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Cancer's unequal impact on incomes in Norway

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Abstract

Background. At a group level, cancer results in reduced labor earnings. Public benefits common to welfare states may, however, compensate for all or parts of the decline in earnings. Norwegian cancer survivors' incomes, including both labor earnings and compensatory welfare benefits, were compared to those of the cancer-free population to assess potential welfare consequences of cancer. Possible modifying effects of parental and marital status, education, prior earnings and age were assessed in depth. *Material and methods*. Log-linear regression models were used to estimate incomes across different sociodemographic variables using register data covering the entire Norwegian population 40–59 years old with any income in 2008, 536 600 men and 502 500 women, of whom more than 17 000 were diagnosed with cancer in 2000–2007. *Results*. Compared to the cancer-free general population, cancer was associated with a modest 7% decline in incomes overall. The decline was, however, significantly associated with sociodemographic factors, marital status exempted. Childless men with low education and low prior earnings were most adversely affected. Lymphomas and lung cancer accounted largely for these unfavorable effects. *Conclusions*. Declines in earnings after cancer are to a large degree compensated by the Norwegian welfare state, and incomes overall are only modestly decreased among cancer survivors compared to the general population. Persons with multiple unfavorable sociodemographic characteristics experience particularly low incomes after cancer. This is of concern in a supposedly egalitarian society with public health care and antidiscrimination acts in place. Welfare state interventions, i.e. work reintegration efforts and/or compensations for labor earning drops, directed specifically towards these subgroups might be warranted.

More people survive cancer than ever before, leading to a growing number of cancer survivors. As a consequence, the long-term health and well-being of people living with a history of cancer have attracted increased attention [1]. Research has been particularly concerned with the adverse effects of cancer on persons' labor marked activities, as this may affect the economic well-being of cancer survivors and their families, their identity, life satisfaction, and social relationships. Cancer has been shown to reduce employment and labor earnings across different studies, although the extent appears to depend upon characteristics of the cancer, person and setting [2–7]. Cancer's impact on incomes may, for instance, depend upon persons' educational and/or social or financial resources at diagnosis, as various sociodemographic factors may in part determine and/or reflect an individual's working capacity, productivity, and thus employment probabilities and incomes [8–10].

Knowledge of possible modifying effects of sociodemographic factors on cancer's impact on incomes is necessary for authorities to reach subgroups in need of counseling and interventions appropriately, i.e. work reintegration efforts run by health care personnel and social services or state-funded compensation programs for labor earnings drops [5,11]. Few studies have, however, addressed these factors in detail. We therefore compare Norwegian cancer survivors' current incomes, including both labor earnings and compensatory welfare benefits, to those of the cancer-free population, and aim to explore the extent to which cancer survivors' sociodemographic features influence their incomes given cancer form and stage, from one to eight years postdiagnosis. More specifically, we explore how cancer survivors' current incomes depend upon their age, educational attainment, prior income, number of children and marital status.

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Materials and methods

Detailed register and census data on all Norwegian adults between 40 and 59 years old in 2008 were obtained from national registries. Data from four sources were linked by means of the personal identification number assigned to everyone who has lived in Norway from 1960 onwards. The *Norwegian Population Register* provided information on date of birth, death or migration, dates of changes in marital status from 1999 onwards, and dates of birth of all children. Persons' highest attained educational level was extracted from the *Norwegian Education Register*. *The Norwegian Directorate of Taxes* provided information on yearly gross labor earnings and compensatory public welfare benefits, including sickness benefits, temporary disability pensions, and rehabilitation benefits, enabling us to study incomes in a wider perspective than merely labor earnings. Permanent disability pensions (uncommon) and capital gains were not included in the income variable. Sickness benefits during the first 52 weeks are fully reimbursed by the Norwegian welfare state, and effects on incomes during the first year after a cancer diagnosis will thus not be present. Information on cancer was drawn from the *Cancer Registry of Norway*, which has registered all cancer diagnoses nationwide since 1953. Mandatory reporting from clinicians, pathologists, and death certificates ensures completeness and high data quality on cancer site and stage [12].

Our cohort consists of persons 40–59 years old with any income in 2008. A total of around 536 600 men and 502 500 women were included, representing 91% of the population in the relevant age groups (Table I). The diverse and complex group constituting the remaining 9% excluded from this study includes permanent disability pensioners, housewives, students, persons with large capital gains, and others not eligible for public and/or private compensatory benefits, i.e. persons not employed the previous six months. More than 17 000 persons in our cohort were diagnosed with cancer in the period 2000 through 2007. Persons diagnosed with cancer prior to 2000 or during 2008 were excluded.

Ordinary least square log-linear regression models were used to estimate the effect of a diagnosis of cancer in 2000–2007 on incomes in 2008, i.e. labor earnings and/or public welfare benefits, for men and women separately. The estimates from fully adjusted models and categorizations of covariates are shown in Table II. Table III presents effects of different cancer disease characteristics (i.e. time since diagnosis, cancer site and stage), whereas Tables IV and V portray effects across various sociodemographic variables. Possible modifying effects of age, educational level, prior earnings, parental and marital status were assessed by interaction terms before stratified analyses were undertaken. The PROC REG procedure in SAS® 9.1 was used for all estimations, and the statistical significance level was set at 5%.

Table I. Descriptive statistics of the cohorts included and not included in this study and persons' current and prior income status[a].

	Women 2008[b]				Men 2008			
	Income ≠ 0[c] *Included in study*		Income = 0[d] *Excluded*		Income ≠ 0[c] *Included in study*		Income = 0[d] *Excluded*	
	N	%	N	%	N	%	N	%
Cancer status								
Without cancer	491 418	90.3%	52 730	9.7%	530 475	93.0%	39 752	7.0%
With cancer[e]	11 042	86.5%	1721	13.5%	6172	89.7%	712	10.3%
Total	*502 460*	90.2%	*54 451*	9.8%	536 647	93.0%	40 464	7.0%
	1999[f]				1999			
	Income ≠ 0[c]		Income = 0[d]		Income ≠ 0[c]		Income = 0[d]	
Without cancer	482 977	88.8%	61 171	11.2%	536 790	94.1%	33 437	5.9%
With cancer[e]	11 296	88.5%	1467	11.5%	6457	93.8%	427	6.2%
Total	*494 273*	88.8%	*62 638*	11.2%	*543 247*	94.1%	*33 864*	5.9%

[a]Women and men's income status (gross labor earnings and compensatory public welfare measures, capital gains exempted) at the end and beginning of follow-up. [b]Incomes per December 31 2008. [c]Employed or on public welfare benefits. [d]Not employed and not on public welfare benefits (includes students, home makers and others not qualified for benefits). [e]Diagnosed with cancer 2000–2007. Persons diagnosed prior to 2000 or in 2008 have been excluded from this study. [f]Incomes per December 31 1999.

Table II. A fully adjusted model of the percent wise effects of any cancer diagnosed between 2000 and 2007 on incomes in 2008[a].

	Women				Men			
	N[b]	%	% change[c]	95% CI[d]	N	%	% change	95% CI
Cancer status[e]								
No cancer	491 418	97.8	ref	ref	530 475	98.8	ref	ref
Dx 1–8 years prior	11 042	2.2	−6.6	−7.6, −5.6	6172	1.2	−6.6	−7.9, −5.3
Dx 1–2 years prior	3691	0.7	−4.9	−6.6, −3.1	2403	0.4	−6.2	−8.3, −4.1
Dx 3–4 years prior	3082	0.6	−5.7	−7.6, −3.9	1609	0.3	−8.2	−10.7, −5.6
Dx 5–6 years prior	2401	0.5	−8.5	−10.5, −6.4	1181	0.2	−6.1	−9.1, −3.1
Dx 7–8 years prior	1868	0.4	−9.1	−11.4, −6.8	979	0.2	−5.4	−8.7, −2.0
Age[e]								
40–44 years	141 321	28.1	<0.1	N/A	149 300	27.8	4.2	3.7, 4.6
45–49 years	129 306	25.7	ref	ref	135 631	25.3	ref	ref
50–54 years	123 870	24.7	−8.4	−8.8, −8.0	131 189	24.4	−6.8	−7.2, −6.4
55–59 years	107 963	21.5	−18.4	−18.7, −18.0	120 529	22.5	−15.2	−15.6, −14.8
Education[e]								
Elementary or missing	96 781	19.3	−19.0	−19.4, −18.6	106 157	19.8	−14.7	−15.0, −14.3
High school	90 647	18.0	−8.7	−9.1, −8.2	78 658	14.7	−6.6	−7.1, −6.1
<3 years of college	140 269	27.9	ref	ref	167 626	31.2	ref	ref
3–4 years of college	146 313	29.1	12.7	12.2, 13.1	133 379	24.9	10.6	10.2, 11.1
>4 years of college	28 450	5.7	31.8	30.8, 32.8	50 827	9.5	26.0	25.5, 26.7
Earnings in 1999								
$0 or missing	31 429	6.6	−12.0	−12.7, −11.2	13 835	2.6	13.8	12.3, 15.3
$1–$9999	33 390	10.9	ref	ref	14 279	2.7	ref	ref
$10 000–$19 999	54 700	10.9	30.8	29.8, 31.8	15 293	2.8	63.1	61.1, 65.2
$20 000–$29 999	98 387	19.6	56.4	55.3, 57.5	24 787	4.6	88.8	86.6, 90.6
$30 000–$39 999	139 227	27.7	87.3	86.1, 88.6	82 939	15.5	127.7	125.5, 130.1
$40 000–$49 999	91 742	18.3	121.8	120.2, 123.4	140 279	26.1	167.4	164.9, 170.1
$50 000–$59 999	29 951	6.0	157.9	155.7, 160.2	96 307	17.9	209.8	206.7, 212.9
$60 000–$79 999	16 388	3.3	207.6	204.4, 210.9	86 276	16.1	270.3	266.6, 274.1
> =$80 000	7246	1.4	296.5	290.8, 302.3	62 652	11.7	410.4	405.2, 415.8
Marital status[e]								
Married	304 354	60.6	<−0.1	N/A	316 631	59.0	8.0	7.7, 8.4
Not married	198 106	39.4	ref	ref	220 016	41.0	ref	ref
Children[e]								
Yes	452 931	90.1	14.8	14.2, 15.4	449 674	83.8	15.1	14.6, 15.6
No	49 529	9.9	ref	ref	86 973	16.2	ref	ref

[a]Effects on cancer on incomes, i.e. labor earnings and any compensatory welfare benefits, are modeled. The analyses are limited to only those alive and with a registered income per December 31, 2008. The modeled income for the reference categories are $36 100 for women and $39 200 for men, respectively. [b]Number of persons. [c]Percent wise deviation from reference category. [d]Confidence interval. [e]Per December 31, 2008.

Results

Incomes in Norway are distributed relatively equally. According to *The World Factbook*, CIA, updated on January 24, 2008, Norway's Gini index is 0.25. The median 2008 incomes in this cohort were US $75 400 for men and $54 200 for women. The lower and upper quartiles were $58 700 and $100 600 for men, and $39 800 and $69 000 for women. According to Statistics Norway, gross labor earnings accounted for 70% of a households' total income in 2008. Investments

Table III. Estimates of the effect of cancer site and stage at diagnosis on incomes in 2008[a].

		Women				Men			
	ICD–10	N[b]	%[c]	% change[d]	95% CI[e]	N	%	% change	95% CI
Cancer status									
No cancer	N/A	491 418	N/A	ref	ref	530 475	N/A	ref	ref
Skin cancer	C43–C44	1310	11.9	0.6	–2.4, 3.7	970	15.7	–2.7	–6.1, 0.8
Colorectal cancer	C17–C21	782	7.1	–6.1	–9.7, –2.3	873	14.1	–7.2	–10.6, –3.6
CNS tumors	C69–C72, D32–D33	632	5.7	–17.6	–21.2, –14.0	468	7.6	–17.1	–21.7, –12.8
Renal/bladder cancer	C64–C68	209	1.9	–11.2	–17.7, –4.2	627	10.2	–5.4	–9.5, –1.1
Non-Hodgkin disease	C82–C85, C95	281	2.5	–17.0	–22.2, –11.4	439	7.1	–12.0	–16.5, –7.2
Leukemia	C90–C95	218	2.0	–18.6	–24.4, –12.3	326	5.3	–12.9	–18.0, –7.4
Endocrine cancer	C73–C75	312	2.8	–1.8	–7.5, 3.9	119	1.9	0.6	–9.1, 11.2
Head-and-neck cancer	C00–C14, C30–C32	109	1.0	–8.0	–17.1, 2.2	285	4.6	–5.1	–11.0, 1.3
Lung cancer	C34	135	1.2	–20.1	–27.3, –12.2	150	2.4	–21.1	–27.8, –13.7
Hodgkin disease	C81	62	0.6	–11.2	–22.8, 2.0	108	1.7	–12.2	–21.0, –2.4
Soft tissue cancer	C45–C49	36	0.3	8.4	–9.6, 30.1	46	0.7	–7.3	–21.1, 9.0
Bone cancer	C40–C41	19	0.2	–33.4	–48.2, –14.4	25	0.4	–20.6	–36.3, –1.1
Prostate cancer	C61	N/A	N/A	N/A	N/A	928	15.0	–2.6	–6.1, 1.0
Testicular cancer	C62–C63	N/A	N/A	N/A	N/A	731	11.8	–0.2	–4.2, 3.9
Breast cancer	C50	4808	43.5	–5.7	–7.2, –4.2	N/A	N/A	N/A	N/A
Cervical/uterine cancer	C53–C55	1318	11.9	–3.8	–6.7, –0.9	N/A	N/A	N/A	N/A
Ovarian cancer	C56	759	6.9	–9.4	–13.0, –5.8	N/A	N/A	N/A	N/A
Other or unknown	C76–C80, C88, nos[f]	52	0.5	–11.7	–24.1, 2.7	77	1.2	–8.2	–19.0, 4.1
Stage at diagnosis									
No cancer	N/A	491 418	N/A	ref	ref	530 475	N/A	ref	ref
Local cancer	N/A	6305	57.1	–5.3	–6.6, –4.0	2952	47.8	–4.8	–6.7, –2.8
Regional cancer	N/A	2753	24.9	–7.0	–8.9, –5.1	1166	18.9	–9.2	–12.1, –6.2
Metastatic cancer	N/A	604	5.5	–19.3	–22.8, –15.6	405	6.6	–18.0	–22.3, –13.4
Unknown[g]	N/A	1380	12.5	–6.0	–8.7, –3.2	1649	26.7	–5.0	–7.5, –2.4

[a]Effects on cancer on incomes, i.e. labor earnings and any compensatory welfare benefits are modeled. The modeled income for the reference categories are $36 100 for women and $39 200 for men, respectively. [b]Number of persons. [c]Percentage of cancer cases only. [d]Percent wise deviation from reference category. [e]Confidence interval. [f]Not otherwise specified. [g]Includes cancers with unknown stage, leukemias and around 25% of the lymphomas for which no stage was recorded.

incomes accounted for 9%, while various public benefits accounted for the remaining 21%. Approximately 30% of the Norwegian work force 16–66 years old is estimated to receive different kinds of public economic benefits. This percentage is markedly lower in the age groups considered here (www.ssb.no/en). The estimated income in 2008 of childless, unmarried men 45–49 years old with a partial college degree and labor earnings below $10 000 in 1999 was $39 200. The corresponding estimate for women was $36 100. All percentages stated hereafter refer to changes relative to these sums. Estimates for persons with different sociodemographic characteristics can be calculated on the basis of Table II.

Cancer was associated with a 7% overall reduction in incomes for both women and men compared to that of persons without cancer, but with otherwise similar sociodemographic characteristics (Table II). Statistical significant declines in incomes were documented for most cancer sites for both genders, with the exception of skin, endocrine, head-and-neck, and soft-tissue cancers (Table III). Size wise, the statistical significant negative effects on income ranged from 4–33%. The strongest income declines were seen for leukemia, CNS, lung and bone tumors. Analyses by cancer stage showed that the reductions were minor for local cancers, modest for regional cancers, and most pronounced for cancers with distant spread.

Models that included interaction terms between cancer and sociodemographic variables revealed statistically significant modifications of education level,

Table IV. Women's percent wise change in income after cancer by education, prior income, age and parental status[a].

	Education (2008)		Prior income (1999)		Age (2008)		Children (2008)	
	Low[b]	High[c]	Low[d]	High[e]	40-49 years	50-59 years	No	Yes
No cancer	ref	ref	ref	ref	ref	ref	ref	ref
Any cancer 2000–2007	−7.5***	−6.1***	−5.3**	−6.5***	−4.2***	−8.8***	−5.5***	−6.8***
Time since diagnosis								
No cancer	ref	ref	ref	ref	ref	ref	ref	ref
1–2 years	−7.2***	−3.5**	−1.5	−4.9***	−3.7*	−6.2***	−6.5*	−4.7***
3–4 years	−4.8**	−6.4***	−6.6*	−5.4***	−4.8**	−7.0***	−2.5	−6.3***
5–6 years	−10.8***	−6.8***	−7.8*	−8.3***	−5.2**	−11.5***	−4.5	−8.9***
7–8 years	−8.0***	−9.8***	−6.8	−9.3***	−2.9	−13.2***	−9.9*	−9.2***
Cancer form								
No cancer	ref	ref	ref	ref	ref	ref	ref	ref
Skin cancer	−1.1	1.6	2.6	0.3	2.2	−1.1	−0.1	5.5
Colorectal cancer	−8.5*	−5.3*	9.6	−8.9***	−5.3	−8.2***	−5.0	−6.1**
CNS tumors	−18.2***	−17.9***	−19.7**	−16.5***	−16.7***	−18.5***	−22.5***	−17.2***
Renal/bladder cancer	−22.8***	0.2	−14.1	−13.5***	−12.9*	−12.8**	−6.5	−11.9**
Non-Hodgkin disease	−13.5*	−18.2***	−8.1	−19.9***	−8.3	−21.5***	−14.8	−17.5***
Leukemia	−17.2**	−21.2***	−11.6	−19.7***	−13.4*	−23.0***	13.3	−21.7***
Head-and-neck cancer	−4.6	−11.5*	−9.7	−6.7	−12.3	−7.4	−14.1	−7.6
Lung cancer	−18.6**	−21.6***	−20.2	−20.8***	−7.0	−23.8***	−16.5	−20.7***
Hodgkin disease	−10.6	−7.8	−6.9	−9.8	−6.5	−15.6	−33.5	−6.8
Breast cancer	−5.9***	−5.5***	−6.7*	−5.1***	−2.9*	−7.8***	−8.7**	−5.5***
Cervical/ uterine cancer	−4.6	−2.9	−2.9	−2.6	0.1	−7.7***	−4.1	−4.7**
Ovarian cancer	−10.1**	−9.1***	−5.2	−8.4***	−12.0***	−8.0**	−2.0	−10.8***
Stage at diagnosis								
No cancer	ref	ref	ref	ref	ref	ref	ref	ref
Local cancer	−5.7***	−5.1***	−3.2	−5.6***	−2.8*	−7.7***	−5.9**	−5.3***
Regional cancer	−8.3***	−6.3***	−8.1*	−6.4***	−5.0**	−8.7***	−4.6	−7.5***
Metastatic cancer	−21.4***	−17.4***	−12.4*	−18.0***	−20.1***	−20.0***	−10.3	−20.2***

[a]All variables from the final model in Table II were included in all models, the respective stratifying variable excempted. [b]Low education includes education at or below high school level and missing. [c]High education includes education beyond high school level. [d]Low income refers to labor earnings < $30 000 in 1999. [e]High income refers to labor earnings > = $30 000 in 1999. *p-value < 0.05. **p-value < 0.01. ***p-value < 0.001.

prior earnings, age and parental status. The effect of marital status did not vary with cancer and these results are thus not shown. The effect of cancer was most severe for those with a low educational level and/or low prior earnings ($p_{interaction}$ 0.03 and < 0.001 for women, respectively, and 0.05 and < 0.001 for men). Similarly, effects of cancer become more pronounced with increasing age ($p_{interaction}$ < 0.01 for women and 0.05 for men). A statistically significant negative modifying effect of parental status was observed for women ($p_{interaction}$ 0.03). An opposite effect was observed for men, albeit not statistically significant ($p_{interaction}$ 0.08). There was no effect modification of marital status ($p_{interaction}$ 0.51 and 0.29 for women and men, respectively).

Cancer had a more severe effect in persons with a low education compared to those with a higher education, especially for men where the reduction was twofold (Tables IV and V). The largest discrepancies in the effect of cancer sites across educational levels were observed for renal and bladder cancer (both genders), and for male skin, lung, and prostate cancer. Central nervous system (CNS) tumors had a similar impact on incomes irrespective of gender and education.

Men's prior earnings were an important determinant of the effect of cancer. Men with low prior earnings experienced a much greater income decline than men with higher prior earnings. The tendency went in the other direction for women, although minor

Table V. Men's percent wise change in income after cancer by education, prior income, age and parental status[a].

	Education		Prior income (1999)		Age (2008)		Children (2008)	
	Low[b]	High[c]	Low[d]	High[e]	40-49 years	50-59 years	No	Yes
No cancer	ref	ref	ref	ref	ref	ref	ref	ref
Any cancer 2000-2007	−9.6*****	−4.8***	−11.5*	−4.7***	−4.9***	−8.7***	−8.9***	−6.1***
Time since diagnosis								
No cancer	ref	ref	ref	ref	ref	ref	ref	ref
1-2 years	−9.2***	−4.5***	−16.0	−5.1***	−6.1**	−7.6***	−8.1*	−5.8***
3-4 years	−9.9***	−6.9***	−9.8	−6.0***	−4.5*	−11.3***	−7.1	−8.2***
5-6 years	−10.1***	−4.0*	−19.3*	−2.3	−6.0*	−7.6***	−11.3*	−5.0**
7-8 years	−9.6**	−3.1	−16.0	−4.3*	−2.3	−8.6***	−11.3*	−4.7**
Cancer form								
Skin cancer	−7.4*	0.8	−21.5	1.4	−3.0	−3.6	−9.1	−1.4
Colorectal cancer	−6.3	−8.3***	9.1	−7.0***	−8.0*	−8.7***	−11.2	−6.8***
CNS tumors	−18.5***	−17.4***	−32.4*	−15.1***	−13.7***	−20.9***	−5.4	−19.2***
Renal/bladder cancer	−12.7***	0.5	−14.9	−2.6	−7.8*	−6.2*	−5.6	−5.3*
Non-Hodgkin disease	−12.9**	−10.7***	−27.7	−6.0*	−12.7**	−12.5***	−21.2**	−9.1***
Leukemia	−9.6	−15.0***	4.5	−15.5***	−6.1	−17.1***	−16.8*	−12.7***
Head-and-neck cancer	−5.5	−3.3	5.8	−3.5	0.2	−7.6*	−10.8	−4.9
Lung cancer	−29.9***	−12.4*	−33.3	−22.0***	−15.2	−24.2***	−51.0***	−15.1***
Hodgkin disease	−8.1	−15.0**	−23.6	−8.7	−13.4*	−10.9	−18.8	−9.7
Testicular cancer	−1.0	0.2	−13.1	0.9	1.0	−1.5	−7.5	1.5
Prostate cancer	−6.5*	−0.2	1.9	−1.7	20.1*	−6.0**	9.6	−3.7*
Stage at diagnosis								
Local cancer	−7.7***	−3.3**	−10.4	−2.5*	−3.4***	−7.0***	−5.2	−4.6***
Regional cancer	−11.3***	−7.6***	−14.2	−6.2***	−9.5***	−10.2***	−15.0**	−8.3***
Metastatic cancer	−23.6***	−13.5***	−19.2	−17.0***	−11.1*	−22.4***	−30.3***	−15.2***

[a]All variables from the final model in Table II were included in all models, the respective stratifying variable excempted. [b]Low education includes education at or below high school level and missing. [c]High education includes education beyond high school level. [d]Low income refers to labor earnings < $30 000 in 1999. [e]High income refers to labor earnings > = $30 000 in 1999. *p-value < 0.05. **p-value < 0.01. ***p-value < 0.001.

differences were observed. Cancer sites where discrepancies were observed among women include non-Hodgkin disease, leukemia, colorectal and ovarian cancer. Among men, this was seen after lymphomas, skin and lung cancer.

Age is an important income determinant in itself, but the effect of cancer on incomes also depended strongly on age. The most severe effects were seen for the oldest persons (50–59 years old vs. 40–49 years old). The effect was doubled for the oldest women, and nearly doubled for the oldest men. Across cancer sites it appeared that effects were most adverse for older women with lymphoma, leukemia, lung, breast, cervical and uterine cancer. For men, the largest effects were observed after leukemia, head-and-neck, lung and prostate cancer.

Parental status had a different effect for women and men. Women with children had more pronounced income declines than childless women, whereas childless men experienced larger declines in income than men with children.

Income declines were particularly strongly associated with sociodemographic variables when more than one adverse factor was present. As an example, cancer was associated with a 46% decline in income among younger, childless men with a low education ($p < 0.01$). For these men, even skin cancer which otherwise appeared not to affect incomes, was associated with an income decline of 76% ($p = 0.04$). The decline became evident shortly after diagnosis and remained pronounced (not shown). For older men with similar characteristics, a 29% decline in incomes was observed, and it was particularly detrimental after lung cancer where a 90% reduction was observed ($p < 0.01$). Such negative effects were also observed after lymphomas, renal, bladder and prostate cancer. For younger men with children, a higher education and decent prior earnings, there was no effect of cancer. For older men, there was a minor 4% reduction (not shown). Differences were less pronounced among women, but those with children, a low education and low prior earnings saw an 8–9% decline in incomes, independent of age ($p = 0.03$, not

shown). Incomes of younger women without children, and with a higher education and higher prior earnings were not affected by cancer, whereas an adverse effect of around 13% was observed for older women with otherwise similar characteristics ($p < 0.01$, not shown).

Discussion

A diagnosis of cancer is associated with statistically significant reductions in actual incomes, measured as a combination of labor earnings and welfare benefits. The estimated effects are likely to underestimate the real effect of cancer in the total population, as the study design and available data provides a cross-sectional snapshot of incomes in 2008 among cancer survivors diagnosed during 2000–2007, and thus portrays fewer short- than long-term survivors for whom effects have been shown to be more pronounced [8].

The documented reduction is minor compared to earlier estimates where compensatory welfare benefits provided by the Norwegian welfare state in case of serious disease were left out, where a 12% average income decline was estimated [9]. Similarly, the differential effect of cancer across social groups appears to be rebuffed quite well by the welfare state. The inclusion of compensatory benefits narrows the gap between the different social groups, as compared to what has been reported earlier [9]. Nevertheless, statistically significant and sometimes pronounced differences remain, suggesting a need for a policy change towards certain underprivileged groups, especially when more than one adverse factor is present.

Only a limited number of other studies have addressed income declines after accounting for welfare compensations, and somewhat mixed results have been found: A Canadian study of the impact of breast cancer suggested a 27% decline in overall income [13], and a Brazilian study of the long-term consequences of head-and-neck cancer stated that 42% of survivors reported a significant decrease in household incomes [14]. A US study including different cancer sites among patients 55 years and older found, however, no effect of cancer on household incomes as compared to non-cancer patients [15]. Likewise, estimated incomes in the absence of cancer were stated to be nearly identical to actual reported incomes among US breast cancer survivors [16].

Cancer disease characteristics

Previous research has suggested that lung, CNS and head-and-neck tumors impact more severely on working ability and opportunity than, for instance testicular or breast cancer [6,10,17,18]. Lung cancer and head-and-neck cancer are more common among persons with a low educational level and a low income [19]. In addition, also the spread of disease at diagnosis may be important for the impact on employment and incomes [9]. At a population level, lesser educated, unmarried persons present with more advanced cancer at diagnosis [19,20]. In this study, the most pronounced income declines are observed for leukemia, non-Hodgkin disease, CNS, lung, bone, renal, bladder and colorectal tumors. Other studies, not accounting for welfare state compensations, have shown similar patterns, bone, renal and bladder cancer exempted [21,22]. The findings are not unexpected due to the nature of these diseases as they may be quite debilitating [23], thus influencing the capacity to uphold work and earnings.

Cognitive function is closely connected to labor earnings and incomes, as is observed for CNS tumors. Focus has recently been diverted to potential adverse effects of the increased use of chemotherapy on cognitive functioning [24]. Leukemia and lymphoma are commonly treated with chemotherapy, and we did find sharp effects on incomes for these cancer sites. Although statistically significant, the reductions in incomes are minor to modest for female survivors of breast and gynecological cancer. The impact of breast cancer thus falls between what has been reported in studies in this area taking compensatory measures into account [13,15,16], perhaps reflecting in part the Norwegian dual earner labor market with a comparatively larger proportion of females in the work force (www.ssb.no/en and www.prb.org/). The effect of head-and-neck cancer is minor and well below previously reported effects [14]. Skin, testicular, and prostate cancer are not associated with reduced incomes, in line with findings from a recent meta-analysis and review on employment [2,6].

Metastatic disease influences incomes adversely, and the effects are three-to-four times that of localized disease. On the one hand, this could be expected based on the likely reduced labor force participation in case of serious illness [3]. However, it does imply that illness-induced welfare options may be less well suited for persons near end-of-life versus in rehabilitation or on their way back to work. Documentation of this may contribute in policy discussions around compensatory benefits at various stages of illness.

Education and prior earnings

Studies have suggested that the effect of cancer on incomes is more severe in persons who perform manual, strenuous labor and have inflexible work schedules [3,6]. This type of labor is most common among persons with less education and lower prior earnings

[25]. Hence, a modifying effect of educational level and prior earnings on the impact of cancer could be expected. In this study, men with low education or low prior income experienced a twofold decline in incomes compared to highly educated or high-income men. Such differences were not observed for various socio-economic groups of women. CNS tumors had an equal effect across educational levels, which is not surprising as both physical and cognitive functioning may be dramatically altered and interfere strongly also with the ability to hold demanding, high earning positions [18].

Overall, declines in incomes are less pronounced than what has been suggested for earnings, i.e. compensatory measures excluded [9]. This may indicate that the welfare system helps reduce differentials in the effect of cancer on incomes, albeit not completely. Education is positively associated with health literacy [26], and persons with higher levels of education might have an advantage in navigating the health and welfare systems to ensure optimal follow-up and/or compensations to help maintain adequate incomes. Further research is warranted in this area, as reviews suggest that studies provide mixed results on the influence of sociodemographic factors on employment and earnings [3,6].

Age

The age span of workers in this study was narrow. Our results suggest nevertheless that cancer has a nearly twofold adverse effect on incomes of the older versus younger persons, in line with what has been reported previously [3].

Gender issues, values and priorities

Individuals' values and priorities may change after cancer, and given sufficient economic flexibility, persons may regard work as less important and thus choose not to work or reduce the working hours, and direct more attention towards family, friends, and rewarding leisure activities [27]. Although the overall effects of cancer on incomes appear relatively similar for men and women, certain disparities deserve being mentioned: Cancer prevalence is higher among women (2.2%) than men (1.2%) in the age groups included here, both due to a slightly higher incidence but also due to better survival [19,20]. Incomes are in general lower among women than men, in Norway as in most other developed countries, and a 7% income reduction may thus have a larger impact for women's total economic situation [28]. However, men remain primary breadwinners in Norway, and may thus have greater economic responsibilities in households. They may therefore be less likely to opt to reduce hours or change to a less demanding position following illness, given that they have a choice. As married persons have a stronger economic flexibility compared to singles, the influence of cancer could be hypothesized to differ between married and unmarried persons, especially for married women who generally contribute less to a household's combined income (www.ssb.no/en). It was therefore somewhat surprising that no significant differences were seen for married and unmarried women or men.

The majority of cancer survivors have completed their fertility at diagnosis. Being a parent is thought to adversely influence the effect of cancer on incomes as caring for minor children in the household may be burdensome for cancer patients when dealing with their own disease [29], thus impacting negatively on their working ability or their employment choices and options. We find overall small differences by parental status. The effects tend, however, to go in opposite directions for men and women: Women without children experience smaller declines in their incomes compared to women with children, and vice versa for men.

Data limitations and methodological considerations

A large and detailed data set including the entire Norwegian population with incomes per December 31, 2008 has been utilized. The use of national register data minimizes bias, and our findings may thus complement results from smaller studies reporting somewhat conflicting results as to the extent of declines in incomes after cancer [2,3,6]. One important limitation of our study is that we lack information on persons' living arrangements. We are thus only able to explore effects on individuals' own incomes, and not effects on equalized household incomes. In an earlier study of married couples in Norway, it was observed that female spouses' incomes dropped significantly when their husbands were diagnosed with cancer, whereas this was not true for men married to women who were diagnosed with cancer [30]. Future research is thus warranted to examine also household level effects. Further, we do not have data on job tasks, work schedules or other information on persons' work situation that might help explain some of the disparities between persons with sociodemographic features.

Furthermore, the cross-sectional snapshot of incomes in 2008 among cancer survivors diagnosed during 2000–2007 provides estimates for fewer short- than long-term survivors, and effects have been shown to be less pronounced for the latter group [8]. In addition, our data cannot shed light on effects during the first year after diagnosis where

treatment burdens are high and work capabilities low [3]. Lastly, persons with cancer appear more likely to be without any income after cancer, and this group was not included in our study. The estimates presented here are thus likely to slightly underestimate the true effect of cancer.

Norway is a welfare state: Public health care is available and provided to all citizens free of charge. The direct costs associated with becoming ill with cancer, i.e. diagnostic work-up and treatment, are thus minimal. In addition, multiple welfare benefits are endorsed to compensate for declines in earnings. These compensatory measures are included in the income variable, and may thus not be explored separately. The comparisons of the possible influence of sociodemographic factors are therefore difficult cross-culturally. Nonetheless, as cancer incidence and mortality (www.globocan.fr) and work force participation rates in Norway are comparable to those of other developed countries, we consider it likely that our findings may apply to countries with similar health and welfare options, as for instance Canada and other Nordic and Western European countries.

Conclusion

On average, persons' earnings are reduced after cancer. The declines in earnings are, however, to a large degree compensated by the Norwegian welfare state, and incomes overall are only modestly decreased among cancer survivors compared to the general population and will likely have a modest impact on the financial situation for most cancer survivors in Norway. Our results show, however, that cancer survivors with low prior earnings and/or a low educational level and survivors of cancer sites with the sharpest effects may be seriously affected even after welfare state compensations are taken into account, and especially when more than one adverse factor is present.

Welfare options appear less well suited for persons with advanced disease compared to those in rehabilitation or on their way back to work, and further research in this area on cancers with poor prognosis is warranted. Such documentation may contribute in policy discussions around the size and duration of compensatory benefits at various stages of illness.

Different opportunities and choices in work attachment following cancer illness that relate to sociodemographic features warrant further research directed at implications at both an individual and a societal level, and specific work reintegration efforts and/or programs compensating for labor income drops might need to target these subgroups specifically.

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