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The transition between work, sickness absence and pension in a cohort of Danish colorectal cancer survivors.

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Abstract

Objectives: The aim of this study was to evaluate the impact of socioeconomic and clinical factors on the transitions between work, sickness absence and retirement in a cohort of Danish colorectal cancer survivors.

Design: Register based cohort study with up to 10 years of follow-up.

Setting: Population based study with use of administrative health related and socioeconomic registers.

Participants: All persons (N=4343) diagnosed with colorectal cancer in Denmark in the years 2001-2009 while they were in their working age (18-63 years) and who were part of the labor force one year post diagnosis.

Primary and secondary outcome measures: By use of multi-state models in Cox proportional hazards models we analyzed the hazard ratio for re-employment, sickness absence and retirement in models including clinical as well as health related variables.

Results: One year after diagnosis 62% were working and 58% continued until end of follow-up. Socioeconomic factors were found to be associated with retirement but not with sickness absence and return to work. The risk for transition from work to sickness absence was increased if the disease was diagnosed at a later stage (stage III) 1.52 (95% CI: 1.21-1.91), not operated curatively 1.35 (95% CI: 1.11-1.63) and with occurrence of post-operative complications 1.25 (95% CI: 1.11-1.41). The opposite was found for the transition from sickness absence back to work.

Conclusion: Stage of disease, general health state, post-operative complications and the history of sickness absence and unemployment have an impact on the transition between work, sickness absence and disability pension. This leads to an increased focus on early detection of colorectal cancer, and the importance of avoidance of post-operative complications.

Article summary

Article focus:

- How many colorectal cancer survivors return to work, stay at sickness absence, get unemployed or become pensioners in the years following diagnosis?
- Does socioeconomic position or clinical factors predict re-employment, sickness absence, unemployment or pension in this cohort?

Key messages:

- First study to differentiate between re-employment, sickness absence, unemployment and retirement in a cohort of colorectal cancer survivors.
- One year after diagnosis 62% had resumed work.
- Socioeconomic factors were associated with early retirement whereas clinical factors were found to be associated with sickness absence and re-employment.

Strengths and limitations:

- This is a longitudinal population based study including more than 4000 persons diagnosed with colorectal cancer.
- The study identifies an association between socioeconomic position / clinical factors and re-employment / sickness absence / pension but is not able to identify mechanisms behind.

What is new in this paper:

Very few studies have analyzed the impact colorectal cancer has on the affiliation to the labor market. In this study we are able to identify clinical and socioeconomic risk factors for sickness absence, work resumption and retirement.

1. Introduction

In 2008 nearly 500.000 persons in Europe were diagnosed with colorectal cancer making it the most common cancer and the second most common cause of cancer deaths in Europe [1]. From 1995 to 2007 the survival from colorectal cancer has steadily improved among all age groups [2] and the relative 5-year survival increased in the years 1990 to 2002 from 50% to 60% among persons aged 15 to 59 years [3].

Throughout Europe life expectancy has increased leading to higher age at pension and longer time in the workforce. As the risk of colorectal cancer increases with age, it can be expected that still more persons will be diagnosed with colorectal cancer while they are an active part of the workforce.

Few studies have analyzed the impact of colorectal cancer on work participation in the years following diagnosis and treatment. The existing studies reported that 2/3 of those working at time of diagnosis resume work in the years after treatment. Risk factors for work cessation were high age; radiation therapy and co-morbidity [4;5]. Several studies [6-9] have shown a negative social gradient in survival of colorectal cancer, but the social consequences has not been studied despite the fact that a negative social gradient in return to work has been observed among cancer survivors in general [10-17]. Compared to persons diagnosed with testicular-, breast-, endocrine- or skin cancer patients with colorectal cancer had a higher risk of not resuming work and had longer time on sickness absence [13;18-22].

In order to get a better understanding of the transitions between sickness absence and work it is important to take both socioeconomic and health related factors into account and to look more in depth on the different pathways in and out of the workforce.

By use of detailed, nationwide, population based registers the aim of this study is to evaluate the impact of both socioeconomic and clinical factors on the transitions between work, sickness absence and retirement in a cohort of colorectal cancer survivors.

2. Materials and methods

This study is based on Danish population based registers linked together with the unique personal identification code given to all Danish residents.

Danish Colorectal Cancer Group (DCCG)

The study population was derived from the national database of DCCG which includes around 93% of patients in Denmark with a first-time adenocarcinoma of the rectum (ICD-10: C20) or colon (ICD-C18). This database comprises prospectively collected data registered by surgeons. The database has previously been used in epidemiological studies and is described in details elsewhere [23]. From the database we obtained clinical data with relevance for the probability of returning to work after treatment. Entry into the study was equal to date of surgery and was used to calculate the follow-up time. Variables describing the disease were cancer type and tumor stage classified according to the International Union Against Cancer (UICC). Information about surgical procedure was included as curative operation (yes/no) and type of operation (1=rectal resection, 2=colonic resection, 3=explorative laparotomy or formation of an ostomy, 4=local procedures). Health status at time of surgery was measured by ASA score (according to the American Society of Anesthesiologists) and postoperative complications.

Statistics Denmark

Information on a number of demographic and socioeconomic characteristics was obtained from the population-based Integrated Database for Labour Market Research (IDA), which has been administrated by Statistics Denmark since 1980 [24]. From IDA we had information about country of origin, marital status, education and job type. In order to obtain information on disposal income for the family we also identified partners and their income. Disposal income was calculated as the average of the family income three years before the year of diagnosis and was deflated according to the 2000 value of the Danish kroner.

The Danish National Patient Registry (NPR)

This register holds information on all hospitalizations and outpatient visits in Denmark since 1978. In this study we used information of date of admission and discharge and diagnosis coded according to *the International Classifications of Diseases* (ICD-10) [25].

The Register of Medical Product Statistics (RMPS)

Since 1994 every medical product sold on prescription by Danish pharmacies has been registered. From this register we had information on date for redemption of the prescription and substance classified according to the *anatomical-therapeutic-chemical* (ATC) system [26].

Co-morbidity preceding five years before the year of diagnosis was obtained from NPR and RMPS. The following co-morbidities from the Charlson index were included and dichotomized to yes/no: Cardiovascular disease, chronic obstructive pulmonary disease, diabetes and liver, kidney or connective tissue diseases.

Register based Evaluation of Marginalization (DREAM)

The Danish labor market is characterized as a flexicurity system. Unemployed persons are warranted economic compensation if they are actively seeking job. If a person is unable to work due to illness or disability it is possible to receive sickness benefit or apply for early retirement if needed. The pathways between these different states are shown in figure 1, where the four outcomes represent four different and mutually separated states.

The outcome of the study was receipt of social transfer payments or in work. Information about social transfer payments was obtained from the Danish population based administrative register DREAM. DREAM covers all residents in Denmark who have received social transfer payments from the state [27] in any given week since 1991until week 13 in 2001. In work was defined as not receiving any social transfer payments for six consecutive weeks. Transfer income was divided into sickness benefit, unemployment benefit and permanent withdrawal from the workforce due to disablement.

Study population

The study population comprised 31.570 persons diagnosed with colorectal cancer between 2001 and 2009. Of these, we included 4343 persons aged 18-63 years, who were part of the workforce and survived the first postoperative year (see figure 2) leading to 12.569 person years and minimum 65 weeks of follow-up.

Statistical analysis

The time duration of a given transfer payment was registered from the payment-starting week until the week the payment ended or time was truncated due to end of follow up time. If a person received a transfer payment that did not fit any of the four states (i.e. education) the time was censored but the person was allowed back into the model if he afterwards received a transfer

payment fitting one of the four states. A transition was defined as a shift between any of the four states illustrated in Figure 1. Permanently censoring was used when a person reached the age limit of 63 years, emigrated or died.

Beside the covariates concerning gender, age, etc. each record included three variables that was processed during follow up and was both time and state dependent. Each of the processed time and state dependent covariates did hold the present number of times the person had experienced work, sick-listing or unemployment counted from start of follow up.

A multi-state model was used for analysing the transitions between the four states [28]. Each transition was analysed separately using the Cox proportional hazards model in SAS (The PHREG procedure, SAS version 9.2). The model included both time dependent covariates like gender and time, and independent covariates like number of unemployment periods during the follow up. The duration of weeks a person spended at each state was used as time scale. Because the baseline hazard for each state was allowed to vary freely, the covariate relied on the assumption of proportionality

3. Results

Table 1 shows the baseline characteristics for all patients stratified on those excluded (N=27.227) and the study population (N=4343).The latter was diagnosed with a less severe disease and had a higher SES at time of inclusion than the excluded.

One year after operation 62% of the study population were in work while 32% were sick listed and 6% were unemployed (Table 2). Of those who were working, 58% continued working for an average of 136 weeks.

Table 3 and 4 shows the Hazard Ratio (HR) for transitions between work and sickness absence and reverse. The occupational history was significantly associated with returning to work and sickness absence. Previous periods of sickness absence and unemployment reduced the rate of

returning to work with 7% and 12% per episode, whereas previous episodes of work increased the rate of both work and sickness absence. In addition, we found that increasing levels of education increased the rate of transition from work back to sickness absence.

Return to work after a period of sickness absence (Table 3) was less common among cancer survivors who were operated in an advanced stage of disease, who did not have curative surgery and who suffered postoperative complications.

Sickness absence following a period of work was primarily associated with disease related factors (Table 4). In contrast to return to work, patients diagnosed with rectal cancer had an increased risk for sickness absence (HR=1.17 (1.03-1.32)) compared to those operated for colonic cancer. Furthermore we found that an ASA score on III increased the risk for sickness absence with almost 40%.

The risk factors associated with permanently withdrawal from the labor market one year after operation are shown in Table 5. Since the transition from work and unemployment to retirement follows the same pathways, these groups were joined in order to gain more power. The risk for retirement was not only related to the disease but also to SEP. Manual work and increasing disposal income reduces the risk for retirement after an episode of sickness absence and work, respectively. Compared to patients in work, the HR for retirement was 5.89 (3.46-10.03) among unemployed survivors.

Advanced stage at diagnosis and high ASA score increased the risk for retirement among both groups.

4. Discussion and conclusion

In this cohort study including 4343 Danish colorectal cancer patients, who were part of the workforce after the first postoperative year, we found that 62% were working one year after operation.

One year after operation previous episodes of sickness absence and unemployment, cancer stage at diagnosis, curative operation and post-operative complications were associated with labor market affiliation during follow-up whereas SEP was only weakly associated with the transition between the different occupational states.

The observed rate of return to work is in accordance with previous studies on colorectal cancer survivors, where return to full time employment was reported in 60%-89% dependent on time from diagnosis, definition of return to work and severity of the disease.

In this study we decided only to include survivors, who were still part of the workforce one year after operation, based on a notion that it is not clinical relevant to study full return to work before the end of a one-year survival period. In this selected group of patients the observed resumption of work was rather low compared to previous studies where up to 89% of patients had returned to work at some point after diagnosis [29]. This could be caused by the fact that there is a lack of consensus regarding definition and measurement of return to work. Thus, in some studies return to work is simply the number of persons working at time of follow-up divided by the number working at baseline [10;30]. In other studies return to work is measured among those persons, who are part of the workforce at time of follow-up, and in still other studies working is self-reported and covers from one week to permanently re-employed [29]

The lack of a clear definition can result in misinterpretation of factors related to the disease and SEP since the underlying mechanisms in the transition from sickness absence back to work or to disability pension seems to follow different pathways. Leaving the workforce for any type of pension is an irreversible process and is assigned when work demands exceeds health and mental

resources and is thus dependent on both health and work related factors. On the other hand, unemployment and sickness absence both include conditions with an expectation of resuming work and is more related to either SEP or health, respectively.

The exclusion of persons who take disability pension the first year and the lower social one-year survival after colorectal cancer among socially deprived (23) might explain our finding of no effect of SEP on work and sickness absence one year after diagnosis of colorectal cancer. It seems as a 'healthy worker effect' where the most affluent survive the first year without leaving the workforce for disability pension.

In the present study, the transition between work, sickness absence and disability pension one year after operation was primarily associated with factors related to the cancer disease. The risk for transition from work to sickness absence was increased if the disease was diagnosed at a later stage, not operated curatively and with occurrence of post-operative complications. The opposite was found for the transition from sickness absence back to work. The association between disease related factors and resuming of work after a cancer diagnosis including colorectal cancer has been observed in other studies where tumor stage [13;31], treatment [4;31], physical symptoms [16] and ASA-score were reported to be negatively associated with return to work.

We found that persons diagnosed with rectal cancer had a significant increased risk for sickness absence and retirement possibly due to the fact that this patient group in contrast to colon cancer patients more often will have to learn to take care of an ostomy or suffer from abnormal bowl and urinary function years after the operation [32]. Unfortunately, we could not account for these factors in our analysis.

Strengths and limitations

The present study is based on data from a well-defined clinical database of all Danish colorectal cancer patients. The database has a high completeness and data validity and missing values are random and not associated with the outcome under study whereby selection-bias is removed. Variables regarding socioeconomic position and the affiliation to the labour market are administrative data collected prospectively why recall-bias is eliminated.

This study has, however, some limitations. First of all we were not able to include complementary treatment as chemotherapy and radiation, reduced working hours or job changes in our analysis. Complementary cancer treatment can have a negative effect on the physical and psychological work ability and has been shown to be associated with reductions in work hours and reassignment to other work tasks [11;16;31]. We defined return to work as not receiving any transfer payments for six consecutive weeks. This can lead to misclassification of persons leaving the workforce without receiving economic compensation from the state. This is, however, very seldom in Denmark and can be ignored in this study.

Conclusion

This nationwide study of colorectal cancer patients who have survived one year shows that stage of disease, general health state of the individual, post-operative complications and the history of sickness absence and unemployment have an impact on the transition between work, sickness absence and disability pension. This leads to an increased focus on early detection of colorectal cancer, and the importance of avoidance of post-operative complications. In addition, special attention should be on the more vulnerable persons who have a history of work related problems with episodes outside the working market.

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Author contribution:

Study conception and design: All authors

Acquisition of data: Merete Osler and Kathrine Carlsen

Analysis of data: Kathrine Carlsen

Interpretation of data: All authors

Writing manuscript: All authors

Figure 1: Transition states between labor market outcomes in Denmark. Work, sickness absence and unemployment covers persons in the workforce while retirement independent of reason (disability or age) are an irreversible state, where persons are considered to leave the workforce forever.

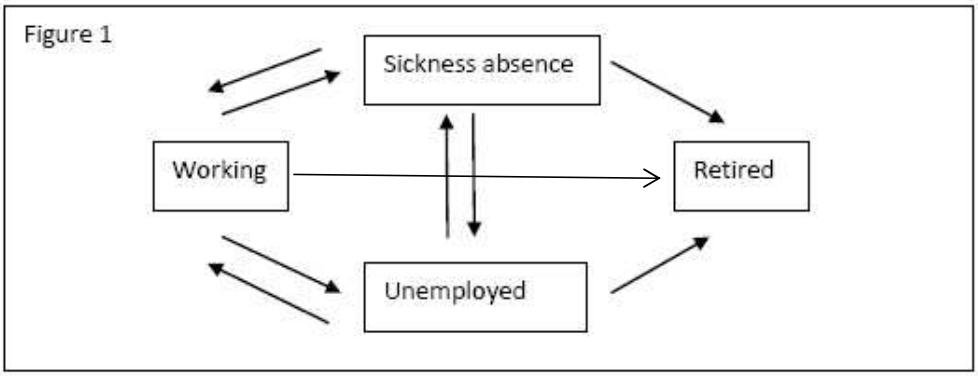
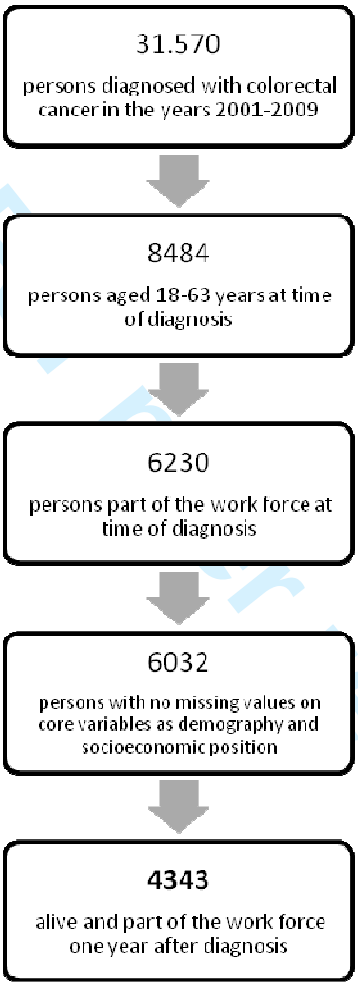


Figure 2: Flowchart showing the selection of persons from the total database to the final study population*.



* From January 2001 to December 2009 a total of 31 570 persons were diagnosed with colonic or rectal cancer. In total we excluded 25 538 persons: 23 086 persons as they were not in their working-age (18-63 years) at time of diagnosis, 2254 had retired due to disability before diagnosis and 198 because of missing values on demographic or socioeconomic variables. In addition, 1689 persons died or withdrew from the workforce within the first year after diagnosis.

Table 1: Characteristics of the colorectal cancer patients diagnosed in Denmark, 2001-2009 (N=31.570).The total population is divided into three groups: A) Excluded due to age, retirement before diagnosis and missing values (N=25.538), B) excluded during the first year due to retirement or death (N=1689) and C) the included persons (N=4343).

	Excluded population N (%)	Excluded during the first year N (%)	Included after the first year N (%)	P
Education				<.0001
Primary school	11 470 (45)	584 (35)	1244 (29)	
Vocational and short education	7576 (30)	781 (46)	2037 (47)	
Medium and long education	2520 (10)	324 (19)	1062 (24)	
Unknown	3972 (15)	0 (0)	0 (0)	
Disposal income (DKr.)				<.0001
Mean	136 134	192 206	210 807	
Job type				<.0001
Management and knowledge work	311 (1)	190 (11)	740 (17)	
Office and sale (non-manual)	722 (3)	401 (24)	1414 (33)	
Manual	21 399 (84)	893 (53)	1661 (38)	
Other	3106 (12)	205 (12)	528 (12)	
Gender				<.0001
Women	12 380 (48)	691 (41)	1913 (44)	
Men	13 158 (52)	998 (59)	2430 (56)	
Age				<.0001
Mean	74.8	56.6	53.8	
Country of birth				<.0001
Denmark	24 648 (97)	1637 (97)	4150 (96)	
Other	890 (3)	52 (3)	193 (4)	
Marital status				<.0001
Married / cohabiting	12 146 (48)	1042 (62)	3162 (73)	
Single	11 655 (46)	494 (29)	1154 (26)	
Unknown	1737 (7)	153 (9)	27 (1)	
Year of operation				0.36
2001	1896 (7)	104 (6)	309 (7)	
2002	2794 (11)	178 (10)	458 (10)	
2003	2754 (11)	176 (10)	439 (10)	
2004	2883 (11)	213 (13)	494 (11)	
2005	2968 (12)	210 (12)	486 (11)	
2006	3064 (12)	199 (12)	568 (13)	
2007	2986 (12)	211 (12)	545 (13)	
2008	3136 (12)	197 (12)	530 (12)	
2009	3057 (12)	201 (12)	514 (12)	
Type of cancer				<.0001
Colonic	16 776 (66)	1063 (63)	2464 (57)	
Rectal	8546 (34)	626 (37)	1879 (43)	
Stage				<.0001
I	8082 (32)	306 (18)	1535 (35)	
II	1052 (4)	43 (3)	146 (3)	
III	6058 (24)	351 (21)	1411 (32)	
IV	6984 (27)	858 (51)	760 (18)	
Unknown	3362 (13)	131 (8)	491 (11)	
Comorbidity				<.0001
No	19 834 (78)	1447 (86)	4018 (93)	
Yes	5704 (22)	224 (14)	325 (7)	
ASA				<.0001
I	3444 (13)	484 (29)	2168 (50)	
II	12 012 (47)	771 (46)	1731 (40)	
->III	7488 (29)	240 (14)	172 (4)	
Unknown	2594 (10)	194 (11)	272 (6)	
Curative operation				<.0001
Yes	15 932 (62)	677 (40)	3278 (75)	
No	7952 (31)	884 (52)	867 (20)	
Unknown	1654 (6)	128 (8)	198 (5)	
Type of operation				<.0001
Rectal resection	2835 (11)	228 (14)	206 (5)	
Colonic resection	4650 (18)	306 (18)	1352 (31)	
Explorative laparotomy or formation of an ostomy	9576 (38)	537 (32)	1445 (33)	
Local procedures	5820 (23)	367 (22)	1197 (28)	
Unknown	2657 (10)	251 (15)	143 (3)	
Post-operative complications				=0.70
No	21 793 (85)	1448 (86)	3689 (85)	
Yes	3745 (15)	241 (14)	654 (15)	

Table 2
Mean number of weeks from one state of employment to the next among 4343 patients aged 18-63 years diagnosed with colorectal cancer in the years 2001 to 2009 and part of the workforce at time of follow-up.

Mean time in weeks from one year after operation and first change in employmental state (% of population)	To work	To sickness absence	To unemploy-ment	To retirement	To censoring due to age, dead, migration or end of follow-up
From work (N=2679 / 62%)	--	57 (31%)	63 (10%)	75 (1%)	136 (58%)
From sickness absence (N=1406 / 32%)	16 (34%)	--	29 (9%)	30 (28%)	36 (30%)
From unemployment (N=258/ 6%)	22 (47%)	28 (17%)	--	63 (13%)	77 (23%)

Table 3: HR (95% CI) for return to Work after sickness absence in relation to socioeconomic and clinical factors among 4343 patients aged 18-63 diagnosed with colorectal cancer in the years 2001 to 2009, and part of the work force at time of follow-up.

SICKNESS ABSENCE → WORK	HR – unadjusted (events: 2125)	HR - ajusted for SES	HR - adjusted for SES and confounders*	HR - adjusted for SES, confounders and clinical variables
Education				
Primary school	1	1	1	1
Vocational and short education	0.87 (0.76-0.98)	0.91 (0.79-1.05)	0.91 (0.78-1.04)	0.92 (0.79-1.06)
Medium and long education	1.01 (0.91-1.13)	1.09 (0.96-1.24)	1.08 (0.95-1.23)	1.06 (0.93-1.21)
Disposal income #				
Lowest quartile	1	1	1	1
Second lowest quartile	1.11 (0.97-1.26)	1.03 (0.90-1.17)	1.01 (0.88-1.15)	1.07 (0.94-1.22)
Second highest quartile	1.27 (1.12-1.44)*	1.14 (1.00-1.29)	1.12 (0.98-1.27)	1.15 (1.00-1.31)
Highest quartile	1.25 (1.10-1.42)*	1.15 (1.00-1.33)	1.14 (0.99-1.3 2)	1.16 (1.00-1.34)
Job type				
Management and knowledge work	1.18 (0.95-1.22)	1.10 (0.90-1.28)	1.10 (0.94-1.28)	1.11 (0.95-1.30)
Office and sale (non-manual)	1.07 (0.97-1.17)	1.07 (0.97-1.19)	1.09 (0.98-1.22)	1.10 (0.99-1.23)
Manual	1	1	1	1
Other	0.71 (0.58-0.87)	0.71 (0.57-0.86)*	1.17 (0.50-2.29)	0.88 (0.37-1.73)
Previous periodsof work	1.01 (1.01-1.02)*	1.13 (1.11-1.16)**	1.13 (1.11-1.16)**	1.13 (1.11-1.16)**
Previous periods of sickness absence	1.05 (1.04-1.05)**	0.94 (0.92-0.96)**	0.94 (0.92-0.96)**	0.93 (0.91-0.95)**
Previous periods of unemployment	0.98 (0.98-0.99)*	0.89 (0.87-0.91)**	0.89 (0.87-0.91)**	0.88 (0.87-0.90)**
Type of cancer				
Colonic	1			1
Rectal	1.01 (0.93-1.10)			0.96 (0.84-1.08)
Stage				
I	1			1
II	0.73 (0.56-0.94)*			0.82 (0.62-1.06)
III	0.76 (0.69-0.84)**			0.74 (0.66-0.82)**
IV	0.36 (0.31-0.41)**			0.53 (0.41-0.68)**
Unknown	1.14 (1.00-1.30)			1.15 (0.96-1.39)
Comorbidity				
No	1			1
Yes	0.81 (0.73-0.89)*			0.90 (0.82-1.00)
ASA				
I	1			1
II	0.84 (0.77-0.92)*			0.93 (0.85-1.03)
>III	0.67 (0.52-0.84)*			0.85 (0.65-1.07)
Unknown	0.89 (0.73-1.06)			1.07 (0.79-1.41)
Curative l operation				
Yes	1			1
No	0.43 (0.38-0.49)**			0.69 (0.55-0.86)*
Unknown	0.83 (0.68-1.02)			0.90 (0.62-1.26)
Type of operation				
Rectal resection	1			1
Colonic resection	0.95 (0.85-1.05)			0.95 (0.83-1.09)
Explorative laparotomy or formation of an ostomy	0.99 (0.89-1.10)			1.06 (0.91-1.23)
Local procedures	0.65 (0.50-0.83)*			0.76 (0.57-1.00)*
Unknown	0.33 (0.22-0.48)**			0.48 (0.30-0.75)*
Post-operative complications				
No	1			1
Yes	0.84 (0.74-0.94)*			0.82 (0.72-0.92)*

*Confounders: Gender, age at time of diagnosis, country of birth, marital status and year of operation

Depending on year the highest disposal income ranged from 175.500 DKr in 2001 to 299.717 DKr in 2009

Table 4: HR (95% CI) for sickness absence after an episode of work in relation to socioeconomic and clinical factors among 4343 patients aged 18-63 diagnosed with colorectal cancer in the years 2001 to 2009, and part of the work force at time of follow-up.

WORK → SICKNESS ABSENCE	HR - unadjusted (events: 2296)	HR - ajusted for SES	HR - adjusted for SES and confounders*	HR - adjusted for SES, confounders* and clinical variables
Education				
Primary school	1	1	1	1
Vocational and short education	1.25 (1.11-1.41)*	1.10 (0.96-1.27)	1.10 (0.96-1.27)	1.07 (0.93-1.23)
Medium and long education	1.40 (1.26-1.56)**	1.22 (1.08-1.38)*	1.21 (1.07-1.37)*	1.18 (1.04-1.34)*
Disposal income #				
Lowest quartile	1	1	1	1
Second lowest quartile	1.18 (1.04-1.33)	1.18 (1.05-1.34)*	1.17 (1.03-1.33)	1.13 (0.99-1.28)
Second highest quartile	1.02 (0.91-1.16)	1.04 (0.92-1.18)	1.02 (0.90-1.16)	1.00 (0.88-1.14)
Highest quartile	0.82 (0.73-0.94)*	0.99 (0.87-1.14)	0.99 (0.86-1.14)	0.96 (0.84-1.11)
Job type				
Management and knowledge	0.69 (0.61-0.78)**	0.96 (0.83-1.12)	0.97 (0.84-1.14)	0.95 (0.82-1.11)
work	0.89 (0.82-0.98)	1.00 (0.91-1.10)	1.00 (0.91-1.12)	1.00 (0.90-1.11)
Office and sale (non-manual)	1	1	1	1
Manual	0.67 (0.54-0.83)*	0.84 (0.67-1.04)	1.00 (0.48-1.82)	1.06 (0.51-1.93)
Other				
Previous episodes of work	1.03 (1.03-1.03)**	1.02 (1.01-1.04)*	1.02 (1.01-1.04)*	1.03 (1.01-1.04)*
Previous episodes of sickness absence	1.10 (1.09-1.11)**	1.08 (1.06-1.09)**	1.08 (1.06-1.09)**	1.08 (1.06-1.09)**
Previous episodes of unemployment	1.01 (1.01-1.02)*	0.98 (0.97-0.99)*	0.98 (0.97-0.99)*	0.98 (0.97-0.99)*
Type of cancer				
Colonic	1			1
Rectal	1.10 (1.01-1.19)			1.17 (1.03-1.32)*
Stage				
I	1			1
II	0.97(0.74-1.25)			0.99(0.75-1.28)
III	1.29 (1.16-1.41)*			1.24 (1.11-1.37)*
IV	1.63 (1.40-1.88)**			1.52 (1.21-1.91)*
Unknown	1.11 (0.98-1.25)			1.08 (0.91-1.29)
Co-morbidity				
No	1			1
Yes	0.99 (0.90-1.08)			1.05 (0.96-1.16)
ASA				
I	1			1
II	1.09 (1.00-1.19)			1.09 (0.99-1.20)
->III	1.42 (1.12-1.75)*			1.33 (1.05-1.67)*
Unknown	1.02 (0.85-1.21)			0.92 (0.70-1.19)
Curative operation				
Yes	1			1
No	1.43 (1.26-1.61)**			1.35 (1.11-1.63)*
Unknown	1.05 (0.87-1.29)			1.07 (0.77-1.45)
Type of operation				
Rectal resection	1			1
Colonic resection	1.0 (0.91-1.11)			1.10 (0.97-1.25)
Explorative laparotomy or formation of an ostomy	0.91 (0.82-1.01)			1.05 (0.91-1.22)
Local procedures	0.72 (0.56-0.91)*			0.78 (0.60-1.01)
Unknown	0.93 (0.66-1.26)			0.81 (0.53-1.20)
Post-operative complications				
No	1			1
Yes	1.18 (1.05-1.31)*			1.25 (1.11-1.41)*

*Confounders: Gender, age at time of diagnosis, country of birth, marital status and year of operation

Depending on year the highest disposal income ranged from 175.500 DKr in 2001 to 299.717 DKr in 2009

Table 5: HR (95% CI) for retirement in relation to socioeconomic and clinical factors among 4343 patients aged 18-63 diagnosed with colorectal cancer in the years 2001 to 2009, and part of the work force at time of follow-up.

Mutually adjusted and controlled for confounders*	HR for transition from sickness absence -> retirement (number of events:569)	HR for transition from work / unemployed -> retirement (number of events: 109)
Status		
Working	---	1
Unemployed		5.89 (3.46-10.03)**
Education		
Primary school	1	1
Vocational and short education	1.13 (0.85-1.51)	1.29 (0.65-2.69)
Medium and long education	1.06 (0.81-1.41)	1.24 (0.64-2.53)
Disposal income #		
Lowest quartile	1	1
Second lowest quartile	0.95 (0.76-1.19)	0.49 (0.27-0.85)*
Second highest quartile	0.77 (0.60-0.98)*	0.47 (0.25-0.83)*
Highest quartile	0.79 (0.60-1.04)	0.29 (0.14-0.57)*
Job type		
Management and knowledge work	0.59 (0.42-0.82)*	0.93 (0.85-1.03)
Office and sale (non-manual)	0.72 (0.580.89)*	0.96 (0.86-1.06)
Manual	1	1
Other	1.05 (0.06-4.85)	0.38 (0.12-1.37)
Previous episodes of work	0.98 (0.95-1.00)	0.93 (0.85-1.03)
Previous episodes of sickness absence	1.00 (0.97-1.02)	0.96 (0.86-1.06)
Previous episodes of unemployment	1.03 (1.00-1.05)*	1.02 (0.94-1.11)
Type of cancer		
Colonic	1	1
Rectal	1.32 (1.04-1.67)*	1.33 (0.75-2.34)
Stage		
I	1	1
II	0.85 (0.46-1.46)	1.70 (0.49-4.51)
III	1.13 (0.89-1.44)	1.91 (1.15-3.21)*
IV	1.58 (1.04-2.42)*	2.30 (0.88-6.14)
Unknown	1.01 (0.68-1.50)	1.72 (0.82-3.59)
Comorbidity		
No	1	1
Yes	1.03 (0.85-1.24)	1.17 (0.76-1.77)
ASA		
I	1	1
II	1.31 (1.08-1.58)*	1.56 (1.00-2.44)*
III	2.16 (1.49-3.06)*	2.57 (1.03-5.75)*
Unknown	1.29 (0.76-2.09)	1.64 (0.50-4.24)
Curative operation		
Yes	1	1
No	1.30 (0.89-1.86)	1.80 (0.77-3.84)
Unknown	1.41 (0.75-2.51)	1.05 (0.19-4.01)
Type of operation		
Rectal resection	1	1
Colonic resection	1.42 (1.11-1.81)*	1.36 (0.74-2.51)
Explorative laparotomy or formation of an ostomy	1.06 (0.78-1.43)	1.23 (0.55-2.32)
Local procedures	1.01 (0.53-1.84)	0.39 (0.08-1.26)
Unknown	1.45 (0.93-2.18)	0.84 (0.16-3.13)
Post-operative complications		
No	1	1
Yes	1.23 (1.00-1.51)*	0.86 (0.47-1.46)

*Confounders: Gender, age at time of diagnosis, country of birth, marital status and year of operation

Depending on year the highest disposal income ranged from 175.500 DKr in 2001 to 299.717 DKr in 2009

Reference List

(1) Ferlay J, Parkin DM, Steliarova-Foucher E. Estimates of cancer incidence and mortality in Europe in 2008. *Eur J Cancer* 2010; 46(4):765-781.

(2) Coleman MP, Forman D, Bryant H, Butler J, Rachet B, Maringe C et al. Cancer survival in Australia, Canada, Denmark, Norway, Sweden, and the UK, 1995-2007 (the International Cancer Benchmarking Partnership): an analysis of population-based cancer registry data. *Lancet* 2011; 377(9760):127-138.

(3) Brenner H, Bouvier AM, Foschi R, Hackl M, Larsen IK, Lemmens V et al. Progress in colorectal cancer survival in Europe from the late 1980s to the early 21st century: The EUROCARE study. *Int J Cancer* 2011.

(4) Gordon L, Lynch BM, Newman B. Transitions in work participation after a diagnosis of colorectal cancer. *Aust N Z J Public Health* 2008; 32(6):569-574.

(5) van den Brink M, van den Hout WB, Kievit J, Marijnen CA, Putter H, van de Velde CJ et al. The impact of diagnosis and treatment of rectal cancer on paid and unpaid labor. *Dis Colon Rectum* 2005; 48(10):1875-1882.

(6) Frederiksen BL, Osler M, Harling H, Ladelund S, Jorgensen T. The impact of socioeconomic factors on 30-day mortality following elective colorectal cancer surgery: a nationwide study. *Eur J Cancer* 2009; 45(7):1248-1256.

(7) Cavalli-Bjorkman N, Lambe M, Eaker S, Sandin F, Glimelius B. Differences according to educational level in the management and survival of colorectal cancer in Sweden. *Eur J Cancer* 2011; 47(9):1398-1406.

(8) Egeberg R, Halkjaer J, Rottmann N, Hansen L, Holten I. Social inequality and incidence of and survival from cancers of the colon and rectum in a population-based study in Denmark, 1994-2003. *Eur J Cancer* 2008; 44(14):1978-1988.

(9) Aarts MJ, Lemmens VEPP, Louwman MWJ, Kunst AE, Coebergh JW. Socioeconomic status and changing inequalities in colorectal cancer? A review of the associations with risk, treatment and outcome. *European Journal of Cancer* 2010; 46(15):2681-2695.

(10) Drolet M, Maunsell E, Brisson J, Brisson C, Masse B, Deschenes L. Not Working 3 Years After Breast Cancer: Predictors in a Population-Based Study. *J Clin Oncol* 2005; 23(33):8305-8312.

(11) Steiner JF, Cavender TA, Nowels CT, Beaty BL, Bradley CJ, Fairclough DL et al. The impact of physical and psychosocial factors on work characteristics after cancer. *Psychooncology* 2008; 17(2):138-147.

(12) Paraponaris A, Teyssier LS, Ventelou B. Job tenure and self-reported workplace discrimination for cancer survivors 2 years after diagnosis: does employment legislation matter? *Health Policy* 2010; 98(2-3):144-155.

(13) Earle CC, Chretien Y, Morris C, Ayanian JZ, Keating NL, Polgreen LA et al. Employment among survivors of lung cancer and colorectal cancer. *J Clin Oncol* 2010; 28(10):1700-1705.

(14) Spelten ER, Sprangers MA, Verbeek JH. Factors reported to influence the return to work of cancer survivors: a literature review
1. *Psychooncology* 2002; 11(2):124-131.

(15) Short PF, Vasey JJ, Tunceli K. Employment pathways in a large cohort of adult cancer survivors. *Cancer* 2005; 103(6):1292-1301.

(16) Mehnert A. Employment and work-related issues in cancer survivors. *Crit Rev Oncol Hematol* 2011; 77(2):109-130.

(17) Dalton SO, Steding-Jessen M, Gislum M, Frederiksen K, Engholm G, Schüz J. Social inequality and incidence and survival of cancer in a population based study in Denmark, 1994-2003: Aims, background and methods. *Eur J Cancer* 2008; x:xx.

(18) Amir Z, Moran T, Walsh L, Iddenden R, Luker K. Return to paid work after cancer: a British experience. *J Cancer Surviv* 2007; 1(2):129-136.

(19) Carlsen K, Dalton SO, Frederiksen K, Diderichsen F, Johansen C. Cancer and the risk for taking early retirement pension:
A Danish cohort study. *Scandinavian Journal of Public Health* 2008; 36(2):117-125.

(20) Mols F, Thong MS, Vissers P, Nijsten T, van de Poll-Franse LV. Socio-economic implications of cancer survivorship: Results from the PROFILES registry. *Eur J Cancer* 2011.

(21) Sjovall K, Attner B, Englund M, Lithman T, Noreen D, Gunnars B et al. Sickness absence among cancer patients in the pre-diagnostic and the post-diagnostic phases of five common forms of cancer. *Support Care Cancer* 2012; 20(4):741-747.

(22) Syse A, Tretli S, Kravdal O. Cancer's impact on employment and earnings--a population-based study from Norway. *J Cancer Surviv* 2008; 2(3):149-158.

(23) Frederiksen BL, Osler M, Harling H, Ladelund S, Jorgensen T. Do patient characteristics, disease, or treatment explain social inequality in survival from colorectal cancer? *Soc Sci Med* 2009; 69(7):1107-1115.

(24) Statistics Denmark. IDA - an integrated data base for labour market research. Main report, 1991 . 2006.
Ref Type: Generic

(25) Lynge E, Sandegaard JL, Rebolj M. The Danish National Patient Register. *Scand J Public Health* 2011; 39(7 Suppl):30-33.

(26) Kildemoes HW, Sorensen HT, Hallas J. The Danish National Prescription Registry. *Scand J Public Health* 2011; 39(7 Suppl):38-41.

(27) Hjollund NH, Larsen FB, Andersen JH. Register-based follow-up of social benefits and other transfer payments: accuracy and degree of completeness in a Danish interdepartmental administrative database compared with a population-based survey. *Scand J Public Health* 2007; 35(5):497-502.

(28) Pedersen J, Bjorner JB, Burr H, Christensen KB. Transitions between sickness absence, work, unemployment, and disability in Denmark 2004-2008. *Scand J Work Environ Health* 2012.

(29) Sanchez KM, Richardson JL, Mason HR. The return to work experiences of colorectal cancer survivors. *AAOHN J* 2004; 52(12):500-510.

(30) Taskila T, Martikainen R, Hietanen P, Lindbohm ML. Comparative study of work ability between cancer survivors and their referents. *Eur J Cancer* 2007; 43(5):914-920.

(31) Mols F, Thong MS, Vreugdenhil G, van de Poll-Franse LV. Long-term cancer survivors experience work changes after diagnosis: results of a population-based study. *Psychooncology* 2009; 18(12):1252-1260.

(32) Rodriguez-Bigas MA, Chang GJ, Skibber JM. Barriers to rehabilitation of colorectal cancer patients. *J Surg Oncol* 2007; 95(5):400-408.

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The transition between work, sickness absence and pension in a cohort of Danish colorectal cancer survivors.

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Abstract

Objectives: The aim of this study was to evaluate the impact of socioeconomic and clinical factors on the transitions between work, sickness absence and retirement in a cohort of Danish colorectal cancer survivors.

Design: Register based cohort study with up to 10 years of follow-up.

Setting: Population based study with use of administrative health related and socioeconomic registers.

Participants: All persons (N=4343) diagnosed with colorectal cancer in Denmark in the years 2001-2009 while they were in their working age (18-63 years) and who were part of the labor force one year post diagnosis.

Primary and secondary outcome measures: By use of multi-state models in Cox proportional hazards models we analyzed the hazard ratio for re-employment, sickness absence and retirement in models including clinical as well as health related variables.

Results: One year after diagnosis 62% were working and 58% continued until end of follow-up. Socioeconomic factors were found to be associated with retirement but not with sickness absence and return to work. The risk for transition from work to sickness absence was increased if the disease was diagnosed at a later stage (stage III) 1.52 (95% CI: 1.21-1.91), not operated curatively 1.35 (95% CI: 1.11-1.63) and with occurrence of post-operative complications 1.25 (95% CI: 1.11-1.41). The opposite was found for the transition from sickness absence back to work.

Conclusion: This nationwide study of colorectal cancer patients who have survived one year shows that stage of disease, general health state of the individual, post-operative complications and the history of sickness absence and unemployment have an impact on the transition between work, sickness absence and disability pension. This leads to an increased focus on the rehabilitation process for the more vulnerable persons who have a combination of severe disease and a history of work related problems with episodes outside the working market.

Article summary

Article focus:

- How many colorectal cancer survivors return to work, stay at sickness absence, get unemployed or become pensioners in the years following diagnosis?
- Does socioeconomic position or clinical factors predict re-employment, sickness absence, unemployment or pension in this cohort?

Key messages:

- First study to differentiate between re-employment, sickness absence, unemployment and retirement in a cohort of colorectal cancer survivors.
- One year after diagnosis 62% had resumed work.
- Socioeconomic factors were associated with early retirement whereas clinical factors were found to be associated with sickness absence and re-employment.

Strengths and limitations:

- This is a longitudinal nationwide population based study including more than 4000 persons diagnosed with colorectal cancer.
- The study identifies an association between socioeconomic position / clinical factors and re-employment / sickness absence / pension but is not able to identify mechanisms behind.

What is new in this paper:

Very few studies have analyzed the impact colorectal cancer has on the affiliation to the labor market. In this study we are able to identify clinical and socioeconomic risk factors for sickness absence, work resumption and retirement.

1. Introduction

In 2008 nearly 500.000 persons in Europe were diagnosed with colorectal cancer making it the most common cancer and the second most common cause of cancer deaths in Europe [1]. From 1995 to 2007 the survival from colorectal cancer has steadily improved among all age groups [2] and the relative 5-year survival increased in the years 1990 to 2002 from 50% to 60% among persons aged 15 to 59 years[3].

Throughout Europe life expectancy has increased leading to higher age at pension and longer time in the workforce. As the risk of colorectal cancer increases with age, it can be expected that still more persons will be diagnosed with colorectal cancer while they are an active part of the workforce.

Few studies have analyzed the impact of colorectal cancer on work participation in the years following diagnosis and treatment. The existing studies reported that 2/3 of those working at time of diagnosis resume work in the years after treatment. Risk factors for work cessation were high age; radiation therapy and co-morbidity [4;5]. Several studies [6-9] have shown a negative social gradient in survival of colorectal cancer, but the social consequences has not been studied despite the fact that a negative social gradient in return to work has been observed among cancer survivors in general [10-17]. Compared to persons diagnosed with testicular-, breast-, endocrine- or skin cancer patients with colorectal cancer had a higher risk of not resuming work and had longer time on sickness absence [13;18-22].

In order to get a better understanding of the occupational consequences of colorectal cancer it is important to take both socioeconomic and health related factors into account and to differentiate more specifically between the different reasons for not working. In the majority of studies the outcome is ‘not returning to work’ which is a mix-up of different reasons for not working, i.e.

unemployment, sickness absence or disability pension and the transition from a cancer diagnosis to one of these outcomes could very well differ according to different risk factors.

These transitions between different states (e.g. from sickness absence to work, or from sickness absence to disability) can be modeled by using multi-state models[23]. Multi-state models are well-known statistical models used for event history analysis, e.g. the study of survival. The application of statistical models for survival analysis in the analysis of sickness absence is relatively new[24;25] and the use of multi-state models is mainly due to Lie et al[26] , but multi-state models have also been applied by other researchers[27;28].

By use of detailed, nationwide, population based registers the aim of this study is to evaluate the impact of both socioeconomic and clinical factors on the transitions between work, sickness absence and retirement in a cohort of colorectal cancer survivors and to test for interaction between clinical and socioeconomic factors.

2. Materials and methods

This study is based on Danish population based registers linked together with the unique personal identification code given to all Danish residents.

Danish Colorectal Cancer Group (DCCG)

The study population was derived from the national database of DCCG which includes around 93% of patients in Denmark with a first-time adenocarcinoma of the rectum (ICD-10: C20) or colon (ICD-C18). This database comprises prospectively collected data registered by surgeons. The database has previously been used in epidemiological studies and is described in details elsewhere [29]. From the database we obtained clinical data with relevance for the probability of returning to work after treatment. Entry into the study was equal to date of surgery and was used to calculate the

follow-up time. Variables describing the disease were cancer type and tumor stage classified according to the International Union Against Cancer (UICC). Information about surgical procedure was included as curative operation (yes/no) and type of operation (1=rectal resection, 2=colonic resection, 3=explorative laparotomy or formation of an ostomy, 4=local procedures). Health status at time of surgery was measured by ASA score (according to the American Society of Anesthesiologists) where patients are categorized into five subgroups by preoperative physical fitness reaching from I - A completely healthy patient to V - A moribund patient who is not expected to live 24 hours with or without surgery. ASA score III-V was collapsed into one group of patients with severe systemic diseases. Postoperative complications were grouped as no complications or one or more complications. The latter group included postoperative bleeding, problems with the ostomy, intra-abdominal infections or infections in the wound, lack of passage through the intestine, leak from the intestine or postoperative rupture of the wound.

Statistics Denmark

Information on a number of demographic and socioeconomic characteristics was obtained from the population-based Integrated Database for Labour Market Research (IDA), which has been administrated by Statistics Denmark since 1980[30]. From IDA we had information about country of origin (grouped as born in Denmark or born outside Denmark) and marital status (married or cohabiting, single including widows and unknown). Education was classified according to length of study (primary school 9-12 years of education, vocational and short education 13-15 years, medium and long education more than 16 years and unknown). Job type was classified as management and knowledge work (e.g. leaders, doctors and teachers at high school), office and sale (e.g. secretary, police and nurses) and manual work (e.g. farmers, craftsmen and social and health care assistants). In order to obtain information on disposal income for the family we also identified partners and

their income. Disposal income was calculated as the average of the family income three years before the year of diagnosis and was deflated according to the 2000 value of the Danish kroner. Education, job type and disposal income were combined under the heading socioeconomic status (SES).

The Danish National Patient Registry (NPR)

This register holds information on all hospitalizations and outpatient visits in Denmark since 1978. In this study we used information of date of admission and discharge and diagnosis coded according to *the International Classifications of Diseases* (ICD-10) [31].

The Register of Medical Product Statistics (RMPS)

Since 1995 every medical product sold on prescription by Danish pharmacies has been registered. From this register we had information on date for redemption of the prescription and substance classified according to the *anatomical-therapeutic-chemical* (ATC) system [32].

Co-morbidity preceding five years before the year of diagnosis was obtained from NPR and RMPS. As comorbidity we included cardiovascular disease, chronic obstructive pulmonary disease, diabetes and liver, kidney or connective tissue diseases – diseases which are all part of the Charlson index. Comorbidity was stated if one or more of these diseases were present at time of diagnosis.

Register based Evaluation of Marginalization (DREAM)

The Danish labor market is characterized as a flexicurity system with a high degree of economic compensation in case of unemployment or reduced work ability (security) but also with a high turnover rate (flexible). Unemployed persons are warranted economic compensation if they are

actively seeking job. During the study period it was possible to receive a maximum of four years of unemployment benefit. After the end of these four years or if a person is not qualified for unemployment benefit (i.e. not member of a union) it is possible to receive social income. If a person is unable to work due to illness or disability it is possible to receive sickness benefit for a maximum of 52 weeks during a period of two years or apply for early retirement if the work ability is reduced to a level where it is not possible to hold a job. This holds for all Danish citizens independent of job type. During the study period the retirement age was 64 years of age.

The outcome of the study was receipt of social transfer payments or in work. Information about social transfer payments was obtained from the Danish population based administrative register DREAM. DREAM covers all residents in Denmark who have received social transfer payments from the state [33] in any given week since 1991. In the present study we included data from DREAM from week 1 in 2001 until week 13 in 2011. In work was defined as not receiving any social transfer payments for six consecutive weeks. Transfer income obtained from DREAM was divided into sickness benefit, unemployment benefit and permanent withdrawal from the workforce due to early retirement pension or post-employment benefit, which is an optional withdraw from the workforce not caused by disability.

Study population

In the years 2001 to 2009 31.570 persons were diagnosed with colorectal cancer in Denmark. The majority of these persons were diagnosed after the age of retirement and the study population consists of 4.343 persons aged 18-63 years, who were part of the workforce and survived the first postoperative year (fig. 2). The follow-up period of this population was between 65 weeks (for persons diagnosed in the last week of 2009) to 535 week (for persons diagnosed in the first week of 2001) leading to 12.569 person years.

Outcome data

For every person in the study population labour market status was recorded on a weekly basis until the person reached the age limit of 63 years, emigrated, died, or until the end of follow-up whichever came first. Labour market status was categorized in four different 'states': work, sickness absence, unemployment, and disability. The multi-state model is a model for the nine possible transitions between these four states (Figure 1).

Statistical analysis

Descriptive analysis by use of chi^2 and t-tests was conducted in order to examine the characteristics of the sample. The outcome data was recoded and for each person time spent in one of the four states was registered. Furthermore it was registered if a transition to another state occurred at the end of the persons stay in the state, and, if so, what state the person shifted to. The time spent in the state was censored if the person died, emigrated, or shifted to a social transfer payment that did not fit any of the four states.

Each of the nine possible transitions shown in Figure 1 was analysed using the Cox proportional hazards model in SAS (The PHREG procedure, SAS version 9.2). The time scale used was duration of stay in current state.

The variables education, disposal income, job type, type of cancer, cancer stage, comorbidity, ASA score, curative operation, type of operation, post-operative complications were included as time constant covariates. Three time dependent covariates were also included: number of times the person been employed, had been sick-listed, or unemployment since the start of follow up.

Because the baseline hazard for each state was allowed to vary freely, the covariate relied on the assumption of proportionality.

3. Results

Table 1 shows the baseline characteristics for all patients stratified on those excluded during the first year after diagnosis (N=1689) and the study population (N=4343). Compared to the excluded population the study population was diagnosed with significantly less severe disease and higher SES at time of inclusion.

One year after operation 62% of the study population were in work while 32% were sick listed and 6% were unemployed (Table 2). Of those who were working, 58% continued working for an average of 136 weeks.

Table 3 and 4 shows the Hazard Ratio (HR) for transitions between work and sickness absence and reverse. Previous periods of sickness absence and unemployment reduced the rate of returning to work with 7% and 12% per episode, whereas previous episodes of work increased the rate of both work and sickness absence. In addition, we found that increasing levels of education increased the rate of transition from work back to sickness absence.

Return to work after a period of sickness absence (Table 3) was less common among cancer survivors who were operated in an advanced stage of disease, who did not have curative surgery and who suffered postoperative complications.

Sickness absence following a period of work was primarily associated with disease related factors (Table 4). In contrast to return to work, patients diagnosed with rectal cancer had an increased risk for sickness absence (HR=1.17 (1.03-1.32)) compared to those operated for colonic cancer. Furthermore we found that an ASA score on III increased the risk for sickness absence with almost 40%.

The risk factors associated with permanently withdrawal from the labor market one year after operation are shown in Table 5. Since the transition from work and unemployment to retirement follows the same pathways, these groups were joined in order to gain more power. The risk for retirement was not only related to the disease but also to SES. Manual work and increasing disposal income reduces the risk for retirement after an episode of sickness absence and work, respectively. Compared to patients in work, the HR for retirement was 5.89 (3.46-10.03) among unemployed survivors.

Advanced stage at diagnosis and high ASA score increased the risk for retirement among both groups.

Finally, we analyzed for effect modification by adding an interaction in the logistic model between disposal income as the strongest socioeconomic predictor and type of cancer, stage of disease, type of operation and post-operative complications. We did not find any significant effect modification between socioeconomic factors and disease related factors (Data not shown).

4. Discussion and conclusion

In this cohort study including 4343 Danish colorectal cancer patients, who were part of the workforce after the first postoperative year, we found that 62% were working one year after operation.

One year after operation previous episodes of sickness absence and unemployment, cancer stage at diagnosis, curative operation and post-operative complications were associated with labor market affiliation during follow-up whereas SES was only weakly associated with the transition between the different occupational states.

The observed rate of return to work is in accordance with previous studies on colorectal cancer survivors, where return to full time employment was reported in 60%-89% dependent on time from diagnosis, definition of return to work and severity of the disease.

In this study we decided only to include survivors, who were still part of the workforce one year after operation, based on a notion that it is not clinical relevant to study full return to work before the end of a one-year survival period. In this selected group of patients the observed resumption of work was rather low compared to previous studies where up to 89% of patients had returned to work at some point after diagnosis [34]. This could be caused by the fact that there is a lack of consensus regarding definition and measurement of return to work. Thus, in some studies return to work is simply the number of persons working at time of follow-up divided by the number working at baseline [10;35]. In other studies return to work is measured among those persons, who are part of the workforce at time of follow-up, and in still other studies working is self-reported and covers from one week to permanently re-employed [34]

The lack of a clear definition can result in misinterpretation of factors related to the disease and SES since the underlying mechanisms in the transition from sickness absence back to work or to disability pension seems to follow different pathways. Leaving the workforce for any type of pension is an irreversible process and is assigned when work demands exceeds health and mental resources and is thus dependent on both health and work related factors. On the other hand, unemployment and sickness absence both include conditions with an expectation of resuming work and is more related to either SES or health, respectively.

The exclusion of persons who take disability pension the first year and the lower social one-year survival after colorectal cancer among socially deprived might explain our finding of no effect of SES on work and sickness absence one year after diagnosis of colorectal cancer. It seems as a

'healthy worker effect' where the most affluent survive the first year without leaving the workforce for disability pension.

In the present study, the transition between work, sickness absence and disability pension one year after operation was primarily associated with factors related to the cancer disease.

The risk for transition from work to sickness absence was increased if the disease was diagnosed at a later stage, not operated curatively and with occurrence of post-operative complications. The opposite was found for the transition from sickness absence back to work. The association between disease related factors and resuming of work after a cancer diagnosis including colorectal cancer has been observed in other studies where tumor stage [13;36], treatment [4;36], physical symptoms [16] and ASA-score were reported to be negatively associated with return to work.

We found that persons diagnosed with rectal cancer had a significant increased risk for sickness absence and retirement possibly due to the fact that this patient group in contrast to colon cancer patients more often will have to learn to take care of an ostomy or suffer from abnormal bowl and urinary function years after the operation [37]. Unfortunately, we could not account for these factors in our analysis.

Strengths and limitations

The present study is based on data from a well-defined clinical database of all Danish colorectal cancer patients. The database has a high completeness and data validity and missing values are random and not associated with the outcome under study whereby selection-bias is removed.

Variables regarding socioeconomic position and the affiliation to the labour market are administrative data collected prospectively why recall-bias is eliminated.

This study has, however, some limitations. First of all we were not able to include complementary treatment as chemotherapy and radiation, reduced working hours or job changes in our analysis.

Complementary cancer treatment can have a negative effect on the physical and psychological work ability and has been shown to be associated with reductions in work hours and reassignment to other work tasks [11;16;36]. We defined return to work as not receiving any transfer payments for six consecutive weeks. This can lead to misclassification of persons leaving the workforce without receiving economic compensation from the state. This is, however, very seldom in Denmark and can be ignored in this study.

The present study is conducted in a Nordic welfare system with high turnover rates on the labour market, high rates of participation and high degrees of social security. Despite the fact that the expenditures to social protection in the Nordic countries including Denmark is higher compared to the rest of the European Union and countries as US and Canada they all have some degree of social welfare systems and universal health care. The size of economic compensation and duration of sickness absence might have an impact on the consequence of a chronic disease but the risk factors and reasons for being on sickness absence or return to work is not influenced by the political context.

Conclusion

This nationwide study of colorectal cancer patients who have survived one year shows that stage of disease, general health state of the individual (ASA score), post-operative complications and the history of sickness absence and unemployment have an impact on the transition between work, sickness absence and disability pension. This leads to an increased focus on the rehabilitation process for the more vulnerable persons who have a history of work related problems with episodes outside the working market. In addition, special attention should be on the impact complications and stage of disease has on the work ability in order to reduce the risk for sickness absence and retirement years after operation.

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Ethics approval: The study based solely on national and administrative registers and did not require any approval from the ethics committee according to national regulations.

Author contribution:

Study conception and design: All authors

Acquisition of data: Merete Osler and Kathrine Carlsen

Analysis of data: Kathrine Carlsen

Interpretation of data: All authors

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Competing Interests

None

Data Sharing

No additional data

Figure Legends : Figure 1: Transition states between labor market outcomes in Denmark. Work, sickness absence and unemployment covers persons in the workforce while retirement independent of reason (disability or age) are an irreversible state, where persons are considered to leave the workforce forever.

Figure 2: Flowchart showing the selection of persons from the total database to the final study population*.

Table 1: Characteristics of the colorectal cancer patients diagnosed in Denmark while in their working age and part of the work force, 2001-2009 (N=6032). Divided into those who were excluded during the first year due to retirement or death (N=1689) and the included persons (N=4343).

	Excluded during the first year N (%)	Included after the first year N (%)	P
Education			<.0001
Primary school	584 (35)	1244 (29)	
Vocational and short education	781 (46)	2037 (47)	
Medium and long education	324 (19)	1062 (24)	
Unknown	0 (0)	0 (0)	
Disposal income (DKr.)			<.0001
Mean	192 206	210 807	
Job type			<.0001
Management and knowledge work	190 (11)	740 (17)	
Office and sale (non-manual)	401 (24)	1414 (33)	
Manual	893 (53)	1661 (38)	
Other	205 (12)	528 (12)	
Gender			0.03
Women	691 (41)	1913 (44)	
Men	998 (59)	2430 (56)	
Age			<.0001
Mean	56.6	53.8	
Country of birth			0.02
Denmark	1637 (97)	4150 (96)	
Other	52 (3)	193 (4)	
Marital status			<.0001
Married / cohabiting	1042 (62)	3162 (73)	
Single	494 (29)	1154 (26)	
Unknown	153 (9)	27 (1)	
Year of operation			0.55
2001	104 (6)	309 (7)	
2002	178 (10)	458 (10)	
2003	176 (10)	439 (10)	
2004	213 (13)	494 (11)	
2005	210 (12)	486 (11)	
2006	199 (12)	568 (13)	
2007	211 (12)	545 (13)	
2008	197 (12)	530 (12)	
2009	201 (12)	514 (12)	
Type of cancer			<.0001
Colonic	1063 (63)	2464 (57)	
Rectal	626 (37)	1879 (43)	
Stage			<.0001
I	306 (18)	1535 (35)	
II	43 (3)	146 (3)	
III	351 (21)	1411 (32)	
IV	858 (51)	760 (18)	
Unknown	131 (8)	491 (11)	
Comorbidity			<.0001
No	1447 (86)	4018 (93)	
Yes	224 (14)	325 (7)	
ASA			<.0001
I	484 (29)	2168 (50)	
II	771 (46)	1731 (40)	
->III	240 (14)	172 (4)	
Unknown	194 (11)	272 (6)	
Curative operation			<.0001
Yes	677 (40)	3278 (75)	
No	884 (52)	867 (20)	
Unknown	128 (8)	198 (5)	
Type of operation			<.0001
Rectal resection	228 (14)	206 (5)	
Colonic resection	306 (18)	1352 (31)	
Explorative laparotomy or formation of an ostomy			
Local procedures	537 (32)	1445 (33)	
Unknown	367 (22)	1197 (28)	
	251 (15)	143 (3)	
Post-operative complications			0.44
No	1448 (86)	3689 (85)	
Yes	241 (14)	654 (15)	

Table 2
Mean number of weeks from one state of employment to the next among 4343 patients aged 18-63 years diagnosed with colorectal cancer in the years 2001 to 2009 and part of the workforce at time of follow-up.

Mean time in weeks from one year after operation and first change in employmental state (% of population)	To work	To sickness absence	To unemploy-ment	To retirement	To censoring due to age, dead, migration or end of follow-up
From work (N=2679 / 62%)	--	57 (31%)	63 (10%)	75 (1%)	136 (58%)
From sickness absence (N=1406 / 32%)	16 (34%)	--	29 (9%)	30 (28%)	36 (30%)
From unemployment (N=258/ 6%)	22 (47%)	28 (17%)	--	63 (13%)	77 (23%)

Table 3: HR (95% CI) for return to Work after sickness absence in relation to socioeconomic and clinical factors among 4343 patients aged 18-63 diagnosed with colorectal cancer in the years 2001 to 2009, and part of the work force at time of follow-up.

SICKNESS ABSENCE → WORK	HR – unadjusted (events: 2125)	HR - ajusted for SES§	HR - adjusted for SES§ and confounders*	HR - adjusted for SES§, confounders and clinical variables
Education				
Primary school	1	1	1	1
Vocational and short education	0.87 (0.76-0.98)	0.91 (0.79-1.05)	0.91 (0.78-1.04)	0.92 (0.79-1.06)
Medium and long education	1.01 (0.91-1.13)	1.09 (0.96-1.24)	1.08 (0.95-1.23)	1.06 (0.93-1.21)
Disposal income #				
Lowest quartile	1	1	1	1
Second lowest quartile	1.11 (0.97-1.26)	1.03 (0.90-1.17)	1.01 (0.88-1.15)	1.07 (0.94-1.22)
Second highest quartile	1.27 (1.12-1.44)¤	1.14 (1.00-1.29)	1.12 (0.98-1.27)	1.15 (1.00-1.31)
Highest quartile	1.25 (1.10-1.42)¤	1.15 (1.00-1.33)	1.14 (0.99-1.3´2)	1.16 (1.00-1.34)
Job type				
Management and knowledge work	1.18 (0.95-1.22)	1.10 (0.90-1.28)	1.10 (0.94-1.28)	1.11 (0.95-1.30)
Office and sale (non-manual)	1.07 (0.97-1.17)	1.07 (0.97-1.19)	1.09 (0.98-1.22)	1.10 (0.99-1.23)
Manual	1	1	1	1
Other	0.71 (0.58-0.87)	0.71 (0.57-0.86)¤	1.17 (0.50-2.29)	0.88 (0.37-1.73)
Previous periodsof work	1.01 (1.01-1.02)¤	1.13 (1.11-1.16)¤¤	1.13 (1.11-1.16)¤¤	1.13 (1.11-1.16)¤¤
Previous periods of sickness absence	1.05 (1.04-1.05)¤¤	0.94 (0.92-0.96)¤¤	0.94 (0.92-0.96)¤¤	0.93 (0.91-0.95)¤¤
Previous periods of unemployment	0.98 (0.98-0.99)¤	0.89 (0.87-0.91)¤¤	0.89 (0.87-0.91)¤¤	0.88 (0.87-0.90)¤¤
Type of cancer				
Colonic	1			1
Rectal	1.01 (0.93-1.10)			0.96 (0.84-1.08)
Stage				
I	1			1
II	0.73 (0.56-0.94)¤			0.82 (0.62-1.06)
III	0.76 (0.69-0.84)¤¤			0.74 (0.66-0.82)¤¤
IV	0.36 (0.31-0.41)¤¤			0.53 (0.41-0.68)¤¤
Unknown	1.14 (1.00-1.30)			1.15 (0.96-1.39)
Comorbidity				
No	1			1
Yes	0.81 (0.73-0.89)¤			0.90 (0.82-1.00)
ASA				
I	1			1
II	0.84 (0.77-0.92)¤			0.93 (0.85-1.03)
>III	0.67 (0.52-0.84)¤			0.85 (0.65-1.07)
Unknown	0.89 (0.73-1.06)			1.07 (0.79-1.41)
Curative l operation				
Yes	1			1
No	0.43 (0.38-0.49)¤¤			0.69 (0.55-0.86)¤
Unknown	0.83 (0.68-1.02)			0.90 (0.62-1.26)
Type of operation				
Rectal resection	1			1
Colonic resection	0.95 (0.85-1.05)			0.95 (0.83-1.09)
Explorative laparotomy or formation of an ostomy	0.99 (0.89-1.10)			1.06 (0.91-1.23)
Local procedures	0.65 (0.50-0.83)¤			0.76 (0.57-1.00)¤
Unknown	0.33 (0.22-0.48)¤¤			0.48 (0.30-0.75)¤
Post-operative complications				
No	1			1
Yes	0.84 (0.74-0.94)¤			0.82 (0.72-0.92)¤

*Confounders: Gender, age at time of diagnosis, country of birth, marital status and year of operation

§ SES (Socioeconomic status): education, disposal income and job type

¤ Significant at a 0.05 level

¤¤ Significant at a <.0001 level

Depending on year the highest disposal income ranged from 175.500 DKr in 2001 to 299.717 DKr in 2009

Table 4: HR (95% CI) for sickness absence after an episode of work in relation to socioeconomic and clinical factors among 4343 patients aged 18-63 diagnosed with colorectal cancer in the years 2001 to 2009, and part of the work force at time of follow-up.

WORK → SICKNESS ABSENCE	HR - unadjusted (events: 2296)	HR - ajusted for SES§	HR - adjusted for SES§ and confounders*	HR - adjusted for SES§, confounders* and clinical variables
Education				
Primary school	1	1	1	1
Vocational and short education	1.25 (1.11-1.41)¤	1.10 (0.96-1.27)	1.10 (0.96-1.27)	1.07 (0.93-1.23)
Medium and long education	1.40 (1.26-1.56)¤¤	1.22 (1.08-1.38)¤	1.21 (1.07-1.37)¤	1.18 (1.04-1.34)¤
Disposal income #				
Lowest quartile	1	1	1	1
Second lowest quartile	1.18 (1.04-1.33)	1.18 (1.05-1.34)¤	1.17 (1.03-1.33)	1.13 (0.99-1.28)
Second highest quartile	1.02 (0.91-1.16)	1.04 (0.92-1.18)	1.02 (0.90-1.16)	1.00 (0.88-1.14)
Highest quartile	0.82 (0.73-0.94)¤	0.99 (0.87-1.14)	0.99 (0.86-1.14)	0.96 (0.84-1.11)
Job type				
Management and knowledge work	0.69 (0.61-0.78)¤¤	0.96 (0.83-1.12)	0.97 (0.84-1.14)	0.95 (0.82-1.11)
Office and sale (non-manual)	0.89 (0.82-0.98)	1.00 (0.91-1.10)	1.00 (0.91-1.12)	1.00 (0.90-1.11)
Manual	1	1	1	1
Other	0.67 (0.54-0.83)¤	0.84 (0.67-1.04)	1.00 (0.48-1.82)	1.06 (0.51-1.93)
Previous episodes of work	1.03 (1.03-1.03)¤¤	1.02 (1.01-1.04)¤	1.02 (1.01-1.04)¤	1.03 (1.01-1.04)¤
Previous episodes of sickness absence	1.10 (1.09-1.11)¤¤	1.08 (1.06-1.09)¤¤	1.08 (1.06-1.09)¤¤	1.08 (1.06-1.09)¤¤
Previous episodes of unemployment	1.01 (1.01-1.02)¤	0.98 (0.97-0.99)¤	0.98 (0.97-0.99)¤	0.98 (0.97-0.99)¤
Type of cancer				
Colonic	1			1
Rectal	1.10 (1.01-1.19)			1.17 (1.03-1.32)¤
Stage				
I	1			1
II	0.97(0.74-1.25)			0.99(0.75-1.28)
III	1.29 (1.16-1.41)¤			1.24 (1.11-1.37)¤
IV	1.63 (1.40-1.88)¤¤			1.52 (1.21-1.91)¤
Unknown	1.11 (0.98-1.25)			1.08 (0.91-1.29)
Co-morbidity				
No	1			1
Yes	0.99 (0.90-1.08)			1.05 (0.96-1.16)
ASA				
I	1			1
II	1.09 (1.00-1.19)			1.09 (0.99-1.20)
->III	1.42 (1.12-1.75)¤			1.33 (1.05-1.67)¤
Unknown	1.02 (0.85-1.21)			0.92 (0.70-1.19)
Curative operation				
Yes	1			1
No	1.43 (1.26-1.61)¤¤			1.35 (1.11-1.63)¤
Unknown	1.05 (0.87-1.29)			1.07 (0.77-1.45)
Type of operation				
Rectal resection	1			1
Colonic resection	1.0 (0.91-1.11)			1.10 (0.97-1.25)
Explorative laparotomy or formation of an ostomy	0.91 (0.82-1.01)			1.05 (0.91-1.22)
Local procedures	0.72 (0.56-0.91)¤			0.78 (0.60-1.01)
Unknown	0.93 (0.66-1.26)			0.81 (0.53-1.20)
Post-operative complications				
No	1			1
Yes	1.18 (1.05-1.31)¤			1.25 (1.11-1.41)¤

*Confounders: Gender, age at time of diagnosis, country of birth, marital status and year of operation

§ SES (Socioeconomic status): education, disposal income and job type

¤ Significant at a 0.05 level

¤¤ Significant at a <.0001 level

Depending on year the highest disposal income ranged from 175.500 DKr in 2001 to 299.717 DKr in 2009

Table 5: HR (95% CI) for retirement in relation to socioeconomic and clinical factors among 4343 patients aged 18-63 diagnosed with colorectal cancer in the years 2001 to 2009, and part of the work force at time of follow-up.

Mutually adjusted and controlled for confounders*	HR for transition from sickness absence -> retirement (number of events:569)	HR for transition from work / unemployed -> retirement (number of events: 109)
Status		
Working	---	1
Unemployed		5.89 (3.46-10.03)¤¤
Education		
Primary school	1	1
Vocational and short education	1.13 (0.85-1.51)	1.29 (0.65-2.69)
Medium and long education	1.06 (0.81-1.41)	1.24 (0.64-2.53)
Disposal income #		
Lowest quartile	1	1
Second lowest quartile	0.95 (0.76-1.19)	0.49 (0.27-0.85)¤
Second highest quartile	0.77 (0.60-0.98)¤	0.47 (0.25-0.83)¤
Highest quartile	0.79 (0.60-1.04)	0.29 (0.14-0.57)¤
Job type		
Management and knowledge work	0.59 (0.42-0.82)¤	0.93 (0.85-1.03)
Office and sale (non-manual)	0.72 (0.580.89)¤	0.96 (0.86-1.06)
Manual	1	1
Other	1.05 (0.06-4.85)	0.38 (0.12-1.37)
Previous episodes of work	0.98 (0.95-1.00)	0.93 (0.85-1.03)
Previous episodes of sickness absence	1.00 (0.97-1.02)	0.96 (0.86-1.06)
Previous episodes of unemployment	1.03 (1.00-1.05)¤	1.02 (0.94-1.11)
Type of cancer		
Colonic	1	1
Rectal	1.32 (1.04-1.67)¤	1.33 (0.75-2.34)
Stage		
I	1	1
II	0.85 (0.46-1.46)	1.70 (0.49-4.51)
III	1.13 (0.89-1.44)	1.91 (1.15-3.21)¤
IV	1.58 (1.04-2.42)¤	2.30 (0.88-6.14)
Unknown	1.01 (0.68-1.50)	1.72 (0.82-3.59)
Comorbidity		
No	1	1
Yes	1.03 (0.85-1.24)	1.17 (0.76-1.77)
ASA		
I	1	1
II	1.31 (1.08-1.58)¤	1.56 (1.00-2.44)¤
III	2.16 (1.49-3.06)¤	2.57 (1.03-5.75)¤
Unknown	1.29 (0.76-2.09)	1.64 (0.50-4.24)
Curative operation		
Yes	1	1
No	1.30 (0.89-1.86)	1.80 (0.77-3.84)
Unknown	1.41 (0.75-2.51)	1.05 (0.19-4.01)
Type of operation		
Rectal resection	1	1
Colonic resection	1.42 (1.11-1.81)¤	1.36 (0.74-2.51)
Explorative laparotomy or formation of an ostomy	1.06 (0.78-1.43)	1.23 (0.55-2.32)
Local procedures	1.01 (0.53-1.84)	0.39 (0.08-1.26)
Unknown	1.45 (0.93-2.18)	0.84 (0.16-3.13)
Post-operative complications		
No	1	1
Yes	1.23 (1.00-1.51)¤	0.86 (0.47-1.46)

*Confounders: Gender, age at time of diagnosis, country of birth, marital status and year of operation

¤ Significant at a 0.05 level

¤¤ Significant at a <.0001 level

Depending on year the highest disposal income ranged from 175.500 DKr in 2001 to 299.717 DKr in 2009

Reference List

(1) Ferlay J, Parkin DM, Steliarova-Foucher E. Estimates of cancer incidence and mortality in Europe in 2008. *Eur J Cancer* 2010; 46(4):765-781.

(2) Coleman MP, Forman D, Bryant H, et al. Cancer survival in Australia, Canada, Denmark, Norway, Sweden, and the UK, 1995-2007 (the International Cancer Benchmarking Partnership): an analysis of population-based cancer registry data. *Lancet* 2011; 377(9760):127-138.

(3) Brenner H, Bouvier AM, Foschi R, et al. Progress in colorectal cancer survival in Europe from the late 1980s to the early 21st century: the EUROCARE study. *Int J Cancer* 2012; 131(7):1649-1658.

(4) Gordon L, Lynch BM, Newman B. Transitions in work participation after a diagnosis of colorectal cancer. *Aust N Z J Public Health* 2008; 32(6):569-574.

(5) van den Brink M, van den Hout WB, Kievit J, et al. The impact of diagnosis and treatment of rectal cancer on paid and unpaid labor. *Dis Colon Rectum* 2005; 48(10):1875-1882.

(6) Frederiksen BL, Osler M, Harling H, et al. The impact of socioeconomic factors on 30-day mortality following elective colorectal cancer surgery: a nationwide study. *Eur J Cancer* 2009; 45(7):1248-1256.

(7) Cavalli-Bjorkman N, Lambe M, Eaker S, et al. Differences according to educational level in the management and survival of colorectal cancer in Sweden. *Eur J Cancer* 2011; 47(9):1398-1406.

(8) Egeberg R, Halkjaer J, Rottmann N, et al. Social inequality and incidence of and survival from cancers of the colon and rectum in a population-based study in Denmark, 1994-2003. *Eur J Cancer* 2008; 44(14):1978-1988.

(9) Aarts MJ, Lemmens VEPP, Louwman MWJ, et al. Socioeconomic status and changing inequalities in colorectal cancer? A review of the associations with risk, treatment and outcome. *European Journal of Cancer* 2010; 46(15):2681-2695.

(10) Drolet M, Maunsell E, Brisson J, et al. Not Working 3 Years After Breast Cancer: Predictors in a Population-Based Study. *J Clin Oncol* 2005; 23(33):8305-8312.

(11) Steiner JF, Cavender TA, Nowels CT, et al. The impact of physical and psychosocial factors on work characteristics after cancer. *Psychooncology* 2008; 17(2):138-147.

(12) Paraponaris A, Teyssier LS, Ventelou B. Job tenure and self-reported workplace discrimination for cancer survivors 2 years after diagnosis: does employment legislation matter? *Health Policy* 2010; 98(2-3):144-155.

(13) Earle CC, Chretien Y, Morris C, et al. Employment among survivors of lung cancer and colorectal cancer. *J Clin Oncol* 2010; 28(10):1700-1705.

(14) Spelten ER, Sprangers MA, Verbeek JH. Factors reported to influence the return to work of cancer survivors: a literature review. *Psychooncology* 2002; 11(2):124-131.

(15) Short PF, Vasey JJ, Tunceli K. Employment pathways in a large cohort of adult cancer survivors. *Cancer* 2005; 103(6):1292-1301.

(16) Mehnert A. Employment and work-related issues in cancer survivors. *Crit Rev Oncol Hematol* 2011; 77(2):109-130.

(17) Dalton SO, Steding-Jessen M, Gislum M, et al. Social inequality and incidence of and survival from cancer in a population-based study in Denmark, 1994-2003: Background, aims, material and methods. *Eur J Cancer* 2008; 44(14):1938-1949.

(18) Amir Z, Moran T, Walsh L, et al. Return to paid work after cancer: a British experience. *J Cancer Surviv* 2007; 1(2):129-136.

(19) Carlsen K, Dalton SO, Frederiksen K, et al. Cancer and the risk for taking early retirement pension: A Danish cohort study. *Scandinavian Journal of Public Health* 2008; 36(2):117-125.

(20) Sjovall K, Attner B, Englund M, et al. Sickness absence among cancer patients in the pre-diagnostic and the post-diagnostic phases of five common forms of cancer. *Support Care Cancer* 2012; 20(4):741-747.

(21) Syse A, Tretli S, Kravdal O. Cancer's impact on employment and earnings--a population-based study from Norway. *J Cancer Surviv* 2008; 2(3):149-158.

(22) Mols F, Thong MS, Vissers P, et al. Socio-economic implications of cancer survivorship: results from the PROFILES registry. *Eur J Cancer* 2012; 48(13):2037-2042.

(23) Andersen PK, Keiding N. Multi-state models for event history analysis. *Stat Methods Med Res* 2002; 11(2):91-115.

(24) Christensen KB, Andersen PK, Smith-Hansen L, et al. Analyzing sickness absence with statistical models for survival data. *Scand J Work Environ Health* 2007; 33(3):233-239.

(25) Gjesdal S, Ringdal PR, Haug K, et al. Long-term sickness absence and disability pension with psychiatric diagnoses: a population-based cohort study. *Nord J Psychiatry* 2008; 62(4):294-301.

(26) Lie SA, Eriksen HR, Ursin H, et al. A multi-state model for sick-leave data applied to a randomized control trial study of low back pain. *Scand J Public Health* 2008; 36(3):279-283.

(27) Pedersen J, Bjorner JB, Burr H, et al. Transitions between sickness absence, work, unemployment, and disability in Denmark 2004-2008. *Scand J Work Environ Health* 2012; 38(6):516-526.

(28) Oyeflaten I, Lie SA, Ihlebaek CM, Eriksen HR et al. Multiple transitions in sick leave, disability benefits, and return to work. - A 4-year follow-up of patients participating in a

work-related rehabilitation program. *BMC Public Health* 2012; 12:748.

(29) Frederiksen BL, Osler M, Harling H, et al. Do patient characteristics, disease, or treatment explain social inequality in survival from colorectal cancer? *Soc Sci Med* 2009; 69(7):1107-1115.

(30) IDA - an integrated data base for labour market research. Main report, 1991 . 2006. Statistics Denmark. Ref Type: Report

(31) Lynge E, Sandegaard JL, Rebolj M. The Danish National Patient Register. *Scand J Public Health* 2011; 39(7 Suppl):30-33.

(32) Kildemoes HW, Sorensen HT, Hallas J. The Danish National Prescription Registry. *Scand J Public Health* 2011; 39(7 Suppl):38-41.

(33) Hjollund NH, Larsen FB, Andersen JH. Register-based follow-up of social benefits and other transfer payments: accuracy and degree of completeness in a Danish interdepartmental administrative database compared with a population-based survey. *Scand J Public Health* 2007; 35(5):497-502.

(34) Sanchez KM, Richardson JL, Mason HR. The return to work experiences of colorectal cancer survivors. *AAOHN J* 2004; 52(12):500-510.

(35) Taskila T, Martikainen R, Hietanen P, et al. Comparative study of work ability between cancer survivors and their referents. *Eur J Cancer* 2007; 43(5):914-920.

(36) Mols F, Thong MS, Vreugdenhil G, et al Long-term cancer survivors experience work changes after diagnosis: results of a population-based study. *Psychooncology* 2009; 18(12):1252-1260.

(37) Rodriguez-Bigas MA, Chang GJ, Skibber JM. Barriers to rehabilitation of colorectal cancer patients. *J Surg Oncol* 2007; 95(5):400-408.

The transition between work, sickness absence and pension in a cohort of Danish colorectal cancer survivors.

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Abstract

Objectives: The aim of this study was to evaluate the impact of socioeconomic and clinical factors on the transitions between work, sickness absence and retirement in a cohort of Danish colorectal cancer survivors.

Design: Register based cohort study with up to 10 years of follow-up.

Setting: Population based study with use of administrative health related and socioeconomic registers.

Participants: All persons (N=4343) diagnosed with colorectal cancer in Denmark in the years 2001-2009 while they were in their working age (18-63 years) and who were part of the labor force one year post diagnosis.

Primary and secondary outcome measures: By use of multi-state models in Cox proportional hazards models we analyzed the hazard ratio for re-employment, sickness absence and retirement in models including clinical as well as health related variables.

Results: One year after diagnosis 62% were working and 58% continued until end of follow-up. Socioeconomic factors were found to be associated with retirement but not with sickness absence and return to work. The risk for transition from work to sickness absence was increased if the disease was diagnosed at a later stage (stage III) 1.52 (95% CI: 1.21-1.91), not operated curatively 1.35 (95% CI: 1.11-1.63) and with occurrence of post-operative complications 1.25 (95% CI: 1.11-1.41). The opposite was found for the transition from sickness absence back to work.

Conclusion: This nationwide study of colorectal cancer patients who have survived one year shows that stage of disease, general health state of the individual, post-operative complications and the history of sickness absence and unemployment have an impact on the transition between work, sickness absence and disability pension. This leads to an increased focus on the rehabilitation process for the more vulnerable persons who have a combination of severe disease and a history of work related problems with episodes outside the working market.

Article summary

Article focus:

- How many colorectal cancer survivors return to work, stay at sickness absence, get unemployed or become pensioners in the years following diagnosis?
- Does socioeconomic position or clinical factors predict re-employment, sickness absence, unemployment or pension in this cohort?

Key messages:

- First study to differentiate between re-employment, sickness absence, unemployment and retirement in a cohort of colorectal cancer survivors.
- One year after diagnosis 62% had resumed work.
- Socioeconomic factors were associated with early retirement whereas clinical factors were found to be associated with sickness absence and re-employment.

Strengths and limitations:

- This is a longitudinal nationwide population based study including more than 4000 persons diagnosed with colorectal cancer.
- The study identifies an association between socioeconomic position / clinical factors and re-employment / sickness absence / pension but is not able to identify mechanisms behind.

What is new in this paper:

Very few studies have analyzed the impact colorectal cancer has on the affiliation to the labor market. In this study we are able to identify clinical and socioeconomic risk factors for sickness absence, work resumption and retirement.

1. Introduction

In 2008 nearly 500.000 persons in Europe were diagnosed with colorectal cancer making it the most common cancer and the second most common cause of cancer deaths in Europe [1]. From 1995 to 2007 the survival from colorectal cancer has steadily improved among all age groups [2] and the relative 5-year survival increased in the years 1990 to 2002 from 50% to 60% among persons aged 15 to 59 years[3].

Throughout Europe life expectancy has increased leading to higher age at pension and longer time in the workforce. As the risk of colorectal cancer increases with age, it can be expected that still more persons will be diagnosed with colorectal cancer while they are an active part of the workforce.

Few studies have analyzed the impact of colorectal cancer on work participation in the years following diagnosis and treatment. The existing studies reported that 2/3 of those working at time of diagnosis resume work in the years after treatment. Risk factors for work cessation were high age; radiation therapy and co-morbidity [4;5]. Several studies [6-9] have shown a negative social gradient in survival of colorectal cancer, but the social consequences has not been studied despite the fact that a negative social gradient in return to work has been observed among cancer survivors in general [10-17]. Compared to persons diagnosed with testicular-, breast-, endocrine- or skin cancer patients with colorectal cancer had a higher risk of not resuming work and had longer time on sickness absence [13;18-22].

In order to get a better understanding of the occupational consequences of colorectal cancer it is important to take both socioeconomic and health related factors into account and to differentiate more specifically between the different reasons for not working. In the majority of studies the outcome is 'not returning to work' which is a mix-up of different reasons for not working, i.e.

unemployment, sickness absence or disability pension and the transition from a cancer diagnosis to one of these outcomes could very well differ according to different risk factors.

These transitions between different states (e.g. from sickness absence to work, or from sickness absence to disability) can be modeled by using multi-state models[23]. Multi-state models are well-known statistical models used for event history analysis, e.g. the study of survival. The application of statistical models for survival analysis in the analysis of sickness absence is relatively new[24;25] and the use of multi-state models is mainly due to Lie et al[26] , but multi-state models have also been applied by other researchers[27;28].

By use of detailed, nationwide, population based registers the aim of this study is to evaluate the impact of both socioeconomic and clinical factors on the transitions between work, sickness absence and retirement in a cohort of colorectal cancer survivors and to test for interaction between clinical and socioeconomic factors.

2. Materials and methods

This study is based on Danish population based registers linked together with the unique personal identification code given to all Danish residents.

Danish Colorectal Cancer Group (DCCG)

The study population was derived from the national database of DCCG which includes around 93% of patients in Denmark with a first-time adenocarcinoma of the rectum (ICD-10: C20) or colon (ICD-C18). This database comprises prospectively collected data registered by surgeons. The database has previously been used in epidemiological studies and is described in details elsewhere [29]. From the database we obtained clinical data with relevance for the probability of returning to work after treatment. Entry into the study was equal to date of surgery and was used to calculate the

follow-up time. Variables describing the disease were cancer type and tumor stage classified according to the International Union Against Cancer (UICC). Information about surgical procedure was included as curative operation (yes/no) and type of operation (1=rectal resection, 2=colonic resection, 3=explorative laparotomy or formation of an ostomy, 4=local procedures). Health status at time of surgery was measured by ASA score (according to the American Society of Anesthesiologists) where patients are categorized into five subgroups by preoperative physical fitness reaching from I - A completely healthy patient to V - A moribund patient who is not expected to live 24 hours with or without surgery. ASA score III-V was collapsed into one group of patients with severe systemic diseases. Postoperative complications were grouped as no complications or one or more complications. The latter group included postoperative bleeding, problems with the ostomy, intra-abdominal infections or infections in the wound, lack of passage through the intestine, leak from the intestine or postoperative rupture of the wound.

Statistics Denmark

Information on a number of demographic and socioeconomic characteristics was obtained from the population-based Integrated Database for Labour Market Research (IDA), which has been administrated by Statistics Denmark since 1980[30]. From IDA we had information about country of origin (grouped as born in Denmark or born outside Denmark) and marital status (married or cohabiting, single including widows and unknown). Education was classified according to length of study (primary school 9-12 years of education, vocational and short education 13-15 years, medium and long education more than 16 years and unknown). Job type was classified as management and knowledge work (e.g. leaders, doctors and teachers at high school), office and sale (e.g. secretary, police and nurses) and manual work (e.g. farmers, craftsmen and social and health care assistants). In order to obtain information on disposal income for the family we also identified partners and

their income. Disposal income was calculated as the average of the family income three years before the year of diagnosis and was deflated according to the 2000 value of the Danish kroner. Education, job type and disposal income were combined under the heading socioeconomic status (SES).

The Danish National Patient Registry (NPR)

This register holds information on all hospitalizations and outpatient visits in Denmark since 1978. In this study we used information of date of admission and discharge and diagnosis coded according to *the International Classifications of Diseases* (ICD-10) [31].

The Register of Medical Product Statistics (RMPS)

Since 1995 every medical product sold on prescription by Danish pharmacies has been registered. From this register we had information on date for redemption of the prescription and substance classified according to the *anatomical-therapeutic-chemical* (ATC) system [32].

Co-morbidity preceding five years before the year of diagnosis was obtained from NPR and RMPS. As comorbidity we included cardiovascular disease, chronic obstructive pulmonary disease, diabetes and liver, kidney or connective tissue diseases – diseases which are all part of the Charlson index. Comorbidity was stated if one or more of these diseases were present at time of diagnosis.

Register based Evaluation of Marginalization (DREAM)

The Danish labor market is characterized as a flexicurity system with a high degree of economic compensation in case of unemployment or reduced work ability (security) but also with a high turnover rate (flexible). Unemployed persons are warranted economic compensation if they are

actively seeking job. During the study period it was possible to receive a maximum of four years of unemployment benefit. After the end of these four years or if a person is not qualified for unemployment benefit (i.e. not member of a union) it is possible to receive social income. If a person is unable to work due to illness or disability it is possible to receive sickness benefit for a maximum of 52 weeks during a period of two years or apply for early retirement if the work ability is reduced to a level where it is not possible to hold a job. This holds for all Danish citizens independent of job type. During the study period the retirement age was 64 years of age.

The outcome of the study was receipt of social transfer payments or in work. Information about social transfer payments was obtained from the Danish population based administrative register DREAM. DREAM covers all residents in Denmark who have received social transfer payments from the state [33] in any given week since 1991. In the present study we included data from DREAM from week 1 in 2001 until week 13 in 2011. In work was defined as not receiving any social transfer payments for six consecutive weeks. Transfer income obtained from DREAM was divided into sickness benefit, unemployment benefit and permanent withdrawal from the workforce due to early retirement pension or post-employment benefit, which is an optional withdraw from the workforce not caused by disability.

Study population

In the years 2001 to 2009 31.570 persons were diagnosed with colorectal cancer in Denmark. The majority of these persons were diagnosed after the age of retirement and the study population consists of 4.343 persons aged 18-63 years, who were part of the workforce and survived the first postoperative year (fig. 2). The follow-up period of this population was between 65 weeks (for persons diagnosed in the last week of 2009) to 535 week (for persons diagnosed in the first week of 2001) leading to 12.569 person years.

Outcome data

For every person in the study population labour market status was recorded on a weekly basis until the person reached the age limit of 63 years, emigrated, died, or until the end of follow-up whichever came first. Labour market status was categorized in four different 'states': work, sickness absence, unemployment, and disability. The multi-state model is a model for the nine possible transitions between these four states (Figure 1).

Statistical analysis

Descriptive analysis by use of chi^2 and t-tests was conducted in order to examine the characteristics of the sample. The outcome data was recoded and for each person time spent in one of the four states was registered. Furthermore it was registered if a transition to another state occurred at the end of the persons stay in the state, and, if so, what state the person shifted to. The time spent in the state was censored if the person died, emigrated, or shifted to a social transfer payment that did not fit any of the four states.

Each of the nine possible transitions shown in Figure 1 was analysed using the Cox proportional hazards model in SAS (The PHREG procedure, SAS version 9.2). The time scale used was duration of stay in current state.

The variables education, disposal income, job type, type of cancer, cancer stage, comorbidity, ASA score, curative operation, type of operation, post-operative complications were included as time constant covariates. Three time dependent covariates were also included: number of times the person been employed, had been sick-listed, or unemployment since the start of follow up.

Because the baseline hazard for each state was allowed to vary freely, the covariate relied on the assumption of proportionality.

3. Results

Table 1 shows the baseline characteristics for all patients stratified on those excluded during the first year after diagnosis (N=1689) and the study population (N=4343). Compared to the excluded population the study population was diagnosed with significantly less severe disease and higher SES at time of inclusion.

One year after operation 62% of the study population were in work while 32% were sick listed and 6% were unemployed (Table 2). Of those who were working, 58% continued working for an average of 136 weeks.

Table 3 and 4 shows the Hazard Ratio (HR) for transitions between work and sickness absence and reverse. Previous periods of sickness absence and unemployment reduced the rate of returning to work with 7% and 12% per episode, whereas previous episodes of work increased the rate of both work and sickness absence. In addition, we found that increasing levels of education increased the rate of transition from work back to sickness absence.

Return to work after a period of sickness absence (Table 3) was less common among cancer survivors who were operated in an advanced stage of disease, who did not have curative surgery and who suffered postoperative complications.

Sickness absence following a period of work was primarily associated with disease related factors (Table 4). In contrast to return to work, patients diagnosed with rectal cancer had an increased risk for sickness absence (HR=1.17 (1.03-1.32)) compared to those operated for colonic cancer. Furthermore we found that an ASA score on III increased the risk for sickness absence with almost 40%.

The risk factors associated with permanently withdrawal from the labor market one year after operation are shown in Table 5. Since the transition from work and unemployment to retirement follows the same pathways, these groups were joined in order to gain more power. The risk for retirement was not only related to the disease but also to SES. Manual work and increasing disposal income reduces the risk for retirement after an episode of sickness absence and work, respectively. Compared to patients in work, the HR for retirement was 5.89 (3.46-10.03) among unemployed survivors.

Advanced stage at diagnosis and high ASA score increased the risk for retirement among both groups.

Finally, we analyzed for effect modification by adding an interaction in the logistic model between disposal income as the strongest socioeconomic predictor and type of cancer, stage of disease, type of operation and post-operative complications. We did not find any significant effect modification between socioeconomic factors and disease related factors (Data not shown).

4. Discussion and conclusion

In this cohort study including 4343 Danish colorectal cancer patients, who were part of the workforce after the first postoperative year, we found that 62% were working one year after operation.

One year after operation previous episodes of sickness absence and unemployment, cancer stage at diagnosis, curative operation and post-operative complications were associated with labor market affiliation during follow-up whereas SES was only weakly associated with the transition between the different occupational states.

The observed rate of return to work is in accordance with previous studies on colorectal cancer survivors, where return to full time employment was reported in 60%-89% dependent on time from diagnosis, definition of return to work and severity of the disease.

In this study we decided only to include survivors, who were still part of the workforce one year after operation, based on a notion that it is not clinical relevant to study full return to work before the end of a one-year survival period. In this selected group of patients the observed resumption of work was rather low compared to previous studies where up to 89% of patients had returned to work at some point after diagnosis [34]. This could be caused by the fact that there is a lack of consensus regarding definition and measurement of return to work. Thus, in some studies return to work is simply the number of persons working at time of follow-up divided by the number working at baseline [10;35]. In other studies return to work is measured among those persons, who are part of the workforce at time of follow-up, and in still other studies working is self-reported and covers from one week to permanently re-employed [34]

The lack of a clear definition can result in misinterpretation of factors related to the disease and SES since the underlying mechanisms in the transition from sickness absence back to work or to disability pension seems to follow different pathways. Leaving the workforce for any type of pension is an irreversible process and is assigned when work demands exceeds health and mental resources and is thus dependent on both health and work related factors. On the other hand, unemployment and sickness absence both include conditions with an expectation of resuming work and is more related to either SES or health, respectively.

The exclusion of persons who take disability pension the first year and the lower social one-year survival after colorectal cancer among socially deprived might explain our finding of no effect of SES on work and sickness absence one year after diagnosis of colorectal cancer. It seems as a

'healthy worker effect' where the most affluent survive the first year without leaving the workforce for disability pension.

In the present study, the transition between work, sickness absence and disability pension one year after operation was primarily associated with factors related to the cancer disease.

The risk for transition from work to sickness absence was increased if the disease was diagnosed at a later stage, not operated curatively and with occurrence of post-operative complications. The opposite was found for the transition from sickness absence back to work. The association between disease related factors and resuming of work after a cancer diagnosis including colorectal cancer has been observed in other studies where tumor stage [13;36], treatment [4;36], physical symptoms [16] and ASA-score were reported to be negatively associated with return to work.

We found that persons diagnosed with rectal cancer had a significant increased risk for sickness absence and retirement possibly due to the fact that this patient group in contrast to colon cancer patients more often will have to learn to take care of an ostomy or suffer from abnormal bowl and urinary function years after the operation [37]. Unfortunately, we could not account for these factors in our analysis.

Strengths and limitations

The present study is based on data from a well-defined clinical database of all Danish colorectal cancer patients. The database has a high completeness and data validity and missing values are random and not associated with the outcome under study whereby selection-bias is removed.

Variables regarding socioeconomic position and the affiliation to the labour market are administrative data collected prospectively why recall-bias is eliminated.

This study has, however, some limitations. First of all we were not able to include complementary treatment as chemotherapy and radiation, reduced working hours or job changes in our analysis.

Complementary cancer treatment can have a negative effect on the physical and psychological work ability and has been shown to be associated with reductions in work hours and reassignment to other work tasks [11;16;36]. We defined return to work as not receiving any transfer payments for six consecutive weeks. This can lead to misclassification of persons leaving the workforce without receiving economic compensation from the state. This is, however, very seldom in Denmark and can be ignored in this study.

The present study is conducted in a Nordic welfare system with high turnover rates on the labour market, high rates of participation and high degrees of social security. Despite the fact that the expenditures to social protection in the Nordic countries including Denmark is higher compared to the rest of the European Union and countries as US and Canada they all have some degree of social welfare systems and universal health care. The size of economic compensation and duration of sickness absence might have an impact on the consequence of a chronic disease but the risk factors and reasons for being on sickness absence or return to work is not influenced by the political context.

Conclusion

This nationwide study of colorectal cancer patients who have survived one year shows that stage of disease, general health state of the individual (ASA score), post-operative complications and the history of sickness absence and unemployment have an impact on the transition between work, sickness absence and disability pension. This leads to an increased focus on the rehabilitation process for the more vulnerable persons who have a history of work related problems with episodes outside the working market. In addition, special attention should be on the impact complications and stage of disease has on the work ability in order to reduce the risk for sickness absence and retirement years after operation.

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Ethics approval: The study based solely on national and administrative registers and did not require any approval from the ethics committee according to national regulations.

Author contribution:

Study conception and design: All authors
Acquisition of data: Merete Osler and Kathrine Carlsen
Analysis of data: Kathrine Carlsen
Interpretation of data: All authors
Writing manuscript: All authors

Figure 1: Transition states between labor market outcomes in Denmark. Work, sickness absence and unemployment covers persons in the workforce while retirement independent of reason (disability or age) are an irreversible state, where persons are considered to leave the workforce forever.

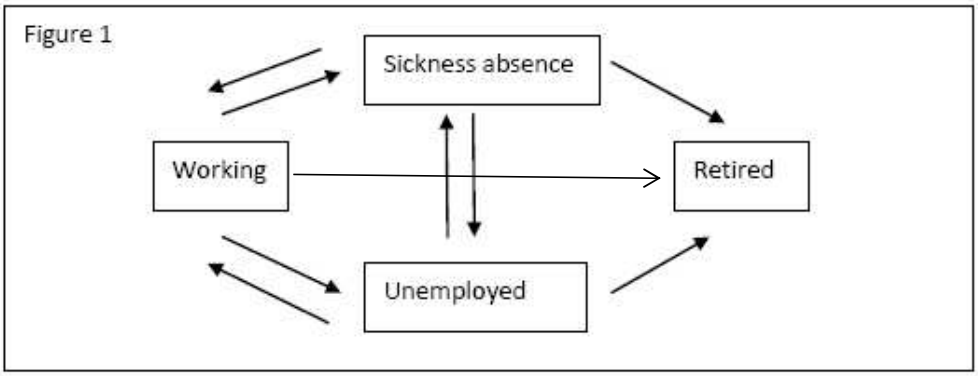
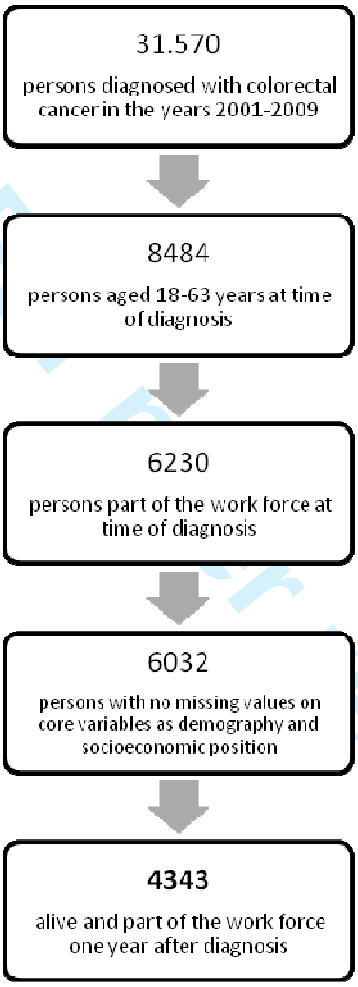


Figure 2: Flowchart showing the selection of persons from the total database to the final study population*.



* From January 2001 to December 2009 a total of 31 570 persons were diagnosed with colonic or rectal cancer. In total we excluded 25 538 persons: 23 086 persons as they were not in their working-age (18-63 years) at time of diagnosis, 2254 had retired due to disability before diagnosis and 198 because of missing values on demographic or socioeconomic variables. In addition, 1689 persons died or withdrew from the workforce within the first year after diagnosis.

Table 1: Characteristics of the colorectal cancer patients diagnosed in Denmark while in their working age and part of the work force, 2001-2009 (N=6032). Divided into those who were excluded during the first year due to retirement or death (N=1689) and the included persons (N=4343).

	Excluded during the first year N (%)	Included after the first year N (%)	P
Education			<.0001
Primary school	584 (35)	1244 (29)	
Vocational and short education	781 (46)	2037 (47)	
Medium and long education	324 (19)	1062 (24)	
Unknown	0 (0)	0 (0)	
Disposal income (DKr.)			<.0001
Mean	192 206	210 807	
Job type			<.0001
Management and knowledge work	190 (11)	740 (17)	
Office and sale (non-manual)	401 (24)	1414 (33)	
Manual	893 (53)	1661 (38)	
Other	205 (12)	528 (12)	
Gender			0.03
Women	691 (41)	1913 (44)	
Men	998 (59)	2430 (56)	
Age			<.0001
Mean	56.6	53.8	
Country of birth			0.02
Denmark	1637 (97)	4150 (96)	
Other	52 (3)	193 (4)	
Marital status			<.0001
Married / cohabiting	1042 (62)	3162 (73)	
Single	494 (29)	1154 (26)	
Unknown	153 (9)	27 (1)	
Year of operation			0.55
2001	104 (6)	309 (7)	
2002	178 (10)	458 (10)	
2003	176 (10)	439 (10)	
2004	213 (13)	494 (11)	
2005	210 (12)	486 (11)	
2006	199 (12)	568 (13)	
2007	211 (12)	545 (13)	
2008	197 (12)	530 (12)	
2009	201 (12)	514 (12)	
Type of cancer			<.0001
Colonic	1063 (63)	2464 (57)	
Rectal	626 (37)	1879 (43)	
Stage			<.0001
I	306 (18)	1535 (35)	
II	43 (3)	146 (3)	
III	351 (21)	1411 (32)	
IV	858 (51)	760 (18)	
Unknown	131 (8)	491 (11)	
Comorbidity			<.0001
No	1447 (86)	4018 (93)	
Yes	224 (14)	325 (7)	
ASA			<.0001
I	484 (29)	2168 (50)	
II	771 (46)	1731 (40)	
->III	240 (14)	172 (4)	
Unknown	194 (11)	272 (6)	
Curative operation			<.0001
Yes	677 (40)	3278 (75)	
No	884 (52)	867 (20)	
Unknown	128 (8)	198 (5)	
Type of operation			<.0001
Rectal resection	228 (14)	206 (5)	
Colonic resection	306 (18)	1352 (31)	
Explorative laparotomy or formation of an ostomy			
Local procedures	537 (32)	1445 (33)	
Unknown	367 (22)	1197 (28)	
	251 (15)	143 (3)	
Post-operative complications			0.44
No	1448 (86)	3689 (85)	
Yes	241 (14)	654 (15)	

Table 2
Mean number of weeks from one state of employment to the next among 4343 patients aged 18-63 years diagnosed with colorectal cancer in the years 2001 to 2009 and part of the workforce at time of follow-up.

Mean time in weeks from one year after operation and first change in employmental state (% of population)	To work	To sickness absence	To unemploy-ment	To retirement	To censoring due to age, dead, migration or end of follow-up
From work (N=2679 / 62%)	--	57 (31%)	63 (10%)	75 (1%)	136 (58%)
From sickness absence (N=1406 / 32%)	16 (34%)	--	29 (9%)	30 (28%)	36 (30%)
From unemployment (N=258/ 6%)	22 (47%)	28 (17%)	--	63 (13%)	77 (23%)

Table 3: HR (95% CI) for return to Work after sickness absence in relation to socioeconomic and clinical factors among 4343 patients aged 18-63 diagnosed with colorectal cancer in the years 2001 to 2009, and part of the work force at time of follow-up.

SICKNESS ABSENCE → WORK	HR – unadjusted (events: 2125)	HR - ajusted for SES§	HR - adjusted for SES§ and confounders*	HR - adjusted for SES§, confounders and clinical variables
Education				
Primary school	1	1	1	1
Vocational and short education	0.87 (0.76-0.98)	0.91 (0.79-1.05)	0.91 (0.78-1.04)	0.92 (0.79-1.06)
Medium and long education	1.01 (0.91-1.13)	1.09 (0.96-1.24)	1.08 (0.95-1.23)	1.06 (0.93-1.21)
Disposal income #				
Lowest quartile	1	1	1	1
Second lowest quartile	1.11 (0.97-1.26)	1.03 (0.90-1.17)	1.01 (0.88-1.15)	1.07 (0.94-1.22)
Second highest quartile	1.27 (1.12-1.44)¤	1.14 (1.00-1.29)	1.12 (0.98-1.27)	1.15 (1.00-1.31)
Highest quartile	1.25 (1.10-1.42)¤	1.15 (1.00-1.33)	1.14 (0.99-1.3´2)	1.16 (1.00-1.34)
Job type				
Management and knowledge work	1.18 (0.95-1.22)	1.10 (0.90-1.28)	1.10 (0.94-1.28)	1.11 (0.95-1.30)
Office and sale (non-manual)	1.07 (0.97-1.17)	1.07 (0.97-1.19)	1.09 (0.98-1.22)	1.10 (0.99-1.23)
Manual	1	1	1	1
Other	0.71 (0.58-0.87)	0.71 (0.57-0.86)¤	1.17 (0.50-2.29)	0.88 (0.37-1.73)
Previous periodsof work	1.01 (1.01-1.02)¤	1.13 (1.11-1.16)¤¤	1.13 (1.11-1.16)¤¤	1.13 (1.11-1.16)¤¤
Previous periods of sickness absence	1.05 (1.04-1.05)¤¤	0.94 (0.92-0.96)¤¤	0.94 (0.92-0.96)¤¤	0.93 (0.91-0.95)¤¤
Previous periods of unemployment	0.98 (0.98-0.99)¤	0.89 (0.87-0.91)¤¤	0.89 (0.87-0.91)¤¤	0.88 (0.87-0.90)¤¤
Type of cancer				
Colonic	1			1
Rectal	1.01 (0.93-1.10)			0.96 (0.84-1.08)
Stage				
I	1			1
II	0.73 (0.56-0.94)¤			0.82 (0.62-1.06)
III	0.76 (0.69-0.84)¤¤			0.74 (0.66-0.82)¤¤
IV	0.36 (0.31-0.41)¤¤			0.53 (0.41-0.68)¤¤
Unknown	1.14 (1.00-1.30)			1.15 (0.96-1.39)
Comorbidity				
No	1			1
Yes	0.81 (0.73-0.89)¤			0.90 (0.82-1.00)
ASA				
I	1			1
II	0.84 (0.77-0.92)¤			0.93 (0.85-1.03)
>III	0.67 (0.52-0.84)¤			0.85 (0.65-1.07)
Unknown	0.89 (0.73-1.06)			1.07 (0.79-1.41)
Curative l operation				
Yes	1			1
No	0.43 (0.38-0.49)¤¤			0.69 (0.55-0.86)¤
Unknown	0.83 (0.68-1.02)			0.90 (0.62-1.26)
Type of operation				
Rectal resection	1			1
Colonic resection	0.95 (0.85-1.05)			0.95 (0.83-1.09)
Explorative laparotomy or formation of an ostomy	0.99 (0.89-1.10)			1.06 (0.91-1.23)
Local procedures	0.65 (0.50-0.83)¤			0.76 (0.57-1.00)¤
Unknown	0.33 (0.22-0.48)¤¤			0.48 (0.30-0.75)¤
Post-operative complications				
No	1			1
Yes	0.84 (0.74-0.94)¤			0.82 (0.72-0.92)¤

*Confounders: Gender, age at time of diagnosis, country of birth, marital status and year of operation

§ SES (Socioeconomic status): education, disposal income and job type

¤ Significant at a 0.05 level

¤¤ Significant at a <.0001 level

Depending on year the highest disposal income ranged from 175.500 DKr in 2001 to 299.717 DKr in 2009

Table 4: HR (95% CI) for sickness absence after an episode of work in relation to socioeconomic and clinical factors among 4343 patients aged 18-63 diagnosed with colorectal cancer in the years 2001 to 2009, and part of the work force at time of follow-up.

WORK → SICKNESS ABSENCE	HR - unadjusted (events: 2296)	HR - ajusted for SES§	HR - adjusted for SES§ and confounders*	HR - adjusted for SES§, confounders* and clinical variables
Education				
Primary school	1	1	1	1
Vocational and short education	1.25 (1.11-1.41)¤	1.10 (0.96-1.27)	1.10 (0.96-1.27)	1.07 (0.93-1.23)
Medium and long education	1.40 (1.26-1.56)¤¤	1.22 (1.08-1.38)¤	1.21 (1.07-1.37)¤	1.18 (1.04-1.34)¤
Disposal income #				
Lowest quartile	1	1	1	1
Second lowest quartile	1.18 (1.04-1.33)	1.18 (1.05-1.34)¤	1.17 (1.03-1.33)	1.13 (0.99-1.28)
Second highest quartile	1.02 (0.91-1.16)	1.04 (0.92-1.18)	1.02 (0.90-1.16)	1.00 (0.88-1.14)
Highest quartile	0.82 (0.73-0.94)¤	0.99 (0.87-1.14)	0.99 (0.86-1.14)	0.96 (0.84-1.11)
Job type				
Management and knowledge	0.69 (0.61-0.78)¤¤	0.96 (0.83-1.12)	0.97 (0.84-1.14)	0.95 (0.82-1.11)
work	0.89 (0.82-0.98)	1.00 (0.91-1.10)	1.00 (0.91-1.12)	1.00 (0.90-1.11)
Office and sale (non-manual)	1	1	1	1
Manual	0.67 (0.54-0.83)¤	0.84 (0.67-1.04)	1.00 (0.48-1.82)	1.06 (0.51-1.93)
Other				
Previous episodes of work	1.03 (1.03-1.03)¤¤	1.02 (1.01-1.04)¤	1.02 (1.01-1.04)¤	1.03 (1.01-1.04)¤
Previous episodes of sickness absence	1.10 (1.09-1.11)¤¤	1.08 (1.06-1.09)¤¤	1.08 (1.06-1.09)¤¤	1.08 (1.06-1.09)¤¤
Previous episodes of unemployment	1.01 (1.01-1.02)¤	0.98 (0.97-0.99)¤	0.98 (0.97-0.99)¤	0.98 (0.97-0.99)¤
Type of cancer				
Colonic	1			1
Rectal	1.10 (1.01-1.19)			1.17 (1.03-1.32)¤
Stage				
I	1			1
II	0.97(0.74-1.25)			0.99(0.75-1.28)
III	1.29 (1.16-1.41)¤			1.24 (1.11-1.37)¤
IV	1.63 (1.40-1.88)¤¤			1.52 (1.21-1.91)¤
Unknown	1.11 (0.98-1.25)			1.08 (0.91-1.29)
Co-morbidity				
No	1			1
Yes	0.99 (0.90-1.08)			1.05 (0.96-1.16)
ASA				
I	1			1
II	1.09 (1.00-1.19)			1.09 (0.99-1.20)
->III	1.42 (1.12-1.75)¤			1.33 (1.05-1.67)¤
Unknown	1.02 (0.85-1.21)			0.92 (0.70-1.19)
Curative operation				
Yes	1			1
No	1.43 (1.26-1.61)¤¤			1.35 (1.11-1.63)¤
Unknown	1.05 (0.87-1.29)			1.07 (0.77-1.45)
Type of operation				
Rectal resection	1			1
Colonic resection	1.0 (0.91-1.11)			1.10 (0.97-1.25)
Explorative laparotomy or formation of an ostomy	0.91 (0.82-1.01)			1.05 (0.91-1.22)
Local procedures	0.72 (0.56-0.91)¤			0.78 (0.60-1.01)
Unknown	0.93 (0.66-1.26)			0.81 (0.53-1.20)
Post-operative complications				
No	1			1
Yes	1.18 (1.05-1.31)¤			1.25 (1.11-1.41)¤

*Confounders: Gender, age at time of diagnosis, country of birth, marital status and year of operation

§ SES (Socioeconomic status): education, disposal income and job type

¤ Significant at a 0.05 level

¤¤ Significant at a <.0001 level

Depending on year the highest disposal income ranged from 175.500 DKr in 2001 to 299.717 DKr in 2009

Table 5: HR (95% CI) for retirement in relation to socioeconomic and clinical factors among 4343 patients aged 18-63 diagnosed with colorectal cancer in the years 2001 to 2009, and part of the work force at time of follow-up.

Mutually adjusted and controlled for confounders*	HR for transition from sickness absence -> retirement (number of events:569)	HR for transition from work / unemployed -> retirement (number of events: 109)
Status		
Working	---	1
Unemployed		5.89 (3.46-10.03)¤¤
Education		
Primary school	1	1
Vocational and short education	1.13 (0.85-1.51)	1.29 (0.65-2.69)
Medium and long education	1.06 (0.81-1.41)	1.24 (0.64-2.53)
Disposal income #		
Lowest quartile	1	1
Second lowest quartile	0.95 (0.76-1.19)	0.49 (0.27-0.85)¤
Second highest quartile	0.77 (0.60-0.98)¤	0.47 (0.25-0.83)¤
Highest quartile	0.79 (0.60-1.04)	0.29 (0.14-0.57)¤
Job type		
Management and knowledge work	0.59 (0.42-0.82)¤	0.93 (0.85-1.03)
Office and sale (non-manual)	0.72 (0.580.89)¤	0.96 (0.86-1.06)
Manual	1	1
Other	1.05 (0.06-4.85)	0.38 (0.12-1.37)
Previous episodes of work	0.98 (0.95-1.00)	0.93 (0.85-1.03)
Previous episodes of sickness absence	1.00 (0.97-1.02)	0.96 (0.86-1.06)
Previous episodes of unemployment	1.03 (1.00-1.05)¤	1.02 (0.94-1.11)
Type of cancer		
Colonic	1	1
Rectal	1.32 (1.04-1.67)¤	1.33 (0.75-2.34)
Stage		
I	1	1
II	0.85 (0.46-1.46)	1.70 (0.49-4.51)
III	1.13 (0.89-1.44)	1.91 (1.15-3.21)¤
IV	1.58 (1.04-2.42)¤	2.30 (0.88-6.14)
Unknown	1.01 (0.68-1.50)	1.72 (0.82-3.59)
Comorbidity		
No	1	1
Yes	1.03 (0.85-1.24)	1.17 (0.76-1.77)
ASA		
I	1	1
II	1.31 (1.08-1.58)¤	1.56 (1.00-2.44)¤
III	2.16 (1.49-3.06)¤	2.57 (1.03-5.75)¤
Unknown	1.29 (0.76-2.09)	1.64 (0.50-4.24)
Curative operation		
Yes	1	1
No	1.30 (0.89-1.86)	1.80 (0.77-3.84)
Unknown	1.41 (0.75-2.51)	1.05 (0.19-4.01)
Type of operation		
Rectal resection	1	1
Colonic resection	1.42 (1.11-1.81)¤	1.36 (0.74-2.51)
Explorative laparotomy or formation of an ostomy	1.06 (0.78-1.43)	1.23 (0.55-2.32)
Local procedures	1.01 (0.53-1.84)	0.39 (0.08-1.26)
Unknown	1.45 (0.93-2.18)	0.84 (0.16-3.13)
Post-operative complications		
No	1	1
Yes	1.23 (1.00-1.51)¤	0.86 (0.47-1.46)

*Confounders: Gender, age at time of diagnosis, country of birth, marital status and year of operation

¤ Significant at a 0.05 level

¤¤ Significant at a <.0001 level

Depending on year the highest disposal income ranged from 175.500 DKr in 2001 to 299.717 DKr in 2009

Reference List

(1) Ferlay J, Parkin DM, Steliarova-Foucher E. Estimates of cancer incidence and mortality in Europe in 2008. *Eur J Cancer* 2010; 46(4):765-781.

(2) Coleman MP, Forman D, Bryant H, Butler J, Rachet B, Maringe C et al. Cancer survival in Australia, Canada, Denmark, Norway, Sweden, and the UK, 1995-2007 (the International Cancer Benchmarking Partnership): an analysis of population-based cancer registry data. *Lancet* 2011; 377(9760):127-138.

(3) Brenner H, Bouvier AM, Foschi R, Hackl M, Larsen IK, Lemmens V et al. Progress in colorectal cancer survival in Europe from the late 1980s to the early 21st century: the EUROCARE study. *Int J Cancer* 2012; 131(7):1649-1658.

(4) Gordon L, Lynch BM, Newman B. Transitions in work participation after a diagnosis of colorectal cancer. *Aust N Z J Public Health* 2008; 32(6):569-574.

(5) van den Brink M, van den Hout WB, Kievit J, Marijnen CA, Putter H, van de Velde CJ et al. The impact of diagnosis and treatment of rectal cancer on paid and unpaid labor. *Dis Colon Rectum* 2005; 48(10):1875-1882.

(6) Frederiksen BL, Osler M, Harling H, Ladelund S, Jorgensen T. The impact of socioeconomic factors on 30-day mortality following elective colorectal cancer surgery: a nationwide study. *Eur J Cancer* 2009; 45(7):1248-1256.

(7) Cavalli-Bjorkman N, Lambe M, Eaker S, Sandin F, Glimelius B. Differences according to educational level in the management and survival of colorectal cancer in Sweden. *Eur J Cancer* 2011; 47(9):1398-1406.

(8) Egeberg R, Halkjaer J, Rottmann N, Hansen L, Holten I. Social inequality and incidence of and survival from cancers of the colon and rectum in a population-based study in Denmark, 1994-2003. *Eur J Cancer* 2008; 44(14):1978-1988.

(9) Aarts MJ, Lemmens VEPP, Louwman MWJ, Kunst AE, Coebergh JW. Socioeconomic status and changing inequalities in colorectal cancer? A review of the associations with risk, treatment and outcome. *European Journal of Cancer* 2010; 46(15):2681-2695.

(10) Drolet M, Maunsell E, Brisson J, Brisson C, Masse B, Deschenes L. Not Working 3 Years After Breast Cancer: Predictors in a Population-Based Study. *J Clin Oncol* 2005; 23(33):8305-8312.

(11) Steiner JF, Cavender TA, Nowels CT, Beaty BL, Bradley CJ, Fairclough DL et al. The impact of physical and psychosocial factors on work characteristics after cancer. *Psychooncology* 2008; 17(2):138-147.

(12) Paraponaris A, Teyssier LS, Ventelou B. Job tenure and self-reported workplace discrimination for cancer survivors 2 years after diagnosis: does employment legislation matter? *Health Policy* 2010; 98(2-3):144-155.

(13) Earle CC, Chretien Y, Morris C, Ayanian JZ, Keating NL, Polgreen LA et al. Employment among survivors of lung cancer and colorectal cancer. *J Clin Oncol* 2010; 28(10):1700-1705.

(14) Spelten ER, Sprangers MA, Verbeek JH. Factors reported to influence the return to work of cancer survivors: a literature review. *Psychooncology* 2002; 11(2):124-131.

(15) Short PF, Vasey JJ, Tunceli K. Employment pathways in a large cohort of adult cancer survivors. *Cancer* 2005; 103(6):1292-1301.

(16) Mehnert A. Employment and work-related issues in cancer survivors. *Crit Rev Oncol Hematol* 2011; 77(2):109-130.

(17) Dalton SO, Steding-Jessen M, Gislum M, Frederiksen K, Engholm G, Schuz J. Social inequality and incidence of and survival from cancer in a population-based study in Denmark, 1994-2003: Background, aims, material and methods. *Eur J Cancer* 2008; 44(14):1938-1949.

(18) Amir Z, Moran T, Walsh L, Iddenden R, Luker K. Return to paid work after cancer: a British experience. *J Cancer Surviv* 2007; 1(2):129-136.

(19) Carlsen K, Dalton SO, Frederiksen K, Diderichsen F, Johansen C. Cancer and the risk for taking early retirement pension: A Danish cohort study. *Scandinavian Journal of Public Health* 2008; 36(2):117-125.

(20) Sjovall K, Attner B, Englund M, Lithman T, Noreen D, Gunnars B et al. Sickness absence among cancer patients in the pre-diagnostic and the post-diagnostic phases of five common forms of cancer. *Support Care Cancer* 2012; 20(4):741-747.

(21) Syse A, Tretli S, Kravdal O. Cancer's impact on employment and earnings--a population-based study from Norway. *J Cancer Surviv* 2008; 2(3):149-158.

(22) Mols F, Thong MS, Vissers P, Nijsten T, van de Poll-Franse LV. Socio-economic implications of cancer survivorship: results from the PROFILES registry. *Eur J Cancer* 2012; 48(13):2037-2042.

(23) Andersen PK, Keiding N. Multi-state models for event history analysis. *Stat Methods Med Res* 2002; 11(2):91-115.

(24) Christensen KB, Andersen PK, Smith-Hansen L, Nielsen ML, Kristensen TS. Analyzing sickness absence with statistical models for survival data. *Scand J Work Environ Health* 2007; 33(3):233-239.

(25) Gjesdal S, Ringdal PR, Haug K, Maeland JG. Long-term sickness absence and disability pension with psychiatric diagnoses: a population-based cohort study. *Nord J Psychiatry* 2008; 62(4):294-301.

(26) Lie SA, Eriksen HR, Ursin H, Hagen EM. A multi-state model for sick-leave data applied to a randomized control trial study of low back pain. *Scand J Public Health* 2008; 36(3):279-283.

(27) Pedersen J, Bjorner JB, Burr H, Christensen KB. Transitions between sickness absence, work, unemployment, and disability in Denmark 2004-2008. *Scand J Work Environ Health* 2012; 38(6):516-526.

(28) Oyeflaten I, Lie SA, Ihlebaek CM, Eriksen HR. Multiple transitions in sick leave, disability benefits, and return to work. - A 4-year follow-up of patients participating in a work-related rehabilitation program. *BMC Public Health* 2012; 12:748.

(29) Frederiksen BL, Osler M, Harling H, Ladelund S, Jorgensen T. Do patient characteristics, disease, or treatment explain social inequality in survival from colorectal cancer? *Soc Sci Med* 2009; 69(7):1107-1115.

(30) IDA - an integrated data base for labour market research. Main report, 1991 . 2006. Statistics Denmark. Ref Type: Report

(31) Lynge E, Sandegaard JL, Rebolj M. The Danish National Patient Register. *Scand J Public Health* 2011; 39(7 Suppl):30-33.

(32) Kildemoes HW, Sorensen HT, Hallas J. The Danish National Prescription Registry. *Scand J Public Health* 2011; 39(7 Suppl):38-41.

(33) Hjollund NH, Larsen FB, Andersen JH. Register-based follow-up of social benefits and other transfer payments: accuracy and degree of completeness in a Danish interdepartmental administrative database compared with a population-based survey. *Scand J Public Health* 2007; 35(5):497-502.

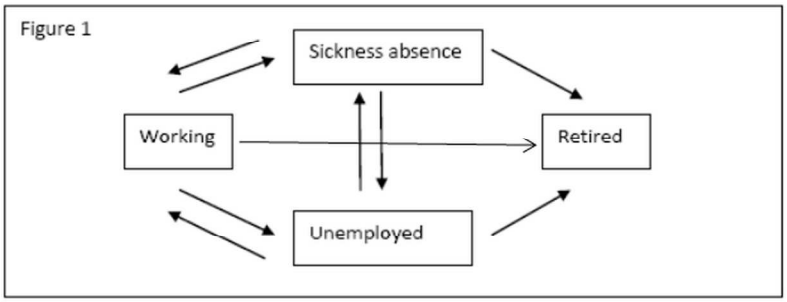
(34) Sanchez KM, Richardson JL, Mason HR. The return to work experiences of colorectal cancer survivors. *AAOHN J* 2004; 52(12):500-510.

(35) Taskila T, Martikainen R, Hietanen P, Lindbohm ML. Comparative study of work ability between cancer survivors and their referents. *Eur J Cancer* 2007; 43(5):914-920.

(36) Mols F, Thong MS, Vreugdenhil G, van de Poll-Franse LV. Long-term cancer survivors experience work changes after diagnosis: results of a population-based study. *Psychooncology* 2009; 18(12):1252-1260.

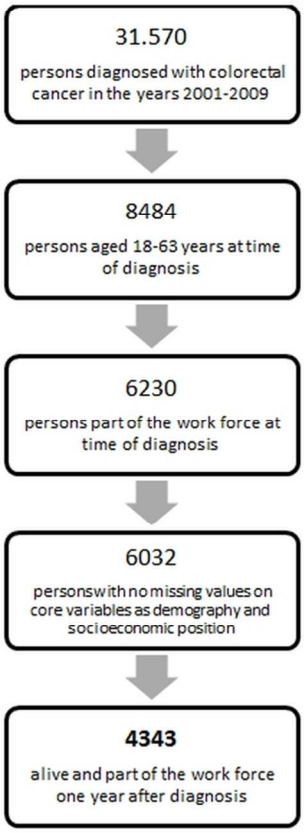
(37) Rodriguez-Bigas MA, Chang GJ, Skibber JM. Barriers to rehabilitation of colorectal cancer patients. *J Surg Oncol* 2007; 95(5):400-408.

Figure 1: Transition states between labor market outcomes in Denmark. Work, sickness absence and unemployment covers persons in the workforce while retirement independent of reason (disability or age) are an irreversible state, where persons are considered to leave the workforce forever.



185x90mm (300 x 300 DPI)

Figure 2: Flowchart showing the selection of persons from the total database to the final study population*.



* From January 2001 to December 2009 a total of 31 570 persons were diagnosed with colonic or rectal cancer. In total we excluded 25 538 persons: 23 086 persons as they were not in their working-age (18-63 years) at time of diagnosis, 2254 had retired due to disability before diagnosis and 198 because of missing values on demographic or socioeconomic variables. In addition, 1689 persons died or withdrew from the workforce within the first year after diagnosis.

90x92mm (300 x 300 DPI)