II: Unemployment and cancer in Denmark, 1970–1975 and 1986–1990

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We have analysed cancer mortality and cancer incidence among unemployed persons identified from the Danish linkage studies based on the 1970 census and the 1986 register-based census. In 1970, 1% of Danish men were unemployed; in 1986, 14% were unemployed. In both periods, unemployed men had an excess cancer mortality of close to 25% when they were followed-up for a five-year period and their mortality was compared with that of all men in the labour force. Unemployed women in the 1970 cohort also had an excess cancer mortality of 25%. Cancer incidence data were not available for the 1986 cohort. For both cohorts, the excess risk came mainly from lung cancer. Survey data from Denmark in the 1980s indicated that unemployed men had a slightly higher smoking prevalence before unemployment than men who continued working, and that unemployment did not increase smoking. It is therefore unlikely that the excess lung cancer risk among unemployed men is explained by differences in smoking habits alone.

In Denmark, several national linkage studies are available on mortality and diseases, and it is therefore possible to study the disease pattern even in small subgroups of the population. Using this methodology, a study has previously been undertaken of the mortality of unemployed persons in 1970 (Iversen *et al.*, 1987). At this time, 1% of men in the economically active age groups were unemployed. Since then unemployment has become a more common phenomenon in Danish society, and 14% of men were unemployed in 1986. We have analysed the cancer mortality and cancer incidence among unemployed persons identified from the Danish linkage studies based on the 1970 census and the 1986 register-based census.

A key question for the interpretation of a possible excess cancer incidence and mortality among unemployed persons is whether this excess is purely an effect of selection of unhealthy persons into unemployment or whether unemployment in itself increases the risk of cancer. To shed light on this problem we have also included data for cancer incidence and mortality among inactive persons. In the economically active age groups, by far the majority of inactive men have been granted an early pension for health reasons.

Material and methods

Our study is based on two cohorts of national census populations, each followed-up for deaths and emigrations for a five-year period. The first of the two cohorts was also followed-up for incident cancer cases for a five-year period.

The first cohort included 2 804 192 persons aged 20–64 years at the Danish census on 9 November 1970. They were followed-up until 8 November 1975 (Lynge, 1979; Andersen, 1985). They were classified by status of work based on the information on their status of work on 9 November 1970 from the self-administered census questionnaires. The total population was divided into those who were economically active on the census date and those who were not (housewives, pensioners, students, and so on). The economically active were divided into those who were employed on the census date and those who were unemployed.

The second cohort included 3 018 942 persons aged 20–64 years on 1 January 1986. They were followed-up until 31 December 1990 (Ingerslev *et al.*, 1994). They were classified by status of work based on information in public administrative registers for the period 1981–1985. Based on tax information from 1985, the population was divided into those who were economically active and whose who were not. The economically active persons were divided into those with unemployment insurance and those without. A distinction between employed and unemployed persons was possible only for the insured persons. Persons classified as unemployed had been unemployed for at least

Table 1. Men and women in Denmark aged 20–64 years in 1970 and 1986, by status of work

	Men		Women	
	1970	1986	1970	1986
Total	1 401 967	1 522 560	1 402 225	1 496 382
Total active	1 292 337	1 352 932	730 545	1 157 464
Insured	NA	1 021 992	NA	910 117
Not insured	NA	330 940	NA	247 347
Employed	1 276 997	838 808	723 849	709 510
– at work	1 177 489	NA	648 638	NA
– not at work	99 508	NA	75 211	NA
Unemployed	15 340	183 184	6700	200 607
Inactive	109 630	169 628	671 676	338 918
Unemployed as % of active	1%	14%	1%	17%
Inactive as % of total	8%	11%	48%	23%

NA, not applicable.

30% of the year for each of the years with insurance during the period 1981–1985.

Data on deaths and emigrations during the follow-up period were retrieved from the Central Population Register, and data on cause of death from the Death Certificate Register. Linkage based on unique personal identification numbers used in all of the registers ensured complete follow-up.

Each person contributed with person years at risk from the entry date until emigration, death or end of follow-up – whichever came first.

Standardized mortality ratios (SMRs) were calculated by dividing the observed numbers of deaths in a given work status group with the expected number based on multiplication of person years at risk in each five-year age group (with age defined

Table 2. Total mortality in Denmark in 1970–1975 for persons aged 20–64 in 1970, and in 1986–1990 for persons aged 20–64 in 1986, by status of work

	Men				Women			
	1970–1975		1986–1990		1970–1975		1986–1990	
	Obs.	SMR	Obs.	SMR	Obs.	SMR	Obs.	SMR
Total	46 869	1.17	46 147	1.30	28 661	1.35	29 114	1.42
Total active	36 037	1.00	29 284	1.00	9036	1.00	12 743	1.00
Insured	NA	NA	21 677	1.04	NA	NA	9543	1.02
Not insured	NA	NA	7607	0.90	NA	NA	3200	0.95
Employed	35 324	0.99	16 828	0.96	8920	0.99	7546	0.97
– at work	31 013	0.93	NA	NA	7561	0.93	NA	NA
– not at work	4311	1.88	NA	NA	1359	1.62	NA	NA
Unemployed	713	1.62	4849	1.49	116	1.71	1997	1.25
Inactive	10 832	2.81	16 863	2.69	19 625	1.61	16 371	2.10

NA, not applicable; Obs., observed; SMR standardized mortality ratio.

Table 3. Cancer mortality in Denmark in 1970–1975 for persons aged 20–64 in 1970, and in 1986–1990 for persons aged 20–64 in 1986, by status of work

| | Men | | | | Women | | | |
| | 1970–1975 | | 1986–1990 | | 1970–1975 | | 1986–1990 | |
	Obs.	SMR	Obs.	SMR	Obs.	SMR	Obs.	SMR
Total	12688	1.07	13093	1.14	11999	1.11	13073	1.15
Total active	10676	1.00	9267	1.00	4577	1.00	6961	1.00
Insured	NA	NA	6760	1.04	NA	NA	5174	1.02
Not insured	NA	NA	2507	0.90	NA	NA	1787	0.95
Employed	10513	1.00	5556	1.01	4535	1.00	4269	1.01
– at work	9090	0.92	NA	NA	3800	0.92	NA	NA
– not at work	1423	2.14	NA	NA	735	1.75	NA	NA
Unemployed	163	1.24	1204	1.23	42	1.25	905	1.08
Inactive	2012	1.65	3826	1.70	7422	1.19	6112	1.38

NA, not applicable; Obs., observed; SMR, standardized mortality ratio

as age at the time of entry) by the mortality rate for all economically active persons in that age group. 95% confidence intervals (95% CIs) were calculated under the assumption that the observed number of cases follow a Poisson distribution if under 30 and a normal distribution if above 30.

Data on incident cancer cases during the follow-up period for the 1970 cohort were retrieved from the Danish Cancer Register (Lynge & Thygesen, 1990). Each person contributed with person years at risk from the entry date until emigration, first cancer diagnosis, death or end of follow-up – whichever came first. As person years were counted only up until first cancer diagnosis, the number of person years at risk was slightly lower for all cancers than for each cancer site. Standardized incidence ratios (SIRs) were calculated following the same procedure as used for calculation of SMRs.

Results

Table 1 shows the number of persons aged 20–64 in the two study populations. There was a dramatic increase in the proportion of unemployed men from 1% in 1970 to 14% in 1986. A marginal increase was seen in the proportion of inactive men (mainly early pensioners) from 8% in 1970 to 11% in 1986. The proportion of unemployed women increased from 1% in 1970 to 17% in 1986. At the same time, the proportion of inactive

women (mainly housewives) decreased from 48% to 23%.

Table 2 shows the total mortality recorded for the five years of follow-up in each of the two study populations. In the 1970 cohort of unemployed men there were 713 deaths, giving an SMR of 1.62 (95% CI = 1.51–1.74). In the 1986 cohort of unemployed men there were 4849 deaths, giving an SMR of 1.49 (95% CI = 1.45–1.53). The SMR values for inactive men in the 1970 and 1986 cohorts were 2.81 and 2.69, respectively. There were only 116 deaths in the 1970 cohort of unemployed women, giving an SMR of 1.71 (95% CI = 1.43–2.05), while the number of deaths in unemployed women in the 1986 cohort was 1997, with an SMR of 1.25 (95% CI = 1.20–1.31). The SMR values for inactive women in the 1970 and 1986 cohorts were 1.61 and 2.10, respectively.

Table 3 shows the cancer mortality for the study populations. In the 1970 cohort of unemployed men there were 163 cancer deaths, giving an SMR of 1.24 (95% CI = 1.06–1.45), and in the 1986 cohort of unemployed men there were 1204 cancer deaths, giving an SMR of 1.23 (95% CI = 1.16–1.30). The SMR values for inactive men in the 1970 and 1986 cohorts were 1.65 and 1.70, respectively. Among unemployed women there were 42 cancer deaths in the 1970 cohort (SMR = 1.25; 95% CI = 0.92–1.69) and 905 cancer deaths in the 1986 cohort

Table 4. Cancer incidence and mortality in Denmark in 1970–1975 for unemployed persons aged 20–64 in 1970, and cancer mortality in 1986–1990 for unemployed persons aged 20–64 in 1986

	Men					Women					
	1970–1975				1986–1990		1970–1975				1986–1990
	Incidence		Mortality		Mortality		Incidence		Mortality		Mortality	
	Obs.	SIR	Obs.	SMR	Obs.	SMR	Obs.	SIR	Obs.	SMR	Obs.	SMR
Total mortality	–	–	713	1.62	4849	1.49	–	–	116	1.71	1997	1.25
Cancer[a]	291	1.25	163	1.24	1204	1.23	90	1.14	42	1.25	905	1.08
Digestive organs[b]	77	1.34	47	1.15	306	1.14	13	1.09	10	1.36	168	1.09
Respiratory organs[c]	97	1.64	70	1.54	464	1.44	6	1.46	7	2.30	212	1.48
Breast[d]	1	2.94	0	–	1	1.04	21	0.97	7	0.89	206	0.97
Female genital organs[e]	0	–	0	–	0	–	33	1.49	11	1.36	139	1.01
Male genital and urinary organs[f]	48	0.98	22	1.27	138	1.10	1	0.35	0	–	22	0.86
Haematopoietic system[g]	14	0.79	8	0.70	89	0.91	3	0.75	4	1.69	49	0.95
Other sites[h]	57	1.09	16	0.96	206	1.23	13	0.98	3	0.83	109	0.98

Obs., observed; SMR, standardized mortality ratio; SIR, standardized incidence ratio
Codes (International Classification of Diseases and Causes of Death) for cancer mortality (first) and cancer incidence (second):
[a]ICD-8 140-209; ICD-7 140-205.
[b]ICD-8 150-159; ICD-7 150-159.
[c]ICD-8 160-163; ICD-7 160-164.
[d]ICD-8 174; ICD-7 170.
[e]ICD-8 180-184; ICD-7 171-176.
[f]ICD-8 185-189; ICD-7 177-181.
[g]ICD-8 200-209; ICD-7 200-205.
[h]ICD-8 140-149, 170-173, 190-199; ICD-7 140-148, 190-199.

(SMR = 1.08; 95% CI = 1.01–1.15). The SMR values for inactive women in the 1970 and 1986 cohorts were 1.19 and 1.38, respectively.

Table 4 shows that the excess cancer mortality among unemployed men came in both cohorts mainly from cancer of the respiratory system, with SMRs of 1.54 (95% CI = 1.22–1.95) and 1.44 (95% CI = 1.31–1.58), respectively. Cancers of the digestive organs, with SMRs of 1.15 (95% CI = 0.86–1.53) and 1.14 (95% CI = 1.02–1.28), and cancers of the male genital and urinary organs, with SMRs of 1.27 (95% CI = 0.77–1.92) and 1.10 (95% CI = 0.93–1.18), also contributed to the excess cancer mortality. An excess risk of other cancers was seen in the 1986 cohort (SMR = 1.23; 95% CI = 1.07–1.41), but not in the 1970 cohort (SMR = 0.96; 95% CI = 0.55–1.56). The excess cancer mortality among unemployed

women in the 1970 cohort came from several cancer sites, but the numbers were small. Among unemployed women in the 1986 cohort, excesses were seen only for cancer of the digestive organs (SMR = 1.09; 95% CI = 0.94–1.27) and for cancer of the respiratory organs (SMR = 1.48; 95% CI = 1.29–1.69).

Table 4 also shows the cancer incidence in the 1970 cohort of unemployed persons. There were 291 incident cancer cases among men, giving an SIR of 1.25 (95% CI = 1.11–1.40). As with cancer mortality, the excess risk came from cancer of the respiratory organs (SIR = 1.64; 95% CI = 1.34–2.00) and from cancer of the digestive organs (SIR = 1.34; 95% CI = 1.07–1.68). A marginal excess risk was seen for the incidence of cancers of other sites (SIR = 1.09; 95% CI = 0.84–1.41). There were 90 incident cancer cases in women, giving an SIR of

Table 5. Cancer incidence and mortality in Denmark in 1970–1975 for inactive persons aged 20–64 in 1970, and cancer mortality in 1986–1990 for inactive persons aged 20–64 in 1986

	Men					Women					
	1970–1975				1986–1990		1970–1975				1986–1990	
	Incidence		Mortality		Mortality		Incidence		Mortality		Mortality	
	Obs.	SIR	Obs.	SMR	Obs.	SMR	Obs.	SIR	Obs.	SMR	Obs.	SMR
Total mortality	–	–	10832	2.81	16863	2.69	–	–	19625	1.61	16371	2.10
Cancer[a]	2581	1.25	2012	1.65	3826	1.70	13581	1.00	7422	1.19	6112	1.38
Digestive organs[b]	653	1.22	552	1.42	902	1.41	2533	1.05	1803	1.18	1249	1.27
Respiratory organs[c]	839	1.52	792	1.82	1546	1.91	828	1.06	677	1.16	1296	1.56
Breast[d]	4	1.24	3	2.91	7	2.42	3448	0.94	1727	1.22	1291	1.35
Female genital organs[e]	0	–	0	–	0	–	3559	1.01	1706	1.19	942	1.29
Male genital and urinary organs[f]	508	1.15	275	1.69	518	1.54	637	1.14	324	1.25	268	1.63
Haematopoietic system[g]	189	1.27	182	1.85	275	1.55	657	0.97	478	1.16	361	1.38
Other sites[h]	434	1.04	208	1.57	578	2.00	2103	1.01	707	1.17	705	1.38

Obs., observed; SMR, standardized mortality ratio; SIR, standardized incidence ratio

Codes (International Classification of Diseases and Causes of Death) for cancer mortality (first) and cancer incidence (second):
[a]ICD-8 140-209; ICD-7 140-205.
[b]ICD-8 150-159; ICD-7 150-159.
[c]ICD-8 160-163; ICD-7 160-164.
[d]ICD-8 174; ICD-7 170.
[e]ICD-8 180-184; ICD-7 171-176.
[f]ICD-8 185-189; ICD-7 177-181.
[g]ICD-8 200-209; ICD-7 200-205.
[h]ICD-8 140-149, 170-173, 190-199; ICD-7 140-148, 190-199.

1.14 (95% CI = 0.93–1.40). The numbers of specific cancer sites were small, but there was a significant excess risk for cancer of the female genital organs (SIR = 1.49; 95% CI = 1.06–2.10).

Table 5 shows that the excess cancer mortality among inactive men and women came from all cancer sites in both the 1970 cohort and the 1986 cohort. The table also shows that for inactive persons the SIR values were systematically below the SMR values.

Discussion
Cancer in unemployed women
In 1970, only half of the Danish women aged 20–64 were working outside their homes; the other half were housewives. In 1986, only a quarter of women were housewives.

The unemployment rate among women increased from 1% in 1970 to 17% in 1986, and it should be kept in mind that as the workforce increased during the same period the 1% in 1970 represented 6700 women whereas the 17% in 1986 represented more than 200000 women. The analysis of mortality and cancer incidence in the unemployed women showed:

• The small group of unemployed women in the 1970 cohort had an excess total mortality of 70%, whereas the much larger group of unemployed women in the 1986 cohort had an excess total mortality of only 25%.
• Similar differences were seen in the cancer mortality, where there was a 25% excess in the 1970 cohort (based on small numbers) and only an 8% excess in the 1986 cohort.

• The moderate excess cancer mortality in the 1986 cohort came from a 50% excess risk of cancer of the respiratory organs and a 10% excess risk of cancer of the digestive organs. The numbers for specific cancer sites for the 1970 cohort of unemployed women were too small for analysis.

• The unemployed women in the 1970 cohort had an excess cancer incidence of 14%, which was less than their excess cancer mortality of 25%; but the numbers were small, and the 95% CIs overlapped.

• Inactive women in the 1970 cohort (which constituted half of the women) had no excess cancer incidence compared with economically active women, but a 19% excess cancer mortality.

Owing to the dramatic change in the proportion of women working outside homes from 1970 to 1986, it is very difficult to interpret the data on mortality and cancer incidence for unemployed women in Denmark, and further discussion is therefore restricted to men.

Cancer in unemployed men

By far the majority of Danish men aged 20–64 were economically active both in 1970 and in 1986. However, the proportion of unemployed men increased from 1% in 1970 to 14% in 1986. The analysis of the mortality and cancer incidence in these men showed:

• The small group of unemployed men in the 1970 cohort had an excess total mortality of 60% during the following five years. The much larger group of unemployed men in the 1986 cohort had a similar excess total mortality of 50% during the following five years.

• The unemployed men in both the 1970 cohort and the 1986 cohort had an excess cancer mortality of 25%.

• The excess cancer mortality for the unemployed men came in both the 1970 cohort and the 1986 cohort mainly from an excess risk of death from cancer of the respiratory organs of close to 50%; in addition, the excess risk of death from cancer of the digestive organs of 15% and the excess risk from cancer of the male genital and urinary organs of 10–25% made minor contributions to the excess cancer mortality.

• The unemployed men in the 1970 cohort had

an excess cancer incidence of 25%, which was equivalent to their excess cancer mortality. As for mortality, the excess cancer incidence came primarily from cancer of the respiratory organs and to a lesser extent from cancer of the digestive organs.

• Among the unemployed men in the 1970 cohort the excess cancer incidence was thus of the same magnitude as the excess cancer mortality. However, this was not the case for the health-selected, inactive men in the 1970 cohort; their excess cancer incidence was systematically below their excess cancer mortality.

It thus seems reasonable to conclude that men who became unemployed or inactive developed cancer with a frequency that is 25% above that of working men. As a major contributor to this excess risk is lung cancer, which has a relatively short average survival time, this increased frequency of developing cancer is reflected in an increased frequency of dying from cancer. In addition, inactive men have an additional excess cancer mortality, which probably results from cancer cases developed before the time of retirement.

It is difficult to explain the 25% excess cancer mortality among unemployed men as a result of selection of unhealthy men into the group, because the excess is the same in the 1970 cohort, when the unemployed men constituted 1%, and in the 1986 cohort, when the unemployed men constituted 14%. Furthermore, if the excess risk was explained by a selection effect, we would expect this excess to disappear over time. In the 1970 cohort of unemployed men, however, the relative risk for dying of cancer was 1.25 during the years 1970–1975 but 1.40 during the years 1976–1980 (Iversen *et al.*, 1987).

As smoking is the main risk factor for lung cancer it is interesting to look at the available data on unemployment and smoking habits. A survey of smoking habits among men in Denmark in 1986–1987 showed that fewer than 50% of salaried employees with a higher education smoked, whereas 60% of unskilled workers and more than 70% of unemployed men smoked. The proportion of smokers among unemployed men in 1986–1987 was thus only slightly higher than the proportion of smokers among unskilled workers. Furthermore, a similar survey in 1990–1991 of salaried employees, unskilled workers and unemployed men showed a

prevalence of smoking between 50% and 60% for all three groups (Osler, 1992).

Data from the longitudinal studies on risk factors for heart disease from the 1980s from Denmark (Osler, 1995) show that the slightly higher prevalence of smoking among unemployed men than among employed men in the 1980s was due to differences in smoking habits established before the unemployment started. The available data thus do not support the hypothesis that smoking increases as a result of unemployment.

We can therefore conclude that unemployed men have a 25% excess risk of developing cancer during their unemployment, and it is unlikely that this excess risk is explained by selection of unhealthy men into the ranks of the unemployed. Furthermore, a major contribution to this excess risk comes from lung cancer, and it seems unlikely that excessive smoking habits either before or during unemployment can explain this.

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