

Lung cancer – changes in incidence by gender, age and county of residence 1984–2013

BACKGROUND The Cancer Registry of Norway has reported a decline in age-standardised lung cancer rates for men and an unconfirmed levelling-off in the rate for women. This study describes the development in trends according to gender and age, nationwide as well as by county.

MATERIAL AND METHOD Data on lung cancer from the Cancer Registry of Norway and the NORDCAN website are presented as age-specific and age-standardised rates by gender and place of residence, with a main emphasis on the period 1984–2013.

RESULTS Out of 62 937 Norwegian lung cancer patients (1984–2013), altogether 63% were men. Nationally there was a decline in the rate for middle-aged men (50–69 years), but only a levelling-off in the oldest age group (≥ 70 years). For women, the rates increased in both age groups, most markedly in the oldest one. The rates for older men in the Agder, Vestfold and Finnmark counties have remained above the national average for a prolonged period, and there are only modest signs of a decline among the middle-aged. Oslo is a clear exception, with a clear and sustained decline among men in both age groups. Vest-Agder county had the highest rate for women during the last five-year period, while the rates in Oslo are now at the national average. The national rates for middle-aged women and middle-aged men are converging, intersecting each other in Akershus county.

INTERPRETATION The large differences between genders, age groups, counties and nations in terms of trends in lung cancer indicate that through preventive efforts, we might have achieved much more in a shorter time.

During the last decades, lung cancer in women has surpassed colon cancer in prevalence, when measured in terms of new cases and as rates (incidence rates). Lung cancer has also surpassed breast cancer as the most common cause of death from cancer in women. In other words, even for women this disease has now become the second most common form of cancer and also the form that causes the highest number of deaths.

Since the 1950s, the causal patterns have been better identified for this form of cancer than for most other cancers. Convincing documentation points out that more than 80% of the current cases are caused by tobacco smoking (1, 2). The cancer burden, measured as the incidence of new cases or as mortality, has increased at a varying pace and to varying levels internationally, including within the Nordic region. Around 1960, Norway had the lowest age-standardised incidence among the Nordic countries, for both genders. Today, Norwegian men are in second place (after Denmark), and Norwegian women are ranked third (after Denmark and Iceland) (Figure 1) (3).

In March 2015, the Cancer Registry of Norway published cancer statistics for 2013 (4). The report pointed out that lung cancer has finally started to show a convincing decline in the age-standardised rate for men. This shift came late when compared to Finland and Denmark, where the rate has been

reduced by 60 per cent and 25 per cent respectively since the 1980s (Figure 1a). The age-standardised rate for Norwegian women has increased by a factor of ten since 1960 (Figure 1b), and the desired decline seems nowhere in sight.

The status and trends in development of lung cancer in Norwegian counties (age-standardised rates, all age groups as a whole) were elucidated in a supplement to the routine report from the Cancer Registry of Norway for the year 2013 (5). The report indicated large differences between the counties. In the last five-year period, women had the lowest rates in Sogn og Fjordane, Nord-Trøndelag and Møre og Romsdal counties, while Agder, Vestfold and Østfold counties had the highest rates. For men, Akerhus and Oslo counties had a lower incidence rate for lung cancer than the country as a whole, while Agder, Vestfold and Finnmark counties were above the average.

Oslo stands out in terms of having had higher rates of lung cancer for both genders historically, while the situation today has improved considerably. In this article we will provide an in-depth description of the gender-specific and age-specific rates, nationally and by county over time.

Material and method

To establish the county-wise trends, all cases of lung cancer (ICD-7: 162), i.e. malignant

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MAIN MESSAGE

In Norway as a whole, the lung cancer rate among older men (≥ 70 years) is now stable and for the middle-aged (50–69 years) it is declining, although some counties lag behind.

Lung cancer rates among elderly and middle-aged women show no signs of declining yet.

Lung cancer rates in Oslo have changed considerably, from a very high level to one at or below the national average for men and women respectively, in both age groups.

The complex picture in the Norwegian counties indicates that the nationwide decline in lung cancer could have occurred at a far earlier stage, but after all the national rates failed to reach the same high levels as those seen in some other countries.

neoplasm of the lung, bronchus and trachea (ICD-10: C33–34) in the period 1984–2013 were counted by the Cancer Registry of Norway. The classification of multiple primary neoplasms adhered to the regulations of the International Agency for Research on Cancer (IARC) (6), meaning that only the first invasive cancer per organ is counted.

Data from the Nordic countries were retrieved from NORDCAN (3). The statistical analyses and preparation of graphs were undertaken using the software applications Stata v. 13.1 (Stata Corp. TX) and R v. 3.0.1. (R Foundation for Statistical Computing, Vienna).

Five-year age-specific and age-standardised incidence rates per 100 000 persons per year by gender and county were estimated. Incidence rates adjusted by the world standard population (7, 8) were estimated for each five-year period (1984–88, 1989–93, ... 2009–13). The routine publications from the Cancer Registry of Norway use the world standard population for purposes of international comparison.

We also estimated age-specific rates for two broad age groups: the middle-aged (50–69 years) and the elderly (≥ 70 years). We chose such wide age bands to simplify the graphical presentation and because the number of people and cases is relatively low in some counties, with concomitantly unstable figures. As a measure for the degree of success in tobacco prevention efforts, we also estimated the national rates for young adults (20–44 years) for the period 1953–2013. Moreover, for all age-specific rates we also performed age standardisation within each age group. The annual rates for the age group 20–44 years were smoothed with the aid of a standard regression method that includes local weighting (locally weighted scatterplot smoothing, LOWESS).

Results

Lung cancer trends for Norway as a whole

The study included 62 937 cases of lung cancer diagnosed during the period 1984–2013. Of these, 39 931 (63%) had been diagnosed in men and 23 006 (37%) in women. The total number of lung cancer cases has been on the increase among men as well as women throughout the last 30 years, and the number of cases of lung cancer in Norway has never been as high as during the last five-year period (2009–2013) (Table 1).

For men in the age group ≥ 70 years, an increase in national rates could be observed until the early 2000s when they levelled off. Among middle-aged men there has been a slight decline since the late 1990s. Among women there have been increasing rates in

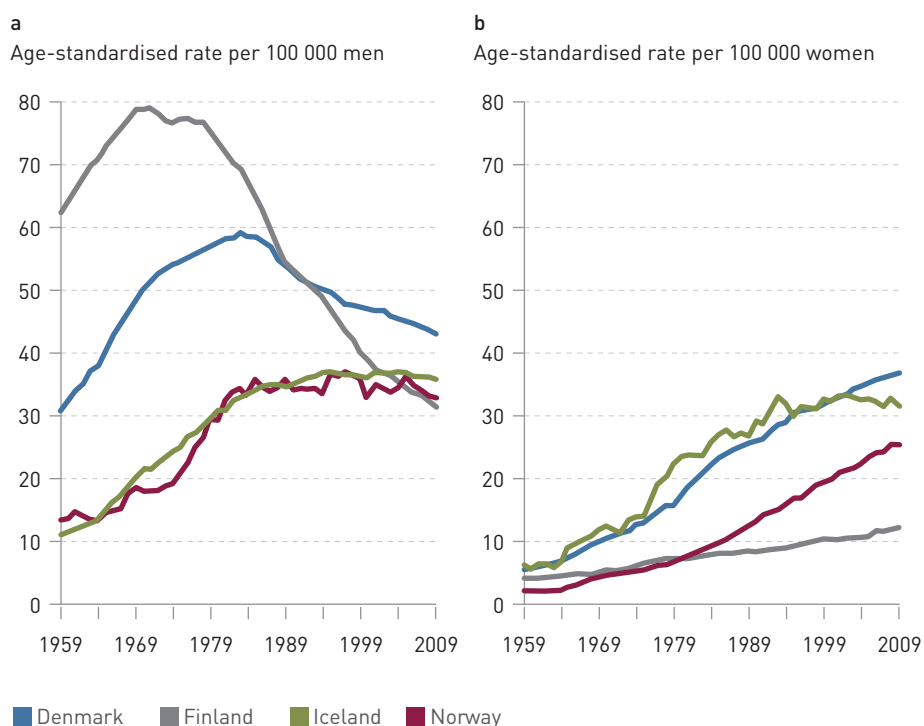


Figure 1 Lung cancer in Denmark, Finland, Iceland and Norway. Incidence rates for a) men and b) women, standardised according to the world standard population, smoothed with five-year sliding averages. Data from Sweden have been excluded because differing registration procedures render the rates incomparable. Data from NORDCAN (3)

both age groups, the largest increase occurring among the oldest (Table 1).

County-wise trends in lung cancer by age

Figure 2 shows the age-specific rates in each county.

Men

For the middle-aged (50–69 years), most counties have seen a reduction in the incidence rate. The exceptions are Hedmark, Oppland, Sogn og Fjordane, Møre og Romsdal, and Nord-Trøndelag counties, where the incidence rate during the last five years has been higher or at the same level as it was 30 years ago.

Among the oldest age group (≥ 70 years), the general impression is a levelling-off after 2000. Østfold, Oppland, Vestfold, Rogaland and Finnmark counties have not followed this trend, showing an increase in their incidence rates.

For both age groups we can see the highest rates in Agder, Vestfold and Finnmark counties. Oslo has seen the steepest decline in lung cancer, observed in both age groups. In general, incidence rates over time have remained considerably higher among men than among women, at the national as well as the county level, but the rates are now converging, especially in the middle-aged group. Akershus is the first county in Nor-

way to show a higher rate among middle-aged women than among middle-aged men (in the last five-year period).

Women

The typical impression of the county-wise rates is an increase among middle-aged as well as elderly women. The prevailing national rate in the oldest age group (≥ 70 years) is approximately three times as high as in the 1980s, and there has been a marked increase in all counties for this age group over the last 30 years. As regards the last five-year period, we can see the highest rates among elderly women in Aust-Agder and Vest-Agder counties, while Sogn og Fjordane have the lowest rate, only half that of the Agder counties.

In Oslo there have been signs of a decline or levelling-off of the rates for both age groups over the last ten years. During the same period there are also certain other counties that show signs of some levelling-off or decline for one of the age groups.

Trends in the youngest age group

Trends in the age group 20–44 years are shown in Figure 3. Because the disease is rare among young people, there are major variations in the annual rates.

The situation today is approximately identical to that of the 1950s for young men and far worse for young women, although a



Figure 2 Age-specific incidence rates for lung cancer in five-year periods from 1984 to 2013 for middle-aged [50-69 year] and older [≥ 70 years] men and women in all Norwegian counties

Table 1 Lung cancer in Norway. Number of cases, age-specific and age-standardised rates (world standard population) by gender and observation period 1984–2013

Age (years)	Period					
	1984–88	1989–93	1994–98	1999–2003	2004–08	2009–13
Gender, data type						
Men, number of cases						
0–29	6	11	11	11	6	14
30–49	232	271	302	281	238	194
50–69	2 995	2 772	2 759	2 762	3 098	3 428
≥ 70	2 451	2 910	3 288	3 686	3 952	4 253
All age groups	5 684	5 964	6 360	6 740	7 294	7 889
Men, rates per 100 000 person-years						
30–49	9.5	9.1	9.5	8.8	7.1	5.3
50–69	137.6	134.2	135.4	125.5	120.3	112.7
≥ 70	270.1	299.4	322.0	358.1	375.3	375.6
Age-standardised rates, world standard population (all age groups)						
	35.2	35.8	37.0	36.6	36.0	34.5
Women, number of cases						
0–29	4	5	8	5	8	15
30–49	137	191	260	236	229	228
50–69	914	1 247	1 450	1 901	2 362	2 811
≥ 70	780	1 071	1 433	1 918	2 580	3 213
All age groups	1 835	2 514	3 151	4 060	5 179	6 267
Women, rates per 100 000 person-years						
30–49	5.7	6.7	8.6	7.6	7.1	6.6
50–69	40.6	58.2	68.1	83.1	90.8	93.8
≥ 70	58.6	75.5	99.5	141.2	189.1	225.3
Age-standardised rates, world standard population (all age groups)						
	10.3	14.0	17.0	20.8	23.9	25.8

certain improvement appears to have manifested itself over the last 15–20 years.

Correlation between the county-wise proportion of smokers and prevalence of lung cancer

Figure 4 shows the proportion of daily smokers in the age group 16–74 years, as reported by Statistics Norway (9) for those counties that have the highest and lowest rates of lung cancer for the period 2009–2013.

The correlation between the reported rates of lung cancer and the proportion of daily smokers in the same period amounts to 0.95 for men and 0.37 for women.

Discussion

This study shows that in most counties there has been a slight decline in the incidence rate

for men under 70 years since the mid-1990s, while the rate for men over 70 years has only recently levelled off. For women, there is a possible levelling-off among the middle-aged, but a persistently marked increase in the oldest age group.

There are nevertheless a few counties that stand out in terms of their trends or incidences. We can see that the proportion of daily smokers in the age group 16–74 years is largely consistent with the county-wise age-standardised rates of lung cancer for men, while the picture is less clear for women (Figure 4). Unfortunately, we have only limited data on age-specific smoking status and history at the county level.

Data from the Cancer Registry of Norway have been shown to be near-complete and have high validity, thus providing a reliable

picture of the real incidence of cancer (10). In some counties and age groups, however, the number of cases may be low, thus rendering the rates vulnerable to random variations. The changes in trends have therefore been interpreted by examining developments over several subsequent periods.

The situation in Oslo is remarkable. The high rates of cancer among men in the capital city levelled off and intersected those of Finnmark county around 1980, and slipped below the national rate during the 1990s. The proportion of smokers in Oslo is now among the country's lowest. One may speculate whether part of the explanation could be that Oslo has the country's highest proportion of inhabitants who come from an immigrant background. Immigrants account for approximately 30 per cent of the city's

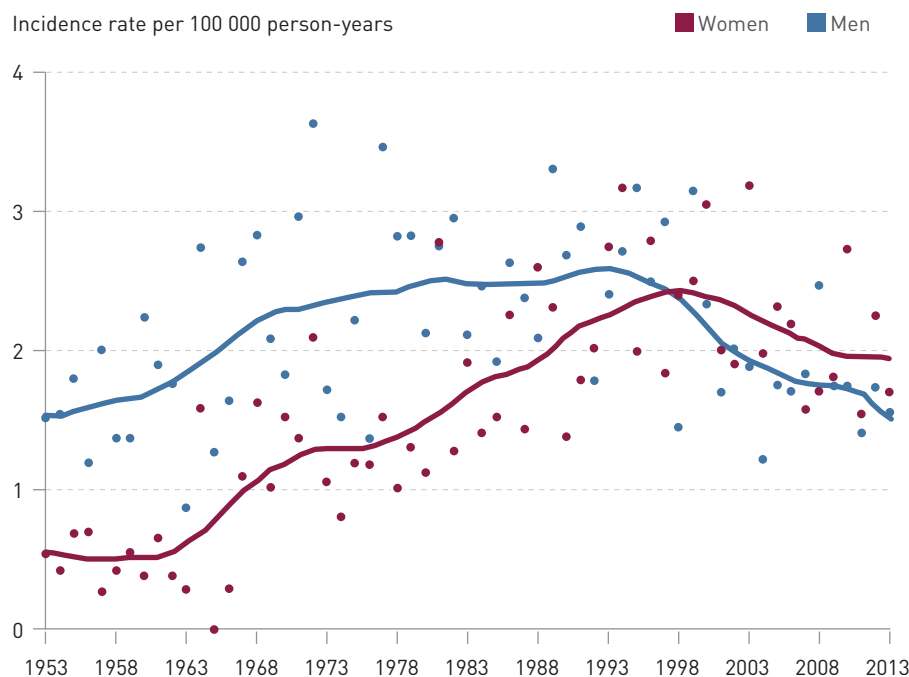


Figure 3 Lung cancer in young adult women and men, 20–44 years. Annual age-standardised rates according to the world standard population (dots) with a regression line produced by local weighting (LOWESS regression) which takes 30 per cent of the closest data points into account

population. Disregarding immigrants from Western countries, the major proportion hail from countries such as Pakistan, Somalia, Iran, Iraq, Turkey, Morocco, Vietnam and Sri Lanka. Among these countries, only Turkey and Vietnam have rates of lung cancer in men higher than those seen in Norway (11). Unfortunately, we have as yet no statistics showing the patterns of cancer in immigrants in Norway, so we have no certain information on how immigration may have affected the trends in lung cancer, neither in the capital city, nor at the national level.

Lung cancer is a multifactor disease, even though the smoking habits in the population exceed all other factors in importance (1, 2). The most widespread and strongest risk factors in addition to active smoking include radon in indoor air (residential houses and workplaces) and exposure to carcinogenic substances at work. Other factors, such as passive smoking and general air pollution, may also contribute because they affect large segments of the population over a long period of time, but the individual increase in risk is relatively modest.

High levels of radon in residential houses may represent a strong risk factor (12), but most residential houses in Norway have levels below the prevailing intervention limit of 100 Bq/m³ (13). In general, lung cancer associated with radon tends to affect smokers and ex-smokers, and it is therefore

assumed that lung cancer linked to radon largely follows the prevalence of smoking habits. This notwithstanding, it should be noted that even medium levels of radon (from 1000 Bq/m³) may be extremely harmful to smokers and may add an amount of risk equal to that of the smoking itself.

Historically, carcinogenic substances in the working environment have tended to primarily affect men. In some studies, the contribution from workplace exposure has been estimated to approximately 20 per cent (attributable proportion, men) in industrialised regions, with a somewhat smaller proportion at the national level (14–16). Even in occupations with a high degree of carcinogenic exposure, the effects of smoking remain important (17), and exposure in the workplace is hardly sufficient to explain more than a small proportion of the differences between the counties.

The prevalence of lung cancer in young adults is regarded by many as a reliable and relatively rapid measure to assess changes in smoking habits (18, 19). The results are relatively modest even here, despite the fact that the Norwegian efforts to combat tobacco use for decades have been based on the mantra «what is most important is to prevent children and youth from taking up smoking». Action plans for a tobacco-free Norway have contained numerous references to passive smoking and children and youth, but relatively few to programmes to persuade adults to

quit smoking (20–22). In line with these efforts, the decline in the number of smokers has been greatest in the younger age groups (9). However, as pointed out by the World Health Organization, efforts targeting children and adolescents will not produce any results until 50 years into the future, making motivation and help for adults to quit smoking a key priority area (23).

Of the nearly 63 000 cases of lung cancer diagnosed in Norway since 1984, we may assume that 80 per cent were avoidable if tobacco smoking could have been eliminated after this causal relationship was discovered 20–30 years previously (1). Assuming that 80 per cent of the lung cancer patients have died prematurely, this human cost of tobacco smoking since 1984 amounts to 40 000 premature deaths.

Conclusion

The lung cancer rate in men ≥ 70 years has now stabilised at the national level, but in some counties the rate continues to rise. The highest rates are seen in the counties of Agder, Vestfold and Finnmark. For middle-aged men (50–69 years) the rates are declining or levelling off in most counties. Only in Oslo is there a convincing decline in both age groups.

For women, rates have increased among the elderly and the middle-aged alike in most counties. During the last five-year period Vest-Agder had the highest level. For many decades Oslo had high levels, but these are now at the national average for both age groups.

Lung cancer rates for middle-aged women and middle-aged men are converging, and in Akershus county women had higher rate than men during the last five-year period. Only during the last 15–20 years has there been a positive trend for young adult men and women (20–44 years).

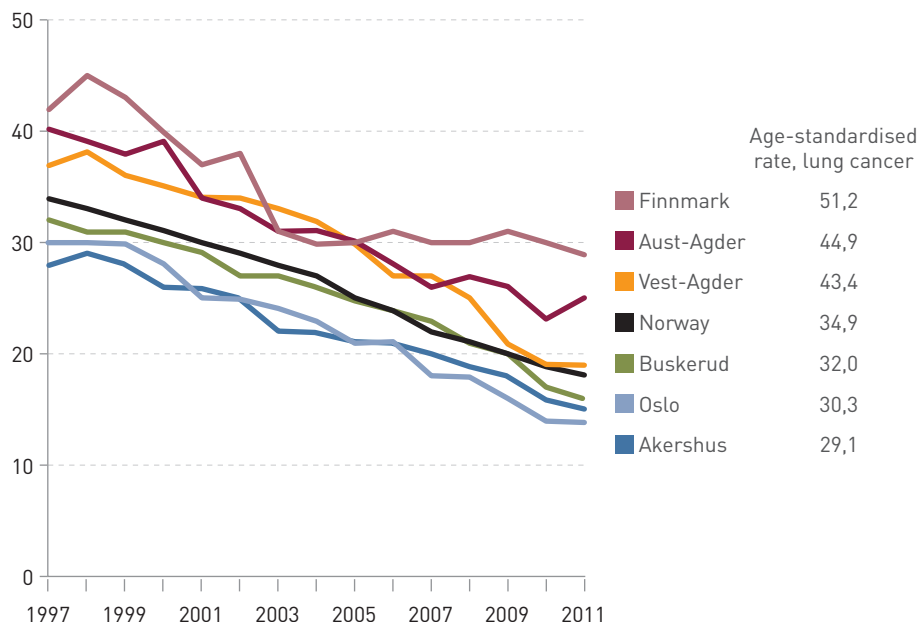
The differences in trend among Norwegian counties indicate that Norway could have and ought to have achieved a far stronger and faster decline in the prevalence of lung cancer. It is nevertheless a positive sign that the lung cancer rates in Norway failed to reach the same levels as in some other countries.

This study has used data from the Cancer Registry of Norway, but the interpretation and reporting of these data are the exclusive responsibility of the authors and have not been subject to any approval from the registry.

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a Men

Proportion of daily smokers (%)



b Women

Proportion of daily smokers (%)

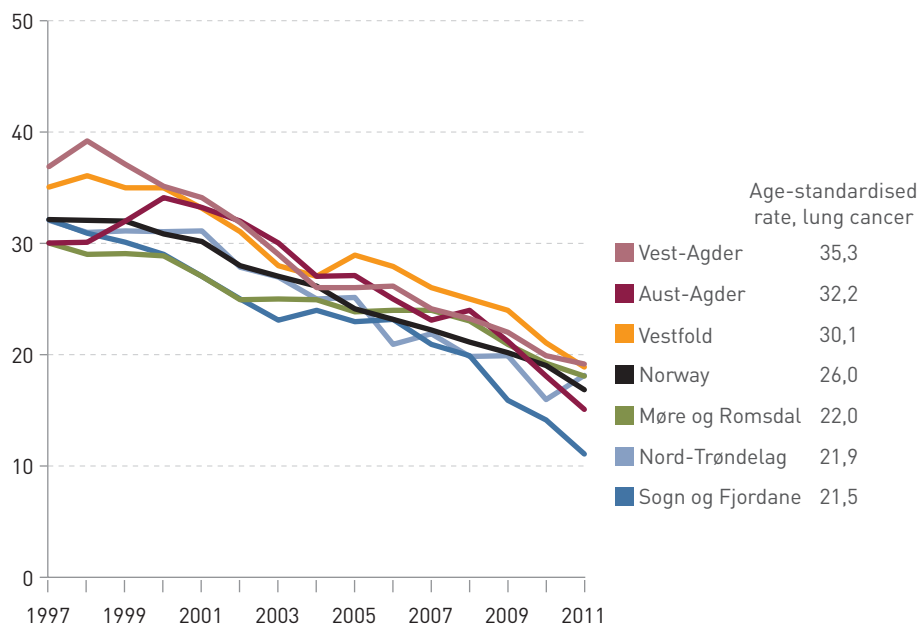


Figure 4 Trends in the proportion of daily smokers aged 16–74 years by place of residence (shown as five-year sliding averages reported by the middle year in each five-year period) for counties with the highest and lowest age-standardised rates of lung cancer (reported as the number of new cases per 100 000 persons per year, adjusted according to the world standard population) for the period 2009–2013. a) Men. b) Women. Data from Statistics Norway (9)

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