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Editorial

Social inequalities in cancer incidence and survival: lessons from Danish studies

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The unequal distribution of diseases among population groups has since long attracted the attention of epidemiologists. Large differences in disease risk have repeatedly been observed in relationship to socioeconomic indicators, such as educational level, occupational class and household income (1). With regards to cancer risk, a first comprehensive review of socioeconomic inequalities was published by IARC in 1997 (2). This review covered inequalities in cancer mortality, incidence and survival and discussed many possible explanations. More recently, there have been numerous studies describing social inequalities in cancer mortality (3-7) and survival (8-11), and comparatively slightly fewer studies on social inequalities in cancer incidence (12-15).

This special issue of the European Journal of Cancer makes a unique contribution to the study of social inequalities and cancer. This work involved more than 50 researchers from one single country, Denmark, who all focused on the same objective: investigating social inequalities in cancer incidence and survival in Denmark. Their work was based on a rich data source obtained through the linkage of national registries with high quality information on cancer incidence and survival and on a variety of social indicators and relevant clinical indicators. Such linked datasets are a specific asset of the Nordic countries, and the envy of epidemiologists elsewhere. In the Danish studies, the national cancer registry was linked to medical registers and to social registers such as the population register, the unemployment

register, and the register for education statistics (16). In all papers included in this special issue (16-27), the authors analysed the linked datasets using the same methods to quantify social inequalities in cancer incidence and cancer survival. The authors used different types of indicators: demographic (e.g. type of district or ethnicity), social (such as education or income) and clinical (including co-morbidities or depression). This systematic work resulted in a comprehensive overview of social inequalities in the incidence and survival of 21 different cancer types, providing much more detail than what is commonly available in international journals.

This overview documented large inequalities in the incidence of many cancer sites, especially lung (17), oesophagus, stomach (18), mouth and pharynx, larynx (19), and cervix (20) (see Table 1). Moderate inequalities were found for pancreas (18), kidney and bladder cancer (21). Inequalities were also indicated for colon and rectum cancer (22). For all these cancer types, higher incidence rates were found among men and women from “lower” social groups. Reverse gradients were shown for malignant melanoma (23), breast cancer (24) and prostate cancer (25), with higher incidence rates among people from “higher” social groups. Inequalities in cancer survival, with higher survival rates among people from higher social groups, were observed for many cancer sites including brain (26), melanoma (23), breast (24), cervical (20), mouth and pharynx, larynx (19), prostate (25), kidney, bladder (21), colon and rectum (22) and non-Hodgkin’s lymphoma (27). The magnitude of inequalities however strongly differed between cancer sites. Together, by carefully mapping social inequalities in cancer in Denmark, the Danish studies allowed identifying areas with the largest inequalities that thus require particular attention by professionals and policy makers.

Can the Danish patterns be assumed to apply to other European countries? The results found for most cancer sites are globally in line with what could be expected from the available literature on incidence and mortality. Thus, the authors supported previous studies in documenting a strong negative association between social position and incidence of lung cancer and cervical cancer, no association for Hodgkin and non-Hodgkin's lymphoma and leukaemia, and a positive association for malignant melanoma, breast cancer and prostate cancer. However, recent overviews have shown wide variations between European countries for some cancer types. This has been found for instance for lung (28) or alcohol related cancers (29). Consequently, for some cancers, the Danish situation may largely differ from that in other countries. For example, socioeconomic inequalities in lung cancer incidence among Danish women (17) were much larger than what is found in other European populations, probably due to the more advanced stage of the smoking epidemic among Danish women than among women in most other European countries (30). Similarly, the Danish studies suggested a higher incidence of cancer of colon and rectum among people from lower social groups (22). This negative association is rarely found in European studies, mostly reporting a positive association (31). This specific finding might reflect particularities of Denmark, such as large socioeconomic inequalities in the prevalence of risk factors including obesogenic diet, physical activity and body mass index. There is evidence to suggest that these inequalities are larger in Denmark than in most other European countries (32).

The comprehensive mapping exercise presented in this special issue cannot be easily replicated in most other European countries, because of the lack of equally comprehensive databases outside Scandinavia. Nonetheless, a number of lessons may be learned and applied to descriptive studies in other parts of Europe. First of all, the Danish work illustrates the great importance of linking cancer registries to population-based registers with information on

co-morbidities or demographic and socioeconomic characteristics of cancer patients. As an example, such a comprehensive linkage has already been performed for the Turin cancer registry (33). In other situations where an individual linkage is not possible, a start could be made with linking cancer registries to other registries at an ecological level. Studies from different European countries documented large inequalities in cancer survival in relationship to area-based measures of socioeconomic position (11, 34, 35). In addition, cancer registries should endeavour to routinely record, in addition to tumour characteristics, other information possibly linked to cancer survival. Thus, in the Eindhoven Cancer Registry, severe co-morbidities at the time of diagnosis are recorded since 1993 (36, 37).

A large body of the literature deals with social inequalities in cancer mortality. Inequalities in mortality reflect the combined effect of inequalities in incidence and inequalities in case-fatality. The contribution of these two components may greatly differ between cancer types. In Denmark, lung cancer showed large incidence but small survival inequalities (17), while the reverse pattern was observed for non-Hodgkin's lymphoma (27). For breast cancer, inequalities favouring women from "low" social groups were found for incidence, whereas inequalities favouring women from "high" social groups were found for survival (24). Also in other European countries, epidemiologists should attempt to look beyond mortality and to identify inequalities in incidence and in survival respectively, in agreement with a suggestion to interpret trends in these disease properties adequately (38).

The Danish studies also underline the importance of statistical power. This is essential to draw conclusions regarding the presence of inequalities but also their magnitude. Sufficient statistical power allows ruling out the possibility that the findings are due to random variation, as in most Danish studies. Thus, the Danish studies demonstrated enormous differences in the

magnitude of differences between cancer sites: cancer incidence among men with basic education (when compared with men with high-school education) was increased by about 50% for lung cancer compared to only a 15% for bladder cancer.

The authors used six socio-economic indicators (level of education, disposable income, affiliation to work market, social class, housing tenure and size of dwelling) as well as four demographic indicators (gender, cohabitation status, type of district and ethnicity) (16). It is important to utilise different socioeconomic indicators as they represent different forms of socioeconomic (dis)advantage and in addition they are formed during different phases of the life course. In addition, the consideration of different complementary indicators helps to identify as accurately as possible the socioeconomic groups where cancer risk is increased most. Increased risk of many cancer types was observed in relationship to low educational level – which is the most widely used socioeconomic indicator in most European countries - but also in relationship to other indicators such as employment status and housing tenure. These large inequalities were also observed after adjusting for educational level, suggesting an independent effect of other variables (39). It is remarkable that for many cancer types inequalities were larger when using housing variables than income (39). This suggests that wealth as accumulated over the life course, and as reflected in ownership and quality of housing, may be a useful predictor for increased cancer incidence.

Social class as defined by occupational class is traditionally considered one of the most important indicators to characterize people's socioeconomic position. A previous study suggested that occupational class was more strongly associated with cancer mortality than educational level (40). In most Danish studies, occupational class was associated with the risk of cancer, although to a generally lesser extent than education and income. Nonetheless, also

when controlling for the effects of income and educational level, an independent effect of occupational class was observed for many cancer types. This effect might perhaps reflect factors such as access to influential social networks, the influence of colleagues on health behaviours, or occupational exposures to carcinogens. Crucial for further analysis and interpretation is the choice of an appropriate classification of occupational classes. In the Danish studies, the classification was based on the theory of the “creative class” (41). This classification is however rarely used in studies on social inequalities in health. We would recommend applying classifications that are based on established traditions in social stratifications research, such as the European Socio-Economic Classification (ESEC) (42).

The Danish studies raise questions about causes underlying the generally higher cancer incidence and lower cancer survival in lower socioeconomic groups. In social epidemiology, a common hypothesis is that a higher exposure to important risk factors like smoking explains the higher incidence of specific cancer types (e.g. lung cancer) in low social group. In this framework, risk factors should be seen as “intermediate factors” or “mediators”, and not as confounders, in the association between cancer incidence and socio-economic status, the latter being a “fundamental cause” that determines people’s exposure to these risk factors (43). The Danish studies included in the special issue do not address the role of such risk factors, although many do offer explanations when interpreting the results (17-27). Previous studies from other countries yielded evidence on risk factors that explained some of, but not all, of the observed inequalities in cancer incidence. Such studies have aim to explain the inequalities in the incidence of many different cancer sites including the cancer of the lung (44), larynx (45), prostate (46), bladder (47), oesophagus and stomach (48) or breast (49). Regarding cancer survival, studies have consistently observed that the stage at diagnosis only partly explained the poorer survival found among more deprived social groups (50).

The contribution of co-morbidities to inequalities in cancer survival, has been investigated in a number of studies, with inconsistent results (50). The presence of co-morbidities is associated with a poorer survival for some cancer sites (36, 37). The presence of co-morbidity may thus partly explain the poorer survival found among subjects from lower social class (51) but this issue has been little investigated. In the Danish studies, the presence of co-morbidities was associated with poorer cancer survival for many various cancer sites including the prostate (25), the kidney (21), the stomach (18) or the leukaemia (27). It is uncertain, however, to what extent the poorer cancer survival of lower socioeconomic groups in Denmark can be attributed to a higher co-prevalence of other diseases.

Finally, there is the question how socioeconomic inequalities in cancer could be diminished by reducing incidence and improving survival of patients from lower socioeconomic groups. A main strategy is primary prevention aimed to decrease both cancer incidence rates and social inequalities in cancer incidence. For example, to decrease inequalities in lung cancer incidence in Denmark, tobacco control policies should be targeted towards people from the lower social groups, where the consumption is the highest (52). It is important to implement as effective as possible preventive policies. An ongoing European project, the Eurocadet project, will help to identify such preventive strategies (53). This project will provide estimations of the effects of different strategies in reducing social inequalities in cancer incidence in many different European countries, and thus give useful input for public health policies.

In addition, important reductions in inequalities could be achieved by improving access to and use of health care system in all population groups, such as access to reference care centres and

state-of-art treatments. Moreover, as organised programs of cancer screening are effective in improving survival rates (54), strategies should be developed to promote screening among all social groups, and especially those groups where attendance rates are the lowest. The latter is shown to be possible through pro-active invitation strategies specifically targeting to more vulnerable groups (55). This is especially relevant as it has been shown that the implementation of mass screening could lead to an increase in social inequalities in cancer survival, even with a very high participation rate (around 85%) (56). In addition, the role of co-morbidities in social inequalities in cancer survival has not been studied extensively and should be further investigated, as co-morbidities may partly account for the worse survival observed among patients from low social groups (51).

While an important challenge for Denmark and other European countries is to improve national rates of cancer survival, an additional challenge will be to reduce social inequalities in cancer survival at the same time. Unfortunately, over the past decades, increase in survival rates tended to concur with an increase in social inequalities in cancer survival (11, 34). Health care policies should be specifically developed to ensure more equitable trends in survival in the years to come.

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Table 1: Cancer incidence rate ratios and 5-year relative survival by education among men and women in Denmark.

Cancer site	IRR ¹		5-year relative survival ² basic or high school/higher	
	Men	Women	Men	Women
Mouth and pharynx	1.43 [#]	1.25	30/39	44/47
Larynx	1.67 [#]	3.23 [#]	52/59	54/65
Oesophagus	1.30 [#]	0.87	5/7	6/16
Stomach	1.37 [#]	1.23 [#]	13/10	16/15
Pancreas	1.20 [#]	1.22 [#]	2/3	2/2
Colon	0.93	1.02	42/46	46/49
Rectum	1.02	1.12	44/50	51/57
Lung	1.53 [#]	1.85 [#]	7/10*	9/10
Breast		0.80 [#]		77/84*
Cervix		1.33 [#]		68/78*
Corpus		0.98		79/81
Ovary		0.97		37/36
Prostate	0.81 [#]		47/59*	
Testis	1.00		93/97	
Kidney	1.22 [#]	1.54 [#]	38/41	42/49
Bladder	1.15 [#]	1.37 [#]	68/75*	62/70
Malignant melanoma	0.65 [#]	0.69 [#]	75/81*	86/92*
Brain and central nervous system	1.04	0.92	39/47*	58/66*
Non-Hodgkin's lymphoma	1.10	1.14	48/58	58/65
Hodgkin's lymphoma	1.05	1.16	82/76	78/90
Leukaemias	0.96	1.10	46/54	46/52
All cancers	1.10 [#]	1.02	37/48*	50/62*

1: Adjusted IRR, incidence rate ratios adjusted for age, period, level of education and disposable income; basic or high-school education compared with higher education. Incidence between 1994 and 2003

2: Cumulative level-specific relative survival in %. Cancers diagnosed between 1994 and 2003 and followed through 2006.

95% confidence interval excludes 1

* 95% confidence intervals non-overlapping between levels of indicator