SSM – Population Health 3 (2017) 99–110

Contents lists available at ScienceDirect

SSM – Population Health

journal homepage: www.elsevier.com/locate/ssmph

Article

In sickness and in health: The role of marital partners in cancer survival

Astri Syse[a,*], Torkild Hovde Lyngstad[b]

[a] Statistics Norway, Dep. of Research, P.O. Box 8131 Dep., N-0033 Oslo, Norway
[b] University of Oslo, Department of Sociology and Human Geography, P.O. Box 1096 Blindern, N-0317 Oslo, Norway

ARTICLE INFO

Keywords:
Norway
Cancer
Education
Married
Partner
Socioeconomic
Spouse
Survival

ABSTRACT

Married cancer patients enjoy a survival advantage, potentially attributable to better health at diagnosis, earlier contact with health personnel, and/or access to resources to ensure more optimal treatment. These mechanisms only invoke the mere presence of a partner, but partners bring varying amounts of resources into the household. It is likely that also spousal resources contribute to differentials in survival net of own resources, as gradients in survival by the latter are well documented. Our aim is to examine the combined roles of own and spouses' socioeconomic characteristics (SES) and age for cancer survival.

Almost 268,000 married patients diagnosed with a first cancer after age 50 during 1975–2007 were identified from the Norwegian Cancer Registry and other national registers. In a sequence of hazard models, differences in survival by patients' own education, income and age and the role of spouses' characteristics were assessed. Furthermore, we also assessed the importance of homogamy/heterogamy along the same dimensions.

Partners' characteristics clearly matter for survival. The relative survival of patients with highly educated partners, net of their own education, is significantly higher than that of patients with lesser-educated partners. Somewhat similar effects are observed for income, net of education. A less consistent pattern is observed for age, although non-normative heterogamy patterns in age and income appear to be associated with a survival disadvantage.

The naïve perspective of only considering the presence of partners may thus conceal important differences in cancer survival. Health personnel may take advantage of such knowledge in interactions with patients and their families, and gather information on resources in immediate networks that may impact prognosis favorable and/or unfavorable and help patients utilize these resources to improve prognosis.

1. Introduction

Cancer survival is associated with marital status, with married persons having a survival advantage (Kravdal, 2001; Pinquart & Duberstein, 2010; Fossa et al., 2011). Some evidence suggests that this improved survival primarily stems from selection mechanisms, i.e. that healthy or resourceful individuals select one another for marriage. The extant literature also suggests, however, that protection mechanisms are at play (Goldman, 1993, 1994). Individuals with partners may have healthier lifestyles and behaviors (Monden, van Lenthe, Dirk De Graaf, & Kraaykamp, 2003), and therefore better general health at diagnosis, which is favorable for tolerating cancer treatment and thus prolonging survival. Having a partner may also promote earlier contact with health personnel in general and perhaps especially when one suspects disease (Seo & Lee, 2010). This may result in married patients presenting with an earlier stage at diagnosis and thus a more favorable prognosis (Nayeri, Pitaro, & Feldman, 1992; Osborne, Ostir, Du, Peek, & Goodwin, 2005; Lai & Stotler, 2010). Finally, having a partner at diagnosis may help ensure more optimal treatment and follow-up care, which in turn affects survival (Kravdal, 2000; DiMatteo, 2004).

Importantly, all these suggested mechanisms invoke the mere presence of partners and do not consider the partners' own characteristics that are indirectly or directly relevant for cancer survival. In a related literature, a large number of studies have documented survival advantages for those who hold various types of resources, including long educations and high incomes. Educational inequalities in cancer survival have been documented across a wide range of countries (Kinsey, Jemal, Liff, Ward, & Thun, 2008; Elstad, Torstensrud, Lyngstad, & Kravdal, 2012; Aarts, Koldewijn, Poortmans, Coebergh, & Louwman, 2013). These differences are obviously shaped by lifestyles and health behaviors, but possibly also by quality of cancer treatment and care. Highly educated individuals may take more effective advantage of available health inputs and have a better under-

* Corresponding author.
E-mail addresses: sya@ssb.no (A. Syse), t.h.lyngstad@sosgeo.uio.no (T.H. Lyngstad).

http://dx.doi.org/10.1016/j.ssmph.2016.12.007
Received 21 January 2016; Received in revised form 2 May 2016; Accepted 12 December 2016

standing of the relationship between health behaviors, treatment and outcomes (e.g. Kenkel, 1991; Cutler & Lleras-Muney, 2012). Patient-provider communication and use of specialist care is known to vary with patients' SES, with the level of education being of particular importance (see e.g. Bago d'Uva & Jones, 2009; Smith, Dixon, Trevena, Nutbeam, & McCaffery, 2009; Marks, Ok, Joung, & Allegrante, 2010; Bowen, Hannon, Harris, & Martin, 2011). Access to and utilization of highly specialized treatment has been shown to affect survival after cancer, and relates to both the level and type of educational attainment (Fiva, Haegeland, Ronning, & Syse, 2014). It may thus be argued that better educated persons have a better understanding of the healthcare system, and thus are better at navigating their way through the health bureaucracy, claiming their rights, acquiring relevant information, and communicating their symptoms.

Further, income, net of education, has been shown to influence general health and mortality positively (Elo, 2009), and also cancer survival specifically (Woods, Rachet, & Coleman, 2006; Lejeune et al., 2010). Most commonly, individuals' own income has been used, but also household income and husbands' incomes in studies of women as a proxy for social class have been applied, along with neighborhood deprivation characteristics (Quaglia, Lillini, Mamo, Ivaldi, & Vercelli, 2013).

Lastly, age plays an important role for cancer survival. Age is a prognostic factor for most cancer forms, with younger individuals in general having better survival (Syse, Veenstra, Aagnes, & Tretli, 2012). However, net of individuals' own age, the age of a spouse may play a role through many of the same mechanisms operating through education: Younger partners may be better at seeking information and navigating the healthcare system, may have less respect for authorities and thus gain access to better treatment and care with implications for survival.

When these literatures are considered in combination, partners' resources emerge as a factor that may help produce and modify the marital survival advantage. Partners are different, and bring varying amounts of resources into the household. These resources may contribute to differentials in survival, net of the patient's own resources. A handful of studies have showed variations in mortality or self-reported health by various measures of spouses' SES, reporting somewhat mixed results (Jaffe, Eisenbach, Neumark, & Manor, 2006; Torssander & Erikson, 2009; Brown, Hummer, & Hayward, 2014; Spoerri, Schmidlin, Richter, Egger, & Clough-Gorr, 2014). A Norwegian study found small effects of spouses' SES on cancer mortality relative to overall and CVD mortality (Skalicka & Kunst, 2008).

Notably, the term cancer refers to more than hundred different forms of disease (Adami, Hunter, & Trichopoulos, 2008). Almost every tissue in the body can spawn malignancies, and each cancer has unique features. This extends to signs, symptoms, treatment options, prognosis and long-term effects. However, for many, cancer as a term is associated with certain connotations and life changes, almost regardless of the uniqueness of the specific cancer in question. Cancer may thus be considered an overarching, broad-spanning disease.

Most of the literature that explicitly include measures of spouses' resources examine mortality and do not account for the fact that illnesses may affect couples differently depending on spouses' resources, cf. Monden et al. (2003) and Monden (2007). Our contribution to the literature is thus threefold: First, we examine differences in cancer survival by patients' and their spouses' educations, incomes and ages. Second, we assess the importance of homogamy and heterogamy along these dimensions by combining information patents and their spouses (Martikainen, 1995). Finally, we test whether or not differentials by SES and/or age homogamy can be attributed to early diagnosis or cancer form.

2. Material and methods

Our data were obtained from various population-wide longitudinal administrative registers. A licensure to link data from the registers was provided by the National Data Inspectorate in Norway after ethical review by the Norwegian Board of Medical Ethics.

As all cancer cases in Norway have been registered by the Norwegian Cancer Registry from 1953 onwards, high quality data at a population level is available (Larsen et al., 2009). Our data include basic demographic information, cancer stage and form, and annually (and in some cases monthly) updated information on persons' children, marital status, income, and educational level. The data were linked by means of a unique personal identification number assigned all residents in Norway. Identical data on the patients' spouses at time of diagnosis were linked through unique family ID numbers. A spouse at time of diagnosis was identified for 99.2% of the married cancer patients, and the 0.8% for which no spouse could be identified was excluded. The data set for analysis thus encompasses the entire population of married persons with a first diagnosis of cancer after age 50, resident in Norway during the period 1975–2007. Altogether 267,946 married individuals were followed from time of diagnosis for an average of 4.3 years. 158,745 deaths occurred during the observation period, of which 87% were due to cancer. A sub-analysis where only cancer deaths were included as events and observations were censored if non-cancer deaths occurred, gave virtually identical results. However, as cause-of-death registration is difficult in older cancer patients with several comorbidities (Mackenbach, Kunst, Lautenbach, Oei, & Bijlsma, 1997), we only report results from all-cause models.

For each individual, a series of one-month observations was created, starting at the time of diagnosis and ending at the end of 2007 or when the person died, experienced a marital status change, had lived ten years since diagnosis (an observation window commonly used when studying cancer survival), were diagnosed with a second cancer or emigrated, whichever came first. Each observation included a number of variables that referred to the situation at the beginning of the one-month period. Our analysis consists of three steps: First, we modeled survival after a cancer diagnosis, within a discrete-time hazard framework (Allison, 1995), as a function of patients' own education and income and controls (Model I). Educational level for both patient and spouse was categorized as having a college-level education or not. Income was measured differently for patients in different age groups at diagnosis. For patients age 50–67 at time of diagnosis, we used income the year prior to diagnosis to avoid issues of reverse causation, as cancer has been shown to affect earnings (Syse, Tretli, & Kravdal, 2008). For patients age 68 and older, we used income at age 67. The income of spouses was assessed the same year as that of their partners, regardless of age, as cancer impacts also on spouses' incomes (Syse, Tretli, & Kravdal, 2009). The income measure was diverted into quintiles for men and women diagnosed at similar ages during the same calendar year. Similarly was done for spouses' incomes.

A set of controls were included in all models. Calendar year was categorized as 1975–79, 1980–84, 1985–89, 1990–94, 1995–99, 2000–04 and 2005–07. Time since diagnosis was grouped into ten one-year intervals. Age of patients and spouses was grouped into five-year categories. Parental status was defined as no, one, two, three or four or more children.

The second step in the analysis was to add a corresponding set of measures of spouses' SES characteristics (Model II). Subsequently we assessed the importance of homogamy/heterogamy in age, education and income (Model III). Patients' and spouses' SES and age were combined in measures of homogamy. Educational homogamy was measured by combining patients' and spouses' high vs low levels into a categorical variable. Differences in age between spouses were categorized in three groups with differences of ± five years. To measure income homogamy, an indicator of the patient's share of the household

income was created based on whether his/her share was less than 40%, equal (40–60%) or more than 60%.

In the final model (IV), we examined to what extent differentials observed in the first set of models could be attributed to cancer stage and form differences. Cancer form was included as a categorical variable with nine and ten levels for men and women, respectively. The categories were: hematopoietic, lymphoid, skin, colorectal, breast (women), gynecological (women), prostate (men), pancreatic, lung, renal/bladder and other cancers. Stage was categorized as localized, regional, distant or not applicable/unknown. Including these latter factors allowed us to shed light on the role of early diagnosis. When cancer form and stage are adequately controlled for, any remaining effects are likely a result of the cancer patients' general health status at diagnosis or health behavior afterwards, or the treatments received, perhaps affected by the resources of the spouse, net of own such resources. Ideally, we would have included also (first course of) treatment, but this information was not available.

Cancer incidence and the importance of partner resources for survival may be dependent on the patient's sex. All models were thus estimated separately for female and male patients. However, to facilitate comparisons across sex, a subanalysis including only cancers common for both sexes was also conducted. A number of sensitivity analyses reported in the Appendix (Tables A1–A6) test whether the focal relationships depend upon cancer stage and form.

3. Results

3.1. Descriptive statistics

There were more male (63%) than female cancer patients in our cohort of married individuals (Table 1). The female cancer patients were younger on average than the male patients: The mean age at diagnosis was 65.4 years for women and 69.7 years for men. Among both patients and their spouses, more women than men held only a basic education. Around 14% were childless at age 50, whereas 20% had one child, 32% had two children and 21% had three children. The most common cancer forms were prostate (men), breast (women), colorectal, and lung. Overall, around half the cancers were localized at diagnosis, 25% regional and 15% were metastatic. Around 10% of the patients were censored due to a second cancer diagnosis. Additional descriptives are available in the Appendix.

3.2. Results from hazard regression models

Table 2 shows results from four models: Model I included only the patients' own age, education and income, whereas Model II also includes a set of corresponding spousal characteristics.

The odds ratio for one's own education was weakened somewhat by the inclusion of spousal characteristics, for both female and male patients. Male patients with wives with a college education had a 17% improved survival relative to that of male patients with wives with a lower education, all else equal, whereas female patients with husbands with a college education had a 14% improved survival relative to that of female patients with husbands with a lower education. For male patients, a weak adverse effect of having high earning wives was observed, whereas a weak protective difference was observed for female patients with high earning husbands. Spouses' age was not associated with patients' survival (not shown).

Model III shows estimates for the combined characteristics of patients and their spouses. Female patients who were more than five years older than their husbands had a survival disadvantage of around 11%. Similarly, male patients with older wives had an 8% survival disadvantage. Models with linear parameterizations of the age difference confirmed these results. Patients in marriages where both spouses had higher education had a significant survival advantage of around 25% relative to patients in marriages where both spouses had a low

Table 1
Descriptive statistics of the study cohort (%).

	Male patients (N=168,019)	Female patients (N=99,927)	Total (N=267,946)
Age at diagnosis (50–101 yrs)			
50–54	5.5	13.9	8.7
55–59	9.3	16.5	12.0
60–64	14.1	18.0	15.6
65–69	18.5	17.3	18.1
70–74	20.7	15.6	18.8
75–79	17.7	11.3	15.3
80–84	10.0	5.5	8.3
85 and older	4.1	1.9	3.3
Spouses' age at diagnosis (19–101 yrs)			
≤ 54	12.5	8.1	10.8
55–59	12.7	13.3	13.0
60–64	17.0	16.5	16.8
65–69	19.1	17.6	18.5
70–74	17.9	17.1	17.6
75–79	12.4	13.8	13.0
80–84	5.8	8.5	6.8
85 and older	2.6	5.1	3.5
Education			
High school or below	84.4	89.3	86.3
Any college education	15.6	10.7	13.7
Spouses' education			
High school or below	90.6	83.1	87.8
Any college education	9.4	16.9	12.2
Parental status			
No children	13.9	14.5	14.1
1 child	19.5	19.6	19.5
2 children	31.1	32.5	31.7
3 children	21.0	20.7	20.9
≥4 children	14.6	12.6	13.8
Cancer form			
Colorectal cancer	20.5	19.3	12.9
Prostate cancer	27.5	N/A	17.3
Lung cancer	11.7	5.8	7.3
Renal/bladder cancer	11.2	4.9	7.0
Breast cancer	N/A	25.5	9.5
Skin cancer	7.9	7.7	5.0
Lymphoid cancer	3.4	3.2	2.1
Hematopoietic cancer	3.7	3.5	2.3
Female gynecological cancer	N/A	16.7	6.2
Pancreatic cancer	2.6	2.7	1.6
Other/unknown cancer	11.5	10.8	7.2
Stage at diagnosis			
Localized cancer	49.0	50.1	49.4
Regional cancer	22.6	29.5	25.1
Metastatic cancer	15.0	14.0	14.6
Unknown or not otherwise stated	13.5	6.4	10.9
Number of cancers			
1	89.4	90.1	89.6
≥2	10.6	9.9	10.4

Table 2
Modeled estimates of the impact of characteristics of patients (Model I), patients and their spouses (Model II) and spousal homogamy/heterogamy (Models III and IV) on the risk of death for male and female cancer patients.[a]

	Male cancer patients								Female cancer patients							
	Model I		Model II		Model III		Model IV		Model I		Model II		Model III		Model IV	
	OR[b]	95% CI[c]	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Patients' SES																
Low education[d]	1	Ref	1	Ref					1	Ref	1	Ref				
High education	0.81	0.79–0.82	0.85	0.83–0.86					0.79	0.76–0.82	0.84	0.81–0.87				
Lowest income quintile[e]	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
4th income quintile	0.80	0.78–0.83	0.80	0.77–0.82	0.94	0.92–0.96	0.96	0.94–0.98	0.88	0.85–0.91	0.88	0.85–0.91	0.97	0.94–0.99	0.98	0.96–1.01
3rd income quintile	0.77	0.74–0.80	0.77	0.74–0.79	0.93	0.91–0.95	0.94	0.92–0.97	0.78	0.75–0.81	0.78	0.76–0.81	0.95	0.93–0.98	0.96	0.93–0.98
2nd income quintile	0.69	0.67–0.72	0.68	0.66–0.70	0.89	0.87–0.91	0.91	0.89–0.93	0.73	0.70–0.76	0.73	0.71–0.76	0.95	0.92–0.98	0.95	0.92–0.97
Highest income quintile	0.61	0.59–0.63	0.60	0.58–0.62	0.80	0.78–0.80	0.84	0.81–0.86	0.69	0.65–0.73	0.70	0.66–0.73	0.88	0.85–0.91	0.91	0.88–0.94
Spouses' SES																
Low education			1	Ref							1	Ref				
High education			0.83	0.81–0.84							0.86	0.83–0.88				
Lowest income quintile			1	Ref							1	Ref				
4th income quintile			1.05	1.02–1.08							0.98	0.94–1.00				
3rd income quintile			1.01	0.97–1.03							0.99	0.95–1.03				
2nd income quintile			1.06	1.02–1.08							0.96	0.92–0.99				
Highest income quintile			1.10	1.07–1.14							0.95	0.91–0.99				
Spousal homogamy/heterogamy																
Patient and spouse similar age (±5 yrs)					1	Ref	1	Ref					1	Ref	1	Ref
Patient > 5 yrs older than spouse					1.02	1.01–1.03	1.02	1.00–1.03					1.11	1.06–1.17	1.10	1.04–1.15
Spouse > 5 yrs older than patient					1.08	1.03–1.13	1.03	0.99–1.08					0.98	0.95–0.99	0.97	0.95–0.99
Both spouses low education[d]					1	Ref	1	Ref					1	Ref	1	Ref
Patient low/spouse high education					0.83	0.80–0.86	0.86	0.83–0.89					0.86	0.83–0.89	0.90	0.87–0.93
Patient high/spouse low education					0.83	0.81–0.85	0.88	0.86–0.90					0.82	0.78–0.87	0.86	0.81–0.90
Both spouses high education					0.73	0.70–0.75	0.82	0.80–0.85					0.74	0.70–0.77	0.82	0.78–0.86
Spouses earn a similar share (40–60%)					1	Ref	1	Ref					1	Ref	1	Ref
Patient earns a smaller share (<40%)					1.09	1.05–1.12	1.08	1.04–1.11					1.18	1.13–1.23	1.16	1.11–1.22
Patient earns a larger share (>60%)					0.96	0.94–0.98	0.97	0.95–0.99					1.15	1.10–1.20	1.10	1.05–1.15
Household income is 0 or missing[f]					1.09	1.06–1.12	1.09	1.06–1.12					1.35	1.29–1.41	1.30	1.24–1.36
Baseline controls[g]	*Yes*		*Yes*		*Yes*		*Yes*		*Yes*		*Yes*		*Yes*		*Yes*	
Control for cancer stage and type[h]	*No*		*No*		*No*		*Yes*		*No*		*No*		*No*		*Yes*	

[a] This table portrays estimates from four models: Model I includes only the patient's own characteristics; Model II includes both the patient's and the spouses's characteristics; whereas Models III and IV portray discrepancies in spousal characteristic without and with control for cancer stage and form.
[b] Odds ratio.
[c] Confidence interval.
[d] Low education refers to no education beyond high school, whereas high education refers to any college education.
[e] For Models III and IV, household income estimates are shown.
[f] No share calculated.
[g] Baseline controls for all models include time since diagnosis, calendar period, patient age and number of children. In Model II, age of spouse was also included.
[h] Categorizations are shown in Table 1.

education. This held for both female and male patients. Survival increased relatively linearly with increasing household income (not shown), but sharper for male than for female patients, regardless of whether we used income quintiles or linear parameterizations. Female patients in marriages where their husbands earned both a smaller and a greater share of the household income had a survival disadvantage compared to female patients in marriages where both spouses earned a fairly similar share. Male patients, on the other hand, were slightly advantaged when they were the main breadwinners, but had a survival disadvantage if their wives earned a larger share.

Model IV is our final model, and is adjusted also for cancer stage and form. When we compared estimates from Model III and IV, the overall pattern appeared to be fairly similar with the exception of age differences for male patients. The effects of educational level became slightly weaker, but an 18% protective effect when both partners held a college education remained for both female and male patients. Low educated patients with college educated spouses had an additional survival advantage, somewhat weaker for female patients (10%) compared to male patients (14%). The effects were fairly similar for high educated patients with low educated spouses, but in opposite directions for female and male patients, but with largely overlapping confidence intervals. As a robustness test, we also ran analyses with a finer educational categorization. These analyses suggested that female patients with a Master degree (or higher) married to spouses with only primary education had a very low mortality (OR 0.13). This group is, however, very small. The risk of death increased consistently for the highest educated female patients with increasing educational attainment of the spouse. As such, the trend was opposite that of all other groups. The effects of household income remained fairly stable and consistent. The pronounced survival advantage for male patients in high income households remained, as did the survival advantage associated with male patients' breadwinner role. To examine difference between male and female patients in more detail, Table 3 presents estimates including only cancers that are diagnosed in both men and women. A comparison of the results from Models III and IV in Tables 2 and 3 showed that it is evident that the result are virtually identical, for both male and female patients.

3.3. Summary of main results

We find that marital partners' characteristics matter for cancer survival, net of patients' own resources. Non-normative hypogamy and hypergamy in age between patients and their spouses appear to be disadvantageous for the survival of both female and male patients. Patients with highly educated spouses have a survival advantage, also net of own resources. Household incomes affect survival for both female and male patients with lower death risks observed with increasing incomes, but somewhat more pronounced for male than female patients. For female patients, the survival is clearly best when spouses earn a fairly similar income, whereas male patients with high earning wives have a disadvantage.

Sensitivity tests show that the results are fairly similar across various cancer stages and across various cancer forms, see Tables A1–A3. Tables A4–A6 further shows that the distributions are fairly consistent. Lastly, various discretionary choices of parameterizations did not affect our substantive conclusions.

4. Discussion

A naïve perspective of only considering the presence of partners may conceal important differences in mortality among cancer patients. Below, we discuss mechanisms related to biological tumor character-

Table 3
Modeled estimates of the impact of characteristics of patients and spousal homogamy/heterogamy (Models III and IV) on the risk of death for cancer patients with cancer forms common for both sexes.[a]

	Male and female patients				Male patients				Female patients			
	Model III		Model IV		Model III		Model IV		Model III		Model IV	
	OR[b]	95% CI[c]	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Female patients	1	Ref	1	Ref	N/A[d]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Male patients	1.33	1.31–1.35	1.33	1.30–1.35	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spousal homogamy/heterogamy												
Patient and spouse similar age (± 5 yrs)	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient > 5 yrs older than spouse	1.03	1.01–1.04	1.02	1.00–1.04	1.02	1.01–1.03	1.01	1.00–1.03	1.14	1.07–1.21	1.07	1.01–1.14
Spouse > 5 yrs older than patient	0.97	0.94–0.99	0.96	0.94–0.98	1.06	1.01–1.11	1.01	0.96–1.07	0.95	0.92–0.97	0.95	0.92–0.97
Both spouses low education[e]	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient low/spouse high education	0.86	0.83–0.88	0.89	0.87–0.92	0.83	0.80–0.86	0.88	0.84–0.91	0.87	0.84–0.91	0.91	0.88–0.94
Patient high/spouse low education	0.85	0.83–0.87	0.88	0.86–0.91	0.85	0.83–0.87	0.88	0.87–0.91	0.86	0.81–0.92	0.87	0.81–0.93
Both spouses high education	0.77	0.75–0.79	0.85	0.82–0.88	0.77	0.75–0.80	0.85	0.82–0.88	0.77	0.72–0.81	0.85	0.80–0.90
Lowest income quintile	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
4th income quintile	0.96	0.95–0.98	0.96	0.94–0.97	0.95	0.93–0.98	0.94	0.91–0.96	0.98	0.95–1.01	0.98	0.95–1.01
3rd income quintile	0.95	0.93–0.97	0.95	0.93–0.97	0.93	0.91–0.95	0.93	0.90–0.95	0.96	0.92–0.99	0.96	0.93–1.00
2nd income quintile	0.90	0.88–0.92	0.90	0.88–0.92	0.87	0.85–0.89	0.87	0.85–0.89	0.95	0.92–0.99	0.94	0.91–0.98
Highest income quintile	0.82	0.80–0.84	0.84	0.82–0.86	0.80	0.77–0.82	0.80	0.78–0.82	0.87	0.83–0.91	0.90	0.86–0.94
Spouses earn a similar share (40–60%)	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient earns a smaller share (< 40%)	1.11	1.08–1.14	1.10	1.07–1.13	1.10	1.06–1.14	1.08	1.04–1.11	1.23	1.16–1.30	1.21	1.15–1.28
Patient earns a larger share (> 60%)	0.98	0.96–1.00	0.99	0.97–1.02	0.94	0.91–0.96	0.95	0.93–0.97	1.19	1.12–1.26	1.13	1.06–1.19
Household income is 0 or missing[f]	1.15	1.12–1.18	1.13	1.10–1.16	1.08	1.05–1.11	1.08	1.02–1.09	1.39	1.32–1.47	1.31	1.24–1.39
Baseline controls[g]	*Yes*		*Yes*		*Yes*		*Yes*		*Yes*		*Yes*	
Control for cancer stage and type[h]	*No*		*Yes*		*No*		*Yes*		*No*		*Yes*	

[a] This table portrays estimates from two: Models III and IV. The models portray discrepancies in spousal characteristic without and with control for cancer stage and form.
[b] Odds ratio.
[c] Confidence interval.
[d] N/A refers to 'not applicable'.
[e] Low education refers to no education beyond high school and high education refers to any college education.
[f] No share calculated.
[g] Baseline controls for all models include time since diagnosis, calendar period, patient age and number of children.
[h] Categorizations are shown in Table 1.

istics, host factors and treatment.

4.1. Biological characteristics of the cancer

Early detection may increase the chance of a successful treatment. It may, however, also be positively associated with measurements of survival simply by increasing the time between diagnosis and death (so-called lead-time bias). It has thus been hypothesized that persons with resourceful spouses to help take care of them may be more prone than those with less resourceful spouses to visit a physician at occurrence of symptoms, thus possibly discovering tumors at an earlier stage. Our study shows, however, that the stage distribution was fairly similar across all variables of interest. Similarly was true for cancer form, discussed below.

4.2. 'Host factors' of patient and spouse

It is well known that patients who are well educated or resourceful in other ways tend to have a better overall physical health at time of diagnosis. Several studies have reported higher scores of self-rated physical health and a lower smoking prevalence among married individuals with a higher education compared to those who are less educated (Joutsenniemi et al., 2006; Lindstrom, 2009). In line with the findings of others (see e.g. Lindstrom, 2010), a strong negative socio-economic gradient in prevalence and mortality was observed for cancers associated with smoking, such as lung and renal/bladder cancer, for both income and education. At the same time, a positive gradient was observed for skin cancer survival, also in concordance with the literature (Ortiz, Goodwin, & Freeman, 2005). However, controls for cancer form did not change our overall findings, and as such 'host factors' are unlikely to fully explain our findings. This was true also when we restricted our analysis to only include cancers that are diagnosed across sex. However, even within a diagnosis, a comparison of male and female patients may be difficult, as there are sex differences in for instance patterns of age at diagnosis, stage at diagnosis, and treatment options. Surgery of for instance colorectal cancer may be different in male and female patients as the biological structures surrounding the tumor are different, although the diagnosis itself is similar.

Spouses bring resources into a household above and beyond those of the cancer patient, and these resources may help shape survival prospects after diagnosis. In terms of age, having a younger spouse may make it more likely for the older partner to take measures to stay healthy and 'young', by for instance exercising more or eating healthier. In our study, there were hardly any effects of age heterogamy for male patients. However, whereas female patients with older spouses had a slight survival advantage, female patients with much younger spouses had a clear survival disadvantage, contrary to what could be expected. It may be that these patterns of non-normative spousal age heterogamy result from selection and thus offset any effects from more positive health behaviors like healthy diet, exercise and sleep.

Similarly, a highly educated spouse provide a manifold of resources where some are directly available, such as more knowledge and higher social status, and some indirectly available through the spouse's own social network. People with educated spouses have been shown to be healthier in general, and to engage in fewer negative health behaviors, such as smoking (Monden et al., 2003). Social support or pressure from a resourceful spouse, economic advantages from sharing a household with a resourceful spouse, and increased knowledge may lead to a healthier lifestyle, with for instance better nutrition, less smoking and less alcohol (Lillard & Panis, 1996; Waite & Lehrer, 2003; Schoenborn, 2004; Lindstrom, 2010).

In a relatively simple model including both spouses educational level, we found that both patients' and spouses' education impacted on patients' survival, and in about the same magnitude for female and male patients. In models including an education matrix to also assess discrepancies in educational resources, we found that relative to couples where both partners held a low education, an advantage was observed for both female and male patients if they themselves or their spouses held a high education. The survival of female patients with a high education did not improve significantly if their husbands also held a high education. For female patients with a low education, it did matter. For male patients, having a wife with a high education significantly improved survival, although also here the greatest benefit was observed for couples where both spouses had a high education. This is in part concurrent with findings from studies on self-rated health (Brown et al., 2014) and all-cause mortality (Torssander & Erikson, 2009). When we looked at the educational level in more detail, the results were fairly consistent for male patients, whereas for female patients their own education appeared to matter more than that of their husbands.

Somewhat surprisingly, a high household income was associated with a survival advantage of almost the same magnitude as having a high education for male patients. The effect was present but weaker for female patients. Female patients in dual-earning marriages had a clear survival advantage relative to women being supported or having a breadwinner role, whereas male patients had a slight survival advantage if they were the main breadwinner, but a survival disadvantage if they earned less than their spouses.

Number of children was included as a covariate, as raising children appears to have a positive association with cancer survival (Kravdal, 2003), probably because young children induce a healthier lifestyle and adult children may provide support during treatment and later. However, as the number of children varied little across spousal resources, it turned out to be a relatively unimportant control variable, and is thus not discussed further.

4.3. Treatment factors

It may be hypothesized that well-educated husbands and wives are more likely to be involved in their spouses' treatment and follow-up care. If this is the case, cancer patients with resourceful spouses may be offered better treatment. Furthermore, patients may receive help from their spouses in navigating a fairly complex healthcare system, in particular in out-patient settings where patient-provider communication is key, which may lead to a better outcome (Smith et al., 2009). Lastly, resourceful couples can be hypothesized to make better use of what is offered, i.e. adhere more closely to recommendations for follow-up treatment.

As our data do not allow us to assess these factors individually, we limit our discussion to the general mechanisms proposed. Today's complex cancer therapy regimens may be difficult to follow, and it is thus possible that individuals with resourceful spouses may be offered or take advantage of better treatment from hospitals than those with less resourceful spouses. Fiva et al. (2014) found that educated individuals with cancer in Norway are more likely to be transferred to specialized hospitals, implying not only asymmetric use of information, but also asymmetric use of specialized treatment with restricted access. Adherence to and compliance with follow-up care is, however, likely to also play a role. A meta-analysis suggests that marriage influences adherence to treatment positively, partly through the partner's support (DiMatteo, 2004). As such, it is likely that partners' resources may play a role and also produce differentials due to differences in partners' resources. Those with a less resourceful spouse may find compliance more difficult than those with a more resourceful spouse. As cancer care is increasingly undertaken in an outpatient setting, support in adhering to treatment and follow-up care protocols may be of great benefit. As such it was somewhat surprising that our results were relatively stables across calendar period. Likewise did we find largely similar effects for older and younger patients, although younger patients can be hypothesized to navigate complex systems more efficiently. Furthermore, it seems to be a common perception

among health personnel that their workload is increasing. If that is the case, physicians may be more likely to yield to pressure from a resourceful next of kin, possibly giving patients with higher educated spouses a treatment advantage.

The mechanisms described above, all apply to education and/or knowledge. However, as was shown, our results also varied by income. This stands in contrast to the fact that cancer care is publicly run and free of charge in Norway (Molven & Ferkis, 2011). Evidently, a higher income must lead to improved survival through either selection of healthy individuals into high income jobs or causal mechanisms such as being able to purchase other services that lead to improved treatment regime implementation.

4.4. Selection – homogamy and heterogamy

A large literature has documented spousal heterogamy across various dimensions (Kalmijn, 1998; Epstein & Guttman, 1984). In this study, we examine heterogamy along three specific dimensions that may be important for cancer survival. Age differences between spouses have previously been shown to affect survival, even when SES and other demographic characteristics are controlled for (Drefahl, 2010). The possible explanations for this finding include selection effects, caregiving patterns, and psycho-social effects of having a younger spouse. Our results indicate that female patients have a higher death probability if they are more than five years older than their spouses. In terms of income, there is a clear pattern in that survival is highest for couples where the husband has the highest income. We are unable to distinguish between the explanations listed above, but the results at least suggest that there is an important gender component in the mechanisms generating these differences: Somehow, those who conform to the traditional model of family formation and gender specialization in the household enjoy improved survival. For education, both spouses' educations seem to contribute to lower mortality. Thus, there is no heterogamy effect of education. Interestingly, the three factors show similar patterns for other family outcomes, for example marital dissolution risk (Lyngstad & Jalovaara, 2010).

Selection obviously contributes to the difference in cancer survival between individuals married to resourceful spouses and those married to less resourceful spouses. For example, men with much knowledge and high income (potential) are seen as desirable partners and therefore tend to marry partners equally resourceful, if in other fields. Similarly, such couples display low divorce rates (Lyngstad & Jalovaara, 2010), while the corresponding effects of women's socio-economic resources are more ambiguous and have changed over time (Sweeney, 2002). Education and income are also important determinants of health (Elo, 2009), and may through such differentials in health, or in treatment, also affect the cancer survival (Kravdal, 2000). Values also play a role, and include for instance lifestyle preferences, with implication for entry into and out of marriage as well as health behavior. Next, healthy individuals are probably more likely to enter and remain in a marriage than the less healthy (Teachman, 2010), although there are also studies indicating a negative health selection into marriage (Lillard & Panis, 1996). Furthermore, the health of the spouse is obviously a determinant of widowhood. As we have shown, our sample of married individuals contains a larger share of male patients than what we find in the general population. As such, some of the selection into marriage has already been accounted for in this study. Relatively few individuals left the sample due to separation and/or divorce, in line with earlier findings that cancer does not increase divorce rates in general – especially when the cancer is diagnosed after the marriage has already taken place (Syse & Kravdal, 2007).

Couples who are heterogamous in age or education may differ in other, unobserved ways from homogenous couples, and resulting potential selection into the group of heterogamous couples must be kept in mind when interpreting the results. In general, non-normative heterogamy in income was unfavorable for male patients, whereas non-normative heterogamy in age and income was unfavorable for female patients. A tendency towards an unfavorable effect was observed for highly educated female patients when we looked at education at a detailed level. No adverse effect was observed for educational heterogamy among spouses for male patients. However, it should be noted that non-normatively selected couples comprised a very small portion of the available data.

4.5. Generalizability and limitations

Contrary to many other systems worldwide, the public healthcare system in Norway offers treatment, including highly specialized cancer care, universally and almost free of charge (Molven & Ferkis, 2011). Income has thus been hypothesized to play a lesser role for cancer outcomes in Norway than in countries where cancer care must be bought in the open market. As such, it was somewhat surprising that we found strong and relatively consistent effects of household income, net of education.

One limitation is that of lead-time bias. We know from previous studies that resourceful patients present with cancers diagnosed at earlier stages (Clegg et al., 2009; Lai & Stotler, 2010). It might be, however, that resourceful patients and/or couples primarily are able to move the time of diagnosis forward, and not postpone time of death, thus making it look as though survival time is increased although it is only longer because of earlier diagnosis (Seo & Lee, 2010; Bowen et al., 2011). It may, however, also be that among patients recorded with a localized tumor those married to resourceful spouses have the smallest ones – i.e. those that to a lesser extent have infiltrated surrounding tissue. Although stage is adjusted for in this study, this control is not complete, as it does not account for sub-stages. It is thus possible that more refined data on stage could have provided different results. The results were, however, fairly consistent with and without control for the available stage information. This may suggest that additional control for sub-stage also would matter little.

Another limitation of this study is that it was not possible to include also cohabitating couples in our study. Cohabitants likely enjoy many of the same benefits as the married (Joutsenniemi et al., 2006). Since an increasingly number of individuals cohabitate, would have been relevant to examine also cohabitants. However, during the period studied, cohabitation after age 50 is still a relatively rare event. Only 13% age 50–54 cohabitated in 2011, up from 4% in 1993. On the other hand, only 4% age 70–79 cohabitated in 2011 (Statistics Norway, 2012).

This study has several obvious strengths: The time-span covered is rather large, and we have complete, high quality data on all married individuals with cancer and cancer characteristics. Further, spouses were identified in more than 99% of the cases, and there is thus virtually no selection bias. Contrary to previous studies, we were able to censor observations on marital status change. We believe this is important, as cancer is a disease strongly associated with age, and marital status change into widowhood is not uncommon. Although some authors argue that the protective effects of having been married to a resourceful spouse lasts beyond the period that the marriage lasts (Skalicka & Kunst, 2008), we find it less clear how this would be the case. Many studies show negative effects on health and quality of life in periods after marital status change (see e.g. Martikainen & Valkonen, 1996; Jin & Christiakis, 2013), and it is likely that this may have implications for cancer patients' ability to handle their illness and/or treatment and follow-up care.

It is reasonable to expect similar results in many other countries. Should that be confirmed in later studies, an important next step is to learn more about the relative importance of the various mechanisms. One could for instance explore potential differentials by spousal resources and the patient/spouse constellation in type of surgery, use of radiation therapy or differences in chemotherapeutic drugs offered. Perhaps even more important is to investigate possible differentials in

treatment compliance, e.g. the taking of medication, meeting to consultations, following the doctors' advices, and so on. As an extension, it is likely that our findings on cancer survival will be relevant also for other major diseases such as cardiovascular disease, for which less reliable data on diagnosis and survival is available.

Lastly, all the mechanisms that have been discussed in terms of spouses could be highly relevant also for adult children, in particular for cancer patients without spouses. In such cases, also the geographical distance between patients and children would be interesting in future research. Furthermore, research is also warranted on possible effects of changes in marital status, such as for instance the loss of a resourceful spouse. In this study, we have merely censored observations at changes in marital status. It future work it could also be interesting to examine differences in effects depending on spousal resources with time since diagnosis more closely.

5. Conclusion

Our study shows that married cancer patients' survival is affected by their spouses' educational attainments. Net of education, individuals in high income household also have a survival advantage. Non-normative discrepancies in spouses' ages, education and incomes also impact on survival, although it is unclear whether these effects are causal or driven by selection. The distributions of stage were not clearly related to the various SES measures, and as such there is little evidence for advantages in terms of early diagnosis.

The importance of persons' own education and income may thus be overestimated in married patients unless one also accounts for spouses' resources in these areas. However, as spousal homogamy in education prevails in Norway, the effects here may be expected to be somewhat less important than what could be the case in countries with greater heterogamy. Income homogamy is more common among younger patients and in more recent time period, and will be important to continue to monitor.

As the mechanisms discussed in this paper should be broadly relevant, it is reasonable to expect similar trends in many other countries. Should that be confirmed in later studies, an important next step is to learn more about the relative importance of the various mechanisms. One could for instance explore mechanisms related to treatment types, e.g. study potential differentials in type of surgery, use of radiation therapy or differences in chemotherapeutic drugs offered by spousal characteristics. Perhaps even more important is to investigate possible differentials in treatment compliance, e.g. the taking of medication, meeting to consultations, following the doctors' advices, and so on, in particular in heterogamous couples. Findings from such research may have important implications for future cancer treatment and care.

Acknowledgements

This study was supported by a grant from the Norwegian Research Council (Grant no. 190709 (FRIPRO)). It is not under consideration for publication elsewhere. A licensure to match data to undertake this study was provided by the National Data Inspectorate in Norway, and the Norwegian Board of Medical Ethics approved the study.

Appendix

See Tables A1–A6 here.

Table A1
Effects of spousal SES resources and discrepancies in these by cancer stage.[a]

	Male patients						Female patients					
	Localized cancer		Regional cancer		Metastatic cancer		Localized cancer		Regional cancer		Metastatic cancer	
	OR	95% CI	OR	95% CI	OR	95% CI	OR[b]	95% CI[c]	OR	95% CI	OR	95% CI
Patient and spouse similar age (± 5 yrs)	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient > 5 yrs older than spouse	1.00	0.99–1.13	1.00	0.98–1.03	1.04	1.01–1.07	1.21	1.12–1.31	1.07	0.99–1.16	1.03	0.92–1.15
Spouse > 5 yrs older than patient	1.06	0.98–1.03	1.00	0.92–1.09	1.03	0.93–1.14	0.97	0.93–1.00	0.99	0.95–1.03	0.96	0.92–1.01
Both spouses low education[d]	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient low/spouse high education	0.83	0.79–0.88	0.83	0.77–0.89	0.90	0.84–0.97	0.85	0.81–0.90	0.87	0.83–0.92	0.90	0.85–0.96
Patient high/spouse low education	0.83	0.80–0.86	0.85	0.82–0.89	0.93	0.88–0.97	0.83	0.76–0.92	0.85	0.78–0.93	0.76	0.69–0.84
Both spouses high education	0.73	0.69–0.77	0.76	0.71–0.82	0.81	0.76–0.87	0.80	0.74–0.87	0.78	0.72–0.85	0.79	0.72–0.87
Lowest income quintile	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
4th income quintile	0.93	0.90–0.96	0.88	0.85–0.92	0.99	0.94–1.05	0.94	0.90–0.99	0.98	0.94–1.03	1.04	0.98–1.10
3rd income quintile	0.92	0.89–0.96	0.89	0.85–0.93	0.91	0.87–0.96	0.92	0.87–0.97	0.97	0.92–1.02	0.96	0.91–1.02
2nd income quintile	0.89	0.85–0.92	0.84	0.80–0.88	0.89	0.85–0.94	0.94	0.89–0.99	0.96	0.91–1.01	0.90	0.84–0.96
Highest income quintile	0.78	0.74–0.81	0.77	0.73–0.81	0.83	0.79–0.88	0.86	0.81–0.92	0.92	0.87–0.98	0.87	0.80–0.94
Spouses earn a similar share (40–60%)	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient earns a smaller share (< 40%)	1.04	0.99–1.09	1.08	1.02–1.15	1.10	1.03–1.16	1.07	0.99–1.16	1.18	1.10–1.27	1.23	1.13–1.34
Patient earns a larger share (> 60%)	0.97	0.93–1.00	0.95	0.90–0.99	0.91	0.87–0.95	1.09	1.00–1.18	1.14	1.06–1.23	1.11	1.01–1.21
Household income is 0 or missing[e]	1.08	1.04–1.13	1.04	0.98–1.10	1.01	0.96–1.08	1.33	1.23–1.43	1.32	1.23–1.41	1.30	1.19–1.41

[a] This table portrays estimates from fully adjusted models stratified by stage. All variables shown in Model III were included.
[b] Odds ratio.
[c] Confidence interval.
[d] Low education refers to no education beyond high school, whereas high education refers to any college education.
[e] No share calculated.

Table A2
Effects of spousal SES resources and discrepancies in these on risk of death for male cancer patients, by cancer form.[a]

	Hematopoietic cancer		Lymphoid cancer		Skin cancer		Colorectal cancer		Pancreatic cancer		Lung cancer		Renal/Bladder cancer		Prostate cancer	
	OR[b]	95% CI[c]	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Patient and spouse similar age (± 5 yrs)	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient > 5 yrs older than spouse	1.00	0.94–1.06	1.06	0.97–1.14	0.96	0.91–1.02	1.02	0.99–1.05	1.00	0.93–1.08	1.01	0.98–1.05	1.02	0.98–1.06	1.03	0.99–1.06
Spouse > 5 yrs older than patient	0.95	0.76–1.17	0.99	0.76–1.30	1.17	0.95–1.44	1.07	0.97–1.17	1.10	0.85–1.40	1.11	0.99–1.23	0.99	0.87–1.15	1.15	1.04–1.26
Both spouses low education[d]	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient low/spouse high education	0.82	0.70–0.96	0.95	0.78–1.16	0.97	0.85–1.10	0.84	0.77–0.90	0.87	0.73–1.04	0.89	0.81–0.98	0.84	0.75–0.94	0.84	0.78–0.91
Patient high/spouse low education	0.88	0.80–0.97	0.91	0.80–1.03	0.86	0.79–0.94	0.87	0.83–0.91	0.93	0.83–1.05	0.99	0.93–1.05	0.86	0.80–0.92	0.85	0.81–0.89
Both spouses high education	0.83	0.73–0.96	0.87	0.74–1.03	0.80	0.71–0.91	0.91	0.85–0.97	0.95	0.80–1.13	1.04	0.93–1.15	0.73	0.65–0.82	0.73	0.68–0.78
Lowest income quintile	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
4th income quintile	0.91	0.84–0.98	0.96	0.84–1.10	0.87	0.79–0.96	0.97	0.92–1.01	0.94	0.84–1.06	1.00	0.95–1.06	0.97	0.91–1.04	0.91	0.87–0.95
3rd income quintile	0.84	0.82–1.01	0.82	0.72–0.93	0.92	0.83–1.01	0.93	0.89–0.98	0.94	0.82–1.06	0.98	0.93–1.04	0.95	0.89–1.03	0.94	0.89–0.98
2nd income quintile	0.77	0.76–0.93	0.84	0.73–0.96	0.84	0.76–0.94	0.88	0.84–0.93	0.87	0.76–0.99	0.91	0.86–0.97	0.91	0.84–0.98	0.93	0.89–0.98
Highest income quintile	0.76	0.68–0.85	0.77	0.66–0.89	0.71	0.63–0.79	0.81	0.77–0.86	0.83	0.72–0.96	0.86	0.81–0.91	0.86	0.79–0.93	0.81	0.76–0.85
Spouses earn a similar share (40–60%)	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient earns a smaller share (< 40%)	1.14	0.99–1.31	1.14	0.96–1.36	0.90	0.79–1.03	1.06	0.99–1.13	1.15	0.98–1.35	1.11	1.03–1.19	1.06	0.96–1.17	0.98	0.92–1.05
Patient earns a larger share (> 60%)	1.04	0.94–1.15	1.04	0.92–1.19	0.89	0.81–0.98	0.94	0.90–0.99	0.97	0.86–1.09	0.92	0.87–0.97	0.96	0.89–1.03	1.01	0.96–1.07
Household income is 0 or missing[e]	1.07	0.95–1.21	1.14	0.97–1.33	1.01	0.90–1.14	1.05	0.99–1.11	1.02	0.88–1.18	0.99	0.93–1.07	1.09	0.99–1.19	1.04	0.98–1.10

[a] Estimates from fully adjusted models (Model III) stratified by cancer form.
[b] Odds ratio.
[c] Confidence interval.
[d] Low education refers to no education beyond high school and high education refers to any college education.
[e] No share calculated.

Table A3
Effects of spousal SES resources and discrepancies in these on risk of death for female cancer patients, by cancer form.[a]

	Hematopoietic cancer		Lymphoid cancer		Skin cancer		Colorectal cancer		Pancreatic cancer		Lung cancer		Renal/Bladder cancer		Breast cancer		Gynecological cancer	
	OR[b]	95% CI[c]	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Patient and spouse similar age (±5 yrs)	1	Ref	1.00	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient >5 yrs older than spouse	1.09	0.87–1.36	1.07	0.82–1.40	1.17	0.93–1.48	1.07	0.97–1.18	1.22	0.97–1.53	1.16	0.99–1.38	1.28	1.04–1.59	1.23	1.10–1.37	1.07	0.94–1.22
Spouse >5 yrs older than patient	1.06	0.95–1.17	0.96	0.84–1.09	0.91	0.80–1.02	0.97	0.93–1.02	0.87	0.77–0.97	1.01	0.94–1.09	0.98	0.88–1.09	1.04	0.98–1.09	1.03	0.97–1.09
Both spouses low education[d]	1	Ref	1.00	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient low/spouse high education	0.87	0.75–1.00	0.81	0.68–0.97	0.90	0.77–1.04	0.94	0.87–1.00	0.94	0.81–1.09	0.95	0.86–1.05	0.94	0.81–1.09	0.83	0.77–0.89	0.90	0.82–0.98
Patient high/spouse low education	1.05	0.83–1.32	2.03	0.79–1.32	0.89	0.69–1.14	0.92	0.82–1.03	0.94	0.74–1.19	0.86	0.71–1.03	0.93	0.72–1.20	0.86	0.76–0.97	0.78	0.68–0.90
Both spouses high education	0.78	0.63–0.96	0.90	0.71–1.15	0.73	0.58–0.91	0.92	0.83–1.02	0.80	0.63–1.01	0.87	0.74–1.03	0.77	0.60–0.99	0.73	0.66–0.81	0.88	0.78–0.99
Lowest income quintile	1	Ref	1.00	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
4th income quintile	0.98	0.87–1.10	1.05	0.90–1.22	0.86	0.74–0.98	0.99	0.93–1.05	0.99	0.88–1.13	0.99	0.90–1.08	0.93	0.83–1.05	0.95	0.89–1.01	0.99	0.92–1.06
3rd income quintile	0.94	0.83–1.07	0.94	0.80–1.10	0.89	0.77–1.03	0.99	0.94–1.06	1.05	0.91–1.21	0.99	0.90–1.09	0.89	0.78–1.01	0.95	0.88–1.02	0.97	0.90–1.04
2nd income quintile	0.91	0.79–1.05	0.90	0.75–1.07	1.00	0.86–1.17	1.01	0.95–1.08	0.92	0.79–1.06	0.99	0.89–1.10	0.92	0.79–1.06	0.93	0.86–1.00	0.97	0.90–1.04
Highest income quintile	0.89	0.75–1.04	0.90	0.74–1.09	0.94	0.79–1.11	0.95	0.88–1.02	0.89	0.75–1.06	0.91	0.81–1.02	0.75	0.64–0.88	0.87	0.80–0.94	0.95	0.87–1.04
Spouses earn a similar share (40–60%)	1	Ref	1.00	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref	1	Ref
Patient earns a smaller share (<40%)	1.14	0.93–1.39	1.06	0.83–1.35	1.21	0.96–1.53	1.14	1.05–1.25	1.28	1.04–1.58	1.16	1.01-.133	1.44	1.15–1.81	1.06	0.97–1.17	1.05	0.95–1.16
Patient earns a larger share (>60%)	1.14	0.92–1.41	1.20	0.93–1.54	1.20	0.94–1.54	1.14	1.03–1.26	1.12	0.90–1.39	0.99	0.86–1.15	1.14	0.90–1.44	1.05	0.95–1.17	1.07	0.96–1.19
Household income is 0 or missing[e]	1.25	1.02–1.53	1.31	1.02–1.66	1.57	1.24–1.97	1.27	1.16–1.40	1.18	0.96–1.45	1.17	1.02–1.34	1.41	1.13–1.76	1.25	1.13–1.38	1.19	1.08–1.32

[a] Estimates from fully adjusted models (Model III) stratified by cancer form.
[b] Odds ratio.
[c] Confidence interval.
[d] Low education refers to no education beyond high school and high education refers to any college education.
[e] No share calculated.

Table A4
Distributions of age and SES discrepancies for male and female cancer patients by cancer stage.

	Male patients (%)				Female patients (%)			
	Local	**Regional**	**Distant**	**Unknown or N/A**	**Local**	**Regional**	**Distant**	**Unknown or N/A**
Age differences								
Patient and spouse similar age (± 5 yrs)	65	17	5	13	65	25	5	5
Patient > 5 yrs older than spouse	66	17	5	13	65	27	4	4
Spouse > 5 yrs older than patient	66	19	6	9	65	26	5	4
Educational differences								
Both spouses low education	65	26	5	5	65	17	5	12
Patient low/spouse high education	66	25	5	5	62	17	5	15
Patient high/spouse low education	63	26	6	5	65	16	5	14
Both spouses high education	66	24	5	5	63	15	6	16
Household income								
Lowest income quintile	64	16	6	14	64	25	5	5
4th income quintile	67	19	4	10	65	26	4	5
3rd income quintile	64	16	6	13	64	26	5	5
2nd income quintile	65	17	5	13	65	26	5	4
Highest income quintile	66	16	5	13	67	25	4	4
Spouses earn a similar share (40–60%)	64	17	6	14	64	26	5	5
Patient earns a smaller share (< 40%)	61	16	6	16	66	25	4	5
Patient earns a larger share (> 60%)	66	17	5	12	64	25	6	5
Household income is 0 or missing	67	17	5	11	65	26	4	5

Table A5
Distributions (%) of age and SES discrepancies for male cancer patients by cancer form.

	Hemapoietic & lymphoid cancers	**Skin cancer**	**Colorectal cancer**	**Pancreatic cancer**	**Lung cancer**	**Renal & bladder cancer**	**Prostate cancer**
Patient and spouse similar age (± 5 yrs)	71	71	70	69	71	71	69
Patient > 5 yrs older than spouse	28	27	28	29	27	27	29
Spouse > 5 yrs older than patient	2	1	2	2	2	2	2
Both spouses low education	76	72	80	80	86	82	78
Patient low/spouse high education	5	5	4	5	4	4	4
Patient high/spouse low education	11	14	11	10	8	10	11
Both spouses high education	8	9	5	5	3	5	7
Lowest income quintile	15	15	17	17	21	17	16
4th income quintile	14	14	15	17	16	15	15
3rd income quintile	20	19	19	20	19	19	19
2nd income quintile	24	22	23	22	22	23	23
Highest income quintile	27	30	26	24	22	26	27
Spouses earn a similar share (40–60%)	15	12	11	13	11	11	10
Patient earns a smaller share (< 40%)	15	18	18	20	20	17	20
Patient earns a larger share (> 60%)	53	54	52	48	47	52	48
Household income is 0 or missing	16	17	20	20	22	20	22

Table A6
Distributions (%) of age and SES discrepancies for female cancer patients by cancer form.

	Hemapoietic & lymphoid cancers	**Skin cancer**	**Colorectal cancer**	**Pancreatic cancer**	**Lung cancer**	**Renal & bladder cancer**	**Breast cancer**	**Gyn. cancer**
Patient and spouse similar age (± 5 yrs)	75	76	75	76	75	76	75	74
Patient > 5 yrs older than spouse	3	2	3	2	3	3	3	3
Spouse > 5 yrs older than patient	22	22	22	22	22	22	22	23
Both spouses low education	78	74	82	79	84	83	74	80
Patient low/spouse high education	11	13	10	12	9	10	12	10
Patient high/spouse low education	4	5	4	3	3	3	5	4
Both spouses high education	7	8	5	6	4	5	9	6
Lowest income quintile	28	27	29	31	35	32	26	27
4th income quintile	20	19	20	21	20	19	19	20
3rd income quintile	19	18	19	16	19	18	19	19
2nd income quintile	16	16	16	17	14	14	17	17
Highest income quintile	17	19	16	15	12	17	19	17
Spouses earn a similar share (40–60%)	10	11	8	9	8	8	12	12
Patient earns a smaller share (< 40%)	44	46	42	41	42	42	46	48
Patient earns a larger share (> 60%)	18	17	19	18	19	18	18	17
Household income is 0 or missing	28	26	31	33	31	32	24	23

References

Aarts, M. J., Koldewijn, E. L., Poortmans, P. M. P., Coebergh, J. W. W., & Louwman, W. J. (2013). The impact of socioeconomic status on prostate cancer treatment and survival in the Southern Netherlands. *Urology*, **81**, 591–599.

Adami, H., Hunter, D., & Trichopoulos, D. (2008). *Textbook of Cancer Epidemiology* (2nd Ed.) Oxford: Oxford University Press.

Allison, P. D. (1995). *Survival analysis using SAS: A practical guide* Cary, NC: SAS Institute Inc..

Bago d'Uva, T., & Jones, M. A. (2009). Health care utilisation in Europe: new evidence from the ECHP. *Journal of Health Economics*, **28**, 265–279.

Bowen, D. J., Hannon, P. A., Harris, J. R., & Martin, D. P. (2011). Prostate cancer screening and informed decision-making: Provider and patient perspectives. *Prostate Cancer and Prostatic Diseases*, **14**(2), 155–161.

Brown, D. C., Hummer, R. A., & Hayward, M. D. (2014). The Importance of Spousal Education for the Self-Rated Health of Married Adults in the United States. *Population Research and Policy Review*, **33**(1), 127–151.

Clegg, L. X., Reichman, M. E., Miller, B. A., Hankey, B. F., Singh, G. K., Lin, Y. D., & Edwards, B. K. (2009). Impact of socioeconomic status on cancer incidence and stage at diagnosis: Selected findings from SEER: National longitudinal mortality study. *Cancer Causes & Control*, **20**, 417–435.

Cutler, D., & Lleras-Muney, A. (2012). Education and health: Insights from international comparisons. NBER Working paper no. 17738

DiMatteo, M. R. (2004). Social support and patient adherence to medical treatment: a meta-analysis. *Health Psychology*, **23**(2), 207–218.

Drefahl, S. (2010). How does the age gap between partners affect their survival? *Demography*, **47**(2), 313–326.

Elo, I. T. (2009). Social class differentials in health and mortality: Patterns and explanations in comparative perspective. *Annual Review of Sociology*, **35**, 553–572.

Elstad, J. I., Torstensrud, R., Lyngstad, T. H., & Kravdal, O. (2012). Trends in educational inequalities in mortality, seven types of cancers, Norway 1971–2002. *European Journal of Public Health*, **22**, 771–776.

Epstein, E., & Guttman, R. (1984). Mate selection in man: evidence, theory, and outcome. *Social Biology*, **31**(3–4), 243–278.

Fiva, J. H., Haegeland, T., Ronning, M., & Syse, A. (2014). Access to treatment and educational inequalities in cancer survival. *Journal of Health Economics*, **36**, 98–111.

Fossa, S. D., Cvancarova, M., Chen, L., Allan, A. L., Oldenburg, J., Peterson, D. R., & Travis, L. B. (2011). Adverse prognostic factors for testicular cancer-specific survival: a population-based study of 27,948 patients. *Journal of Clinical Oncology*, **29**(8), 963–970.

Goldman, N. (1993). Marriage selection and mortality patterns: inferences and fallacies. *Demography*, **30**(2), 189–208.

Goldman, N. (1994). Social factors and health: the causation-selection issue revisited. *Proceedings of the National Academy of Sciences of the United States of America*, **91**(4), 1251–1255.

Jaffe, D. H., Eisenbach, Z., Neumark, Y. D., & Manor, O. (2006). Effects of husbands' and wives' education on each other's mortality. *Social Science & Medicine*, **62**(8), 2014–2023.

Jin, L., & Christiakis, N. A. (2013). Investigating the mechanism of marital mortality reduction: the transition to widowhood and quality of health care. *Demography*, **46**(3), 605–625.

Joutsenniemi, K. E., Martelin, T. P., Koskinen, S. V., Martikainen, P. T., Harkanen, T. T., Luoto, R. M., & Aromaa, A. J. (2006). Official marital status, cohabiting, and self-rated health-time trends in Finland, 1978–2001. *European Journal of Public Health*, **16**(5), 476–483.

Kalmijn, M. (1998). Intermarriage and homogamy: causes, patterns, trends. *Annual Review of Sociology*, **24**, 395–421.

Kenkel, D. S. (1991). Health behavior, health knowledge, and schooling. *Journal of Political Economy*, **99**, 287–305.

Kinsey, T., Jemal, A., Liff, J., Ward, E., & Thun, M. (2008). Secular trends in mortality from common cancers in the United States by educational attainment, 1993–2001. *Journal of National Cancer Institute*, **100**, 1003–1012.

Kravdal, O. (2000). Social inequalities in cancer survival. *Population Studies*, **54**(1), 1–18.

Kravdal, O. (2001). The impact of marital status on cancer survival. *Social Science & Medicine*, **52**(3), 357–368.

Kravdal, O. (2003). Children, family and cancer survival in Norway. *International Journal of Cancer*, **105**(2), 261–266.

Lai, K. C., & Stotler, B. A. (2010). Marital status and colon cancer stage at diagnosis. *The Open Colorectal Cancer Journal*, **3**, 5–11.

Larsen, I. K., Smastuen, M., Johannesen, T. B., Langmark, F., Parkin, D. M., Bray, F., & Moller, B. (2009). Data quality at the Cancer Registry of Norway: An overview of comparability, completeness, validity and timeliness. *European Journal of Cancer*, **45**(7), 1218–1231.

Lejeune, C., Sassi, F., Ellis, L., Godward, S., Mak, V., Day, M., & Rachet, B. (2010). Socio-economic disparities in access to treatment and their impact on colorectal cancer survival. *International Journal of Epidemiology*, **39**(3), 710–717.

Lillard, L. A., & Panis, C. W. (1996). Marital status and mortality: the role of health. *Demography*, **33**(3), 313–327.

Lindstrom, M. (2009). Marital status, social capital, material conditions and self-rated health: a population-based study. *Health Policy*, **93**(2–3), 172–179.

Lindstrom, M. (2010). Social capital, economic conditions, marital status and daily smoking: a population-based study. *Public Health*, **124**(2), 71–77.

Lyngstad, T. H., & Jalovaara, M. (2010). A review of the antecedents of union dissolution. *Demographic Research*, **23**, 257–291.

Mackenbach, J. P., Kunst, A. E., Lautenbach, H., Oei, Y. B., & Bijlsma, F. (1997). Competing causes of death: a death certificate study. *Journal of Clinical Epidemiology*, **50**(10), 1069–1077.

Marks, R., Ok, H., Joung, H., & Allegrante, J. P. (2010). Perceptions about collaborative decisions: Perceived provider effectiveness among 2003 and 2007 health information national trends survey (HINTS) respondents. *Journal of Health Communication*, **15**(83), 135–146.

Martikainen, P. (1995). Socioeconomic mortality differentials in men and women according to own and spouse's characteristics in Finland. *Sociology of Health and Illness*, **17**(3), 353–375.

Martikainen, P., & Valkonen, T. (1996). Mortality after death of a spouse: Rates and causes of death in a large Finnish cohort. *American Journal of Public Health*, **86**, 1087–1093.

Molven, O., & Ferkis, J. (2011). *Healthcare, welfare and law. Health legislation as a mirror of the Norwegian welfare state* Oslo: Gyldendal Akademisk.

Monden, C. (2007). Partners in health? Exploring resemblance in health between partners in married and cohabiting couples. *Sociology of Health & Illness*, **29**(3), 391–411.

Monden, C. W. S., van Lenthe, F., Dirk De Graaf, N., & Kraaykamp, G. (2003). Partner's and own education: does who you live with matter for self-assessed health, smoking and excessive alcohol consumption? *Social Science & Medicine*, **57**(10), 1901–1912.

Nayeri, K., Pitaro, G., & Feldman, J. G. (1992). Marital status and stage at diagnosis in cancer. *New York State Journal of Medicine*, **92**(1), 8–11.

Ortiz, C. A., Goodwin, J. S., & Freeman, J. L. (2005). The effect of socioeconomic factors on incidence, stage at diagnosis and survival of cutaneous melanoma. *Medical Science Monitor*, **11**(5), RA163–RA172.

Osborne, C., Ostir, G. V., Du, X., Peek, M. K., & Goodwin, J. S. (2005). The influence of marital status on the stage at diagnosis, treatment, and survival of older women with breast cancer. *Breast Cancer Research and Treatment*, **93**(1), 41–47.

Pinquart, M., & Duberstein, P. R. (2010). Associations of social networks with cancer mortality: a meta-analysis. *Critical Reviews in Oncology/Hematology*, **75**(2), 122–137.

Quaglia, A., Lillini, R., Mamo, C., Ivaldi, E., & Vercelli, M. (2013). Socio-economic inequalities: a review of methodological issues and the relationships with cancer survival. *Critical Reviews in Oncology/Hematology*, **85**(3), 266–277.

Schoenborn, C. A. (2004). Marital status and health: United States, 1999–2002. *Advanced Data*, **351**, 1–32.

Seo, H. S., & Lee, N. K. (2010). Predictors of PSA screening among men over 40 years of age who had ever heard about PSA. *Korean Journal of Urology*, **51**(6), 391–397.

Skalicka, V., & Kunst, A. (2008). Effects of spouses' socioeconomic characteristics on mortality among men and women in a Norwegian longitudinal study. *Social Science & Medicine*, **66**(9), 2035–2047.

Smith, S. K., Dixon, A., Trevena, L., Nutbeam, D., & McCaffery, K. J. (2009). Exploring patient involvement in healthcare decisions across different education and functional literacy groups. *Social Science & Medicine*, **69**, 1805–1812.

Spoerri, A., Schmidlin, K., Richter, M., Egger, M., & Clough-Gorr, K. M. (2014). Individual and spousal education, mortality and life expectancy in Switzerland: A national cohort study. *Journal of Epidemiology and Community Health*, **68**(9), 804–810.

Statistics Norway (2012). *Cohabitants 2011*. ⟨www.ssb.no/english/subjects/02/01/20/samboer_en/⟩

Sweeney, M. M. (2002). Two decades of family change: The shifting economic foundations of marriage. *American Sociological Review*, **67**, 132–147.

Syse, A., & Kravdal, O. (2007). Does cancer affect the divorce rate? *Demographic Research*, **16**(15), 469–492.

Syse, A., Tretli, S., & Kravdal, O. (2008). Cancer's impact on employment and earnings – a population-based study from Norway. *Journal of Cancer Survivorship*, 2(3), 149–158.

Syse, A., Tretli, S., & Kravdal, O. (2009). The impact of cancer on spouses' labor earnings: a population-based study. *Cancer*, **115**(18 Suppl), S4350–S4361.

Syse, A., Veenstra, M., Aagnes, B., & Tretli, S. (2012). Cancer incidence, prevalence and survival in an aging Norwegian population. *Norwegian Epidemiology*, **22**(2), 109–120.

Teachman, J. (2010). Work-related limitations, education and risk of marital disruption. *Journal of Marriage and Family*, **72**, 919–932.

Torssander, J., & Erikson, R. (2009). Marital partner and mortality: the effects of the social positions of both spouses. *Journal of Epidemiology & Community Health*, **63**(12), 992–998.

Waite, L. J., & Lehrer, E. L. (2003). The benefits from marriage and religion in the United States: a comparative analysis. *Population and Development Review*, **29**(2), 255–276.

Woods, L. M., Rachet, B., & Coleman, M. P. (2006). Origins of socio-economic inequalities in cancer survival: a review. *Annals of Oncology*, **17**(1), 5–19.

Astri Syse holds a Ph.D. in public health and is a senior researcher at the Research Department at Statistics Norway. Her focus is concentrated on health, health behaviors and mortality. astri.syse@ssb.no

Torkild Hovde Lyngstad is a Professor in Sociology at the University of Oslo. His focus is directed towards marriage and union formation, social inequality in health and effects of union dissolution. T.h.lyngstad@sosgeo.uio.no