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Research Article

Keywords: Health shocks, Diseases, Labour market participation

Posted Date: April 8th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9342839/v1

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Additional Declarations: The authors declare no competing interests.

The impact of acute hearth attack, stroke, and cancer on labour market participation: A panel data study from Norway

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Abstract

Background

Previous literature has examined the causal effect of specific diseases on individuals' labour market participation, including cardiovascular diseases, stroke, heart attacks or cancer. However, different diseases, with varying severities, are likely to affect labour market participation differently. Moreover, there is considerable uncertainty regarding heterogeneity across educational attainment that may contribute to explain differences in labour market participation. This paper compares the differential effects from acute heart attack, stroke and cancer, and analyse heterogeneity by educational attainment. Moreover, the paper categorize cancer by severity, which is unique in the context of labour market participation.

Method

We combined self-reported data from the Tromsø study with register-based data from the State Register of Employers and Employees and the Norwegian Patient Register (NPR). The State Register provided annual data on individuals' labour market participation from 2007 to 2018, while the NPR provided medical information, including ICD-10 codes (International Classification of Diseases, 10th version), and date of hospitalization for the period between 2006 and 2018. We treated acute heart attack, stroke, and cancer as separate diseases. Cancer was further categorized into three severity levels by their five-year survival rate prognosis (good prognosis, intermediate prognosis, and poor prognosis) provided by the Cancer Registry of Norway. We organized the data into a panel format where each panel represented one year in the study period from 2007 to 2018. We used an event study approach to model labour market participation, where we estimated linear models with correlated random effects.

Results

Labour market participation was most negatively impacted by cancer with a poor survival prognosis, followed by cancer with an intermediate survival prognosis and stroke, while cancer with a good survival prognosis and acute heart attack showed the least impacts on labour market participation. Furthermore, significant heterogeneities were observed across educational attainment and sex.

Conclusion

The impact on labour market participation of a sudden health reduction depends on the disease and its severity, as well as the affected individuals' sex and educational attainment.

Background

Substantial increases in life expectancy are putting pressure on public pension systems, something that make governments consider increases in the retirement age. However, with older age, higher incidence of diseases threatens older individuals' ability to work. Hence, more knowledge is needed on the diverse impacts that various diseases will have on individuals' labour market participation.

Previous literature has examined the causal effect of specific diseases on individuals' labour market participation, including cardiovascular diseases(1-3), stroke(4) (5, 6), heart attacks(4) (5) or cancer (4, 7-12). However, different diseases, with varying severities, sometimes referred to as 'health shocks', are likely to affect labour market participation differently. This aspect has received limited empirical attention in the literature to date(5). To our knowledge, only one study(4) has compared different diseases in terms of their impact on labour market participation, finding that their impacts differ— stroke has the greatest impact, followed by cancer and acute heart attacks.

There is considerable uncertainty regarding heterogeneity across educational attainment, and previous literature argues for the protective role of education in understanding and using health information (13). One study reported that individuals with higher education are more likely to work after a stroke(6), while another found no educational difference(5). Yet another study found that highly educated women experienced a larger reduction in labour market participation than their less educated counterparts(4). These studies differ in institutional settings (Australia, the USA, and Europe), highlighting the need for further research in different countries.

This paper contributes to the limited literature on heterogeneous effects by disease type (4). It compares the differential impacts of acute heart attack, stroke, and cancer. Moreover, we categorize cancer by severity, which is unique in the context of labour market participation. This provides new insight into how individuals adjust to varying levels of cancer severity. Specifically, we apply an event study approach to panel data to model labour market participation and estimate linear models with correlated random effects.

To identify disease causality, prior studies assume that (i) diseases occur suddenly and without anticipation. This is observed when the onset of disease is followed by a sharp decline in the outcome; (ii) the outcomes of the treatment and control groups follow parallel trends prior to the disease; and (iii) diseases are exogeneous. We adopt the same methods as previous research to explore these assumptions(5, 10, 11, 14).

Aim

This study investigates impacts of acute heart attack, stroke, and different cancer severities on individuals' labour market participation in Norway, while accounting for the importance of sex and educational attainment.

Method

Data sources and material

We combined self-reported data from the Tromsø study with register-based data from the State Register of Employers and Employees (Aa Register) and the Norwegian Patient Register (NPR).

The Tromsø study is a prospective cohort study of adults in the municipality of Tromsø in Northern Norway. It is the most comprehensive cohort study in Norway, with high participation rate, providing a solid foundation for general population research. The study population is broadly representative of the Norwegian adult population, although individuals with a university degree are slightly overrepresented. The study design is described in detail elsewhere (15, 16). The Tromsø study provided data on individuals' age, sex, and educational attainment).

The Aa Register was established in 1978, and lists all current employment in Norway (17). This register provided annual data, from 2007 to 2018, on how many hours per week individuals were expected to work according to their employment contract. Hence, the data does not include sick leave, vacation, and overtime, and is recorded only for working years. Years when individuals were not working were marked as missing values.

The NPR collects and manages medical information, including ICD-10 codes (International Classification of Diseases, 10th version), and date of hospitalization. For the period between 2006 and 2018, the NPR provided the date of participants' first hospitalization admission, and the corresponding ICD-10 codes. No information on subsequent admissions or unrelated care was provided. This use of objective data derived from administrative systems avoids the risk of justification bias inherent in self-reported survey data, which has been a concern in previous studies (18, 19).

We rearranged the Aa Register data into a panel format where each panel represented one year in the study period from 2007 to 2018. We merged this dataset with hospitalization data from NPR and demographic data from the Tromsø study.

The Regional Committee for Medical and Health Research Ethics (ID 2016/607) approved this study.

Sample selection

A total of 25,158 unique individuals who participated in the Tromsø study were available for this analysis. We included individuals who were *not* hospitalized during the study period from 2007 and 2018, and those who were hospitalized for acute heart attack, stroke, and cancer, and excluded those hospitalized for other diseases.

We focused on working-age individuals, excluding those who turned 67 years (the age in Norway when most people retire) during the study period. Additionally, we excluded those not working in the first year of the study period. To identify the impact of a disease, we required at least one observation of individuals' labour market participation before and after onset. Therefore, we excluded individuals hospitalized in the first and last year of the study. Since the diseases occur randomly during the study period, the time observed before and after hospitalization is unbalanced among included individuals.

Variables

Labour market participation variables

Labor market participation is measured by the number of hours individuals are expected to work each week throughout a year, termed '*work hours per week*'. We replaced missing values with zeros and created a new binary variable to indicate whether individuals were working (at least one hour per week) or not working (zero hours per week).

Diseases

We treated acute heart attack (ICD-10 code I21), stroke (ICD-10 code I63), and cancer (ICD-10 codes C01-C92) as separate diseases. Cancer was further categorized into three severity levels by their five-year survival rate prognosis provided by the Cancer Registry of Norway (20). Cancer diagnoses with at least 85% probability of five-year survival were categorized as *good*, while those ranging from 84% to 60% were considered *intermediate*, and those below 60% *poor*. These cut-off points were motivated by the frequency distribution of the five-year survival rates (see Supplementary Material Figure A1).

Age and education

Individuals' age was split into two-year bins for the analyses. Individuals' educational attainment was originally recorded using four levels (primary, secondary, tertiary short, tertiary long) which we split into 'no tertiary education' and 'tertiary education'.

Model specifications

Like previous studies, we used an event study approach to model labour market participation (5, 14, 21). We estimated linear models with correlated random effects, a methodology that combines the fixed effects and random effects approaches(22). This methodology allows estimating the effect of time-invariant individual characteristics on the outcome variable while retaining the ability to estimate the within-individual effects of diseases(23). The within-effect is estimated only for hospitalized individuals, so non-hospitalized individuals (i.e. those who have not encountered a relevant sudden severe disease) contribute only to the control variables. Additionally, we controlled for time. We specified the correlated random effects model as follows:

$$y_{it} = \alpha + \sum_{a=1}^{A} \delta_a Age_{it,a} + \sum_{k=1}^{5} \beta_k Disease_{it,k} + \gamma X'_i + \sum_{b=1}^{A} \delta_b \overline{Age_{it,b}} + \sum_{l=1}^{5} \beta_l \overline{Disease_{it,l}} + u_i + \lambda_t + e_{it} \quad (1)$$

The outcome y_{it} is hours worked per week for individual $i = 1, \dots, N$ at time $t = 1 \dots, T$, while α is the overall intercept. $Age_{it,a}$ represents binary variables denoting two-year bins with $a = 1, \dots, N$. $Disease_{it,k}$ are indicator variables that take the value 0 before onset and 1 following the disease k at $t = t^*$, while X' is a vector of time-invariant independent variables (sex and educational attainment). $\overline{Age_{it,b}}$ represents cluster means for the two-year age bins with $b = 1, \dots, N$, and $\overline{Disease_{it,l}}$ are the cluster means for the diseases. The term u_i captures random individual differences, while λ_t is a set of time indicators. The parameters of interest are β_k, which captures the within-effect for each of the five diseases over the disease and post-disease periods.

We investigated heterogeneity by including interaction terms in both model specifications for diseases and the variables sex and education. The same estimators and specifications were used in the linear probability models, with a binary indicator of working (no/yes) as the outcome variable.

To assess whether diseases occur suddenly and without anticipation, we estimated a linear trend in individuals' work hours per week in the years leading up to hospitalization and extrapolated it forward. This approach allowed us to analyse whether disease onset was followed by a sharp decline in individuals' work hours. We performed the same analysis for control groups, which consist of individuals who are not hospitalized during the study period. We assigned a placebo for each disease using propensity score matching which result in five control groups. A summary of the propensity score matching results is shown in the Supplementary Material (Table A2:A8).

Next, we explored the assumption that the outcomes of the treatment and control groups follow parallel trends prior to disease onset. We therefore plotted the trajectories in work hours per week

for both groups and compared them. Although the pre-trends may appear visually aligned, there could still be differences in the *levels* of work hours per week. To address this, we performing a two-sample t-test comparing the mean work hours per week prior to hospitalization.

Finally, a concern in previous literature is that the diseases considered may not be exogeneous but rather caused by time-varying shocks affecting both health and labour market participation(21). For instance, an economic downturn might lead to job loss, which could subsequently harm individuals' health. Previous studies have demonstrated that unemployment negatively affects health(24), and that the health status of those who become unemployed is lower than that of those who remain employed(25). However, having annual data on labour market participation and the exact date of hospitalization helps mitigate concerns about underlying secular trends affecting both labour market participation and health simultaneously.

Results

Descriptive statistics

Figure 1 presents the selection procedure, resulting in a sample of 10,307 unique individuals and a balanced panel dataset of 123,684 individual-period observations. In total, 680 unique individuals were hospitalised for either acute heart attack (n=131), stroke (n=71), or cancer (n=478) during the study period between 2007 and 2018.

Table 1 provides descriptive statistics of labour market participation among participants in the year before and the year after hospitalization. These statistics suggest that stroke has a greater short-term effect on labour market participation than acute heart attack, and that labour market participation reduces with cancer severity, both in terms of work hours per week and the proportion of individuals working. Table 1 provides an early indication of the potential results, in terms of the different negative effects from the diseases. Table A2 provides sample characteristics in the year of hospitalization.

Main analyses

Table 2 presents the results of the linear model and the linear probability model.

For all diseases the number of hours worked reduced significantly. Stroke reduces labour market participation more than acute heart attack. For cancer, the decrease in working hours increased with cancer severity. More specifically, following an acute heart attack, individuals worked 1.7 hours less per week, whereas those who suffered a stroke reduced their working hours by 4.2 hours per week. For cancer, the average reduction was 2.4 hours (good survival prognosis), 5.1 hours (intermediate), and 10.9 hours (poor prognosis) per week, respectively.

The results from the linear probability model provide similar results: all diseases reduced the probability of working but to different degrees. On average, an acute heart attack reduced the probability of working by 6 percentage points, while the reduction was 10 percentage points for stroke. Again, the effect of cancer increased with severity: the reduction was 4, 12, and 30 percentage points for the good, intermediate, and poor survival prognoses, respectively.

Table 3 andTable 4 provides heterogeneity analyses by sex and education. The models are organized similarly to Table 2, with additional interaction terms. Main effects (*i.e.* without interaction terms) represent the average within-effects for women. The results for women closely resemble the main results in Table 2; however, an acute heart attack is more detrimental than stroke for women's labour market participation. Meanwhile, the interaction term suggests that the main result for acute heart attack in Table 2 is largely influenced by women. Otherwise, we do not find evidence of heterogeneity by sex for stroke and cancer.

In the linear probability model, all diseases except stroke reduced women's probability of continuing to work. Again, except for acute heart attack, we do not find heterogeneity by sex for stroke and cancer. Men are more likely to work than women following an acute heart attack.

In Table 4 individuals without a university degree are the reference category. All diseases reduced number of hours worked per week for individuals without a university degree. The interaction term suggests that individuals with a university degree experience the largest reduction in hours worked per week following a stroke. In the linear probability model, individuals with a university degree are more likely to continue working following an acute heart attack.

Assessing the identifying assumptions

Figure A2, A3 and Table A9 provides the analyses where we investigated the identifying assumptions. To assess whether disease onset was followed by a sharp decline in work hours per week, we estimated a linear trend by using individuals' work hours per week in the years leading up to disease and then extrapolating it forward. We did the same for the control group that were assigned a placebo hospitalisation. The left column of Figure A2 provides the plots of the extrapolated line for the hospitalized individuals, while the right column provides the plots of the extrapolated lines for the control group.

First, by looking at the left column, we see that following a disease there is a sharp decline in individuals' labour market trajectories. This strongly indicates that individuals did not anticipate the

disease. Meanwhile from the right column, it is evident that the placebos do not impact individuals' labour market trajectory.

Figure A3 provides the trends for the treatment and control groups, grouped by disease type. For acute heart attack and stroke, the slopes appear somewhat similar prior to disease onset. Following onset, a growing disparity in work hours per week emerges between the placebo and treatment groups. The disparity decreases toward the end of the analysis, due to a decreasing trend for the control groups. This is likely because individuals in the control groups are approaching retirement age. However, for cancer, the disparity in work hours per week appear to begin prior to disease onset. Thereafter the disparity also decreases towards the end of the analysis. Hence, this suggest that the parallel trend assumption does not hold for cancer.

Although the pre-trends may appear visually aligned, there could still be differences in the *levels* of work hours per week. Table A9 investigates group differences in hours worked per week prior to a hospitalization for the treatment and the control groups. As expected, for cancer with an intermediate and poor survival prognosis, the results suggest that these groups initially have a lower labour market participation than their control groups. However, the rest of the groups do not statistically differ, suggesting that these groups are comparable prior to hospitalization.

Discussion

This study compares the effect of acute heart attack, stroke, and three levels of cancer severity on individuals' labour market participation, both in terms of hours worked per week and working status (yes/no). We further investigated heterogeneity by sex and education.

Among all diseases, we found that labour market participation was most negatively impacted by cancer with a poor survival prognosis, followed by cancer with an intermediate survival prognosis, stroke, cancer with a good survival prognosis, and then acute heart attack. We found heterogeneity by educational attainment, with stroke decreasing labour market participation more for individuals with a university degree, and acute heart attack decreasing labour market participation more for individuals without a university degree. We also found heterogeneity by sex for acute heart attack.

Our results are broadly in line with a study based on data from sixteen European countries which found that stroke reduced labour market participation more than acute heart attack and cancer(4). However, previous studies have either analysed single types of cancer(10), or collapsed all types of cancer(4, 9, 11, 12), thereby implicitly assuming similar effects on labour market participation across various types of cancer with varying survival prognoses. Our approach of categorising the cancer diagnoses by survival prognosis offers greater transparency into how different *cancer severities* affect

labour market participation. However, cancer itself may not reduce individuals' ability to work, but their ability to survive, which again creates the differential effects from the different types of cancer.

For women, acute heart attack reduced labour market participation more than stroke, which contrasts with previous literature(4). Meanwhile, our results for heterogeneity by sex for cancer are in line with previous literature (9, 11, 26). Previous literature, that found heterogeneity by sex, highlighted the challenge of identifying the drivers of response to a disease. For example, experiencing a disease may alter an individuals' future time horizon, which affects their preference for work and leisure. If preferences between the sexes differ, it could explain the heterogeneity; however, the research on identifying the drivers of response to diseases is scarce (4).

Previous literature argues for the protective role of education in understanding and using health information (13). One could hypothesize that highly educated individuals are more focused on their health and detect signs of cancer earlier, leading to a better prognosis and thereby reducing its impact on labour market participation. Our heterogeneity results for cancer support this theory and is in line with previous research[7,8,(11)].

However, individuals with a university degree who experienced a stroke reduced their labour market participation *more* than those without a university degree. This contrast with the protective effect hypothesis. Another possibility is that higher education could lead to more flexible job opportunities, making it easier to transition to part-time work after a stroke. Alternatively, if highly educated individuals have occupations with cognitively demanding work, strokes may simply have a more detrimental impact within these types of occupations. Previous research on stroke reports mixed results: Some did not find heterogeneity by education(5) while others reported that higher educated individuals are more likely to work after a stroke(4, 6). The policy implications suggest the need for providing more flexible work opportunities that correspond with the capabilities and productivity of individuals who have experienced health shocks with different degrees of severity.

In this paper, we use the event study method. This approach allows us to analyse the effects of diseases across multiple time periods before and after the event. We consider this method more flexible than the difference-in-differences approach, which only compares a single period before the event with a single period after. When exploring the identifying assumption, the results for cancer with intermediate and poor survival prognoses support the existence of anticipation behaviour. This may not come as a surprise, since a cancer diagnosis may not be as acute as stroke or acute heart attack. Since the timing of a cancer diagnosis may not directly affect labour market participation, it raises the question of whether these types of cancer could be detected earlier. For future studies in this field, there is a need to adjust for different severity of cancers.

253 This paper makes several contributions to the literature. First, we compare the differential effects
254 from acute heart attack, stroke, and cancer, thus contributing to the scarce literature on the
255 heterogeneous effects by disease type (4). Second, inspired by previous literature(27), our
256 categorisation of cancer severities within a labour market context is unique and offers new insight
257 into individuals' adjustments to various severities of cancer. Third, we contribute to the limited and
258 conflicting literature regarding the heterogeneity by educational attainment (5, 6, 10). Finally, this is
259 the first study from Norway which offers unique insight into how individuals adjust to diseases in a
260 country with generous social insurance and sickness benefit schemes that support individuals who
261 are unable to work. More research is needed to compare our results with institutional contexts
262 characterized by less generous sickness benefit schemes.

263 We acknowledge that having data only for individuals' *first* hospitalization is a limitation. If
264 individuals experience several hospitalizations during the study period, this may affect the estimates
265 and bias our results. We do not have data on retirement, and if some older individuals use the
266 hospitalization to opt for early retirement, it could bias our results.

267 We did not adjust for self-employed individuals, implying that the working group might be
268 underestimated. Since the hours worked per week variable does not include sick leave, we
269 acknowledge that we may have underestimated the effect of diseases on actual hours worked.
270 Additionally, replacing missing values with zeros could potentially oversimplify the underlying labour
271 dynamics of individuals affected by severe diseases.

272 Another limitation is the absence of information on individuals' wealth, a crucial factor in
273 determining labour supply decisions, particularly after a severe illness and as they near retirement
274 age.

275 Conclusions

276 We demonstrate that a sudden severe disease significantly reduces individuals' labour market
277 participation, whit the extent depending on the disease, its severity, educational attainment, and
278 sex.

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Abbrevations

ICD-10 codes - International Classification of Diseases, 10th version

NPR - Norwegian Patient Register

Declarations

Ethics approval and consent to participate

All methods were carried out in accordance with relevant guidelines and regulations. The study was approved by the regional committee for Medical and Health Research Ethics (ID 2016/607). All participants gave written informed consent before admission.

Consent for publication

Not applicable

Availability of data and materials

Since the data contains potentially identifying or sensitive information about the participants in the Tromsø study, we are not allowed to share a data set. Contact information for the Tromsø study can be found by the following link: https://uit.no/research/tromsostudy/project?pid=709148.

Competing interests

The authors declare that they have no competing interests

Funding

This study is founded by the Norwegian Research Council (Grant Number 273812). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript

Authors' contributions

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Project administration: Jan Abel Olsen.

Supervisions: Jan Abel Olsen, Birgit Abelsen, Nils Gutacker

Writing – original draft: Espen Berthung.

Writing – review & editing, Espen Berthung, Birgit Abelsen, Nils Gutacker, Jan Abel Olsen

Acknowledgements

Not applicable

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Tables and figures

Figure 1. Study sample selection procedure

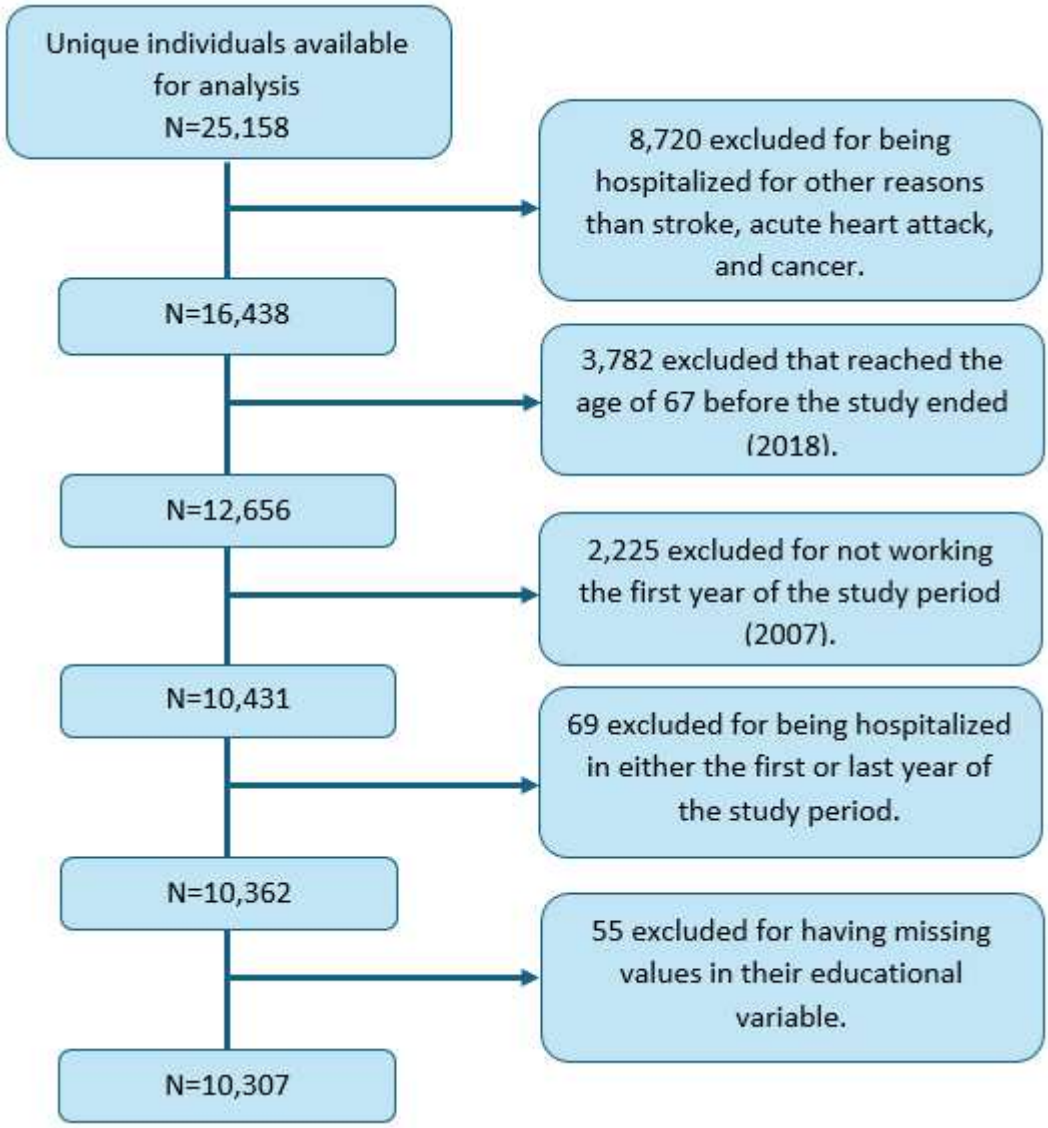


Table 1. Descriptive statistics of labour market participation before and after hospitalization for acute heart attack, stroke, cancer, sex, and education (N=680). Hours worked per week (standard deviation in parentheses) and percentage working.

		One year before hospitalization (t-1)		One year after hospitalization (t+1)		Change in hours worked per week	Change in % working
	N	Hours worked per week	% Working[1]	Hours worked per week	% Working		
Acute heart attack	131	32.3 (11.2)	92.4	30.6 (13.6)	85.5	-5%	-7%
Stroke	71	32.9 (10.5)	94.0	27.1 (15.0)	80.6	-18%	-14%
Cancer, by five-year survival prognosis							
Good prognosis	277	32.1 (11.0)	92.1	28.1 (14.5)	83.8	-12%	-9%
Intermediate prognosis	156	31.8 (11.1)	92.9	25.4 (15.5)	80.8	-20%	-13%
Poor prognosis	45	31.6 (12.6)	88.9	20.6 (18.2)	60.0	-35%	-33%
Sex							
Women	290	30.4 (11.8)	91.4	25.1 (15.2)	80.7	-17%	-12%
Men	390	33.4 (10.4)	93.1	29.0 (14.8)	82.3	-13%	-12%
Education							
No tertiary education	340	31.6 (11.6)	90.9	27.0 (15.2)	81.8	-15%	-10%
Tertiary education	340	32.6 (10.5)	93.8	27.7 (15.0)	81.5	-15%	-13%

[1]The individuals who were not working one year before the hospitalization was working at the beginning of the study period.

Table 2. The effects of acute heart attack, stroke, and cancer on hours worked and the probability of working (no/yes). Linear model (LM) and linear probability model (LP) with correlated random effects (CRE).

	Work hours per week	Working(no/yes)
	LM CRE	LP CRE
Acute heart attack	-1.74**	-0.06**
	(0.78)	(0.02)
Stroke	-4.22***	-0.10***
	(1.29)	(0.04)
Cancer, five-year survival prognosis		
Good survival prognosis	-2.04***	-0.04**
	(0.59)	(0.02)
Intermediate survival prognosis	-5.14***	-0.12***
	(0.92)	(0.02)
Poor survival prognosis	-10.89***	-0.30***
	(1.84)	(0.05)
Men (ref: women)	2.29***	0.01***
	(0.14)	(0.003)
Education (ref: no tertiary education)		
Tertiary education	2.17***	0.03***
	(0.14)	(0.003)
Other control variables		
Age groups with two-year bins	V	V
Cluster mean for age groups, two-year bins	V	V
Cluster mean for diseases	V	V
Year indicators	V	V
Constant	-13.45	1.24
	(43,95)	(0.83)
Number of individuals	10 307	10 307
Observations	123,684	123,684
R^2	0.13	0.13

Note: *p<0.1, **p<0.05, ***p<0.01

The V represents which control variables that are adjusted for in a model.

Clustered standard errors at the individual level are reported in parentheses.

Table 3. Heterogeneity analyses by sex. Linear model (LM) and linear probability model (LP) with correlated random effects (CRE).

	Work hours per week LM CRE	Working(yes) LP CRE
Acute heart attack	-4.24***	-0.17***
	(1.61)	(0.06)
Stroke	-3.09*	-0.04
	(1.63)	(0.04)
Cancer, five-year survival prognosis		
Good survival prognosis	-2.74***	-0.06***
	(0.74)	(0.02)
Intermediate survival prognosis	-4.92***	-0.12***
	(1.23)	(0.03)
Poor survival prognosis	-7.39**	-0.20**
	(3.08)	(0.08)
Interaction terms		
Men * **acute heart attack**	3.01*	0.13***
	(1.83)	(0.07)
Men * **stroke**	-1.63	-0.09
	(2.37)	(0.06)
Cancer, five-year survival rate		
Men * good survival prognosis	1.50	0.05
	(1.20)	(0.03)
Men * intermediate survival prognosis	-0.43	0.01
	(1.83)	(0.05)
Men * poor survival prognosis	-5.51	-0.15
	(3.77)	(0.10)
Men (ref: women)	2.71	0.19
	(7.96)	(0.18)
University degree (ref: no tertiary education)	2.16***	0.03***
	(0.14)	(0.003)
Other control variables		

Age with two-year bins	V	V
Cluster mean for age groups, two-year bins	V	V
Cluster mean for diseases	V	V
Mean interaction terms	V	V
Constant	-11.76	1.15
	(44.34)	(1.84)
Number of individuals	10 307	10 307
Observations	123,684	123,684
R2	0.13	0.13

Note: *p<0.1, **p<0.05, ***p<0.01

The V represents which control variables that are adjusted for in a model.

Clustered standard errors at the individual level are reported in parentheses.

Table 4. Heterogeneity analyses by education. Linear model (LM) and linear probability model (LP) with correlated random effects (CRE).

	Work hours per week	Working (Yes)
	LM CRE	LP CRE
Acute heart attack	-2.26**	-0.09***
	(1.03)	(0.03)
Stroke	-2.11	-0.07
	(1.37)	(0.04)
Cancer, five-year survival prognosis		
Good survival prognosis	-2.90***	-0.05**
	(0.86)	(0.02)
Intermediate survival prognosis	-5.74***	-0.11***
	(1.36)	(0.04)
Poor survival prognosis	-12.93***	-0.36***
	(2.96)	(0.08)
Interaction terms		
Tertiary education * acute heart attack	1.27	0.08*
	(1.56)	(0.04)
Tertiary education * stroke	-5.31*	-0.08
	(2.72)	(0.08)
Cancer, five-year survival rate		
Tertiary education * good survival prognosis	1.60	0.02
	(1.18)	(0.03)
Tertiary education * intermediate survival prognosis	1.17	-0.02
	(1.83)	(0.05)
Tertiary education * poor survival prognosis	3.59	0.11
	(3.71)	(0.10)
Men (ref: women)	2.29***	0.01***
	(0.14)	(0.003)
Tertiary education (ref: no tertiary education)	3.33	0.04
	(6.19)	(0.14)

Other control variables		
Age with two-year bins	V	V
Cluster mean for age groups, two-year bins	V	V
Cluster mean for diseases	V	V
Mean interaction terms	V	V
Constant	-16.27	1.19
	(44.16)	(0.84)
Number of individuals	10 307	10 307
Observations	123,684	123,684
R2	0.13	0.13

Note: *p<0.1, **p<0.05, ***p<0.01

The v represents which control variables that are adjusted for in a model.

Clustered standard errors at the individual level are reported in parentheses.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementarymaterial7.4.2026.docx