Social inequalities in non-small cell lung cancer management and survival: a population-based study in central Sweden

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Received 2 September 2009

Accepted 12 January 2010

ABSTRACT

Objectives To examine possible associations between socioeconomic status, management and survival of patients with non-small cell lung cancer (NSCLC).

Methods In a population-based cohort study, information was retrieved from the Regional Lung Cancer Register in central Sweden, the Cause of Death Register and a social database. ORs and HRs were compared to assess associations between educational level and management and survival.

Results 3370 eligible patients with an NSCLC diagnosis between 1996 and 2004 were identified. There were no differences in stage at diagnosis between educational groups. A higher diagnostic intensity was observed in patients with high compared with low education. There were also social gradients in time between referral and diagnosis in early stage disease (median time: low, 32 days; high, 17 days). Social differences in treatment remained following adjustment for prognostic factors (surgery in early stage disease, high vs low OR 2.84; CI 1.40 to 5.79). Following adjustment for prognostic factors and treatment, the risk of death in early stage disease was lower in women with a high education (high vs low HR 0.33; CI 0.14 to 0.77).

Conclusion The results of this study indicate that socioeconomically disadvantaged groups with NSCLC receive less intensive care. Low education remained an independent predictor of poor survival only in women with early stage disease. The exact underlying mechanisms of these social inequalities are unknown, but differences in access to care, co-morbidity and lifestyle factors may all contribute.

BACKGROUND

The prognosis of lung cancer (LC) is generally poor, with long-term survival dependent on early diagnosis and access to surgery. Since the early 1990s a decline in the incidence of LC has been observed in Swedish men, while the incidence continues to increase in women,¹ a trend associated with gender-specific differences in smoking uptake and cessation.² Several studies have shown that the risk of developing LC is associated with socioeconomic status,^{3–5} but few studies to date have examined socioeconomic inequalities in access to treatment and in survival.^{6,7} While the National Health Care System in Sweden aims to provide medical care on equal terms to all residents, Eaker *et al*⁸ recently found evidence of socioeconomic gradients not only in breast cancer survival, but also in its management. This population-based cohort study was

conducted to examine possible associations between socioeconomic status, management and survival in patients diagnosed with non-small cell lung cancer (NSCLC).

SUBJECTS AND METHODS

The present study was based on information retrieved from the Regional Lung Cancer Register (RLCR) in central Sweden, the Cause of Death Register (CDR) and the longitudinal integration database for health insurance and labour market studies (LISA), containing sociodemographic data. A system of individually unique National Registration Numbers in Sweden allows record linkages between registers.

The RLCR

The population-based RLCR in the Uppsala/Örebro region in central Sweden was established in 1995 to monitor quality of care after the introduction of regional management guidelines for LC.⁹ The RLCR covers >98% of all patients diagnosed with LC in central Sweden, an area with a population of 1.9 million, and contains information on sex, age at diagnosis, smoking status, performance status (PS), mode of detection, histopathology, stage at diagnosis and planned first-time treatment (surgery, chemotherapy, radiotherapy and no active curative treatment). Smoking status is recorded as smoker (current smoker), ex-smoker (no smoking during the last year) and non-smoker (never smoked on a regular basis). Diagnostic procedures and staging methods recorded in the register include mediastinoscopy, CT thorax, CT upper abdomen, bronchoscopy, positron emission tomography (PET) scan of thorax, thoracoscopy, thoracocentesis, transthoracic biopsy and CT/MRI of the brain.

For the purpose of the present study, information on diagnostic intensity was scored with one point assigned for each diagnostic procedure and staging method used. In a subsequent step, the total score was dichotomised into low and high diagnostic intensity. Waiting time was defined as the number of days from referral to morphological diagnosis.

The CDR

Information on cause of death was obtained from the CDR administered by the National Board of Health and Welfare. The CDR covers all deaths in Sweden, with cause of death reported by the attending physician according to WHO

International Classification of Diseases (ICD). The number of non-reported cases is low; estimated at 0.7% of all deaths among individuals in 2006.¹⁰

Social database

Information on socioeconomic characteristics was retrieved from the LISA database, managed by Statistics Sweden.¹¹ This nationwide database, which integrates existing data from the labour, educational and the social sector, consists of individual level data collected since 1990 for all residents of Sweden aged 16 and over. The database is updated annually regarding educational level, disposable income, socioeconomic index, welfare benefits and employment status.

Study population

A total of 6171 patients diagnosed with LC between 1 January 1996 and 31 December 2004 were identified in the RLCR. For the present study, we excluded cases with a previously recorded malignancy (n=3), first diagnosis at autopsy (n=368), <30 years old at diagnosis (n=6), with negative survival time (n=41) and not born in Sweden (n=781). To ensure a homogeneous population with confirmed diagnosis, patients diagnosed with forms of LC other than NSCLC and without information on histological diagnosis were also excluded (n=1602). The final study population consisted of 3370 patients with a histologically confirmed diagnosis of NSCLC.

Socioeconomic status

Educational level was collapsed into three groups according to total number of years of schooling: low ≤ 9 years, middle 10–12 years and high ≥ 13 years, which in the Swedish school system corresponds to mandatory school, high school and posthigh school (college and university). The socioeconomic index (SEI) based on occupation on the household level was categorised into low (blue collar and low level white collar workers), high (intermediate and high level white collar workers and the self-employed) and unknown, due to no employment or missing. For cases diagnosed after retirement, historical data were used to assess the highest lifetime SEI. The variable household disposable income was stratified by patient's sex and dichotomised into the lowest 50% and highest 50% income. The variable number of people in the household (1 and >1) was also considered in initial analyses. Educational level was least affected by missing information and was chosen as the main indicator of socioeconomic position.

The study was approved by the Research Ethics Committee at Uppsala University, Sweden.

Statistical methods

The primary outcome of interest was LC death (coded in the CDR as 162/C34 in ICD 9/10, respectively). Survival time was defined as the interval between the date of the primary diagnosis of LC on or after 1 January 1996 and the date of LC death, emigration or end of follow-up on 31 December 2006, whichever came first. Cumulative crude 1- and 3-year cause-specific survival (CSS) was assessed using the Kaplan–Meier method¹² and estimates were obtained for all indicators of socioeconomic standing. Proportional hazard (PH) models¹³ with HRs and 95% CIs were calculated to assess the risk of LC death for each socioeconomic indicator adjusted for sex, age and stage at diagnosis, with the lowest social category as reference.

In a subsequent step, using education as the socioeconomic indicator of choice, PH models were also adjusted for smoking status, PS, histopathology and treatment, and stratified by sex

and stage at diagnosis. Schoenfeld's residuals were plotted against survival time and tested to verify that assumptions of PHs were fulfilled.¹³ In logistic regression models, ORs with 95% CIs were calculated to assess whether treatment differed by education, adjusted for age and stage at diagnosis, sex, histopathology, smoking status and PS. All statistical analyses were performed using R 2.8.0.

RESULTS

Our study population encompassed 1965 (58%) men and 1405 women (42%) with a median age of 69 at NSCLC diagnosis (range 30–94 years). Median length of follow-up was 7.5 months. The proportion of non-smokers was 11.5% and a quarter of patients were diagnosed with early stage disease (stage IA–IIB). The overall 1- and 3-year NSCLC survival was 42% and 20%, respectively. Over 78% of these patients died of LC, 11% died of other causes and 11% were still alive at the end of follow-up. Almost 10% of the patients with NSCLC were categorised as having high education, 31% middle and 59% low education. Low education were more common in older (≥ 70 years) compared with younger (<70) patients with NSCLC. Compared with patients with low education, it was more common for patients with high education to be never smokers (11.3% and 18.6%, respectively).

Socioeconomic status and survival

For all socioeconomic indicators, both 1- and 3-year crude CSS was longer among patients with high compared with low socioeconomic status (table 1). The difference in absolute risk between categories ranged from 1% to 11% for 1-year crude CSS and from 2% to 7% for 3-year crude CSS. These gradients remained statistically significant for educational level and disposable income after adjustment for sex, age and stage at diagnosis.

Education and patient characteristics

Almost one-fifth (18.8%) of all patients with low educational levels had poor PS (3–4) compared with 10.7% of patients with high education (table 2). This pattern was evident across all age groups (data not shown). No statistically significant differences were found with regard to stage at diagnosis between educational groups.

Education, diagnostic intensity and waiting time

There were no clear differences between educational groups with regard to mode of detection (table 2). However, we found evidence of greater diagnostic intensity in patients with high education based on a scoring system, with 90% of patients in the low education group and 95% of patients with high education, categorised into the high diagnostic intensity group. Waiting times in relation to educational background and stratified by stage at diagnosis are shown in figure 1. A difference in median waiting time was observed among patients with early stage disease only, with waiting time for the low and high education groups 32 and 17 days, respectively. In later stage disease a longer waiting time from referral until 80% of the patients had received their diagnosis was observed in patients with low compared with high education.

Education and treatment modality

For patients with early stage disease, surgery was more common in high (80.9%) compared with low (56.2%) educational groups (table 3). Proportional differences in chemotherapy by education

Table 1 Socioeconomic standing, vital status and cause of death, crude 1- and 3-year cause-specific survival (CSS) and HRs with 95% CIs in 3370 patients aged 30–94 years and diagnosed with primary non-small cell lung cancer in central Sweden, between 1996 and 2004

		Vital status			CSS		Adjusted model†	
Cases n (%)	Alive n (%)	Death due to		Other causes n (%)	1 year	3 year	HR	CI
		Lung cancer*						
Level of education								
Low	2001 (59.4)	180 (9.0)	1594 (79.7)	227 (11.3)	0.39	0.18	1.00	Reference
Middle	1039 (30.8)	139 (13.4)	811 (78.1)	89 (8.6)	0.44	0.23	0.92	0.84 to 1.00
High	329 (9.8)	52 (15.8)	247 (75.1)	30 (9.1)	0.50	0.25	0.84	0.73 to 0.96
Missing	1 (0.0)							
Socioeconomic index (household)								
Low	1966 (58.3)	209 (10.6)	1551 (78.9)	206 (10.5)	0.41	0.20	1.00	Reference
High	1094 (32.5)	145 (13.3)	853 (78.0)	96 (8.8)	0.46	0.22	0.93	0.85 to 1.01
Unknown‡	41 (1.2)	5 (12.2)	33 (80.5)	3 (7.3)	0.34	0.17	1.11	0.79 to 1.57
Missing	269 (8.0)							
Disposable income (household)§								
Low	1687 (50.1)	151 (9.0)	1330 (78.8)	206 (12.2)	0.38	0.18	1.00	Reference
High	1681 (49.9)	219 (13.0)	1322 (78.6)	140 (8.3)	0.45	0.22	0.89	0.83 to 0.97
Missing	2 (0.0)							
No. of people in the household								
1	1340 (40.0)	144 (10.7)	1065 (79.5)	131 (9.8)	0.41	0.19	1.00	Reference
2–9	2028 (60.0)	226 (11.1)	1587 (78.3)	215 (10.6)	0.42	0.21	0.93	0.86 to 1.01
Missing	2 (0.0)							

*Death due to lung cancer according to the International Classification of Diseases (ICD C34/162).

†Proportional hazard model adjusted for age at diagnosis, sex and stage at diagnosis.

‡Unknown due to unclassified employment, students and unemployed.

§Disposable income dichotomised by gender-specific income; lowest 50% and highest 50%.

were most pronounced in stage IIIA–B disease (low education 40.6%, high education 60.5%). In this group, the likelihood of receiving surgery and/or radiotherapy was also greater in high compared with low educational groups. In logistic regression analyses, the likelihood for different treatment modalities was assessed by education and adjusted for prognostic factors (table 3). Among patients with early stage disease, surgery was more likely to be offered to patients with high education (high vs low OR 2.84; CI 1.40 to 5.79). In all stages, chemotherapy was more often given as treatment to patients with high education (high vs low OR 1.36; CI 1.01 to 1.83), while no clear pattern was seen for radiotherapy in patients with stage IIIA–B disease (high vs low OR 1.19; CI 0.76 to 1.85).

Education and survival

Both 1- and 3-year crude CSS differences between educational groups were observed among women, elderly patients, never smokers, patients with PS 0–1 and in early stage disease (data not shown). To assess the risk of death, separate PH models were calculated adjusted for sex, age and stage at diagnosis, histopathology, PS, smoking status and with or without treatment (table 4). In a model without treatment (Model 1), a non-statistically significant better survival was observed for patients with high education (high vs low HR 0.94; CI 0.81 to 1.08). No clear pattern was observed in a model including treatment (Model 2; high vs low HR 1.02; CI 0.87 to 1.19).

In analysis stratified on sex and stage at diagnosis, a statistically significant difference was found between educational groups in stage IA–IIB (high vs low HR 0.58; CI 0.40 to 0.85), which was even more pronounced among women (high vs low HR 0.28; CI 0.13 to 0.62), when treatment was not considered. When treatment was included, the decreased risk remained statistically significant only among women with early stage disease (high vs low HR 0.33; CI 0.14 to 0.77). However, in men with stage IIIA–B disease, the risk of death was greater in

patients with high compared with low education (high vs low HR 1.41; CI 1.04 to 1.90).

DISCUSSION

We found evidence of higher diagnostic and treatment intensity in patients with high compared with low education in a study set in a region with a National Health Care System aiming to provide equal quality care. Social disparities in length of time from referral to diagnosis were observed in all patients, but foremost in patients with early stage disease. However, there were no proportional differences in stage at diagnosis by educational background. It was more common that patients with high education underwent surgery and received chemotherapy, and these differences remained following adjustment for prognostic factors including PS at diagnosis. We observed social inequalities in 1- and 3-year crude survival for all patients, but, after adjustment for known prognostic factors and treatment, a social gradient in survival remained only among women with early stage disease. In men with stage IIIA–B disease, the reverse pattern was observed, with higher risk of death in patients with high education. Corroborating results from earlier studies, women consistently had a survival advantage over men.^{14 15}

Strengths of this study include the availability of high quality and reliable clinical information on cause of death. Information on PS was used to assess the general health status of patients, minimising the potential confounding influences of comorbidity. Also, external validity was high since the study was population based and encompassed virtually all Swedish-born patients in central Sweden with a diagnosis of NSCLC.

Education is considered a good indicator of social position in relation to health and survival.¹⁶ Education may also reflect dimensions of health awareness and ability to access and navigate the Health Care System.¹⁷ Educational level has the benefit of not being affected by retirement, with data available on the

Table 2 Background and clinical characteristics of 3369 patients aged 30–94 years diagnosed with primary non-small cell lung cancer in central Sweden between 1996 and 2004, by educational level

	Level of education			Total n
	Low n (%)	Middle n (%)	High n (%)	
Total number	2001 (100)	1039 (100)	329 (100)	3369
Sex				
Male	1185 (59.2)	582 (56.0)	197 (59.9)	1964
Female	816 (40.8)	457 (44.0)	132 (40.1)	1405
Age at diagnosis				
<70	877 (43.8)	659 (63.0)	208 (63.2)	1744
≥70	1124 (56.2)	380 (37.0)	121 (36.8)	1625
Year of diagnosis				
1996–1999	876 (43.8)	426 (41.0)	128 (38.9)	1430
2000–2004	1125 (56.2)	613 (59.0)	201 (61.1)	1939
Smoking status				
Smoker	878 (45.5)	510 (50.2)	121 (37.5)	1509
Ex-smoker	833 (43.2)	408 (40.2)	142 (44.0)	1383
Never smoked	219 (11.3)	98 (9.6)	60 (18.6)	377
Performance status (PS)*				
PS 0–1	1073 (56.1)	638 (63.5)	222 (69.8)	1933
PS 2	478 (25.0)	246 (24.5)	62 (19.5)	786
PS 3–4	360 (18.8)	121 (12.0)	34 (10.7)	515
Mode of detection				
Bronchoscopy	1603 (79.1)	872 (82.0)	272 (76.8)	2747
CT thorax	1783 (88.0)	965 (90.7)	310 (87.6)	3058
US/CT upper abdomen	1656 (81.7)	908 (85.3)	292 (82.5)	2856
Mediastinoscopy	118 (5.8)	65 (6.1)	22 (6.2)	205
Other†	905 (44.7)	516 (48.5)	165 (46.6)	1586
At least bronchoscopy, CT thorax and US/CT	1358 (67.0)	775 (72.8)	247 (69.8)	2380
At least bronchoscopy and CT thorax	1496 (73.8)	827 (77.7)	263 (74.3)	2586
Stage at diagnosis				
IA–IIB	486 (25.1)	266 (26.3)	89 (27.5)	841
IIIA–IIIB	710 (36.7)	341 (33.7)	118 (36.4)	1169
IV	740 (38.2)	405 (40.0)	117 (36.1)	1262

*WHO PS (0, 1, fully active or symptomatic but completely ambulatory; 2, symptomatic, <50% in bed during the day; 3, 4, symptomatic >50% in bed during the day or bedbound, completely disabled).

†Other includes: positron emission tomography scan of thorax, thoracoscopy, thoracocentesis, transthoracic biopsy and CT or MRI of the brain.
US, ultrasound.

individual level. However, assigned educational level may have been affected by changes in the Swedish school system over calendar time. In our study 80% of all cases were born before 1942 and entered school before most changes were initiated. In a separate analysis, restricted to these birth cohorts (born ≤1942), results remained virtually unchanged with regard to both social gradients in management and survival differences in women with early stage disease.

Smoking status was based on self-report and may have led to misclassification; also no information was available on dose and duration of smoking. Data were also lacking for complete treatment history and co-morbidity. Instead smoking history and WHO PS were used as indicators of co-morbidity burden. While results from some studies suggest that the role of co-morbidity on general prognosis in NSCLC is limited,^{3 18 19} others have found evidence of an influence of co-morbidity burden on survival in early stage NSCLC.^{20 21}

While differences were found between educational groups in waiting times following initial contact with the Health Care System, no evidence of clinically important inequality was found in the timing of diagnosis, since stage distribution did not differ by education. An earlier study based on the RLCR found evidence of regional differences in treatment of NSCLC in central Sweden.²² Hence, since low education is more common

in rural areas, the observed social gradient in waiting times may be explained by the patients' proximity to larger urban hospitals.²³ Also, a multidisciplinary management approach often available in larger hospitals is likely to reduce waiting times.²⁴ While not always a determinant of survival, prolonged waiting time is likely to cause psychosocial stress for the patient. The longer waiting times observed in early compared with more advanced stage disease may well reflect the extensive investigation necessary to determine appropriate candidates for surgery (eg, PET scan, mediastinoscopy).

Possible reasons for the observed social gradients in diagnostic intensity may include differences in doctor–patient interaction, adherence to guidelines between small and large hospitals, and the impact of co-morbidity in the low educational groups.

The observed inequalities in the likelihood of receiving surgery and chemotherapy could not be explained by sex, smoking status, PS, stage or age at diagnosis. Corroborating findings from at least one earlier study,²⁵ the social gradient in receiving surgical treatment was particularly distinct in patients with early stage NSCLC, where surgery is the primary treatment of choice. Although we controlled for PS, our limited data on co-morbidity cannot exclude that poorer general health and surgical risks in disadvantaged groups are influencing physicians' treatment decisions.²¹

Figure 1 Writing time (days) from referral to morphological diagnosis by stage and level of education.

The finding of a greater social difference in 1- compared with 3-year survival is consistent with results from a Danish cohort study.³ In that study, which included data on co-morbidity but lacked information about stage at diagnosis, a social gradient in short-term survival was observed. The authors speculated that inequalities in short-term survival could be explained by social differences in stage at diagnosis, a pattern which was not evident in the present study. A social gradient in overall LC survival was observed in two other studies, although both lacked data on co-morbidity and stage at diagnosis.^{6,7} However, other research groups have found no association between socioeconomic standing and survival.^{26,27}

Our findings of survival inequalities in women with stage IA–IIB disease corroborate results from earlier studies focusing on early stage NSCLC.^{20,25,28} Two of these studies lacked information on PS and smoking status,^{25,28} factors which have been associated with poorer survival in early stage NSCLC,^{29,30} and did not present gender-specific analyses. Bach *et al*²⁰ found that low median income was associated with poor survival

among patients with NSCLC with early stage disease after adjustments for prognostic factors and co-morbidity.

It has been suggested that socioeconomic factors play little or no role in survival in cancers with poor prognosis, but play a more important role in cancers with good prognosis for which choice of treatment affects prospects of survival.³¹ This is consistent with our findings of social gradients in survival among women with early stage disease, which may reflect an influence of general health status, lifestyle factors and family support. A Swedish government report indicates that the prevalence of risk behaviours including high alcohol consumption, low physical activity and low intake of fruit and vegetables is higher among women with low socioeconomic status.² It is possible that the observed social gradients in survival in women, but not in men, with early stage disease may be explained by intergender social differences in lifestyle and general health behaviour. In recent decades social gradients in smoking in Sweden have been more pronounced among women than men. Accordingly, differences in smoking related to co-morbidity

Table 3 Planned treatment of 3369 patients aged 30–94 years diagnosed with primary non-small cell lung cancer in central Sweden between 1996 and 2004, by educational level and stratified on stage at diagnosis

		Level of education					
		Low		Middle		High	
		n (%)	OR (CI)	n (%)	OR (CI)	n (%)	OR (CI)
All stages	Planned treatment*						
	Surgery	318 (16.4)	1.00 (ref.)	221 (21.8)	1.33 (0.98 to 1.81)	87 (26.8)	1.93 (1.25 to 3.00)
	Chemotherapy	674 (34.8)	1.00 (ref.)	458 (45.2)	1.25 (1.03 to 1.52)	153 (47.1)	1.35 (1.00 to 1.81)
	Radiotherapy	491 (25.3)	1.00 (ref.)	290 (28.6)	1.12 (0.93 to 1.36)	82 (25.2)	0.91 (0.67 to 1.22)
Stage IA–IIB	No active curative treatment	403 (20.8)	1.00 (ref.)	198 (19.5)	0.93 (0.58 to 1.49)	68 (20.9)	1.63 (0.70 to 3.80)
	Planned treatment						
	Surgery	273 (56.2)	1.00 (ref.)	189 (71.1)	1.53 (1.01 to 2.31)	72 (80.9)	2.84 (1.40 to 5.79)
	Chemotherapy	74 (15.2)	1.00 (ref.)	50 (18.8)	1.18 (0.78 to 1.80)	18 (20.2)	1.31 (0.71 to 2.42)
Stage IIIA–B	Radiotherapy	109 (22.4)	1.00 (ref.)	58 (21.8)	1.04 (0.71 to 1.54)	10 (11.2)	0.37 (0.17 to 0.82)
	No active curative treatment	52 (10.7)	1.00 (ref.)	20 (7.5)	0.77 (0.14 to 4.36)	7 (7.9)	0.14 (0.01 to 2.39)
	Planned treatment						
	Surgery	41 (5.8)	1.00 (ref.)	21 (6.1)	0.84 (0.48 to 1.47)	11 (9.2)	1.07 (0.52 to 2.23)
Stage IV	Chemotherapy	289 (40.6)	1.00 (ref.)	195 (57.2)	1.64 (1.19 to 2.25)	72 (60.5)	1.45 (0.90 to 2.34)
	Radiotherapy	240 (33.8)	1.00 (ref.)	155 (45.3)	1.49 (1.10 to 2.01)	50 (42.5)	1.19 (0.76 to 1.85)
	No active curative treatment	158 (22.2)	1.00 (ref.)	66 (19.3)	1.08 (0.46 to 2.55)	26 (21.8)	2.82 (0.55 to 14.49)
	Planned treatment						
	Surgery	4 (0.5)	1.00 (ref.)	11 (2.7)	4.21 (1.26 to 14.03)	4 (3.4)	6.33 (1.48 to 27.1)
Stage IV	Chemotherapy	311 (42.2)	1.00 (ref.)	213 (52.6)	0.99 (0.71 to 1.37)	63 (53.8)	1.41 (0.83 to 2.40)
	Radiotherapy	142 (19.2)	1.00 (ref.)	77 (19.9)	0.84 (0.60 to 1.18)	22 (18.8)	0.98 (0.57 to 1.66)
	No active curative treatment	193 (26.1)	1.00 (ref.)	112 (27.7)	0.91 (0.48 to 1.72)	35 (29.9)	1.87 (0.59 to 5.91)

The ORs with 95% CIs were adjusted for age at diagnosis, sex, histopathology, smoking status and performance status.

*The planned treatment was defined as at least surgery, chemotherapy and radiotherapy (without taking into account if a single or a combined treatment was administered).
ref., reference.

burden between educational groups may be larger in women, contributing to detectable social inequalities in survival in potentially curable early stage LC. Another explanation for the observed gradients in survival could be lower diagnostic intensity in patients with low education. Thus, a proportion of patients with late stage disease might be misclassified as having early stage disease. Such stage migration ('Will Rogers phenomenon')³² may lead to inaccurate staging and poorer stage-specific survival.

It cannot be excluded that the higher risk of death in men with high education and stage IIIA–B disease observed in the

present study may reflect social differences in the intensity of treatment efforts. In stage IIIA–B disease, all treatment modalities, including surgery, were more common in patients with high compared with low education, which may have had a negative influence on survival in frail patients.

In conclusion, our results indicate that disadvantaged groups receive less intensive care for NSCLC within the setting of a uniform National Health Care System, which suggests that inequalities may be even more pronounced in other systems. Of particular concern was our finding of disparities in the likelihood of receiving surgery in early stage disease, a treatment of

Table 4 Cause-specific proportional hazard models with HRs and 95% CIs estimated in 3369 patients aged 30–94 years diagnosed with primary non-small cell lung cancer in central Sweden between 1996 and 2004, by educational level and stratified on stage at diagnosis

		Model 1*						Model 2†					
		All patients		Male		Female		All patients		Male		Female	
		HR	CI	HR	CI	HR	CI	HR	CI	HR	CI	HR	CI
Stage IA–IV	Education												
	Low	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
	Middle	0.97	0.88 to 1.06	1.02	0.91 to 1.15	0.88	0.76 to 1.01	0.99	0.89 to 1.09	1.05	0.92 to 1.19	0.91	0.78 to 1.07
Stage IA–IIB	High	0.94	0.81 to 1.08	1.05	0.88 to 1.25	0.76	0.60 to 0.96	1.02	0.87 to 1.19	1.12	0.92 to 1.36	0.84	0.65 to 1.08
	Education												
	Low	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
Stage IA–IIB	Middle	0.69	0.55 to 0.87	0.79	0.59 to 1.06	0.58	0.40 to 0.83	0.69	0.55 to 0.88	0.76	0.56 to 1.04	0.65	0.44 to 0.96
	High	0.58	0.40 to 0.85	0.77	0.5 to 1.19	0.28	0.13 to 0.62	0.70	0.47 to 1.03	0.95	0.60 to 1.51	0.33	0.14 to 0.77
Stage IIIA–IIIB	Education												
	Low	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
	Middle	0.94	0.81 to 1.08	0.96	0.80 to 1.15	0.88	0.69 to 1.11	0.97	0.83 to 1.14	1.04	0.85 to 1.28	0.89	0.69 to 1.15
Stage IV	High	1.18	0.95 to 1.47	1.34	1.02 to 1.76	0.93	0.64 to 1.34	1.30	1.03 to 1.65	1.41	1.04 to 1.90	1.08	0.74 to 1.59
	Education												
	Low	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference	1.00	Reference
Stage IV	Middle	1.09	0.96 to 1.26	1.15	0.96 to 1.38	1.04	0.84 to 1.29	1.12	0.96 to 1.31	1.15	0.94 to 1.42	1.13	0.89 to 1.45
	High	0.95	0.76 to 1.17	1.00	0.76 to 1.33	0.86	0.61 to 1.22	0.98	0.77 to 1.25	1.04	0.75 to 1.43	0.92	0.62 to 1.37

*Proportional hazard model adjusted for sex, age at diagnosis, histopathology, performance status and smoking status.

†Proportional hazard model adjusted for sex, age at diagnosis, histopathology, performance status, smoking status and treatment.

significant potential benefit. To improve the understanding of factors contributing to social gradients in management and survival of LC, future studies need to address in detail the role of access to care, doctor–patient interactions, adherence to treatment guidelines and co-morbidity. The pattern of care and survival observed in the most privileged groups should represent a minimum standard for all patients with LC.

Acknowledgements We thank the Lung Cancer Group at the Regional Oncological Centre in Uppsala for providing data for this study. AB was funded by a postgraduate scholarship from the Health Care Sciences Postgraduate School at Karolinska Institutet in Sweden.

Funding Swedish Council for Working life and Social Research 2006-0587, Swedish Cancer Society Grant 03-0287.

Competing interests None.

Ethics approval This study was conducted with the approval of the Research Ethics Committee at Uppsala University.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1. **N.B.o.H.a. Welfare**, ed. *Cancer incidence in Sweden 2007*. Stockholm: Epidemiologiskt Centrum, 2008.
2. **N.B.o.H.a. Welfare**, ed. *Folkhälsorapport 2009, Sweden*. Stockholm: Epidemiologiskt Centrum, 2008.
3. **Dalton SO**, Steding-Jessen M, Engholm G, *et al.* Social inequality and incidence of and survival from lung cancer in a population-based study in Denmark, 1994–2003. *Eur J Cancer* 2008;**44**:1989–95.
4. **Sidorchuk A**, Agardh EE, Aremu O, *et al.* Socioeconomic differences in lung cancer incidence: a systematic review and meta-analysis. *Cancer Causes Control* 2009;**20**:459–71.
5. **Ekberg-Aronsson M**, Nilsson PM, Nilsson JA, *et al.* Socio-economic status and lung cancer risk including histologic subtyping—a longitudinal study. *Lung Cancer* 2006;**51**:21–9.
6. **Hussain SK**, Lenner P, Sundquist J, *et al.* Influence of education level on cancer survival in Sweden. *Ann Oncol* 2008;**19**:156–62.
7. **Van der Heyden JH**, Schaap MM, Kunst AE, *et al.* Socioeconomic inequalities in lung cancer mortality in 16 European populations. *Lung Cancer* 2009;**63**:322–30.
8. **Eaker S**, Halmin M, Bellocco R, *et al.* Social differences in breast cancer survival in relation to patient management within a National Health Care System (Sweden). *Int J Cancer* 2008;**124**:180–7.
9. **Regional Oncologic Centre in Uppsala/Örebro region, Lung Cancer Quality Register**. Regional Register of Lung Cancer. www.roc.se.
10. **Dödsorsaker**. 2006 [Cause of Death]: *Epidemiologic Centre, National Board of Health and Welfare*, 2008.
11. Longitudinal integration database for health insurance and labour market studies (LISA by Swedish acronym). Statistics Sweden. www.scb.se.
12. **Kaplan EL**, Meier P. Nonparametric estimation from incomplete observations. *Am Stat Assoc* 1958;457–81.
13. **Harrell EFJ**. *Regression modeling strategies: with applications to linear models, logistic regression and survival analysis*. Berlin: Springer, 2001.
14. **de Perrot M**, Licker M, Bouchardy C, *et al.* Sex differences in presentation, management, and prognosis of patients with non-small cell lung carcinoma. *J Thorac Cardiovasc Surg* 2000;**119**:21–6.
15. **Johnson BE**, Steinberg SM, Phelps R, *et al.* Female patients with small cell lung cancer live longer than male patients. *Am J Med* 1988;**85**:194–6.
16. **Geyer S**, Hemström O, Peter R, *et al.* Education, income, and occupational class cannot be used interchangeably in social epidemiology. Empirical evidence against a common practice. *J Epidemiol Community Health* 2006;**60**:804–10.
17. **Galobardes B**, Morabia A, Bernstein MS. Diet and socioeconomic position: does the use of different indicators matter? *Int J Epidemiol* 2001;**30**:334–40.
18. **Janssen-Heijnen ML**, Housterman S, Lemmens VE, *et al.* Prognostic impact of increasing age and co-morbidity in cancer patients: a population-based approach. *Crit Rev Oncol Hematol* 2005;**55**:231–40.
19. **Janssen-Heijnen ML**, Smulders S, Lemmens VE, *et al.* Effect of comorbidity on the treatment and prognosis of elderly patients with non-small cell lung cancer. *Thorax* 2004;**59**:602–7.
20. **Bach PB**, Cramer LD, Warren JL, *et al.* Racial differences in the treatment of early-stage lung cancer. *N Engl J Med* 1999;**341**:1198–205.
21. **Battafarano RJ**, Piccirillo JF, Meyers BF, *et al.* Impact of comorbidity on survival after surgical resection in patients with stage I non-small cell lung cancer. *J Thorac Cardiovasc Surg* 2002;**123**:280–7.
22. **Myrdal G**, Lamberg K, Lambe M, *et al.* Regional differences in treatment and outcome in non-small cell lung cancer: a population-based study (Sweden). *Lung Cancer* 2009;**63**:16–22.
23. **Living Conditions**. Report no 111. *Education level and field of education 1975–2003*. Statistics Sweden, 2005.
24. **Deegan PC**, Heath L, Brunskill J, *et al.* Reducing waiting times in lung cancer. *J R Coll Physicians Lond* 1998;**32**:339–43.
25. **Greenwald HP**, Polissar NL, Borgatta EF, *et al.* Social factors, treatment, and survival in early-stage non-small cell lung cancer. *Am J Public Health* 1998;**88**:1681–4.
26. **Vagero D**, Persson G. Cancer survival and social class in Sweden. *J Epidemiol Community Health* 1987;**41**:204–9.
27. **Bonett A**, Roder D, Esterman A. Determinants of case survival for cancers of the lung, colon, breast and cervix in South Australia. *Med J Aust* 1984;**141**:705–9.
28. **Ou SH**, Zell JA, Ziogas A, *et al.* Low socioeconomic status is a poor prognostic factor for survival in stage I nonsmall cell lung cancer and is independent of surgical treatment, race, and marital status. *Cancer* 2008;**112**:2011–20.
29. **Fujisawa T**, Iizasa T, Saitoh Y, *et al.* Smoking before surgery predicts poor long-term survival in patients with stage I non-small-cell lung carcinomas. *J Clin Oncol* 1999;**17**:2086–91.
30. **Wu YC**, Lin CF, Hsu WH, *et al.* Long-term results of pathological stage I non-small cell lung cancer: validation of using the number of totally removed lymph nodes as a staging control. *Eur J Cardiothorac Surg* 2003;**24**:994–1001.
31. **Kogevinas M**, Marmot MG, Fox AJ, *et al.* Socioeconomic differences in cancer survival. *J Epidemiol Community Health* 1991;**45**:216–9.
32. **Feinstein AR**, Sosin DM, Wells CK. The Will Rogers phenomenon. Stage migration and new diagnostic techniques as a source of misleading statistics for survival in cancer. *N Engl J Med* 1985;**312**:1604–8.