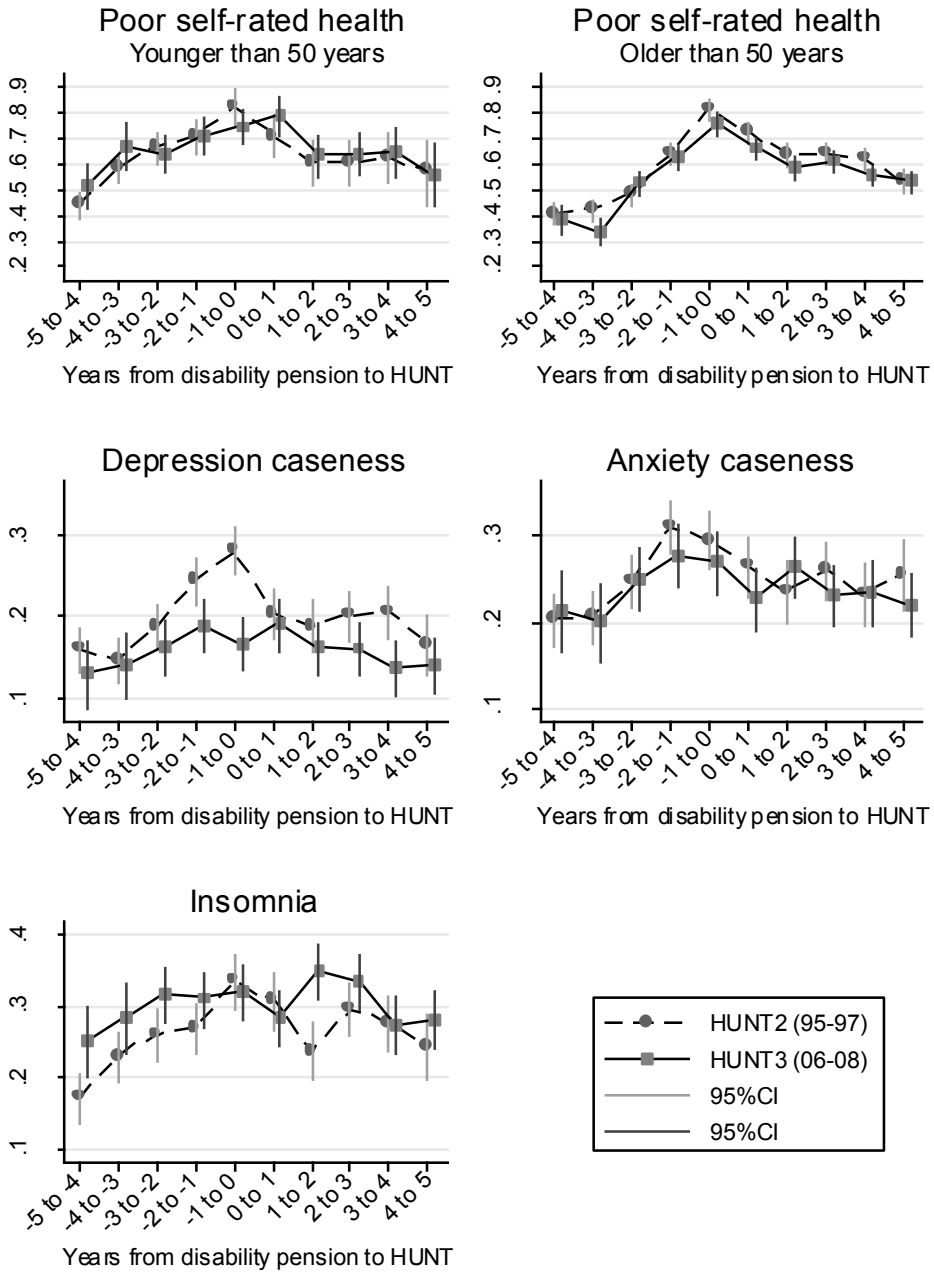


Mixed models

Although no participants received a disability pension within five years before or after participation in both HUNT2 and HUNT3, several participants participated in both study waves. We were thus able to analyse data using mixed models with observations clustered within individuals. Mixed models are less susceptible to bias due to outcome related missingness under the assumption of missing at random.[2] We added one time category for participation in a survey more than five years before receiving disability pension and one time category for participating in a survey more than five years after receiving a disability pension. We thereby estimated the health of participants before and after receiving a disability pension in each study wave, while also considering the health reported by the same individuals in the other study wave.

We allowed for both random intercepts and random slopes in our model, and used a linear regression model (xtmixed command in Stata). As argued above, linear regression estimates are similar to probability estimates from a logistic model. The random intercept implies that the probability of poor health is allowed to differ between individuals, and the random slope implies that the association between time before or after disability pension and poor health is also allowed to vary between individuals. Individuals contributed with either one or two observations each. Results from mixed models were also in line with results from complete case analyses (Supplementary figure S3).

Supplementary figure S3. Predicted prevalence of poor self-rated health, insomnia, depression and anxiety caseness according to time before or after disability pension for participants in HUNT2 (1995-97) and HUNT3 (2006-08), based on mixed models with observations clustered within individuals and with random intercept and random slope. Predicted prevalence of poor self-rated health is stratified by age. Depression/anxiety caseness is defined as a score of 8 or more on the respective subscale of the Hospital Anxiety Depression Scale.



Effect measure modification

The log-likelihood ratio (LR) test indicated borderline statistical evidence of an effect measure modification by age (p=0.06). Analysed separately by age over/under 50, the prevalence of depression symptoms was overall higher among the younger compared to the older participants (data not shown). Prevalence of depression symptoms was independent of time since disability pension among the older participants in HUNT3, but with some indication of an inverse U-shape among the younger participants.

We found no indication of effect measure modification by sex (LR test p-values >=0.2). There was, however indication of an effect measure modification by level of education for self-rated health (LR test p=0.047), depression symptoms (LR test p=0.023) and anxiety symptoms (LR test p=0.035), but not for insomnia (LR test p=0.26). Participants with tertiary education tended to have less pronounced peak prevalence of poor self-rated health at the time of disability pension, differences were otherwise inconsistent (data not shown).

Social security system

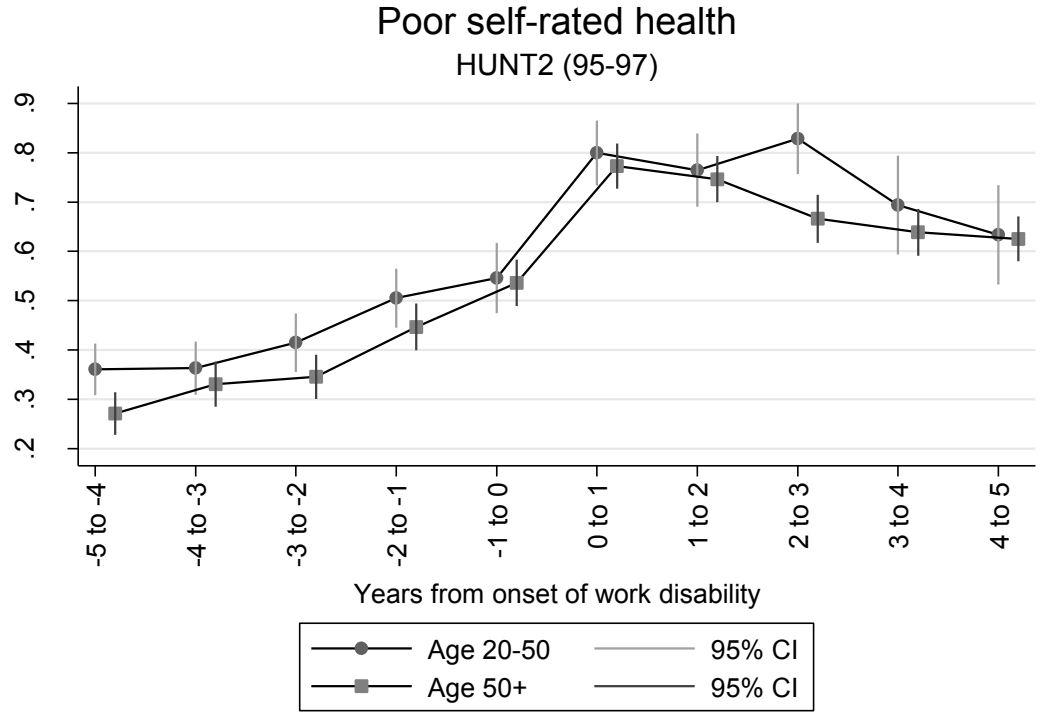
The social security database contains information about all ongoing disability pensions by January 1992 and new disability pensions until December 2013. For disability pensions received in 1990 and 1991, data would not be found in the registry if the person had left the disability scheme (e.g. transferred to old age retirement) before January 1992. The *start date* for each disability pension was left censored in January 1992, but was available for all records from January 1992 to December 2013. The *eligibility date* is the date when criteria for receiving a disability pension are found to be fulfilled. This information was not left censored, and was therefore also available for disability pensions ongoing by January 1992. The eligibility date was used as a proxy for start date for participants who received a disability pension between 1990 and 1992. The date of *onset of work disability,* when the work ability was first permanently reduced, and the eligibility date was only available for disability pensions which started before 2009.

We calculated the casework time as the time between eligibility date and the time the disability pension was started. Median casework time was 152 days in the '90s and 31 days in the '00s, whereas median rehabilitation time was 485 days in the '90s and 824 days in the'00s.

Shorter casework time might be associated with less strain from the disability process; we therefore adjusted for duration of each of these time spans in supplementary analyses. Rehabilitation time was categorised as <1, 1-2, 2-3 3-4 and more than 4 years and casework time was categorised as <2 months, 2-12 months, 1-2 years, 2-3 years, 3-4 years and more than 4 years. Rehabilitation time and casework time was entered as indicator variables in separate models. This had only minor effects on the estimated differences between HUNT2 and HUNT3 (data not shown).

However, when we predicted the self-rated health for participants younger vs older than 50 years of age relative to the onset of work disability rather than relative to work disability, we found little difference between health trajectories for younger versus older participants (supplementary figure 4).

Supplementary figure S4 Prevalence of poor self-rated health depending on time since onset of work disability by age groups, the HUNT2 Study (1995-97)



Even though the main difference between a time-limited and a permanent disability pension is the duration criteria, the time-limited benefit might be less strictly handled by the agency. We therefore also examined associations with permanent disability pensions only, this did not alter the conclusions (data not shown).

References

1. White IR, Carlin JB. Bias and efficiency of multiple imputation compared with complete-case analysis for missing covariate values. Stat. Med. 2010;29(28):2920-31.
2. Rabe-Hesketh S, Skrondal A. Multilevel and longitudinal modeling using Stata. College Station TX: Stata Corp; 2008.