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ORIGINAL ARTICLE

Socioeconomic inequalities in cancer incidence and mortality—a spatial analysis in Bremen, Germany

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Abstract
Aim Several international studies have already investigated the influence of socioeconomic factors on the risk of cancer. For Germany, however, the data are still insufficient. We examined the effects of social differences on cancer incidence and mortality on the population of Bremen, a town in northwest Germany.
Subjects and methods Data were obtained from the Bremen Cancer Registry, a population-based registry. The database comprised 27,430 incident cases, newly diagnosed between 2000 and 2006. The allocation of social class for each patient was based on the home address at the time of diagnosis, which led to the corresponding town district, which again could be linked to the "Bremen discrimination index." Based on this index, cases were allocated to five categories, for which we compared standardized incidence ratios (SIR) and mortality ratios (SMR) for different cancers: prostate, breast, lung, colorectal, bladder, uterine, ovarian, cervical, malignant melanoma of the skin, non-melanoma skin cancer and all cancer sites summarized.
Results The influence of social status was observed for different cancer sites. An inverse association was ascertained for all cancer sites (only men) and for tumors of the oral cavity and pharynx, and for lung, cervical and bladder cancers. A positive correlation was observed for female breast cancer, malignant melanoma, non-melanoma skin tumors and prostate cancer.
Conclusions In spite of the methodical restrictions, our analyses suggest an association between social factors and cancer incidence and mortality. The results are in agreement with international studies. Many of the observed social class differences could probably be explained by known risk factors, such as smoking, alcohol consumption, diet and physical activity.

Keywords Cancer · Socioeconomic inequality · Incidence · Mortality · Social class

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Introduction

The influence of socioeconomic status on health is an established part of epidemiological research. The effects of social inequality on human health in industrialized countries have been observed particularly for chronic degenerative diseases, e.g., cardiovascular and respiratory diseases, diabetes and cancer. Several studies have been carried out in Scandinavia and Great Britain in the last 2 decades (Braaten et al. 2005; Coleman et al. 2004; Dalton et al. 2008; Shack et al. 2008), especially regarding the influence on cancer incidence and mortality. For various types of cancer, socioeconomic differences were discovered, mostly showing an inverse association between social class and mortality and morbidity: the higher the social class, the lower the incidence and mortality of cancer (Faggiano et al. 1997).

The majority of studies determined social classes on an individual level regarding education, occupational status or income. Scandinavian research is often based on individual-related data linkage between "Cancer Registry" and public registry data, such as "Central Population Registries," the taxation authorities, the "Register for Education Statistics" or registers relating to unemployment or census data. In other countries, especially Great Britain, patients were assigned to categories of material deprivation using, e.g., the Carstairs index or the Townsend index, standard indices derived from characteristics of the small areas in which the patient lived when the cancer was diagnosed (Carstairs 1995; Townsend et al. 1988).

In Germany, the available data regarding socioeconomic status as an influence factor for cancer incidence and mortality are still insufficient. Existing results are based on only small cohorts with individual determination of social status on personal questionnaires. Already in 1991, Brenner et al. published an ecological study regarding the association of socioeconomic status on the survival in colorectal cancer, but they did not address cancer incidence (Brenner et al. 1991). Every state in the Federal Republic has installed population-based cancer registries, but they do not register data regarding the social status of the patient. Due to restrictions for data protection, in Germany it is not possible to link cancer registry with individual data from official statistics about social indicators.

The aim of this population-based study was to investigate differences regarding cancer incidence and mortality by means of an existing social index on the level of town districts in Bremen.

Materials and methods

Incidence data for this study were obtained from the Bremen Cancer Registry, a population-based cancer registry covering an urban area of approximately 660,000 inhabitants in northwest Germany. The Federal State of Bremen consists of two separated cities: Bremen and Bremerhaven. In 1998, the Bremen Cancer Registry started to record newly diagnosed cases of cancer through reports from hospitals, pathology institutes and medical practitioners from outpatient centers. The completeness of cancer registration in the study region is good (>90%), with a proportion of cases notified only from death certificates (DCO) at 6.6%. The analyses of cancer incidence include all patients with invasive primary cancer diagnosed between 2000 and 2006. Data of cancer mortality are based on the official statistics of mortality in the state of Bremen that were obtained on the cluster level from the Statistics Board of Bremen. The analyses of cancer mortality include cases of death between 2000 and 2006.

As there are no individual-related data of socioeconomic factors in the cancer registries, a two-step procedure was applied in this analysis to allocate patients to a social status. In a first step, patients were assigned to their corresponding town district by means of the Gauss-Krueger coordinates of their living address at the time of diagnosis. Then, in a second step, the town district was assigned to an existing social class index, which was constructed in another context to describe the socioeconomic situation of all 79 town districts in the city of Bremen. Cases with unknown coordinates were excluded from the study (n=862; 3.1%).

The index comprises 24 different social indicators, which are available for the smallest units of official statistics—the town districts—and refer to four different sections, such as education, employment and earning capacity, identification, and de-mixing and conflict potential (Table 1). The index is published by the Bremen Ministry of Labor, Women's Affaires, Health, Youth and Welfare and is updated regularly (Senator für Arbeit, Frauen, Gesundheit, Jugend und Soziales 2007).

Regarding the index, all 79 town districts of Bremen (only districts with more than 1,000 inhabitants) were ranked, and a partition into quintiles was made. Each resulting cluster represents 17–24% of the Bremen population (city of Bremen), which corresponds to an average population of 96,000–128,000. The distribution of clusters regarding the town area is described in Fig. 1. The town districts are quite heterogeneous: Town districts with a lower social index have mostly a greater share of multi-family houses and industrial facilities, especially near the harbors. The town districts with a higher social index are often purely residential areas with a high proportion of detached houses.

The results of the small area analyses are presented as a standardized incidence ratio (SIR) and mortality ratio (SMR) for the average population in the observation period 2000–2006. SIRs and SMRs were calculated as the ratio of the observed to expected number of cases. The expected numbers were estimated from 5-year age group-, sex- and cancer site-specific incidence rates in the highest cluster, which was defined as the reference cluster.

Confidence intervals (95% CI) were determined assuming that the observed number of cases followed a Poisson distribution. All analyses were performed using SAS 8.2.

Results

The analyses comprised 27,430 incident cancer cases (13,891 men and 13,539 women) and 10,669 cases of cancer mortality (5,463 men and 5,206 women).

Results are presented for all cancer sites, without non-melanoma skin cancer (ICD-10:C00-C97 except C44), for the five most common cancer sites of men and women in the state of Bremen and for further cancer entities for which cancer screening programs are offered by the statuary health insurance (Tables 2 and 3).

All cancer sites

Analyses comprising all cancer sites except non-melanoma skin cancer showed a significant increase regarding

Table 1 The 24 social indicators of the general discrimination index for Bremen, 2007 (Senator für Arbeit, Frauen, Gesundheit, Jugend und Soziales 2007)

Education	**Employment and earning capacity**
Quota of secondary general school pupils 13–<17 years	Number of unemployed
Quota of intermediate school pupils 13–<17 years	Number of unemployed foreigners
Quota of grammar school classes 7–10, pupils 13–<17 years	Housing allowance recipients per 1,000 inhabitants
Quota of grammar school classes 11–13, pupils 17–<20 years	Unemployment benefit (SGB II) recipients per 100 inhabitants
Low-level education of pupils (pupils with special needs) 7–<16 years	Foreign unemployment benefit (SGB II) recipients per 100 foreigners
Identification	**De-mixing and conflict potential**
Turnout in parliamentary election for the Federal State of Bremen 2007	Number of cases social service adults 18–25 years 2006
Turnout in parliamentary election for the Federal Republic of Germany 2005	Number of cases social service adults 26–60 years 2006
Removals per 1,000 inhabitants	Number of cases of social service adults more than 60 years 2006
Number of foreigners in population	Number of cases of juvenile court help 2006
	Single parent households 2006
	Number of children <1 year per 100 women 15–<45 years
	Portion of young people 12–<18 years of population
	People ≥65 years per 100 people <15 years
	Men per 100 women ≥65 years
	Portion of foreigners <18 years of population <18 years

incidence and mortality rate in men with decreasing social class (Table 2). This effect was more clear in mortality as compared to incidence (lowest social class: SMR 1.47, 95% CI 1.39–1.55; SIR 1.16, 95% CI 1.12–1.21). In women, no significant differences in incidence between the clusters were seen. In contrast, cancer mortality was slightly increased with decreasing social status (lowest social class: SMR 1.10, 95% CI 1.04–1.16).

The five most frequent cancer sites

Prostate

The most common cancer site for men is the prostate. The investigation comprised 2,329 incident cases. Compared to the highest social class, the groups of lower social status were associated with a lower incidence of prostate cancer.

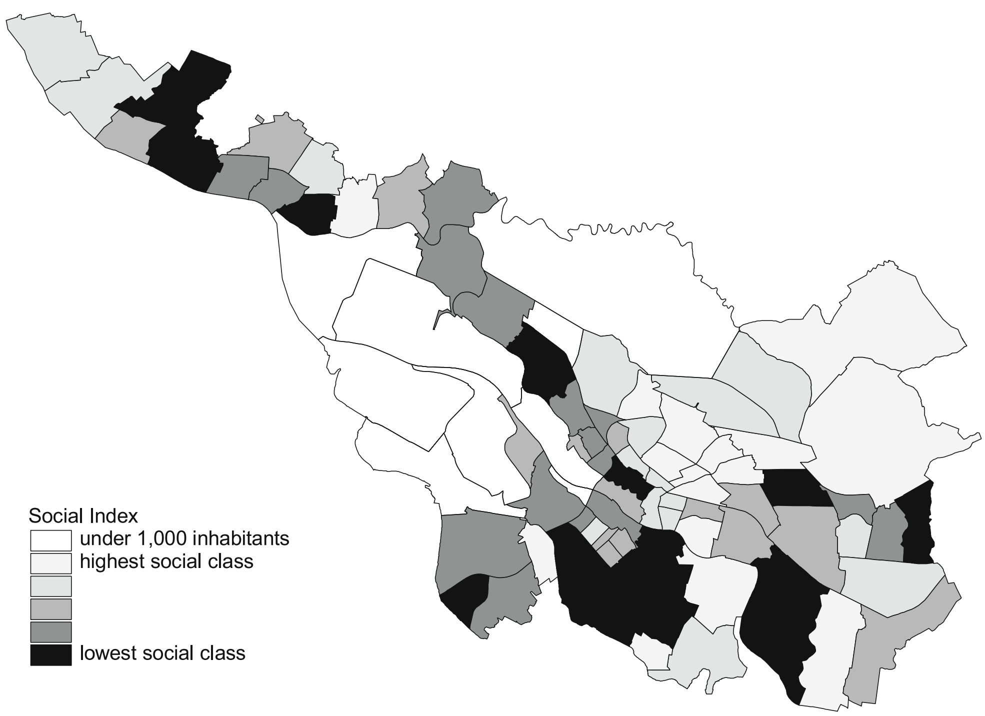

Fig. 1 Distribution of clusters and town districts in Bremen

Table 2 Number of cancer cases observed (obs) among men, standardized incidence and mortality ratio (SIR and SMR) with 95% confidence intervals (95% CI) for different cancers in 2000–2006, by social class in Bremen. Reference: highest social class*, n.a. = not analyzed. *Based on 24 different social indicators in Bremen

	Incidence		Mortality	
	Obs.	SIR (95% CI)	Obs.	SMR (95% CI)
All cancer sites (without C44)				
Highest social class	2,038	1.00 (0.96–1.04)	883	1.00 (0.94–1.07)
↓	1,751	1.00 (0.95–1.04)	826	1.11 (1.04–1.19)
↓	2,043	1.13 (1.08–1.18)	1,005	1.29 (1.22–1.38)
↓	2,684	1.14 (1.09–1.18)	1,333	1.34 (1.27–1.42)
Lowest social class	2,680	1.16 (1.12–1.21)	1,416	1.47 (1.39–1.55)
Prostate				
Highest social class	520	1.00 (0.92–1.09)	101	1.00 (0.82–1.20)
↓	402	0.93 (0.84–1.02)	82	1.00 (0.80–1.23)
↓	426	0.94 (0.95–1.03)	86	0.97 (0.78–1.19)
↓	482	0.81 (0.74–0.89)	104	0.97 (0.79–1.17)
Lowest social class	499	0.86 (0.79–0.94)	137	1.32 (1.10–1.54)
Lung				
Highest social class	277	1.00 (0.89–1.12)	211	1.00 (0.87–1.14)
↓	264	1.12 (0.99–1.26)	224	1.26 (1.10–1.43)
↓	379	1.55 (1.40–1.71)	303	1.64 (1.46–1.83)
↓	510	1.59 (1.46–1.73)	395	1.65 (1.50–1.82)
Lowest social class	563	1.81 (1.66–1.96)	457	1.97 (1.79–2.15)
Colon and rectum				
Highest social class	307	1.00 (0.89–1.12)	95	1.00 (0.81–1.21)
↓	245	0.94 (0.83–1.06)	79	1.02 (0.80–1.25)
↓	250	0.93 (0.82–1.05)	115	1.38 (1.14–1.65)
↓	385	1.09 (0.99–1.20)	136	1.28 (1.08–1.51)
Lowest social class	302	0.88 (0.79–0.99)	128	1.24 (1.03–1.46)
Bladder				
Highest social class	155	1.00 (0.85–1.16)	34	1.00 (0.69–1.36)
↓	144	1.10 (0.92–1.28)	22	0.93 (0.58–1.35)
↓	180	1.32 (1.14–1.52)	32	1.14 (0.78–1.56)
↓	249	1.41 (1.24–1.59)	36	1.02 (0.71–1.38)
Lowest social class	221	1.28 (1.12–1.45)	43	1.25 (0.91–1.66)
Oral cavity and pharynx				
Highest social class	55	1.00 (0.75–1.28)	16	1.00 (0.57–1.55)
↓	64	1.33 (1.02–1.68)	28	2.39 (1.59–3.36)
↓	101	2.12 (1.73–2.55)	37	2.94 (2.07–3.97)
↓	119	1.89 (1.57–2.25)	45	2.34 (1.70–3.07)
Lowest social class	127	2.07 (1.72–2.44)	52	2.76 (2.06–3.57)
Malignant melanoma of the skin				
Highest social class	64	1.00 (0.77–1.26)		n.a.
↓	55	0.97 (0.73–1.24)		n.a.
↓	48	0.87 (0.64–1.13)		n.a.
↓	56	0.74 (0.56–0.95)		n.a.
Lowest social class	60	0.85 (0.65–1.07)		n.a.
Non-melanoma skin cancer				
Highest social class	614	1.00 (0.92–1.08)		n.a.
↓	496	0.95 (0.87–1.04)		n.a.
↓	483	0.89 (0.81–0.97)		n.a.
↓	571	0.81 (0.75–0.88)		n.a.
Lowest social class	531	0.78 (0.71–0.84)		n.a.

Table 3 Number of cancer cases observed (obs) among women, standardized incidence and mortality ratio (SIR and SMR) with 95% confidence intervals (95% CI) for different cancers in 2000–2006 by social class in Bremen. Reference: highest social class*, n.a. = not analyzed. *Based on 24 different social indicators in Bremen

	Incidence		**Mortality**	
	Obs.	SIR (95% CI)	Obs.	SMR (95% CI)
All cancer sites (without C44)				
Highest social class	2,213	1.00 (0.96–1.04)	1,049	1.00 (0.94–1.06)
↓	1,901	1.00 (0.95–1.04)	845	0.96 (0.90–1.02)
↓	1,994	1.04 (1.00–1.09)	950	1.05 (0.99–1.12)
↓	2,425	1.02 (0.98–1.07)	1,116	1.03 (0.98–1.10)
Lowest social class	2,368	0.97 (0.94–1.01)	1,246	1.10 (1.04–1.16)
Breast				
Highest social class	718	1.00 (0.93–1.08)	217	1.00 (0.87–1.14)
↓	614	0.98 (0.90–1.06)	150	0.82 (0.69–0.96)
↓	606	0.98 (0.91–1.06)	179	0.95 (0.82–1.09)
↓	694	0.89 (0.82–0.96)	188	0.82 (0.71–0.94)
Lowest social class	655	0.83 (0.77–0.90)	183	0.77 (0.66–0.89)
Colon and rectum				
Highest social class	325	1.00 (0.89–1.11)	129	1.00 (0.84–1.18)
↓	293	1.07 (0.95–1.20)	121	1.13 (0.94–1.34)
↓	283	1.02 (0.90–1.14)	130	1.20 (1.00–1.41)
↓	403	1.19 (1.08–1.31)	161	1.24 (1.05–1.44)
Lowest social class	359	1.02 (0.91–1.12)	167	1.20 (1.02–1.39)
Lung				
Highest social class	147	1.00 (0.85–1.17)	126	1.00 (0.83–1.18)
↓	131	1.06 (0.88–1.24)	112	1.06 (0.87–1.27)
↓	171	1.36 (1.16–1.57)	140	1.29 (1.09–1.52)
↓	219	1.38 (1.21–1.57)	185	1.40 (1.20–1.61)
Lowest social class	246	1.53 (1.35–1.73)	224	1.64 (1.43–1.86)
Uterus				
Highest social class	121	1.00 (0.83–1.19)	19	1.00 (0.60–1.50)
↓	87	0.83 (0.66–1.01)	13	0.88 (0.47–1.43)
↓	108	1.01 (0.83–1.21)	18	1.32 (0.78–2.00)
↓	126	0.93 (0.77–1.10)	15	0.93 (0.52–1.46)
Lowest social class	131	0.95 (0.79–1.12)	24	1.20 (0.77–1.73)
Ovaries				
Highest social class	95	1.00 (0.81–1.21)	54	1.00 (0.75–1.29)
↓	84	1.01 (0.81–1.24)	37	0.82 (0.58–1.11)
↓	88	1.07 (0.86–1.31)	47	1.03 (0.76–1.35)
↓	101	0.98 (0.80–1.18)	45	0.94 (0.68–1.23)
Lowest social class	88	0.85 (0.68–1.03)	61	1.24 (0.95–1.57)
Cervix				
Highest social class	45	1.00 (0.73–1.31)	12	1.00 (0.51–1.65)
↓	45	1.15 (0.84–1.52)	11	1.63 (0.81–2.73)
↓	59	1.56 (1.19–1.98)	14	1.78 (0.97–2.83)
↓	61	1.34 (1.02–1.69)	20	1.58 (0.96–2.35)
Lowest social class	66	1.33 (1.03–1.67)	21	1.60 (0.99–2.35)
Malignant melanoma of the skin				
Highest social class	58	1.00 (0.76–1.27)		n.a.
↓	72	1.33 (1.04–1.65)		n.a.

Table 3 (continued)

	Incidence		Mortality	
	Obs.	SIR (95% CI)	Obs.	SMR (95% CI)
↓	50	0.95 (0.70–1.23)		n.a.
↓	56	0.90 (0.68–1.15)		n.a.
Lowest social class	55	0.78 (0.58–1.02)		n.a.
Non-melanoma skin cancer				
Highest social class	616	1.00 (0.92–1.08)		n.a.
↓	521	0.99 (0.91–1.08)		n.a.
↓	466	0.88 (0.80–0.96)		n.a.
↓	524	0.81 (0.74–0.88)		n.a.
Lowest social class	511	0.76 (0.70–0.83)		n.a.

This difference did not occur with mortality, where the association was inverse and the cluster with the lowest status yielded an increased mortality rate.

Breast

Breast cancer is the most common cancer for women. The analysis included 3,287 incident cases. The disease showed a positive correlation between social status and risk of cancer. A decrease in social status was associated with a decrease of incidence rate. The lowest social class had a SIR of 0.83, which was significantly different from the highest social class. The found pattern was also visible regarding mortality.

Lung

Lung cancer is the third most common cancer among men and women in Germany. In our study, 2,907 incident cases of lung cancer were examined. The SIRs and SMRs increased with declining social class. For men the incidence was increased by 80% and the mortality by 100% within the lowest social cluster. This tendency was stronger for men than for women (incidence +50%; mortality +65%).

Colon and rectum

Colorectal cancer is the second most frequent cancer in both sexes in Germany. No consistent correlation was seen for either men or women in cancer incidence. For men the incidence decreased slightly with decreasing social class. Whereas a slight increase in incidence was observed for women with decreasing social status, mortality for both sexes was increased with decreasing social status.

Bladder

The bladder is the fifth most common tumor site for men. An inverse correlation between incidence and social status was observed for this cancer, with a significantly increased risk of bladder cancer in the lower social clusters. This tendency did not appear for mortality, where no obvious correlation was seen.

Oral cavity and pharynx

Cancer of the oral cavity and pharynx was ranked as the fifth most common cancer for men in Bremen. The analysis for men shows a clear increase in incidence as well as in mortality rates with a decrease of social status. Incidence rates increased by 100% and mortality rates by 175% within the lowest social class. This reflects a significantly higher risk of cancer incidence and mortality for this cancer site for persons affiliated with the lowest social class as compared to persons of the highest social class.

Uterus corpus and ovaries

Cancer incidence of the uterus corpus as well as of the ovaries ranks in both the state of Bremen and Germany among the fifth most common tumors in women. No association between social class and cancer incidence or mortality was found in this analysis for these tumors.

Further tumors for which public screening programs are implemented

Skin cancer

Due to the low mortality rate, only incidence has been ascertained for this localization.

For malignant melanoma of the skin, a decrease of social status resulted in a decreased incidence for men and women (lowest social class: SIR men 0.85, women 0.78). Among women, the second highest cluster was remarkable with an increase in incidence of 33%.

A comparable correlation between incidence and social class for both men and women was seen for non-melanoma skin cancer. With the decrease of social status, a steady decrease of incidence was shown for both sexes in Bremen. Within the two lowest social classes, these differences were significant compared with the highest class.

Cervix

For cancer of the cervix, a social inequality was seen with an inverse association between social status and the distribution of incidence and mortality. With a decrease of social status, the clusters showed an incidence increase of 33% and mortality of 60% compared to the highest social class. The observed differences, however, were not significant because of the size of the confidence intervals.

Discussion

It is a known fact in epidemiology that low social class is often associated with a higher risk of disease. Socioeconomic status in epidemiological studies is mostly defined by the variables of education, occupation and income on an individual basis. In this study, an ecological design was used where the social status was defined by the specific living address within the city of Bremen. Because of this fact, an inaccuracy in the definition of social class and additionally the possibility of an ecological fallacy exists, an error in the interpretation of potential risk factors observable at the population level and an outcome at the individual level.

In spite of this methodical restriction, our analyses suggest an influence of social factors on cancer incidence and mortality. Results are consistent with various international studies, where especially the Scandinavian studies show the methodical advantage that indications regarding social status could be extracted from official statistics data by individual data linkage (Hemminki et al. 2003; Pukkala and Weiderpass 2002; Weiderpass and Pukkala 2006). The design of our study could be compared with examinations from Great Britain where cancer patients were assigned by their address at diagnosis to one of five categories (quintiles of the national distribution) of material deprivation by using standard indices, e.g. the Carstairs or Townsend index. Variables that comprised the indices were unemployment, car ownership, home ownership, household over-crowding (more than one person per room) and head of household in social class IV or V (partly skilled or unskilled), which were available for all 109,000 census tracts in Great Britain.

In existing studies, regardless of the definition of social class, it was not addressed as a primary risk factor, but as an indicator for certain ways of life and behaviors. The risk of cancer is influenced by different factors. An association between social status and cancer incidence occurs especially in relation to

- lifestyle (healthy and unhealthy behavior),
- participation in screening programs (diagnoses in the early stage of tumors) and
- exposure to occupational carcinogens and environmental exposure.

A large portion of the observed differences in cancer incidence and mortality between the social classes can be explained by behavioral factors: smoking, alcohol consumption, nutrition and physical inactivity. Especially tumors of the lung belong to those diseases with a close association to behavior—smoking in this case. The prevalence of tobacco consumption is different within social classes. A survey in Bremen in 2004 yielded a smoking prevalence of 23% for men aged 40–59 years with the highest education level, which was used as an indicator for the social class, and of 46% for men with the lowest education level (Senator für Arbeit, Frauen, Gesundheit, Jugend und Soziales 2005). Data of the German Federal Health Survey of 1998 also show a higher smoking prevalence for socially discriminated population groups than for higher status groups: prevalence in the lowest social class was 47% for men and 30% for women, and in the highest class 29% for men and 25% for women. In this survey, social class was defined by the variables of education, occupation and income (Knopf et al. 1999).

The risk factor “high and frequent alcohol consumption” also shows a different prevalence within the social classes. According to data from the German Federal Health Survey, alcohol consumption above the “tolerable amount of alcohol intake” (TOAM) is 16% for women and 31% for men. An association between alcohol consumption and social status exists for women. The frequency of women with consumption above a tolerable amount of alcohol intake (TOAM) is 9% for the lowest social class, 14% for the middle class and 30% for the upper class. Such a class gradient does not occur among men. Within the three status groups, 29–35% of men consume more than the TOAM (Robert Koch Institute 2003). A high and regular consumption of alcohol leads to a higher risk of incidence, especially of tumors of the oral cavity and pharynx, esophagus, pancreas, liver, larynx and breast.

Obesity and physical inactivity are further risk factors for cancer incidence. Both factors may account for 25 to 30% of several major cancers: colon, breast (postmenopausal), endometrial, kidney and esophagus (Vainio and Bianchini 2002). In Germany, for the risk factors massive obesity and inactivity in sports, a distinct social gradient with a decrease in prevalence with increasing social class can be observed for both sexes. In this context, unfavorable social circumstances have a higher influence among women than in men (Helmert and Strube 2004).

The participation in screening activities also has an effect on cancer incidence and may lead to an increase of cancer incidence by overdiagnosis, as is described for breast cancer and prostate cancer (Gotzsche et al. 2009; Welch and Albertsen 2009). In Germany, participation rates in cancer screening programs are significantly correlated with educational level and employment: the higher the social status, the more individuals take advantage of screening. For men the association between social class and participation rate is less significant (Scheffer et al. 2006). In our study, the observed differences between social classes in the incidence of breast, prostate and skin cancer could be caused by a different participation rate. Unfortunately, there are no data available regarding participation rates and social status for Bremen. But the higher incidence in higher social classes for these cancers may also result from known risk factors, e.g., for breast cancer: older age at first pregnancy, low parity and use of hormone replacement therapy, which occur more frequently in higher social classes (Bouchardy et al. 2006; Lagerlund et al. 2005; Pukkala and Weiderpass 1999).

Further explanations for the differences in cancer incidence between social classes are different exposures to occupational carcinogens and environmental exposure. Since 1971, the Monographs Program of the International Agency for Research on Cancer (IARC) has systematically evaluated a large number of chemical, physical and biological agents, of which approximately 400 have been identified as carcinogenic or potentially carcinogenic to humans. Occupational exposures are more common in blue-collar workers and thereby in lower social classes, and usually affect only a limited number of cancer sites, namely the respiratory tract, the urinary tract and the lymphatic and hematopoietic system (Boffetta et al. 1997).

Regarding environmental exposure, in particular air pollution, there is limited evidence suggesting that lower social classes are exposed to higher levels of environmental pollutants than higher social classes. This may be due to residence in neighborhoods with higher air pollution, such as in industrial areas (Woodward and Boffetta 1997). The assessment of the effect of occupational and environmental exposures on the association between social class and cancer risk is complicated by the interaction between these factors and other risk factors linked with social status, particularly tobacco smoking as the most important risk factor for lung and bladder cancer (Eriksen et al. 2008).

Explanatory approaches for the observed higher cancer mortality in lower social status groups may be a higher co-morbidity, a worse treatment-compliance, more prognostic unfavorable tumor stages at time of diagnosis, or a different access to therapies and treatments in less specialized clinics.

Conclusion

The observed socioeconomic inequalities in cancer incidence reflected partly different prevalence rates of essential risk factors for cancer, which have been known for years: tobacco and alcohol consumption, nutrition and physical inactivity.

Living in a town district considered as a district of low social class is certainly not a risk factor in itself. However, since the prevalence of risk factors in general is higher for people living in poorer residential areas, higher rates of cancer incidence and mortality can be expected in such districts.

As the analyses could not be accomplished on an individual level, results can only be interpreted as a potential indication of different risk factor profiles within population groups. Thus a varied offer for primary, secondary and tertiary cancer prevention from the health care policy is needed.

Conflict of interest statement The authors declare that they have no conflict of interest.

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