In Sickness and in Health: the Role of Marital Partners in Cancer Survival

Abstract

Married cancer patients have a survival advantage. Research suggests this may be attributed to better health at diagnosis, earlier contact with health personnel, and/or access to resources to ensure more optimal treatment. Many of these mechanisms invoke the mere presence of a partner. Partners bring, however, varying amounts of resources into households. It is likely that such resources may produce differentials in survival net of own resources, and our aim is to examine the role of spouses' age and socioeconomic characteristics (SES) for cancer survival.

Data on complete birth cohorts and marital partners were obtained from the Norwegian Cancer Registry and other national registers. Around 267 000 married patients diagnosed with a first cancer after age 50 during 1975-2007 were included to study gross differences in survival by own and spouse's education, income and age. In a sequence of hazard models, we estimate differences in survival by patients' own education, income and age, examine the role of spouses' characteristics, and finally assess the importance of homogamy/heterogamy along the same dimensions. In supplementary analyses, we assess whether differentials by SES and age can be attributed to early diagnosis (i.e. cancer stage and form), and examine differences in SES effects for cancers of different stages and forms.

Our results show that partners' characteristics 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. As such, the naïve perspective of only considering the presence of partners may conceal important differences in survival among cancer patients.

Introduction

Cancer survival is associated with marital status, with married persons having a survival advantage relative to others (Fossa et al., 2011;Kravdal, 2001;Pinquart and Duberstein, 2010). These differences have increased over time (Berntsen, 2011;Kravdal and Syse, 2011). There is some evidence suggesting that the effects of spouses' resources on cancer survival or mortality in general may stem from selection mechanisms, i.e. that resourceful individuals select one another for marriage, there is also much evidence that protection mechanisms are at play (Goldman, 1993;Goldman, 1994).

The underlying mechanisms for the survival advantage associated with being married have not been firmly established, but some research suggests that persons with partners have a better general health at diagnosis, which is favorable for tolerating cancer treatment and thus prolongs survival, and that having a partner is associated better lifestyles and health behaviors (Monden et al., 2003). Some studies also suggest that having a partner may promote earlier contact with health personnel in general and when one suspects something is wrong (Seo and Lee, 2010), which may result in married patients presenting with an earlier stage at diagnosis and thus a more favorable prognosis (Lai and Stotler, 2010;Nayeri et al., 1992;Osborne et al., 2005). Lastly, having a partner at time of diagnosis may help ensure more optimal treatment and follow-up care, which in turn affects survival positively (DiMatteo, 2004;Kravdal, 2000).

All these suggested mechanisms invoke the mere presence of partners, but it is likely that partners bring varying amounts of resources into the household and that these resources of various types may produce differentials in survival, net of own resources. It is, for instance, well known that many of the mechanisms listed above also operate among the well-educated, the wealthy, and younger individuals who may have more resources to divert when encountering cancer. All mechanisms may also apply to spouses' resources, but research efforts have been directed almost exclusively towards cancer patients' own resources.

This study contributes to the literature on marriage and cancer survival differences in several ways. We first examine differences in cancer survival by patients' and their spouses' education, income and age. Then, we study the importance of heterogamy along these dimensions by combining information on both spouses' resources. Finally, we assess whether differentials by SES and/or age can be attributed to early diagnosis (i.e. differences in stage and form), and examine differences in SES effects for cancers of various stages and forms.

Marriage, Resources, and Cancer Survival

In the following, we will provide a brief review of the impact of these important socioeconomic (SES) variables for cancer survival, before we look more closely at the relatively sparse research that takes the resources of patients themselves and their spouses into account, and show how our study contributes to this literature.

Three types of factors are crucial for cancer survival (Kravdal, 2000): Biological characteristics of the tumor (e.g. location, histological type, grade, stage etc.); host factors,

(i.e. characteristics of the cancer patient such as comorbidities, nutritional status and immune function that may influence the progression of the malignancy after diagnosis and the ability to tolerate treatment); and treatment factors such as the type of primary and follow-up treatment and care provided, the actual quality of the treatment, as well as the patient's compliance with the treatment. Age and socioeconomic characteristics of patients and spouses may operate through all these three factors.

Educational inequalities in cancer survival have been documented across a wide range of countries (Aarts et al., 2013;Elstad et al., 2012;Kinsey et al., 2008). Differences in lifestyle and health behaviors are major factors, but the quality of cancer treatment and care could also play a role. Treatment quality is expected to depend on education and income when health services must be bought in the open market, such as in the United States. This is less obvious in egalitarian welfare states such as the Nordic countries. The public health care systems in the Nordic countries provide high quality care almost free of charge to all citizens, regardless of SES and geographic location (Molven and Ferkis, 2011). This is particularly true for cancer diagnosis, treatment, and care, where private options are virtually nonexistent. Against this background, it is surprising that educational inequalities in cancer mortality are of a similar magnitude in the United States and in the Nordic countries (see e.g. Elstad et al., 2012;Kinsey et al., 2008). A difference in economic resources is, however, not the only possible mechanism behind the relationship between education and health. Education may affect health directly, as highly educated individuals may take more effective advantage of available health inputs (e.g. Cutler and Lleras-Muney, 2012). Highly educated individuals may for instance have a better understanding of the relationship between health behaviors and treatment and outcomes (Kenkel, 1991), and one study shows that educated individuals have a greater survival advantage from diseases for which there has been rapid health-related technological progress, indicating that they are quicker to take advantage of technological advances that may improve health (Glied and Lleras-Muney, 2008). Other studies show that patient-provider communication varies with patients' SES, with the level of education being of particular importance (see e.g. Grytten et al., 2011;Marks et al., 2010;Smith et al., 2009). Bago d'Uva and Jones (2009) document that highly educated individuals use specialist care more frequently in many European countries, irrespective of actual needs. It may thus be argued that better educated persons have a better understanding of the health care system, and thus are better at navigating their way through the health bureaucracy, claiming their rights, acquiring relevant information, and communicating their symptoms. In a study from Norway, Fiva et al. (2014) find that access to and utilization of highly specialized treatment affects survival after cancer, and that this is related to both the level and type of educational attainment.

Further, income, net of education, has been shown to matter for general health and mortality (Elo, 2009), and for cancer survival more specifically (Lejeune et al., 2010;Woods et al., 2006). 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 has been applied, along with neighborhood deprivation characteristics (Quaglia et al., 2013). For retirees in particular, income and earnings may be a less relevant measure, and this causes certain

problems as the median age of a cancer diagnosis is above 70 years in most developed countries.

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 et al., 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 individuals or younger partners may be better at seeking information and navigating the health care system, may have less respect for authorities and thus gain access to better treatment and care with implications for survival.

There is, however, far less research on how spouses resources such as education, income or age, may modify this effect, although some exceptions exist. There are a handful of studies showing variations in all-cause mortality or self-reported health by various measures of spouses' SES, reporting somewhat mixed results (Brown et al., 2014;Torssander and Erikson, 2009). A Norwegian study examines effects of spouses' SES on overall and cause-specific mortality, including lung, breast, prostate and all cancers combined (Skalicka and Kunst, 2008). Results from this study suggest that there is less impact of partners' resources in terms of education, occupational class and income for cancer than for overall mortality and cardiovascular mortality. The only significant result for cancer mortality was a pronounced increase in lung cancer mortality for women whose husbands belonged to a low occupational class (hazard ratio 3.2). Two similar studies from Israel examine spouses' impact on all-cause and cardiovascular mortality in middle age (Jaffe et al., 2006) and all-cause and cause-specific mortality (including cancer) in old age (Jaffe et al., 2005). In general, they find that all-cause and cardiovascular mortality is strongly related to spouses' educational level, whereas cancer mortality is either weakly or unrelated to spouses' educational resources. A somewhat older study from Finland examining occupation and education of spouses in relation to mortality show, on the other hand, that although both partners' resources impacted on overall mortality, female breast cancer mortality and other cancer mortality (both sexes), there were no important interactions between own and spouse's SES (Martikainen, 1995). In a study of male mortality, Bosma et al. (1995) find that the spouse's educational level appears to have independent effects on a man's risk of mortality, but cancer mortality was not studied specifically.

There as some inherent limitations in the aforementioned studies on mortality (see e.g. Skalicka and Kunst (2008), Jaffe et al. (2005;2006)). Because they examine mortality, they do not account for the fact that illnesses may 'hit' couples differently depending on spouses' resources, as discussed in detail by for instance Monden et al. (2003) and Monden (2007).

From the above review, we expect to replicate earlier findings of substantial survival differences across SES dimensions. Previous research and theory do not provide clear arguments for expecting that heterogamy is particularly helpful or harmful. It is likely, however, that survival differences by education or income may partly be explained by differences in disease characteristics.

Material and Methods

Our data were obtained from various population-wide longitudinal administrative registers. The data were linked by means of the unique personal identification number assigned all residents in Norway from 1960 onwards. 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). The 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. Information on education in the period before 1980 was taken from the 1970 Census. 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 (N=267 946).

For each individual, a series of three-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 three-month period, and the outcome variable was death from any cause.

Calendar year was grouped into seven categories: 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 the patient and spouse was grouped into five-year categories. Differences in age between spouses were categorized in three groups with differences of ± five years indicating age hypogamy or hypergamy. Parental status was defined as no, one, two, three or four or more children. Educational attainment of both patients and spouses was initially categorized as limited to primary education (10 years), secondary education (11-13 years), lower tertiary education (14-17 years) or higher tertiary education (18+ years). In addition, a matrix looking at discrepancies in education between spouses was created. In the final models, educational level and the matrix was limited to having a college 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 et al., 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 et al., 2009). The income measure was diverted into quintiles for men and women diagnosed at similar ages and during the same calendar year. Similarly was done for the household income of spouses.

Lastly, an indicator of the patient's share of the household income was created based on whether the patient's share was less than 40%, equal (40-60%) or more than 60%.

Cancer characteristics (stage and tumor localization) were included as SES resources have been shown to affect the risk of several cancer forms and also impact on the stage at diagnosis. Tumor localization was included as a categorical variable with eight and nine 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.

Our analysis consists of three steps. First, we modelled survival, within a discrete-time hazard framework, as a function of patients' own age, education, income (Model I). Then measures of the spouses' same characteristics were added (Model II). Finally, we assessed the importance of homogamy/heterogamy along these dimensions (Model III). In supplementary analyses (Model IV), we examined to what extent differentials observed in the first set of models could be attributed to cancer stage and form differences, which may shed light on the role of early diagnosis. When tumor localization and stage are 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, which all might be affected by the resources of the spouse, net of own such resources. Lastly, stage and cancer form specific analyses were conducted to assess differences in SES effects for cancers where treatment is likely to have a pronounced impact compared to cancers for which treatment is likely to matter less.

All models were estimated separately for female and male patients. Because the association between sociodemographic factors and all-cause or cause-specific mortality may vary across age (Dupre and Meadows, 2007;Murphy et al., 2007), we estimated some models separately for those who were diagnosed with cancer below age 70 and those diagnosed at a higher age (which were two almost equally large groups). Similarly, we estimated models separately for the early (1975-1990) and the more recent (1991-2007) calendar period, as there has been important changes in education and labor market participation (especially for women) and developments in cancer therapy over the time period.

Results

Descriptive statistics

The 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 (which are available upon request). However, as cause-of-death registration is difficult in older cancer patients with several comorbidities (Mackenbach et al., 1997), results from the all-cause models are shown here.

As is shown in Table 1, there were more male (63%) than female cancer patients in our cohort of married individuals. The distribution of cancer cases was, however, more similar in the Norwegian population if no restrictions were made on marital status (53% male). 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, whereas the opposite was true for higher 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), colorectal, breast (women) and lung cancer. Overall, around 49% of 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.

Table 1 about here

Figure 1 shows the distribution of patient and spouse hypergamy/hypogamy in terms of age, education and income. In general, female patients had older spouses (up to 45 years older) than male patients, and tended to be less educated than their husbands. Similarly, female patients tended to earn a smaller share of the total household income.

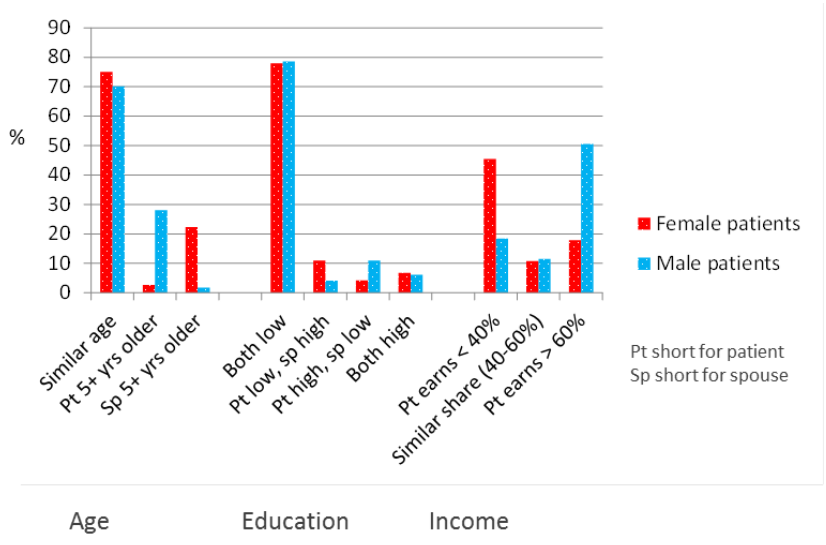

Figure 1. Differences in age, educational level and earned share of household income for female and male patients.

The distribution of stage was fairly similar across the SES measures of interest, and is shown in Table 2.

Table 2 about here

Discrete-time hazard regression models of survival

Table 3 show results from two models; Model I included patients' own age, education and income, whereas Model II also included the same spousal characteristics.

Table 3 about here

As can be seen from Table 3, the coefficient for one's own education was weakened somewhat by the inclusion of spousal characteristics, for both female and male patients. Men with wives with a college education had a 17% improved survival relative to that of men with wives with a lower education, all else equal (odds ratio (OR) 0.83, 95% confidence interval (CI) 0.81-0.84), whereas women with husbands with a college education had a 14% improved survival (OR 0.86, CI 0.83-0.88). Spouses' age did not impact significantly for female or male patients' risk of death, whereas only a weak protective effect was observed for female patients with high earning husbands.

Table 4 portrays results from Model III and Model IV. Model III shows estimates for the combined characteristics of patients and their spouses. As could be expected, 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. Estimation results of models with linear parameterizations of the age difference confirmed these results. Patients in marriages where both spouses have higher education had a significant survival advantage of around 25% relative to patients in marriages where both spouses have a low education. This held for both female and male patients. Survival increased relatively linearly with increasing household income, but somewhat sharper for male patients as compared to female patients. Income quintiles are shown here, but the results were virtually identical with linear parameterizations. Female patients in marriages where their husbands earned both a smaller and a greater share had a survival disadvantage compared to female patients in marriages where both spouses earned a fairly similar share. Male patients, on the other hand, had a survival disadvantage if their wives earned a larger share, and were slightly protected when they were the main breadwinners. Having children was protective, as is well known, but there appeared to be little safety in numbers.

Table 4 about here

The final model (Model IV) is adjusted also for cancer stage and form. When we compared these estimates with those from Model III, the overall pattern appeared to be fairly similar. 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. Consequently, if appears as one's own education was most important for female patients' survival – whereas the spouse's education was most important for male patients' survival. The effects of household income remained fairly stable and consistent, with a greater survival advantage remaining for male patients in high income households. Also the survival advantage associated with male patients' breadwinner role remained in the analyses adjusted for cancer stage and form.

Figure 2 shows the effects associated with being a doctor or being married to a doctor, all else equal. Female patients who themselves were doctors, had a 25% survival advantage. In

addition, female patients married to a doctor had a slight, but statistically significant, survival advantage. Male patients had a slight survival advantage if they were doctors themselves, but gained no further protection from having wives with a medical training.

Figure 2. Risk of death (OR) by being a doctor or having a spouse who is a doctor, adjusted for all variables from model IV. The red line indicates the reference category.

In Table 5, we look more closely at the various combinations of education between spouses on the risk of death, and find that increasing levels of education in general are protective for both male and female patients, although the effect was much stronger for female patients. On the other hand, if we look more closely at the spouses' education, the survival advantage associated with having a more highly educated partner was more pronounced for male patients. For highly educated female patients, there was actually an increased risk of death when the husbands held higher levels of education. As the differences appeared most pronounced between individuals with and without a college education, this simplified categorization was preferred.

Table 5 about here

Stratified analyses

Analyses stratified by age and calendar period (not shown, available upon request) indicated only minor differences. Female patients diagnosed before age 70 had a survival disadvantage if they earned a minor share (<40%) and a major share (>60%) of the household income (the respective ORs were 1.18, CI 1.13-1.24, and 1.21, CI 1.15-.127), whereas no such disadvantage was observed for women diagnose after age 70 (the respective ORs were 1.07, CI 0.97-1.18, and 0.93, CI 0.85-1.02). Also male patients diagnosed before age 70 had a survival disadvantage if they earned a minor share of the household income (OR 1.24 (CI 1.19-1.30), whereas they had a survival advantage after age 70 (OR 0.93, CI 0.89-0.97). Similarly, male patients diagnosed before age 70 had a survival advantage if they earned a major share (OR 0.93, CI 0.91-0.96), whereas no such advantage was observed after age 70 (OR 0.99, CI 0.96-1.03). In terms of age differences between spouses, no survival advantage or disadvantage was observed for male patients diagnosed before age 70. After age 70, being more than five years older than the wife was disadvantageous (OR 1.08, CI 1.06-1.10) whereas being more than five years younger than the wife was advantageous (OR 0.92,

CI0.87-0.98). No differences were observed for either female or male patients by age at diagnosis in terms of education.

Similarly, when we examined the SES effects by calendar period we found a stronger effect of having a high educated husband for high educated female patients for the more recent calendar period compared to earlier (OR 0.78, CI 0.74-0.82 vs OR 0.95, CI 0.86-1.01). For male patients, no such differences were observed. On the other hand, the protective effect of being the main breadwinner for male patients was only present in the earlier time period (OR 0.92, CI 0.88-0.95 vs OR 1.00, CI 0.95-1.05).

Analyses stratified by stage showed that the effects of age, education and income and spousal discrepancies in these features were fairly similar for localized, regional and metastatic cancer, for both female and male patients (Table A1, in Appendix). The only exception was observed for female patients with localized cancer who were more than five years older than their husbands. These women had a 21% increased risk of death compared to female patients with older husbands or husbands of similar age (OR 1.21, CI 1.12-1.31). When we stratified by cancer form, we found that the patterns were fairly consistent also here, although not all differences were statistically significant (Tables A2 and A3, in Appendix).

Summary of main results

Cancer patients' age, education and income are important for survival in Norway, as has been shown across most developed countries. We find, however, that also marital partners' characteristics matter for survival, net of patients' own resources. Thus, the naïve perspective of only considering the presence of partners may conceal important differences in mortality among cancer patients.

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. This difference is largest for male patients. Household incomes affect survival for both female and male patients with lower death risks observed for increasing incomes, but somewhat more pronounced for male than female patients. At the same time, non-normative breadwinner roles appear to be disadvantageous for both female and male patients. For female patients, the survival is clearly best when the 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, and that various discretionary choices of parameterizations do not affect our substantive conclusions.

Discussion

Tumor characteristics, host characteristics and treatment factors may all impact on survival, and age and SES of patients and spouses may work through all these mechanisms, and is discussed in more detail below.

Biological characteristics of the cancer

Earlier research has shown that individuals' own resources influence both the cancer forms diagnosed as well as stage at diagnosis (e.g. Lai and Stotler, 2010;Nayeri et al., 1992;Osborne et al., 2005). This may in part be related to the sociodemographic pattern observed in for instance partaking in cancer screening programs (Bowen et al., 2011;Seo and Lee, 2010), which is observed for screening participation rates for cervical, breast and prostate cancer in Norway (Cancer Registry of Norway, 2014). 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 (the 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. Similarly, several know risk factors for various cancer forms are known to vary with SES, such as for instance smoking (Albano et al., 2007)

Our study shows, however, that the stage distribution was fairly similar across all variables of interest. As an example, patients with highly educated partners had only a slightly different stage distribution than others, and the differences were not statistically significant. Furthermore, as the SES effects in question remained statistically significant also after controlling for cancer stage and form, it appears that patients' general health at diagnosis, treatment and follow-up care are affected by spouses' resources, but there is little evidence for advantages in terms of early diagnosis. Lastly, stratified analyses showed that the patterns associated with age, education and income and discrepancies in these were fairly consistent across the various stages, and also across the cancer forms known to be associated with SES. The remaining discussion is thus centered on other causal pathways.

'Host factors' of patient and spouse

It is well known that patients who are well educated or resourceful in other ways in general have a better overall physical health at time of diagnosis. In support of such a relationship, 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 socioeconomic 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 et al., 2005).

Spouses bring resources into a household above and beyond that of the 'host', 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. On the other hand, female patients with much older spouses had a slight survival advantage, whereas female patients with much younger spouses had a 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 for instance healthy diet, exercise and sleep. This issue is discussed in more in the 'Selection section'.

Similarly, spouses' education represents a manifold of directly available resources such as more knowledge and higher social status, as well as indirect resources available through the social network of spouses. People with educated spouses have been shown to be healthier in general, and to engage in fewer behaviors not conducive to good health, such as smoking (Monden et al., 2003). Social support or pressure from a resourceful spouse, economic advantages achieved by sharing a household with such a spouse and having a spouse who contributes lead to a healthier lifestyle, with for instance better nutrition, less smoking and less alcohol use (Lillard and Panis, 1996;Lindstrom, 2010;Schoenborn, 2004;Waite and Lehrer, 2003). In a relatively simple model including both spouses educational level, we found that both patients' and spouses' educational level 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 did significantly improve survival, although also here the greatest benefit was observed for couples where both spouses had a high education. When we looked at the educational level in more detail, the results were fairly consistent for male patients, whereas the education of female patients themselves appeared to matter more than that of their husbands. In line with this, the clearest benefit was observed for female patients with a medical degree.

Somewhat surprisingly, for male patients a high household income was associated with a survival advantage of almost the same magnitude as having a high education. The effect was present but weaker for female patients. When we examined the patients' share of the earnings, we found that female patients in dual-earning marriages had a clear survival advantage relative to women being supported or having a breadwinner role. Male patients had a slight survival advantage if they were the main breadwinner. At the same time, they had a survival disadvantage if they earned less than 40% of the total income.

Number of children was included as a covariate, as raising children appears to have a positive effect on cancer survival (Kravdal, 2003), probably because children induce a healthier lifestyle and (especially if they are adults) 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.

Alternatively, it could be related to differences in treatment provided or adherence, or the ability to follow-up over time, which is discussed in more detail below.

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 health care 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. We cannot assess these different factors specifically, and will thus just discuss these general mechanisms.

Today's complex cancer therapy regimens may be difficult to follow, and it is thus possible that even in a supposedly egalitarian country such as Norway, individuals with resourceful spouses may be offered or take advantage of better treatment from hospitals than those with less resourceful spouses. Fiva et al. find 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 an specialized treatment with restricted access (2014). 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. In line with this, being a doctor or having a doctor spouse gave a survival advantage above and beyond that of having a high education in general.

Cancer treatment regimens are quite complex, and even more so today than earlier, since more care is increasingly undertaken in an outpatient setting. As such, support in adhering to treatment and follow-up care protocols may be of great benefit. As such it was somewhat surprising that only the effect for high educated female patients with highly educated spouses varied over calendar period. Likewise, the effects were largely similar for older and younger individuals, although younger patients can be hypothesized to be better able to navigate complex systems.

Furthermore, it seems to be a common perception among health personnel that their workload is increasing. If that is the case, it is not impossible that physicians perhaps are more likely to yield to pressure from a resourceful next of kin, possibly giving individuals with higher educated spouses an advantage in receiving better treatment.

The mechanisms described above, all apply to education and/or knowledge. However, as was shown, our results also varied by income. This was somewhat surprising, as cancer care is publicly run and free of charge in Norway.

Selection – homogamy and heterogamy

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 and 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 and Panis, 1996). Furthermore, the health of the spouse is obviously a determinant of widowhood, and is linked to the health of the person under study. 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 and Kravdal, 2007). However, a more recent article shows that the protective effects of remaining married have become more important recently (Kravdal and Syse, 2011).

Couples who are heterogamous in age or education may differ in other, unobserved ways from homogamous 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 a favorable 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.

Generalizability and limitations

The public health care system in Norway offers treatment, including highly specialized cancer care, universally and almost free of charge (Molven and Ferkis, 2011), contrary to many other systems worldwide. As such, income has been hypothesized to play a lesser role for cancer outcomes in Norway compared to 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.

The speed and quality of access to cancer care depends on referrals from publicly employed general practitioners (GPs) working at in the various municipalities. These GPs are limited and obligated in their actions, as common guidelines exist for diagnostic work-up and referrals of persons who may have cancer or are in need of follow-up treatment. The decision to either treat patients at a local hospital or transfer them to more specialized care depends on an overall assessment of patients' age, cancer form and spread, likely outcomes, and the availability of specialized treatment, including surgical, radiation and chemotherapeutic options at local levels. The patient's interaction with the GP as well as with doctors at the local hospital is likely to play a role for referrals and treatments, as there is room for judgment calls depending on cancer form, likely outcomes, patient age etc. This may be affected by

patients' and spouses' resources, in particular in terms of age and education, and is likely to apply also to other countries with similar healthcare organization.

One limitation of the current study, and of all studies examining cancer survival, is that of lead-time bias. It might be that resourceful 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 longer although it is only longer because of earlier diagnosis. This has become increasingly relevant with improved diagnostics and screening tests (Bowen et al., 2011;Seo and Lee, 2010). The latter has become an increasingly relevant issue because of the technological development, and the consequence may 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. We know from previous studies that resourceful patients present with cancers diagnosed at earlier stages (Clegg et al., 2009;Lai and Stotler, 2010). This stage difference has been accounted for. However, sub-stages are not available or commonly reported, and may produce such effects, thus overestimating the effect of spouse's resources. However, the estimates were very similar when we did not include tumor stage in the models, which suggests that additional control for sub-stages would also matter little.

Another limitation of this study is that it was not possible to include also cohabitating couples in our study. If cohabitants enjoy many of the same benefits as the married, which is not unlikely (Joutsenniemi et al., 2006), this could be important for survival for this group. Also cohabitating partners provide resources in a relationship, although the amount and time use may be different. 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).

Due to difficulties with assigning correct causes of death to elderly individuals with up to several comorbidities, we chose to assess all-cause survival in cancer patients. An alternative could have been, as mentioned previously, cause-specific death, but as the results were very similar we chose to stick with all-cause survival. A different, and perhaps even better alternative, would be the relative-survival approach, which is a comparison of all-cause mortality in cancer patients with that in individuals of the same age and sex in the 'normal population' (Hakulinen et al., 2011), or even those with similar marital status, education or other socio-demographic characteristics (McKenzie et al., 2012). This is, however, a more cumbersome procedure, and life tables by marital status are not available in Norway. Further, findings from such analyses have shown that the results are almost identical with respect to marital status differentials although spouses' resources were unaccounted for (Kravdal, 2002).

This study has several obvious strengths. The time-span covered is rather large, and we have complete, high quality data on all married individuals diagnosed with cancer after age 50 in Norway. It is also important that we can control for tumor stage at diagnosis. 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 and 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. Jin and Christiakis, 2013;Martikainen and Valkonen, 1996), and it is likely that this may have implications for a cancer patient's ability to handle his or her 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.

Conclusion

Cancer survival is associated with marital status, with married persons having a survival advantage relative to others. Underlying mechanisms appear unclear, but research suggests that persons with partners have better general health at diagnosis, favorable for tolerating cancer treatment and thus contributing to prolonged survival. Further, having a partner has been shown to be associated with earlier contact with health personnel, in particular when suspecting something is wrong. Lastly, having a partner at time of diagnosis may help ensure more optimal treatment and follow-up care, which in turn can affect survival positively. These suggested mechanisms only invoke the mere presence of a partner.

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 patient-spouse age, education and income

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. Although patients' general health at diagnosis, treatment and follow-up care are affected by spouses' resources, there is little evidence for advantages in terms of early diagnosis.

To conclude, the importance of persons' own education and income is 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 couples with non-normative distributions in age and education. Findings from such research may have important implications for future cancer treatment and care in dealing with couples and not the least individuals without a resourceful spouse or a spouse at all.

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Table 1. Descriptive statistics of the study cohort.

	Female patients		Male patients		Total	
	N	%	N	%	N	%
Total	99927	37.3	168019	62.7	267946	100.0
Age at diagnosis (50-101 yrs)						
50-54	13919	13.9	9307	5.5	23226	8.7
55-59	16497	16.5	15662	9.3	32159	12.0
60-64	17946	18.0	23729	14.1	41675	15.6
65-69	17318	17.3	31146	18.5	48464	18.1
70-74	15590	15.6	34812	20.7	50402	18.8
75-79	11286	11.3	29744	17.7	41030	15.3
80-84	5489	5.5	16725	10.0	22214	8.3
85 and older	1882	1.9	6894	4.1	8776	3.3
Spouses' age at diagnosis (19-101 yrs)						
≤ 54	8046	8.1	21003	12.5	29049	10.8
55-59	13336	13.3	21381	12.7	34717	13.0
60-64	16455	16.5	28610	17.0	45065	16.8
65-69	17569	17.6	32041	19.1	49610	18.5
70-74	17122	17.1	30001	17.9	47123	17.6
75-79	13835	13.8	20876	12.4	34711	13.0
80-84	8515	8.5	9733	5.8	18248	6.8
85 and older	5049	5.1	4374	2.6	9423	3.5
Education						
≤ Primary school	50295	50.3	74052	44.1	124347	46.4
High school	38946	39.0	67820	40.4	106766	39.8
≤ Bachelor	9547	9.6	17127	10.2	26674	10.0
≥ Master	1139	1.1	9020	5.4	10159	3.8
Doctor	205	0.2	8020	4.8	8225	3.1
Spouses' education						
≤ Primary school	41967	42.0	88098	52.4	130065	48.5
High school	41065	41.1	64069	38.1	105134	39.2
≤ Bachelor	10859	10.9	14255	8.5	25114	9.4
≥ Master	6036	6.0	1597	1.0	7633	2.8
Doctor	4835	4.8	340	0.2	5175	1.9
Parental status						
No children	14511	14.5	23301	13.9	37812	14.1
1 child	19597	19.6	32683	19.5	52280	19.5
2 children	32517	32.5	52299	31.1	84816	31.7
3 children	20733	20.7	35279	21.0	56012	20.9
≥ 4 children	12569	12.6	24457	14.6	37026	13.8
Cancer form						
Colorectal cancer	19250	19.3	34524	20.5	34524	12.9
Prostate cancer	N/A	N/A	46225	27.5	46225	17.3
Lung cancer	5773	5.8	19675	11.7	19675	7.3
Renal/bladder cancer	4852	4.9	18775	11.2	18775	7.0
Breast cancer	25511	25.5	N/A	N/A	25511	9.5
Skin cancer	7657	7.7	13343	7.9	13343	5.0
Hematopoietic/lymphoid cancer	6727	6.7	11889	7.1	11889	4.4
Female gynecological cancer	16686	16.7	N/A	N/A	16686	6.2
Pancreatic cancer	2669	2.7	4290	2.6	4290	1.6
Other/unknown cancer	10802	10.8	19298	11.5	19298	7.2
Stage at diagnosis						
Localized cancer	50072	50.1	82307	49.0	132379	49.4
Regional cancer	29448	29.5	37889	22.6	67337	25.1
Metastatic cancer	13973	14.0	25133	15.0	39106	14.6
Unknown or not otherwise stated	6434	6.4	22690	13.5	29124	10.9
Number of cancers						
1	90071	90.1	150129	89.4	240200	89.6
≥ 2	9856	9.9	17890	10.6	27746	10.4

Table 2. Stage distribution for female and male patients by age and educational differences, and household income.

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

Table 3. Modeled estimates of the impact of characteristics of patients (Model I) as well as patients and their spouses (Model II) on the risk of death.[a]

	Model I				Model II			
	Female patients		Male patients		Female patients		Male patients	
	OR[b]	95% CI[c]	OR	95% CI	OR	95% CI	OR	95% CI
1975-1984	1	ref	1	ref	1	ref	1	ref
1985-1994	0.89	0.87-0.92	0.85	0.84-0.87	0.90	0.87-0.92	0.84	0.83-0.85
1995-2007	0.70	0.68-0.72	0.64	0.63-0.65	0.70	0.68-0.72	0.63	0.62-0.64
Patients' characteristics								
age 50-54	1	ref	1	ref	1	ref	1	ref
age 55-59	1.24	1.19-1.30	0.97	0.93-1.01	1.23	1.17-1.29	0.98	0.94-1.02
age 60-64	1.43	1.37-1.49	1.00	0.96-1.04	1.43	1.35-1.50	1.02	0.97-1.07
age 65-69	1.66	1.59-1.74	1.09	1.05-1.13	1.69	1.59-1.79	1.09	1.04-1.14
age 70-74	2.03	1.94-2.12	1.21	1.16-1.25	2.06	1.93-2.20	1.18	1.12-1.24
age 75-79	2.47	2.36-2.59	1.42	1.37-1.48	2.49	2.32-2.67	1.34	1.27-1.41
age 80+	3.50	3.34-3.68	2.07	1.99-2.16	3.53	3.27-3.80	1.80	1.70-1.90
Low education[d]	1	ref	1	ref	1	ref	1	ref
High education	0.79	0.76-0.82	0.81	0.79-0.82	0.84	0.81-0.87	0.85	0.83-0.86
Lowest income quintile	1	ref	1	ref	1	ref	1	ref
4th income quintile	0.88	0.85-0.91	0.81	0.78-0.84	0.88	0.85-0.91	0.80	0.77-0.82
3rd income quintile	0.78	0.75-0.81	0.77	0.74-0.80	0.78	0.76-0.81	0.77	0.74-0.79
2nd income quintile	0.73	0.70-0.76	0.69	0.67-0.72	0.74	0.71-0.76	0.68	0.66-0.70
Highest income quintile	0.69	0.65-0.73	0.61	0.59-0.63	0.70	0.66-0.73	0.60	0.58-0.62
No children	1	ref	1	ref	1	ref	1	ref
1 child	0.92	0.90-0.95	0.99	0.97-1.02	0.93	0.90-0-95	1.00	0.98-1.01
2 children	0.85	0.82-0.87	0.92	0.90-0.94	0.85	0.83-0.88	0.93	0.91-0.94
3 children	0.85	0.82-0.88	0.89	0.87-0.91	0.85	0.83-0.88	0.91	0.89-0.92
4+ children	0.92	0.89-0.96	0.90	0.88-0.92	0.92	0.89-0.95	0.92	0.90-0.94
Spouses' characteristics								
age < 50					1.06	0.92-1.21	1.02	0.98-1.07
age 50-54					1	ref	1	ref
age 55-59					1.04	0.97-1.10	0.98	0.94-1.01
age 60-64					1.05	0.98-1.11	0.96	0.92-0.99
age 65-69					1.01	0.94-1.08	0.97	0.93-1.01
age 70-74					0.98	0.91-1.06	1.01	0.97-1.05
age 75-79					1.01	0.93-1.09	1.05	1.00-1.09
age 80+					1.01	0.93-1.09	1.23	1.18-1.29
Low education					1	ref	1	ref
High education					0.86	0.83-0.88	0.83	0.81-0.84
Lowest income quintile					1	ref	1	ref
4th income quintile					0.98	0.94-1.00	1.05	1.02-1.08
3rd income quintile					0.99	0.95-1.03	1.01	0.97-1.03
2nd income quintile					0.96	0.92-0.99	1.06	1.02-1.08
Highest income quintile					0.95	0.91-0.99	1.10	1.07-1.14

[a]This table portrays estimates from two models: Model I includes only the patient's own characteristics, whereas Model II includes both the patient's and the spouses's characteristics. Time since diagnosis was included in both models (available upon request). [b]Odds ratio. [c]Confidence interval. [d]Low education refers to no education beyond high school, whereas high education refers to any college education.

Table 4. Modeled estimates of the impact of spousal discrepancies in resources on the risk of death (Model III), and adjusted also for cancer stage and type (Model IV). [a]

	Model III				Model IV			
	Female patients		Male patients		Female patients		Male patients	
	OR[b]	95% CI[c]	OR	95% CI	OR	95% CI	OR	95% CI
1975-1984	1	ref	1	ref	1	ref	1	ref
1985-1994	0.91	0.88-0.93	0.86	0.84-0.87	0.70	0.68-0.72	0.72	0.71-0.73
1995-2007	0.71	0.69-0.73	0.65	0.64-0.66	0.48	0.47-0.50	0.52	0.51-0.53
Patient age 50-54	1	ref	1	ref	1	ref	1	ref
Patient age 55-59	1.23	1.17-1.28	0.98	0.93-1.02	1.14	1.08-1.19	1.02	0.97-1.06
Patient age 60-64	1.36	1.30-1.43	1.02	0.98-1.06	1.23	1.18-1.29	1.11	1.07-1.16
Patient age 65-69	1.47	1.41-1.54	1.08	1.04-1.12	1.32	1.26-1.39	1.26	1.21-1.31
Patient age 70-74	1.75	1.67-1.84	1.19	1.14-1.23	1.56	1.49-1.63	1.49	1.43-1.55
Patient age 75-79	2.12	2.03-2.23	1.39	1.34-1.45	1.92	1.83-2.02	1.90	1.82-1.98
Patient age 80+	3.00	2.85-3.15	2.01	1.94-2.10	2.98	2.84-3.13	2.98	2.87-3.11
Patient and spouse similar age (± 5 yrs)	1	ref	1	ref	1	ref	1	ref
Patient > 5 yrs older than spouse	1.11	1.06-1.17	1.02	1.01-1.03	1.10	1.04-1.15	1.02	1.00-1.03
Spouse > 5 yrs older than patient	0.98	0.95-0.99	1.08	1.03-1.13	0.97	0.95-0.99	1.03	0.99-1.08
Both spouses low education[d]	1	ref	1	ref	1	ref	1	ref
Patient low/spouse high education	0.86	0.83-0.89	0.83	0.80-0.86	0.90	0.87-0.92	0.86	0.83-0.90
Patient high/spouse low education	0.82	0.78-0.87	0.83	0.81-0.85	0.84	0.80-0.89	0.88	0.86-0.91
Both spouses high education	0.74	0.70-0.77	0.73	0.70-0.75	0.82	0.78-0.86	0.82	0.79-0.85
Lowest income quintile	1	ref	1	ref	1	ref	1	ref
4th income quintile	0.97	0.94-0.99	0.94	0.92-0.96	0.98	0.96-1.01	0.96	0.94-0.98
3rd income quintile	0.95	0.93-0.98	0.93	0.91-0.95	0.96	0.93-0.99	0.95	0.93-0.97
2nd income quintile	0.95	0.92-0.98	0.89	0.87-0.91	0.95	0.92-0.98	0.91	0.89-0.93
Highest income quintile	0.88	0.85-0.91	0.80	0.78-0.80	0.91	0.88-0.95	0.84	0.81-0.86
Spouses earn a similar share (40-60%)	1	ref	1	ref	1	ref	1	ref
Patient earns a smaller share (< 40%)	1.18	1.13-1.23	1.09	1.05-1.12	1.16	1.11-1.22	1.08	1.04-1.11
Patient earns a larger share (>60%)	1.15	1.10-1.20	0.96	0.94-0.98	1.10	1.05-1.15	0.97	0.95-0.99
Household income is 0 or missing[e]	1.35	1.29-1.41	1.09	1.06-1.12	1.30	1.25-1.36	1.09	1.06-1.12
No children	1	ref	1	ref	1	ref	1	ref
1 child	0.93	0.90-0.96	0.99	0.97-1.01	0.92	0.89-0.95	0.99	0.97-1.01
2 children	0.86	0.84-0.89	0.92	0.90-0.94	0.84	0.82-0.87	0.93	0.91-0.95
3 children	0.86	0.84-0.89	0.89	0.87-0.91	0.83	0.81-0.86	0.91	0.89-0.93
4+ children	0.93	0.90-0.97	0.90	0.88-0.93	0.84	0.81-0.87	0.90	0.88-0.92
Localized cancer					1	ref	1	ref
Regional cancer					2.54	2.48-2.60	1.84	1.80-1.87
Metastatic cancer					7.29	7.09-7.51	4.75	4.66-4.84
Stage not applicable (N/A) or missing					1.82	1.74-1.90	1.37	1.34-1.40
Other cancer[f]					1	ref	1	ref
Leukemia/lymphoma					0.83	0.80-0.87	0.95	0.93-0.98
Skin cancer					0.29	0.28-0.31	0.42	0.41-0.44
Colorectal cancer					0.56	0.54-0.57	0.70	0.69-0.72
Breast cancer					0.32	0.31-0.34	N/A	N/A
Gynecological cancers					0.43	0.41-0.44	N/A	N/A
Prostate cancer					N/A	N/A	0.43	0.42-0.44
Pancreatic cancer					2.87	2.72-3.02	3.36	3.24-3.50
Lung cancer					1.72	1.65-1.79	2.00	1.95-2.05
Renal and bladder cancer					0.64	0.61-0.67	0.58	0.57-0.60

[a]This table portrays estimates from two fully adjusted models, including both spouses characteristics and discrepancies in these (Model III), as well as cancer stage and form (Model IV). Time since diagnosis was included in both models (available upon request). [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. [f]The reference category includes all cancers not specified below. N/A is short for 'not applicable'.

Table 5. Estimates from a detailed model of the effect of education of patients' and their spouses on risk of death.[a]

	Female spouses' education			
	≤ Primary school	**High school**	**≤ Bachelor**	**≥ Master**
Male patients' education	**OR**[b]	**OR**	**OR**	**OR**
≤ Primary school	ref	0.95	0.80	0.77 (ns[c])
High school	0.93	0.89	0.81	0.88 (ns)
≤ Bachelor	0.90	0.83	0.77	0.73
≥ Master	0.85	0.80	0.79	0.72
	Male spouses' education			
	≤ Primary school	**High school**	**≤ Bachelor**	**≥ Master**
Female patients' education	**OR**	**OR**	**OR**	**OR**
≤ Primary school	ref	0.98 (ns)	1.00 (ns)	0.81
High school	0.90	0.87	0.79	0.84
≤ Bachelor	0.84	0.81	0.80	0.71
≥ Master	0.13	0.42	0.61	0.84

[a]Adjusted for all variables in Model IV. [b]Odds ratio. [c]Not statistically significant at the 5% level.

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

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

[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 female cancer patients, by cancer form.[a]

	Leukemia/lymphoma		Skin cancer		Colorectal cancer		Pancreatic cancer		Lung cancer		Renal/Bladder cancer		Breast cancer		Gynecoloical 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	1.05	0.88-1.24	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	1.00	0.92-1.09	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	ref	1	ref	1	ref	1	ref	1	ref	1	ref	1	ref
Patient low/spouse high education	0.94	0.75-0.94	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	1.01	0.85-1.20	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	0.82	0.70-0.97	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	ref	1	ref	1	ref	1	ref	1	ref	1	ref	1	ref
4th income quintile	0.98	0.90-1.08	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	0.91	0.83-1.01	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	0.81-1.01	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	0.90	0.79-1.01	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	ref	1	ref	1	ref	1	ref	1	ref	1	ref	1	ref
Patient earns a smaller share (< 40%)	1.11	0.95-1.30	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%)	1.18	1.01-1.39	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]	1.27	1.09-1.48	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]This table portrays estimates from fully adjusted models stratified by cancer form. 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 A3. Effects of spousal SES resources and discrepancies in these on risk of death for male cancer patients, by cancer form. [a]

	Leukemia/lymphoma		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
Patient and spouse similar age (± 5 yrs)	1	ref	1	ref	1	ref	1	ref	1	ref	1	ref	1	ref
Patient > 5 yrs older than spouse	1.02	0.97-1.07	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	0.96	0.81-1.14	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
Patient low/spouse high education	0.88	0.78-0.99	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	0.89	0.82-0.96	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	0.84	0.76-0.94	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
4th income quintile	0.91	0.84-0.98	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	0.85	0.78-0.93	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	0.80	0.74-0.88	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	0.78	0.71-0.85	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
Patient earns a smaller share (< 40%)	1.13	1.02-1.27	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	0.96-1.13	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]	1.10	0.99-1.21	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]This table portrays estimates from fully adjusted models stratified by cancer form. 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.