Socio-economic factors and cancer: Incidence, mortality, and survival (1991 – 2000)

A preliminary analysis of relationships between socio-economic factors and cancer in the NYCRIS Cancer Registry area for all cancers (excluding non-melanoma skin), plus breast, colorectal and lung cancers individually, during the period 1991 - 2000.

Headlines

- There are important differences in cancer incidence, mortality, and survival across socio-economic groups. Work to reduce health inequalities in cancer needs to take these trends into account.
- Men have a significantly higher age-standardised incidence of cancer than women, although more women have cancer overall. This mirrors the national picture.
- During the decade 1991 - 2000 the historic socio-economic pattern whereby greater deprivation was associated with higher incidence of all cancers (excluding non-melanoma skin) has reversed for women, and the trend is the same for men. Incidence for the most recent time period is now highest in the most affluent quintiles.
  This is a new observation that will need to be examined carefully.
- For the common cancers there are some strong established trends in incidence. In breast cancer, incidence is higher in the more affluent, whereas in lung cancer there is a much higher incidence in the more deprived. Both observations are consistent with the longstanding national pictures for these diseases.
- In colorectal cancer incidence trends are much weaker and more complicated to interpret. Incidence in the affluent has recently overtaken that for the more deprived in both men and women. This trend was also observed by the West Midlands Cancer Intelligence Unit.
- Mortality shows a strong and consistent picture, with clear gradients across the socio-economic groups. Mortality is highest in the most deprived with the lowest mortality rates in the most affluent.
- Despite the consistent pattern of mortality differences between socio-economic groups, in the NYCRIS area the gaps between socio-economic groups have been narrowing steadily over the last decade, particularly in men. Mortality in the most deprived groups has improved more rapidly than in the other categories.
- Much of the observed difference in mortality between deprivation categories (all cancers) is explained by lung cancer.
- Mortality rates for breast, colorectal cancer in both sexes, and lung cancer in men fell significantly over the decade from 1991 - 2000 for all deprivation categories. In contrast, lung cancer mortality in women showed a small increase overall (significant differences in mortality by socio-economic group remained).
- The chances of surviving cancer by one and five years reduce with increased deprivation.
- Increases in survival over time are general and occur across all deprivation categories.
- The relative position of survival in each of the socio-economic groups shows little change over the last decade.

Introduction

NYCRIS registers all cancers occurring in residents of the North East of England, North Cumbria, Yorkshire (excluding South Yorkshire), and North Lincolnshire - a population of about 6.5 million people. It records detailed information on all new cancers diagnosed and on deaths in this population. It can provide detailed information and analyses for the whole area, as well as for subsets of that population, such as Primary Care Trusts, Cancer Networks, Health and Local Authorities, and Government Offices. The data can be used to identify patterns and trends of public health importance or to examine healthcare delivery.

The aim of this report is to present these patterns and trends as they relate to deprivation and cancer in this population, in the ten-year period 1991 – 2000. Information is presented under three main headings: Incidence, Mortality, and Survival. Each topic covers all cancers together (excluding non-melanoma skin) and the three common cancers separately, i.e. breast, colorectal and lung.

This report, prepared jointly by NYCRIS and NEPHO, was begun prior to the inception of the Yorkshire and Humber PHO. In order to give sufficient statistical power to assess socio-economic influences on cancer, it covers the whole NYCRIS area. Some data are excluded from this report because of space, but are available through the PHO and NYCRIS websites.

It is expected that this report will prompt questions that will be addressed by specific pieces of work. Consideration is being given to further joint work on this topic using further years' data and alternative study methods – particularly since national initiatives to standardise usage of population data and analytical methods will help comparisons between studies. This is expected to be completed during 2005/6.

Summary of methods

This report uses standard sources for population numbers and socio-economic breakdown, together with information from the cancer registration database.

All analyses use deprivation quintile groups as the means of dividing the population into different socio-economic categories for analysis. The deprivation quintile groups were produced by calculating deprivation scores for each ward within the area covered by NYCRIS, using the Townsend Material Deprivation Index. This is made up of four 1991 Census variables: unemployment, overcrowding, non-car ownership, and non-home ownership. Wards were sorted by deprivation score and grouped into quintiles, ensuring each quintile group had a similar population size. Deprivation quintile 1 refers to the most affluent quintile, while deprivation quintile 5 is the most deprived. This is set out in more detail in the Appendix.

Background and Literature

Investigation and research into socio-economic issues and health has a long history, closely intertwined with developments in public health over the last century. At different times it has played its part in both influencing (and sometimes failing to influence) health and social policy[1]. The Black report[2] (1980) provided a definitive review of the evidence and identified opportunities for intervention. Although its main recommendations were rejected by the government of the day, it was a seminal document. It concluded that there were significant differences in health status and mortality between what were then called social classes. The report's authors expressed concern that the gaps between mortality in different social groups were widening. Papers[3,4] published to mark the 10th anniversary of this report were pessimistic about the trends through the 1980s, arguing that the limited evidence suggested a further deterioration in this position. The political approach to deprivation changed with a new

government in 1997, and the need to address inequalities has since become an explicit objective for health organisations, local government and many other agencies.

However, as Sally Macintyre points out[5], what is described is very dependent on how socio-economic states are defined and measured and on what measures or indicators of health are used. Age and gender are important too, yet are not always dealt with adequately. Easy assumptions of equivalence between different methods of study and alternative measures of deprivation are not always well validated. Although there is an abundance of data and many descriptive studies, reliable evidence showing patterns and trends for specific diseases is an important starting point. This in turn needs to be supported by evidence to help explain the causal factors underlying observed differences. Knowledge about effective interventions to change that position is not always plentiful, nor is it easy to implement.

Cancer has a head start compared to many other health topics because of the data available from cancer registration. Registries hold many years of consistent data and since the data are population based they can be analysed using other sources of information about the same populations. As a result, cancer registries can provide information about cancer and deprivation and many have done so - such as the West Midlands[6] in 2002.

The issues are relevant to all countries and the International Association for Research on Cancer (IARC) produced a monograph[7] on this issue in 1997 with many distinguished international contributors. This report covered general features and issues, evidence of inequalities, and wide-ranging analyses of potential explanations. In that review Fogianno et al[8] (for incidence and mortality) and Kogevinas and Porta[9] (for survival) drew attention to the consistency of the socio-economic differences across different counties and over time. Auvinen and Karjalainen[10] offered explanations for social class differences in survival. However, such factors as stage at diagnosis, which is an important explanatory variable for observed survival differences, raises further questions as to why rates of advanced disease at diagnosis should vary by socio-economic group.

Michel Coleman[11] (2004) published a comprehensive UK analysis of social deprivation and survival in cancer, which showed a widening of gaps between socio-economic groups from the late 1980s to the late 1990s. However, such national trends can only go so far. It is important to examine data in each part of the country to see what is happening. This report begins that process for all cancers and the three key common cancers in the NYCRIS area.

This work suggests that some trends and effect sizes may be different from those described in some published work. These include a narrowing of cancer mortality differences between socio-economic groups and apparent changes in incidence patterns of cancer by socio-economic group. The important part played by lung cancer in explaining the variation in all cancer mortality across socio-economic groups is also highlighted.

1 Oliver A, Nutbeam D. Addressing health inequalities in the United Kingdom: a case study. *Journal of Public Health Medicine.* 2003; **25**(4): 281-287
2 DHSS. Inequalities in Health-Report of a Research Working Group. 1980: 'The Black Report'
3 Morris J N. Inequalities in health: ten-years and little further on. *Lancet* 1990; **336**: 491-493
4 Smith G D, Bartley M, Blane D. The Black report on socio-economic inequalities in health 10 years on. *BMJ* 1990; **301**: 373-377
5 Macintyre S, McKay L, Der G, Hiscock R. Socio-economic position and health: what you observe depends on how you measure it. *Journal of Public Health Medicine*. 2003; **25**(4): 288-294
6 West Midlands Cancer Intelligence Unit. Cancer and Deprivation 2002
7 Social Inequalities and Cancer (1997) ed Kogevinas M, Pearce N, Susser M, Bofetta P. *IARC Scientific publications:* No 138.
8 Faggiano F, Partanen T, Kogevinas M and Boffetta P. Socioeconomic differences in cancer incidence and mortality. Chapter 5. *Social Inequalities and Cancer* 1997; 65-176
9 Kogevinas M, Porta M. Socioeconomic differences in cancer survival: a review of the evidence. Chapter 6. *Social Inequalities and Cancer* 1997; 177-207

10 Auvinen A, Karjalainen S. Possible explanations for social class differences in cancer patient survival. Chapter 20. *Social Inequalities and Cancer* 1997; 377-397
11 Coleman MP, Rachet B, Woods LM et al. Trends and socioeconomic inequalities in cancer survival in England and Wales up to 2001. *BJC* 2004; **90**: 1367-1373

Section 1 - Incidence

1.1 All malignant cancers excluding non-melanoma skin (NMSC) (C00-C97 excl C44)

Figure 1 shows the directly age-standardised incidence rates, standardised to the European Standard Population, by deprivation quintile and sex. The overall annual age-standardised incidence rates for both sexes within NYCRIS for the years 1998 - 2000 was 464.6 per 100,000 (95% CI 461.8 - 467.3). It shows that the most affluent quintile had the highest incidence rates for males, females and both sexes. The confidence intervals displayed with the incidence rates show a significant difference in cancer incidence rates between the most affluent and most deprived quintiles for females and both sexes combined.

The graph also shows that there were significantly higher cancer incidence levels for males compared to females for each deprivation quintile; the overall incidence rate for males was 533.0 per 100,000 (95% CI 528.6 – 537.3) and for females 425.0 per 100,000 (95% CI 412.4 – 428.7).

Figure 1. Annual age-standardised incidence rates 1998 - 2000 by deprivation quintile

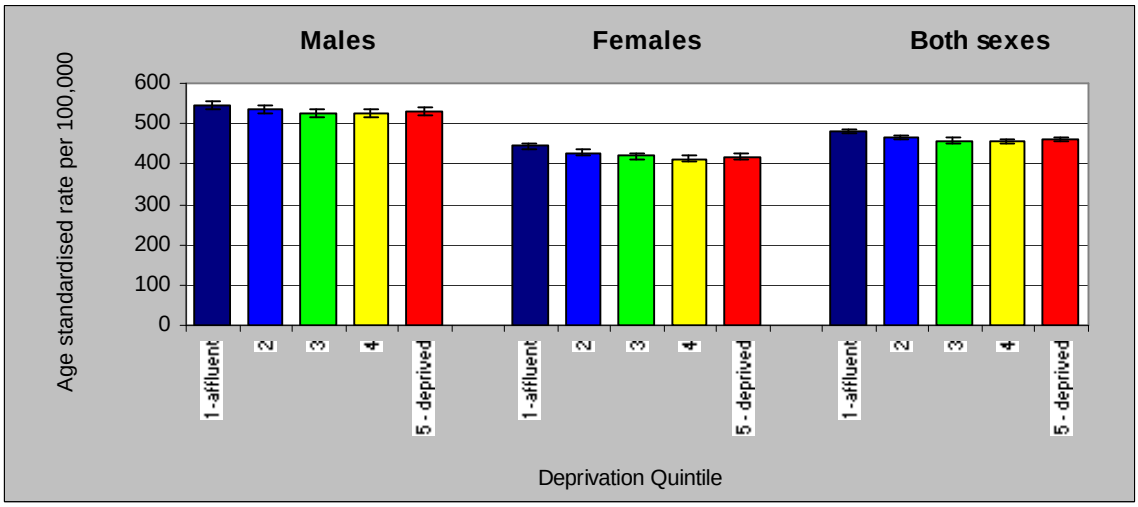
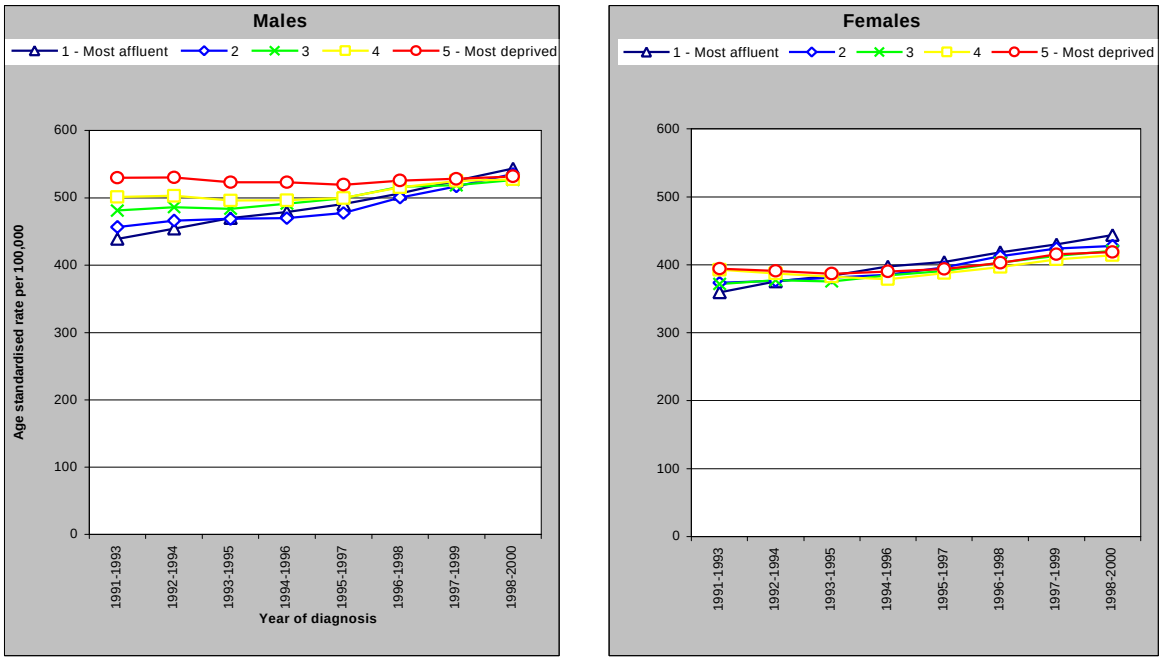


Figure 2 shows the age-standardised incidence of malignant cancer over time by sex. Both graphs show a clear change in the pattern of cancer incidence by deprivation quintile over time.

The graph for males suggests that until approximately 1996 - 1998, men from the most deprived wards had the highest levels of cancer, while men from the most affluent wards had the lowest levels. During the ten-year period, however, while the incidence for men within the most deprived quintile has remained fairly static, the incidence for men from the more affluent quintiles has been steadily increasing. This has resulted in the incidence for males from the most affluent quintile overtaking that for the most deprived quintile for the latest period.

A similar pattern of incidence also occurred in females, but the differences are much smaller.

Figure 2. Time trends: 3-year moving average annual age-standardised incidence rates 1991 - 2000 by deprivation quintile: All ages



1.2 Female breast cancer (C50)

The overall age-standardised breast cancer incidence rate for the period 1998 - 2000 was 108.6 per 100,000 women (95% CI 106.7 - 110.6). Consistently higher incidence levels occur within more affluent areas compared with more deprived areas. Figure 3 shows this differential by deprivation quintile, with a linear trend between age-standardised incidence rates and deprivation quintile. The incidence rate for women within the most affluent quintile (123.1 per 100,000) is 29% higher than the most deprived quintile (95.1 per 100,000), a significant difference.

Figure 3. Annual age-standardised incidence rates 1998 - 2000 by deprivation quintile

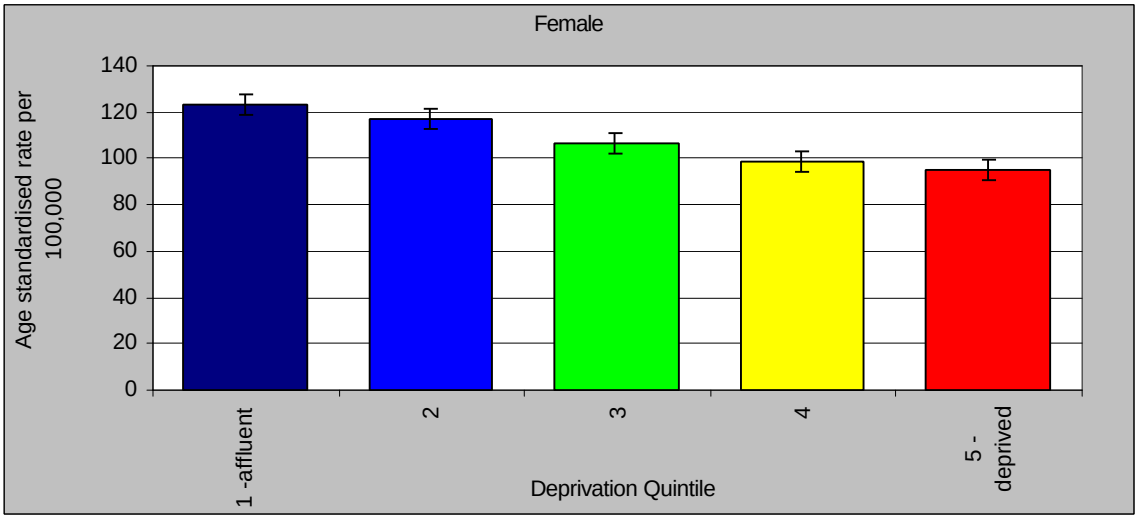
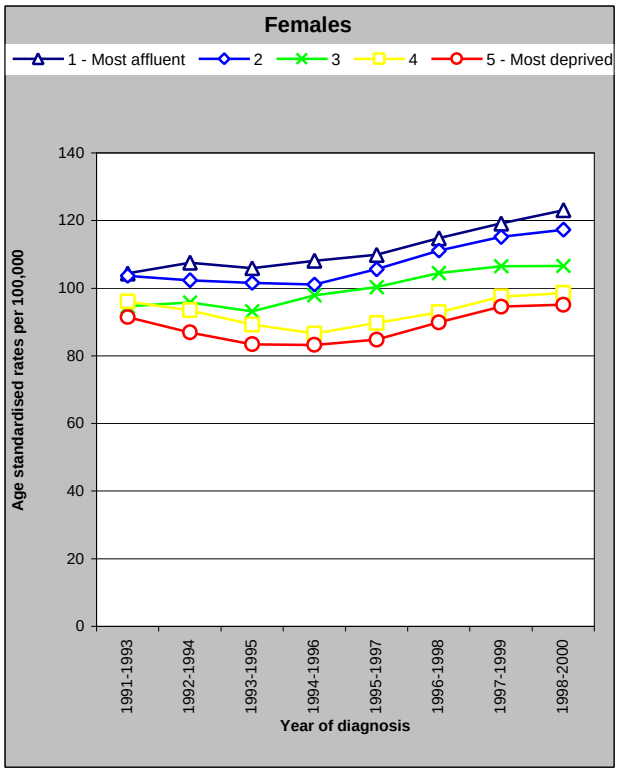


Figure 4 below shows the changes in incidence rates over the ten-year period by deprivation quintile, demonstrating an increasing incidence since 1995 for all quintiles. The disparity in incidence rates by deprivation has been consistent over the period, with women in more affluent quintiles experiencing higher rates than women in more deprived quintiles. The graph suggests that there may be a widening gap in incidence rates between the most affluent and the most deprived quintiles since 1993. While the incidence rate in the most affluent quintile has increased by 18%, the rate in the most deprived quintile has increased by only 4%.

Figure 4. Time trends: 3-year moving average annual age-standardised incidence rates 1991 - 2000 by deprivation quintile: All ages



1.3 Colorectal cancer (C18-C20)

On average there were 4,159 colorectal cancer registrations each year from 1998 - 2000; approximately 55% were for males and 45% for females. Of these, 60% were in the colon (C18), 10% the rectosigmoid junction (C19) and 30% in the rectum (C20).

Approximately 22% of colorectal registrations were for residents of the most affluent wards (deprivation quintile 1), compared to 17% of registrations for residents of the most deprived wards (deprivation quintile 5). This difference was statistically significant, suggesting overall that there was an 18% reduced likelihood of residents from deprivation quintile 5 being registered with colorectal cancer over the period, compared to residents from deprivation quintile 1 (odds ratio 0.82, 95% CI 0.76 - 0.88). The equivalent values for males and females were both statistically significant, showing a 17% decrease (odds ratio 0.83, 95% CI 0.75 - 0.90), and 19% decrease (odds ratio 0.81, 95% CI 0.72 - 0.89) respectively.

There was a marked age incidence gradient with just over 26% of all registrations for people aged under 65 years, 32% for those aged between 65 and 74 years and 42% for people aged 75 years and over. There was no significant association in the pattern of registrations by age

group between deprivation groups in males or females; however, a significant pattern was found in both sexes combined (chi^2 = 18.79, 8 degrees of freedom, $p<0.05$).

Figure 5. Annual age-standardised incidence rates 1998 - 2000 by deprivation quintile

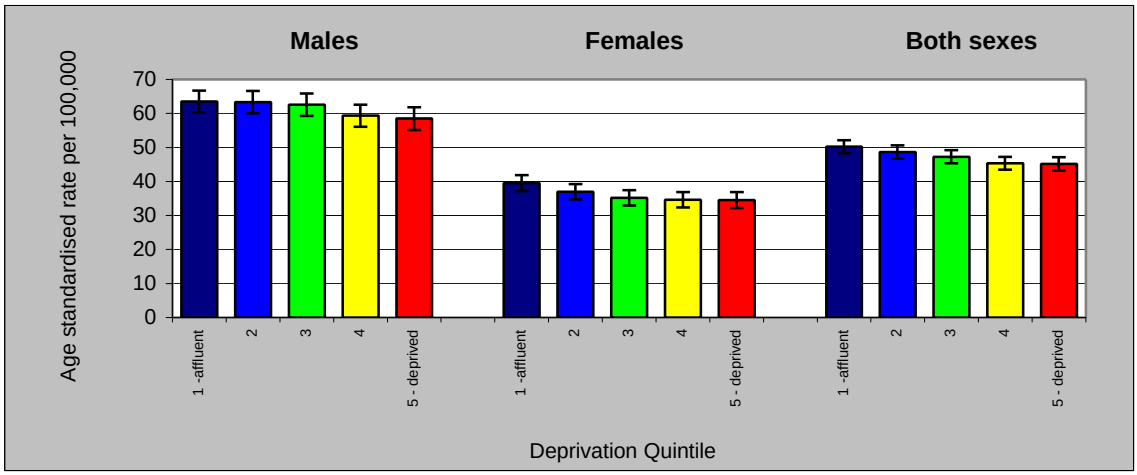
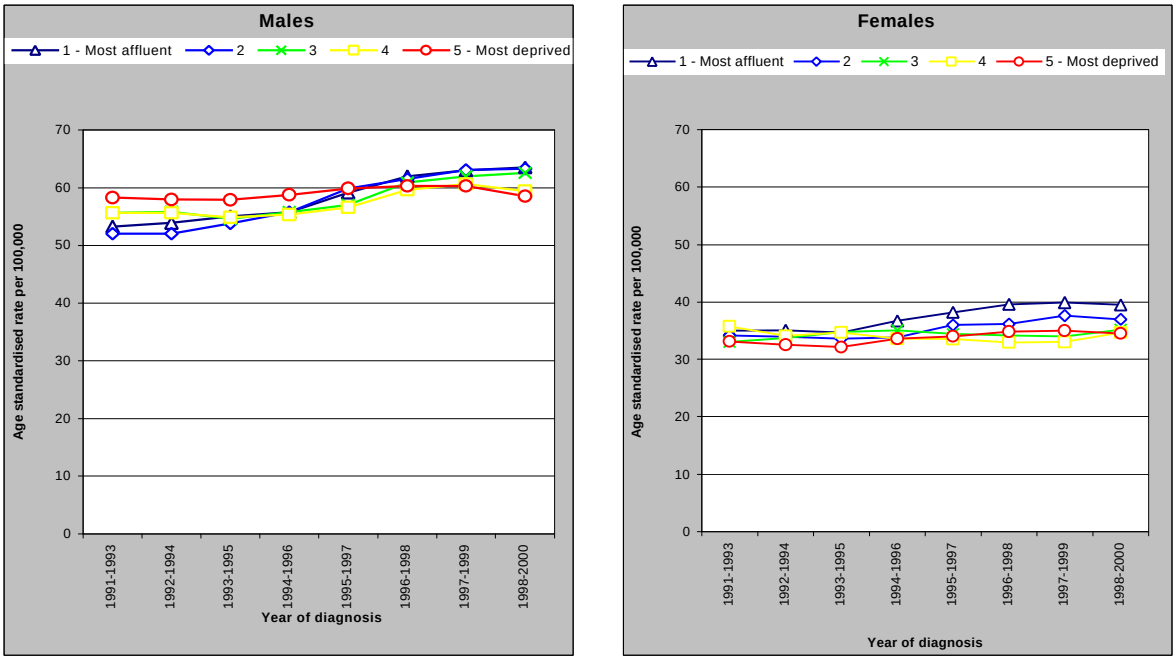


Figure 5 shows the directly age-standardised incidence rates, by deprivation quintile and sex. The overall annual age-standardised incidence rate for both sexes for the years 1998 - 2000 was 47.4 per 100,000 (95% CI 45.8 - 49.0). There was a linear trend in the incidence of colorectal cancer by deprivation quintile, with incidence reducing with increased deprivation for males and females. The graph also shows that males had a significantly higher incidence of colorectal cancer compared to females for each deprivation quintile; the overall incidence rate for males was 61.5 per 100,000 (95% CI 60.0 - 63.0) and for females 36.2 per 100,000 (95% CI 35.2 - 37.2).

Figure 6. Time trends Colorectal Cancer: 3-year moving average annual age-standardised incidence rates 1991 - 2000 by deprivation quintile: All ages



The graphs in figure 6 display incidence over time, showing that the negative association between incidence and deprivation is a recent phenomenon.

The graph for males suggests that until approximately 1995 - 1997, men from the most deprived wards had higher levels of colorectal cancer than men from the most affluent wards. However, while the incidence within the most deprived quintile has remained fairly static over the ten-year period, the incidence for the most affluent quintile has steadily increased.

The equivalent graph for females shows that the incidence has increased for both the most affluent quintile and the most deprived quintile, although the rate of increase for the most affluent quintile is greater. The position in 2000 showed a negative association between incidence and deprivation.

The graph for both sexes (not shown) revealed a similar pattern to that of males, with reversal in the pattern of incidence by deprivation quintile over the ten years.

1.4 Lung cancer (C33-C34)

On average there were 5,272 lung cancer registrations each year between the years 1998 - 2000. Males accounted for 60% of these registrations. One quarter of all registrations (24% males, 26% females) were from residents in the most deprived wards (deprivation quintile 5), compared to only 15% of registrations (15% males, 14% females) from residents in the most affluent wards (deprivation quintile 1). This difference was statistically significant, suggesting overall that there was a 72% increased likelihood of residents from deprivation quintile 5 being diagnosed with lung cancer over the period compared to deprivation quintile 1 (odds ratio 1.72, 95% CI 1.67 - 1.77). The equivalent values for males and females were both statistically significant, showing a 62% increase (odds ratio 1.62, 95% CI 1.56 - 1.68), and 87% increase (odds ratio 1.87, 95% CI 1.79 - 1.95) respectively.

There is a strong age incidence gradient, with only 25% of all registrations from people aged under 65 years, while the remaining 75% of registrations were equally from the 65 - 74 and 75 and over age groups. While 23% of people in the most affluent quintile were aged under 65 years at registration, this percentage rose to 28% for those from the most deprived quintile. On the other hand, 43% of people in the most affluent quintile were aged at least 75 years, compared with only 33% of those from the most deprived quintile. The pattern of registrations by age group between deprivation groups was significantly different for males (chi^2 = 64.38, 8 degrees of freedom, p<0.001); females (chi^2 = 32.99, 8 degrees of freedom, p<0.001) and both sexes (chi^2 = 81.33, 8 degrees of freedom, p<0.001).

Figure 7. Annual age-standardised incidence rates 1998 - 2000 by deprivation quintile

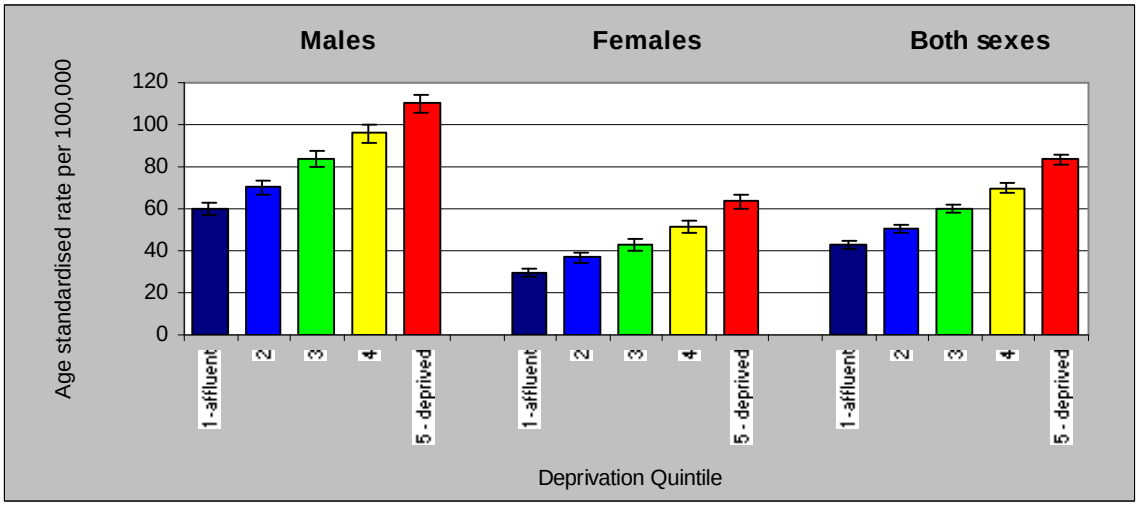


Figure 7 shows the directly age-standardised incidence rates, standardised to the European Standard Population, by deprivation quintile and sex. The overall rate for both sexes for 1998 - 2000 was 60.8 per 100,000 (95% CI 59.8 - 61.8). There is a clear positive association between deprivation and lung cancer incidence. The confidence intervals show that there is a significant difference in incidence rates between the deprivation groups for males, females and both sexes. The graph also shows that incidence of lung cancer in males was significantly higher than that for females for each deprivation quintile; the overall incidence rate for males was 83.3 per 100,000 (95% CI 81.6 - 85.0) and for females 44.3 per 100,000 (95% CI 43.1 - 45.4).

Lung cancer incidence (data not shown) was significantly higher for older people compared to younger people for both males and females and in each deprivation quintile. The age-standardised incidence rates were significantly lower for females compared to males, for all age groups and for each deprivation group, and the pattern of increasing incidence by deprivation quintile is consistent for each age group and for males and females.

Figure 8. Time trends: 3-year moving average annual age-standardised incidence rates 1991 - 2000 by deprivation quintile: All ages

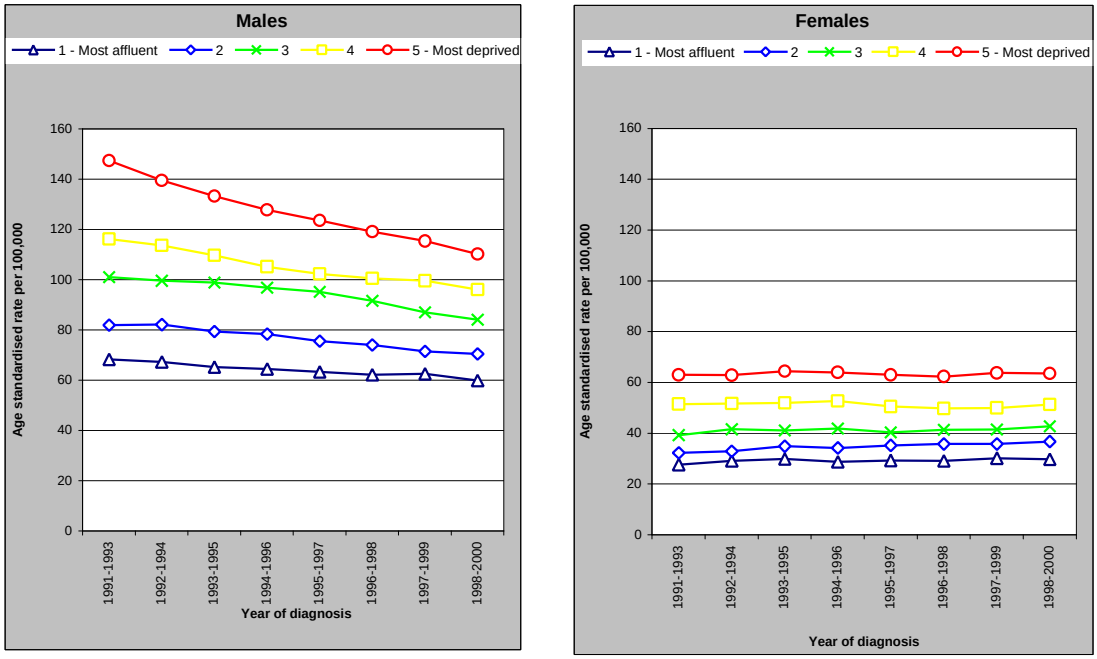


Figure 8 shows the 3-year moving average time trends in age-standardised lung cancer incidence rates over the decade for males and females. Both show the consistent differential in lung cancer incidence by deprivation quintile, with higher incidence rates in the most deprived quintiles than in the most affluent quintiles.

The graph showing male incidence over the ten years strongly suggests that the incidence rate has been steadily reducing over the period for all five deprivation quintiles. The gap between the most affluent and most deprived has narrowed.

However, the graph showing female age-standardised lung cancer incidence rates has hardly changed. Incidence has remained static for the most deprived quintiles, with no real change for deprivation quintiles 4 and 5, although incidence has increased very slightly (5% overall) for the most affluent quintiles 1, 2 and 3.

Section 2 - Mortality

2.1 All malignant cancers excluding non-melanoma skin (NMSC)

On average, 4,736 people from the NYCRIS region died of malignant cancer (excluding NMSC) each year between the years 1998 - 2000. Slightly more of these were males. The lowest percentages of deaths were in the most affluent quintiles for both males and females. The risk of dying in the most deprived quintile compared to the most affluent quintile shows an overall odds ratio of 1.10 (95% CI 1.08 - 1.13); for males the odds ratio was 1.13 (95% CI 1.09 - 1.17) and females 1.08 (95% CI 1.04 - 1.12).

24.9% of deaths were in the under 65 age group; 30.5% were in those aged between 65 and 74 years, and 44.6% were at least 75 years. There is a significant difference in the pattern of deaths by age group between the deprivation quintiles for males (chi^2 = 100.7, 8 degrees of freedom, p<0.001), females (chi^2 = 45.52, 8 degrees of freedom, p<0.001) and both sexes (chi^2 = 132.17, 8 degrees of freedom, p<0.001).

Figure 9. Annual age-standardised mortality rates 1998 - 2000 by deprivation quintile

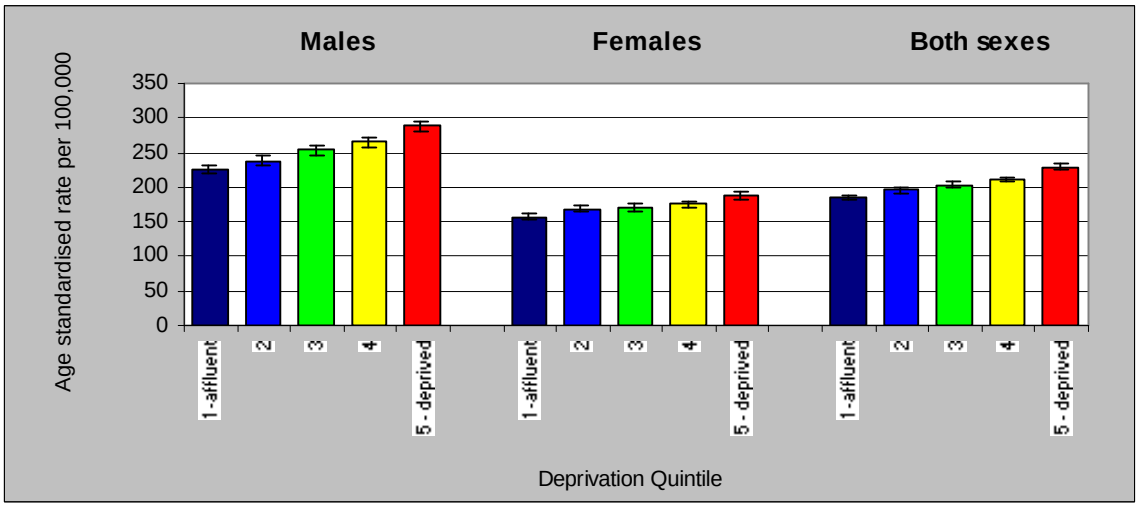


Figure 9 shows the directly age-standardised mortality rates, standardised to the European Standard Population. The overall age-standardised all malignant cancer (excluding non-melanoma skin) mortality rates for residents within the NYCRIS area for the years 1998 - 2000 was 204.5 per 100,000 (95% CI 202.7 – 206.3). The equivalent rates for males and females were 253.7 per 100,000 (95% CI 250.7 – 256.6) and 171.8 per 100,000 (95% CI 169.5 – 174.0) respectively. The graph suggests a linear trend in cancer mortality rates by deprivation. Mortality rates were significantly higher in the most deprived quintile than in the most affluent quintiles for males, females and both sexes. This pattern is also true for each of the age groups individually.

Figure 10 shows the age-standardised malignant cancer mortality rates for males, females and both sexes, over the ten-year period. The graphs show a clear differential in rates between deprivation quintiles for both sexes. Male malignant cancer mortality has been reducing over the ten years for all deprivation quintiles and the graph shows that the difference between the deprivation quintiles has narrowed. The percentage reduction in mortality between 1991 - 1993 and 1998 - 2000 increased with deprivation quintile.

The pattern of female malignant cancer mortality over the same period is similar to that of males, although the scale of the differences is smaller. There has been a reduction in

mortality over the period for all five deprivation groups; this varies from 5.7% for deprivation quintile 1 to 11.9% for deprivation quinitile 5.

Figure 10. Time trends: 3-year moving average annual age-standardised mortality rates 1991 - 2000 by deprivation quintile: All ages

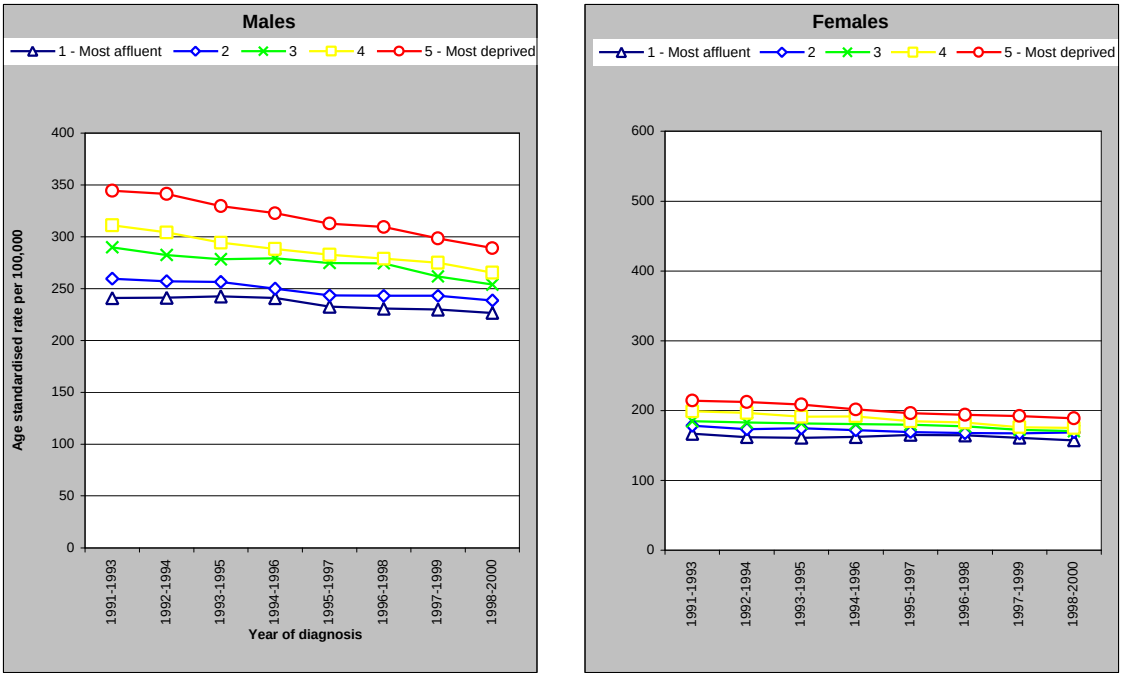


Figure 11: 3-year moving average incidence and mortality rates: All malignant neoplasms excluding non melanoma skin cancer 1991 - 2000

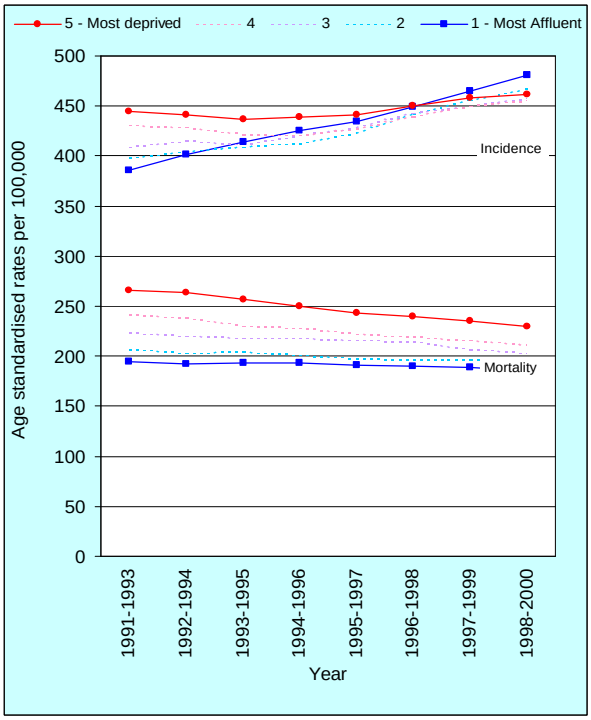


Figure 12: Age-standardised mortality rates 1991 - 2000 showing the effect of removing lung, & lung with stomach cancer, from the all malignant cancer rates

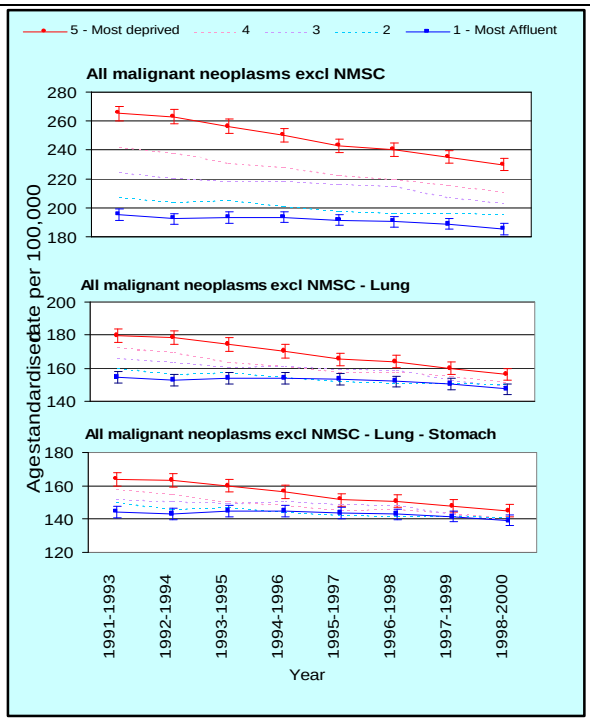


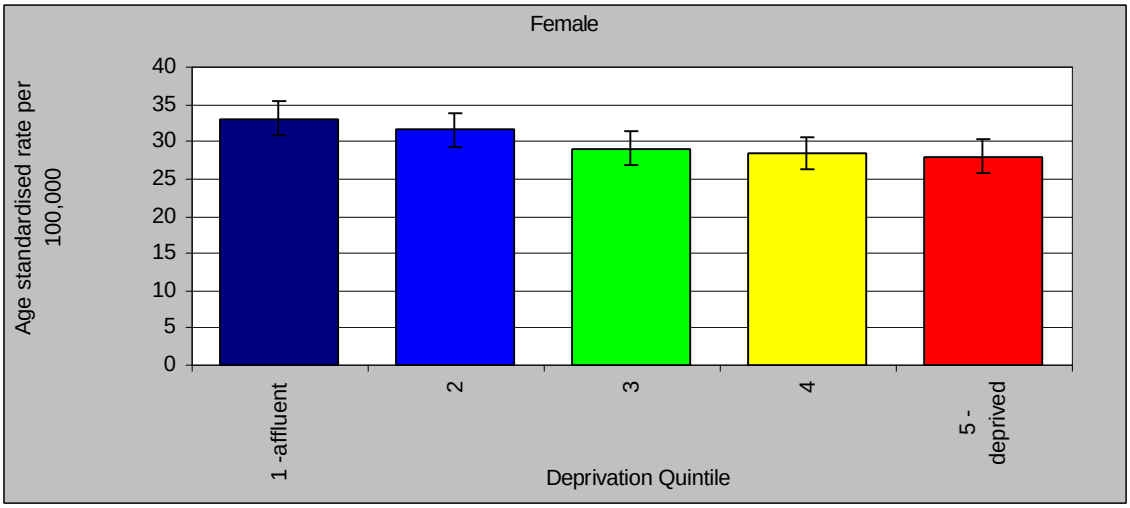
Figure 11 shows that the incidence rates have increased across all deprivation quintiles over the ten-year period, while mortality rates have decreased across all deprivation quintiles. There is a substantial difference of 24% in mortality from all malignant neoplasms excluding non-melanoma skin cancer between most affluent and most deprived quintiles.

Figure 12 shows the effect of removing lung and lung with stomach cancer from the all malignant cancer rates over time by deprivation quintile. This demonstrates that lung cancer is the major contributor to this inequality in cancer deaths. Although the difference remains statistically significant after removing lung cancer, the difference drops to just 6.2%. A further reduction can be achieved by removing stomach cancer from the calculation, reducing the difference still further to 4.2%. Thus, although the effect on cancer mortality from deprivation arises from a mixture of differences over many cancer sites, the scale of the disparity is dominated largely by the impact of one disease.

2.2 Female breast cancer

The age-standardised female breast cancer mortality rate in the period 1998 -2000 was 30.2 per 100,000 (95% CI 29.19 - 31.17) within the NYCRIS area.

Figure 13. Annual age-standardised mortality rates 1998-2000 by deprivation quintile



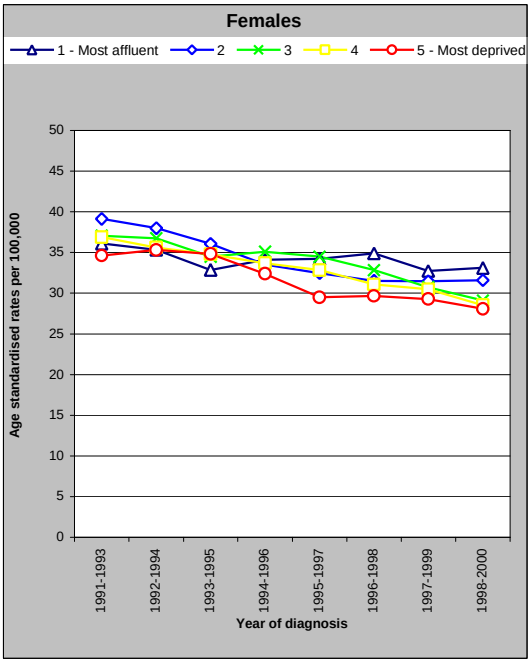
On average, 1,376 women died each year of breast cancer between 1998 and 2000 within the NYCRIS area. Approximately 22% were resident within the most affluent quintile compared with approximately 17% from the most deprived quintile. This difference was statistically significant, there being a 28% (odds ratio 1.28, 95% CI 1.11 - 1.45) increase in the likelihood of dying from breast cancer for women in the most affluent quintile compared to the most deprived quintile. This is illustrated in figure 13.

Approximately 13% of all female breast cancer deaths were in women under the age of 50, 26.3% were between 50 and 64 years, 22.4% were between 65 and 74 years and 38.3% were 75 years and over. A highly significant difference in the percentage of deaths by age group between the deprivation quintile groups was identified (chi^2 = 26.4, 12 degrees of freedom, $p<0.01$).

Figure 14 shows that there has been an overall reduction in mortality for all deprivation quintiles. Year-on-year fluctuations are greater for mortality rates compared to the equivalent graph showing incidence rates over time. This is due to smaller numbers; however, the graph still clearly shows that with the exception of the years 1993 - 1995 there have been lower mortality rates in the most deprived quintile compared to the more affluent quintiles.

Comparing mortality rates for 1991 - 1993 and 1998 - 2000, suggests that there has been a greater reduction in mortality (18.9%) for women in the more deprived quintile compared with the more affluent quintile (8.3%). However this does not take account of the fluctuations between these periods.

Figure 14. Time trends: 3-year moving average annual age-standardised mortality rates 1991 - 2000 by deprivation quintile: All ages



2.3 Colorectal cancer

The overall directly age-standardised annual mortality rate for the period 1998 - 2000 was 20.3 per 100,000 (95% CI 19.8 - 20.9). On average, 1,883 people from the NYCRIS region died each year between 1998 and 2000; 64% of those deaths were due to cancer of the colon (C18), 6% cancer of the recto-sigmoid junction (C19), and 30% cancer of the rectum (C20). Males accounted for 54% of all deaths.

21% of deaths were from deprivation quintile 1 compared with 19% of deaths from deprivation quintile 5. Comparing these percentages with those for incidence (22% and 17% respectively) shows that the difference between the most and least deprived quintiles is narrower for mortality than for incidence. There was no significant difference in colorectal cancer deaths between the most affluent and most deprived quintiles. The odds ratio of residents from deprivation quintile 5 dying from colorectal cancer compared to residents from deprivation quintile 1 was 0.94. This was not significant at the 5% level (95% CI 0.85 - 1.02). The equivalent odds ratios for males (odds ratio 0.91, 95% CI 0.80 - 1.02) and females (odds ratio 0.97, 95% CI 0.85 - 1.09) were also not significant.

51% of all deaths were in people aged 75 and over, 29% were aged between 65 and 74 and 20% were under 65 years. This highlighted a higher proportion of over 75s dying of colorectal cancer (51%) compared with new cases being diagnosed in the same age group (42%). The difference in percentage of deaths by age group was significant for both sexes (chi^2=19.9, 8 degrees of freedom, $p<0.05$). However, there was not a significant association in males (chi^2=11.74, 8 degrees of freedom, $p>0.05$) or females (chi^2 = 14.86, 8 degrees of freedom, $p>0.05$) separately.

Figure 15. Annual age-standardised mortality rates 1998 - 2000 by deprivation quintile

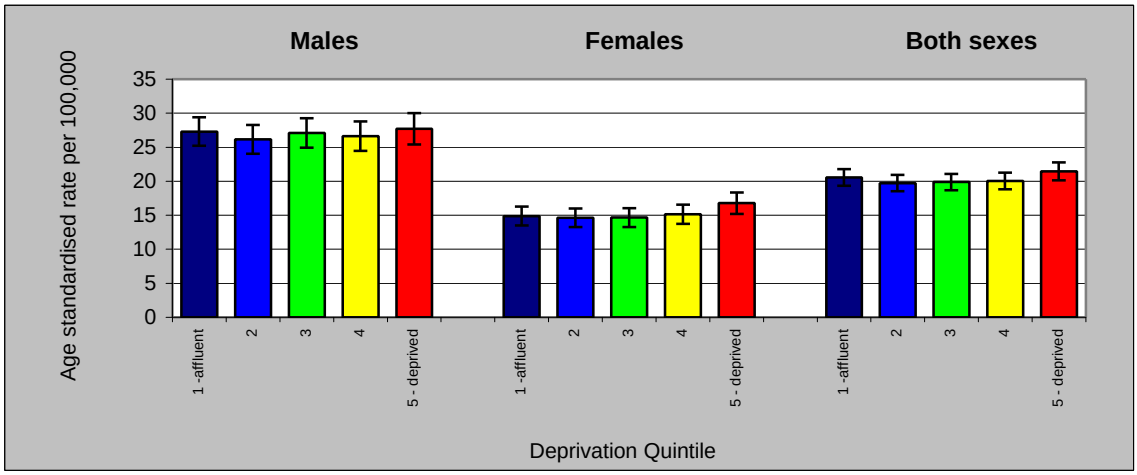
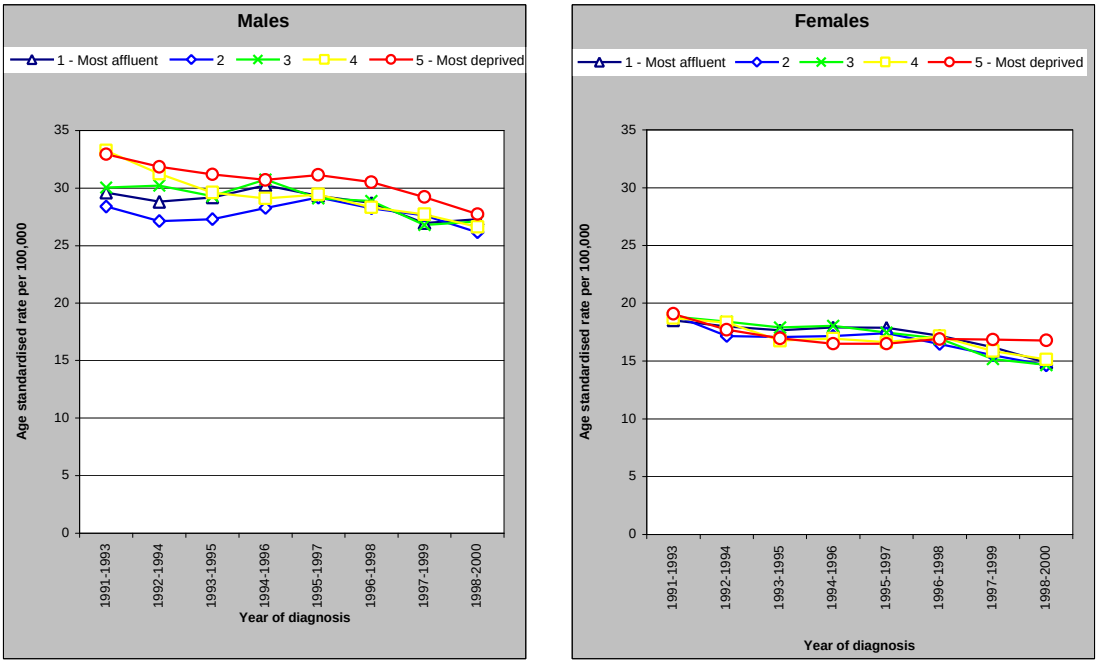


Figure 15 above shows the directly age-standardised mortality rates for colorectal cancer by deprivation quintile and sex. Although the mortality rate for deprivation quintile 5 is slightly higher than the rate for other quintiles, it is not significantly higher in males, females, or both sexes together and there is no observable pattern in mortality rate by deprivation. There were significantly higher mortality rates for males than for females overall and for each age group and deprivation quintile.

Figure 16. Time trends: 3-year moving average annual age-standardised mortality rates 1991 - 2000 by deprivation quintile: All ages



The graph (Figure 16) of male mortality rates shows that the rates have fallen over the ten-year period for all deprivation quintiles. The most deprived quintile has been consistently higher than the most affluent quintile; however, the graph suggests that the mortality rates for the most deprived quintiles have reduced more than for other deprivation quintiles. The mortality rate for deprivation quintile 1 has reduced by 7.6%, whereas the reduction in mortality for deprivation quintile 5 is 15.9%.

Female mortality rates have also fallen over the ten-year period; however, the mortality rate for the most deprived quintile does not appear to have reduced to the same extent as that for

the other quintiles. The overall reduction in mortality for females is greater than the overall reduction in mortality for males.

The combined rate for both sexes shows that overall there has been a reduction in mortality due to colorectal cancer by 14.6%. The most deprived quintile has been consistently higher than the most affluent quintile over the whole of the period.

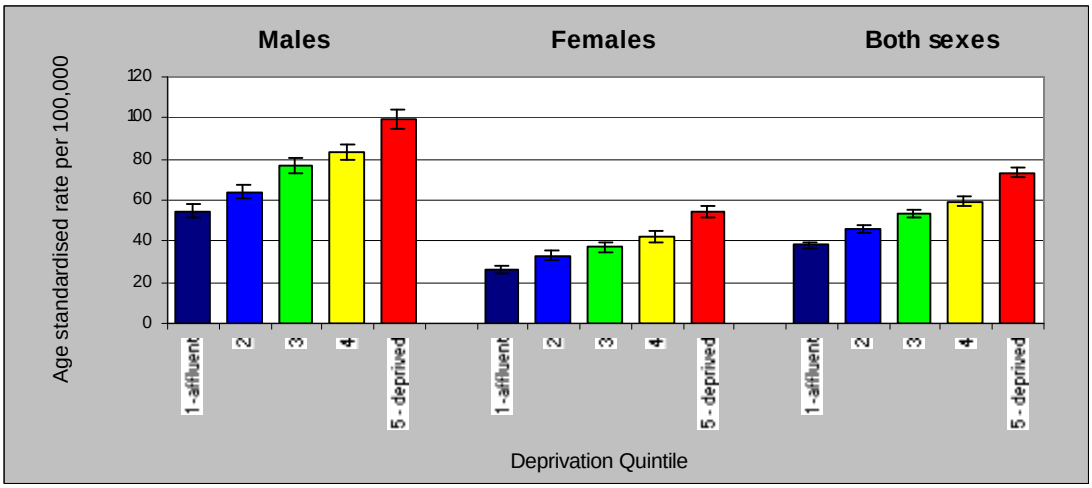
2.4 Lung cancer

The overall annual age-standardised mortality rate for both sexes within NYCRIS for the years 1998 - 2000 was 53.6 per 100,000 (95% CI 59.8 - 61.8). Between 1998 and 2000 an average of 4,736 people living in the NYCRIS area died each year due to lung cancer. The proportion of males to females is similar to that for incidence, with males accounting for 60% of all deaths. The pattern of deaths by deprivation quintile is very close to the pattern of registrations by deprivation quintile, with people in the 20% most deprived wards being at significantly greater risk of dying from the disease than people in the 20% most affluent wards. The odds ratio of dying in the most deprived wards compared to the most affluent wards was 1.70 (95% CI 1.65 - 1.76); for males the odds ratio was 1.61 (95% CI 1.54 - 1.68) and females 1.86 (95% CI 1.77 - 1.94).

23% of deaths were in people aged under 65 years, 37% were between 65 and 74 years, and 40% were aged at least 75. There is a significant difference in the pattern of deaths by age group between the deprivation quintiles for males (chi^2 = 53.38, 8 degrees of freedom, $p<0.001$), females (chi^2 = 18.94, 8 degrees of freedom, $p<0.05$) and both sexes (chi^2 = 68.09, 8 degrees of freedom, $p<0.001$).

Figure 17 below shows the directly age-standardised mortality rates, standardised to the European Standard Population. It clearly shows the positive association between deprivation and lung cancer mortality within the NYCRIS area. The confidence intervals displayed with the mortality rates show that there is a significant difference in lung cancer mortality between the deprivation groups for males, females and both sexes, with significantly higher mortality rates in the most deprived areas, compared to the more affluent areas.

Figure 17. Annual age-standardised mortality rates 1998 - 2000 by deprivation quintile



Mortality rates for males were significantly higher than females for each deprivation quintile. The overall mortality rate for males was 75.1 per 100,000 (95% CI 74.4 - 75.8), and 38.3 for females per 100,000 (95% CI 37.7 - 38.8). There were consistently higher mortality rates in the most deprived areas for each age group, both for males and females.

Figure 18. Time trends: 3-year moving average annual age-standardised mortality rates 1991 - 2000 by deprivation quintile: All ages

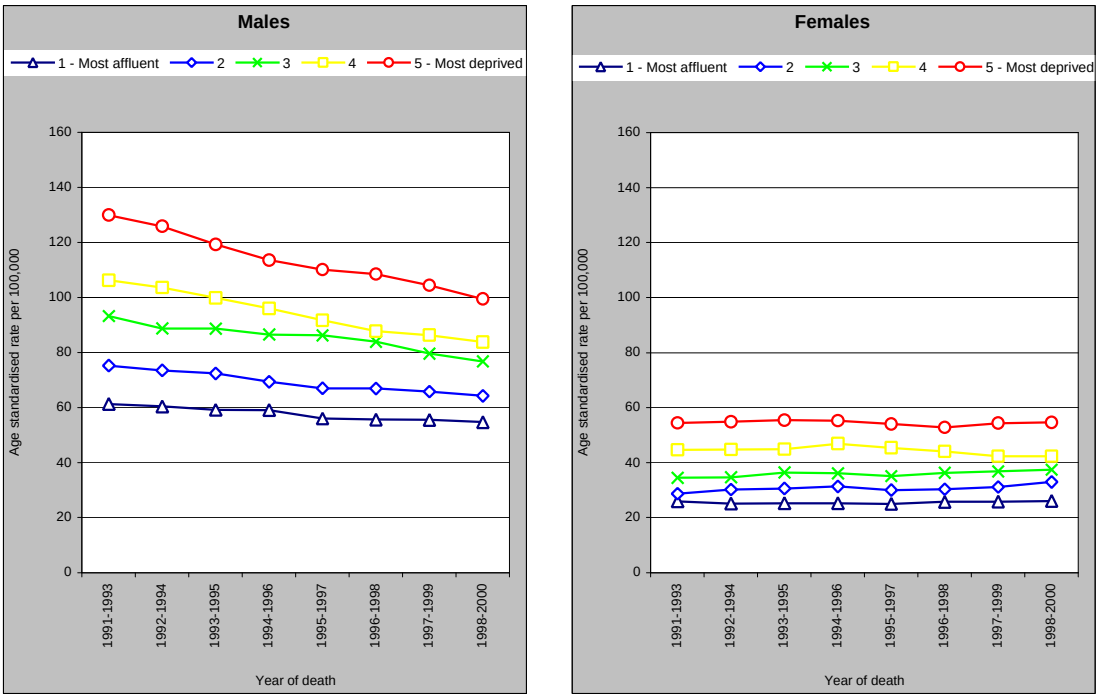


Figure 18 shows the age-standardised lung cancer mortality rates for males and females over the ten-year period. The graphs show a clear differential in rates in both sexes between deprivation quintiles.

The graph for males shows that mortality rates have been reducing over the ten-year period for all deprivation quintiles. However, this rate has been greater in the more deprived quintiles than in the more affluent quintiles, leading to a reduction in the differences between quintiles.

The graph showing female mortality over time suggests that the rate has remained fairly static over the ten-year period overall, with deprivation quintiles 2 and 3 showing a slight increase and deprivation quintile 4 showing a slight reduction.

Comparison of differences in mortality between the earliest and latest periods shows that while male rates have reduced by 18.6% overall, the rate for females has increased by 2.5%.

Section 3 - Survival

3.1 All malignant cancers excluding non-melanoma skin (NMSC)

The pattern of survival by deprivation suggests that the probability of surviving one and five years from the date of diagnosis reduces with increased deprivation.

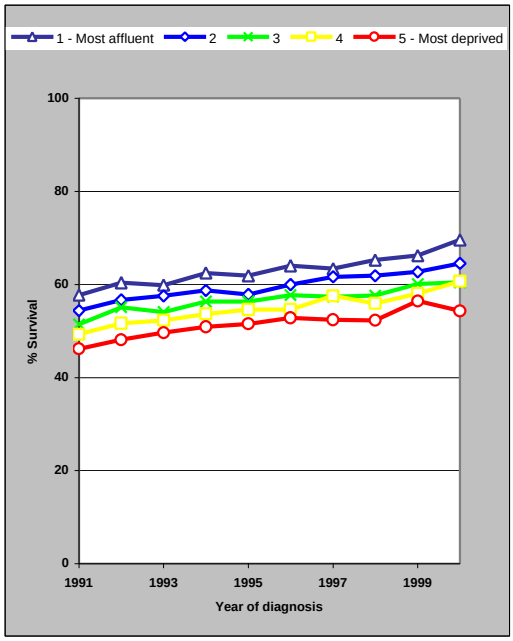
Table 1. One and five-year relative survival

Age band	Deprivation Quintile					Combined
	1	2	3	4	5	
1 year survival (2000 cohort)						
Rate	69.62	64.59	60.49	60.72	54.36	62.69
95% CI	68.38-70.81	63.31-65.84	59.19-61.77	59.39-62.02	52.98-55.72	62.11-63.26
5 year survival (1997 cohort)						
Rate	46.6	43.72	40.61	39.1	34.63	41.77
95% CI	45.11-48.07	42.24-45.18	39.15-42.07	37.63-40.56	33.16-36.1	41.11-42.43

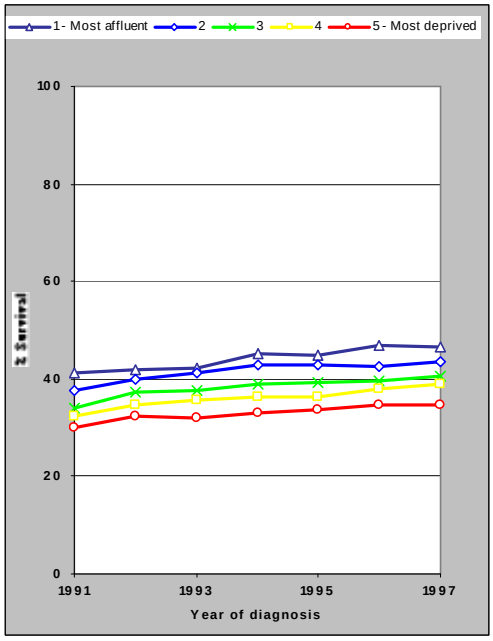
Table 1 shows the latest one and five-year all malignant cancer (excluding NMSC) survival for NYCRIS residents.

Figure 19: Time trends relative survival by deprivation quintile 1991 - 2000

1-year survival



5-year survival



The confidence intervals displayed in Table 1 show that the one and five-year survival rates for the most deprived quintile are significantly worse than for all other quintiles. The most affluent quintile has significantly better one-year survival than all other quintiles and significantly better five-year survival than deprivation quintiles 3, 4 and 5.

Figure 19 above shows the one and five-year survival probabilities over time. It shows that the pattern of survival by deprivation group has been consistent. Both graphs show that an improvement in survival can be seen for all deprivation quintiles. The difference in survival

between the most deprived and most affluent is not dominated by the influence of a single disease such as lung cancer, as was the case with mortality.

One-year survival increased from 52.9% (95% CI 52.3% - 53.6%) overall in 1991 to 62.7% (95% CI 62.1% - 63.3%) overall in 2000. Five-year survival has increased from 36.5% (95% CI 35.8% - 37.1%) overall in 1991 to 41.8% (95% CI 41.1% - 42.4%) overall in 1997.

3.2 Female breast cancer

One-year survival is not a usual measure for breast cancer as most patients survive beyond this point, but is included for consistency, together with five-year relative survival by deprivation.

Table 2. One and five-year relative survival

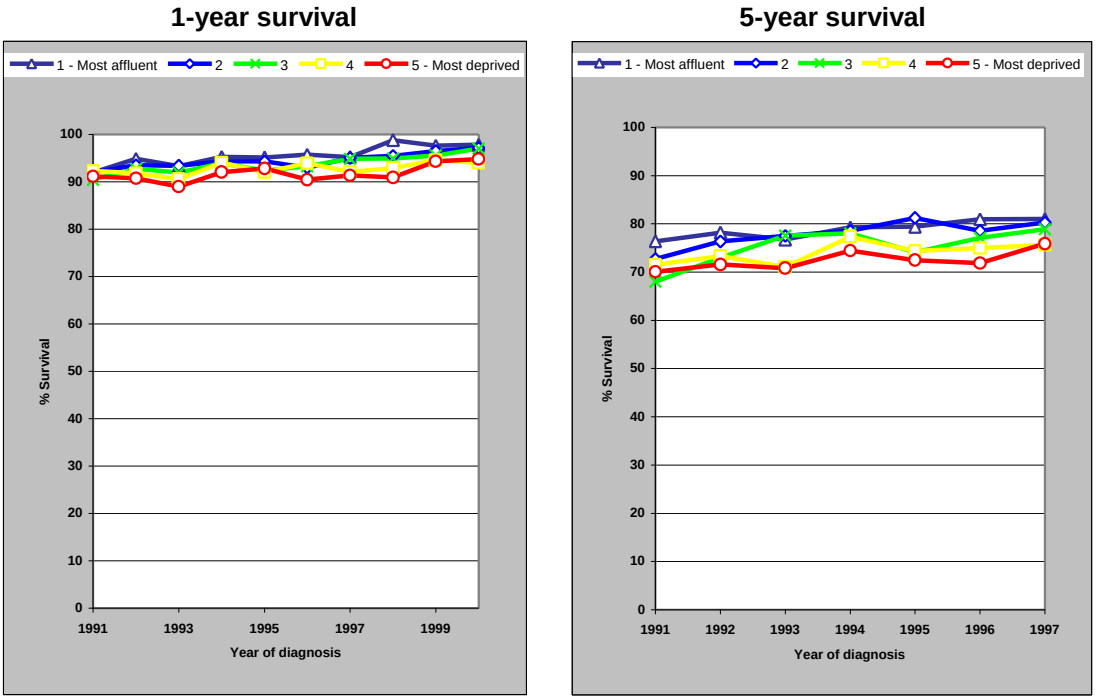
Age band	Deprivation Quintile					Combined
	1	2	3	4	5	
1 year survival (2000 cohort)						
Rate	97.83	97.19	97.06	94.02	94.82	96.61
95% CI	96.28 - 98.74	95.57 - 98.22	95.08 – 98.25	91.59 - 95.76	92.05 - 96.64	95.83 - 97.24
5 year survival (1997 cohort)						
Rate	80.98	80.23	78.87	75.66	75.87	79.08
95% CI	77.73 - 83.81	76.93 - 83.12	75.17 – 82.07	71.56 - 79.25	71.17 - 79.92	77.49 - 80.57

In 2000, only 3.4% (95% CI 2.8% - 4.1%) of women died within the first year following diagnosis. There was a 3% increase in survival for women in the most affluent quintile (97.8% survival, 95% CI 96.3% - 98.7%) compared to women from the most deprived quintile (94.8% survival, 95% CI 92.1% - 96.6%). The 1997 registration cohort shows that about 20% of women with breast cancer died within five years. There was an approximate 5% increase in survival between the most affluent quintile (81.0% survival, 95% CI 77.7% - 83.8%) and the most deprived quintile (75.9% survival, 95% CI 71.2% to 80.0%).

Figure 20 shows the trends in one and five-year survival over the ten-year period. The graphs show quite clearly that, despite year-on-year fluctuations, survival improved for all deprivation groups.

The graph showing one-year survival suggests that there was a slightly greater increase in survival for women in the most affluent quintile (92.0% to 97.8%) compared with the most deprived quintile (91.2% to 94.8%). The five-year survival graph suggests the increase in survival has been fairly consistent across the five deprivation quintiles.

Figure 20. Time trends: relative survival by deprivation quintile 1991-2000



3.3 Colorectal cancer

Table 3 shows the latest one and five-year colorectal survival for NYCRIS residents. There is a general trend showing decreasing survival with increasing deprivation. One-year survival in the most deprived quintile was significantly lower than in deprivation quintiles 1, 2 and 3, and all deprivation quintiles overall. Five-year survival was significantly higher in the most affluent quintile compared to that of deprivation quintiles 3 and 4, and all deprivation quintiles combined.

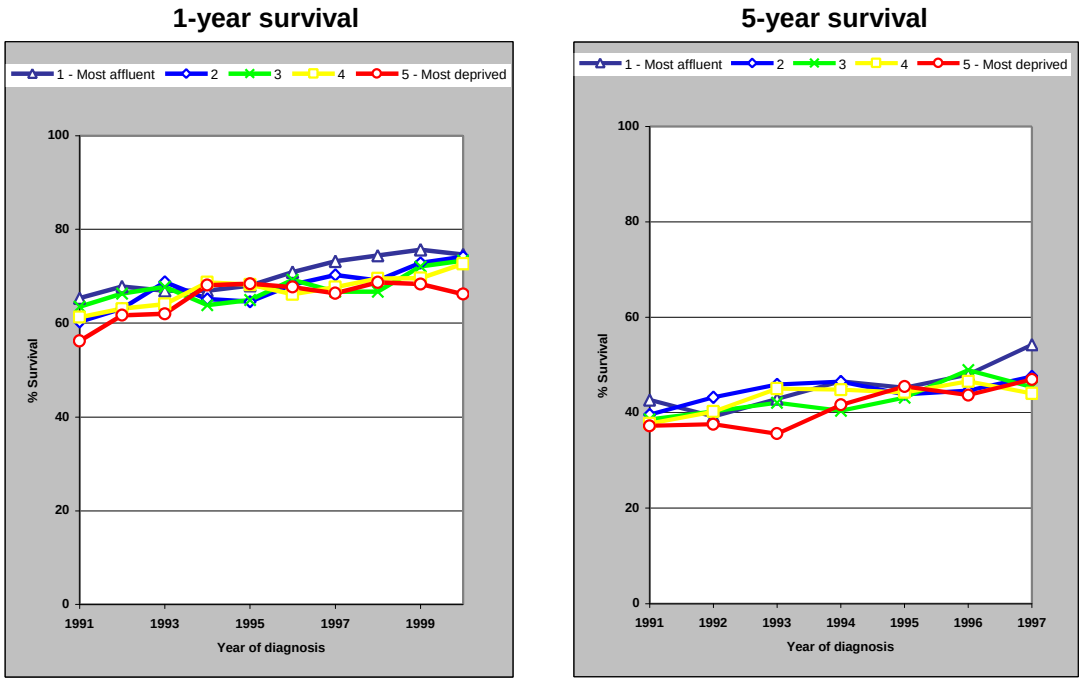
Table 3. One and five-year relative survival

Age band	Deprivation Quintile					Combined
	1	2	3	4	5	
1 year survival (2000 cohort)						
Rate	74.64	74.2	73.37	72.65	66.19	72.88
95% CI	71.34-77.61	70.82-77.25	69.92-76.50	69.07-75.89	62.21-69.85	71.36-74.33
5 year survival (1997 cohort)						
Rate	54.26	47.6	45.39	44.03	47	48.58
95% CI	50.17-58.17	43.59-51.49	41.05-49.62	39.69-48.28	42.41-51.45	46.69-50.45

Figure 21 shows one and five-year colorectal cancer survival over the ten-year period. Overall, one-year survival has increased from 62.4% (95% CI 60.6 - 64.1) to 72.9% (95% CI 71.4 - 74.3), and improvements in one-year survival can be seen for every deprivation quintile. Despite yearly fluctuations, the graph shows that in general survival for residents in the most affluent areas of NYCRIS has been better than for residents within the more deprived areas.

Five-year survival also shows an improvement overall, increasing from 40.5% (95% CI 38.6 - 42.4) in 1991 to 48.6% (95% CI 46.7 - 50.5) in 1997. There has been improved five-year survival for each deprivation quintile over the period; however, with the exception of the 1995 cohort, the five-year survival for the most deprived quintile has been lower than that for the most affluent quintile.

Figure 21: Time trends survival by deprivation quintile 1991 - 2000



3.4 Lung cancer

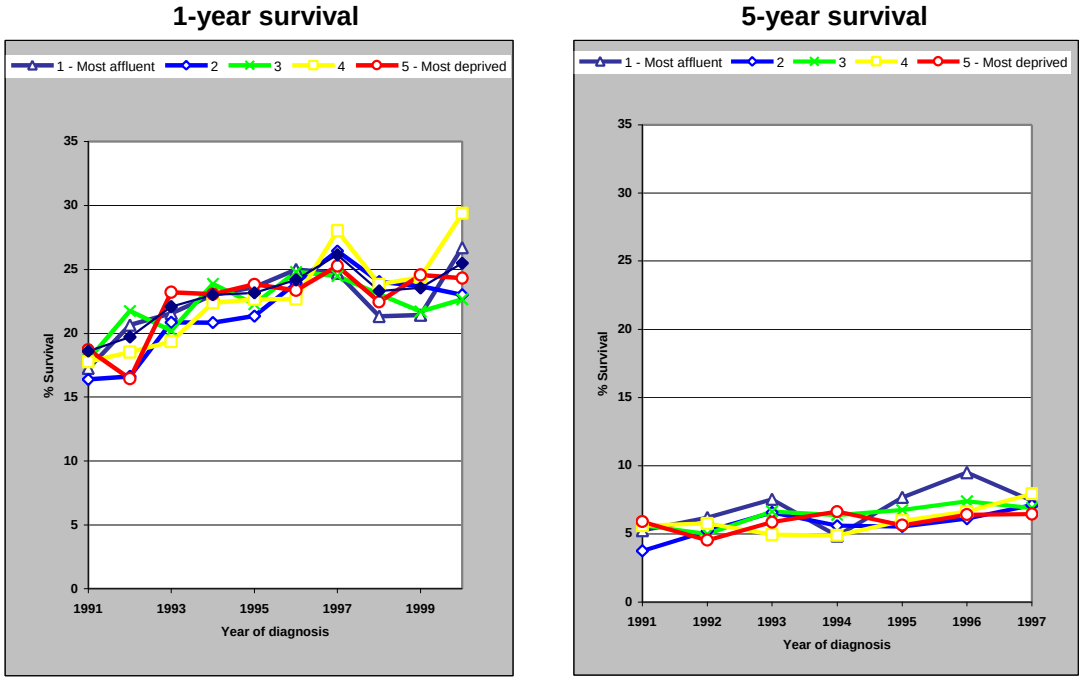
Overall, approximately 75% of all NYCRIS residents diagnosed with lung cancer in 2000 died within the first year. Figure 22 does not show a clear association between one-year survival and deprivation. Although there was a statistically improved survival for deprivation quintile 4, there was no general trend in relation to deprivation and this is probably a chance result.

7.5% of the cohort of NYCRIS residents diagnosed with lung cancer in 1997 survived five years. Five-year survival was the lowest in the most deprived quintile; however, there was no significant difference in five-year survival between the deprivation groups.

Table 7. One and five-year relative survival

Age band	Deprivation Quintile					Combined
	1	2	3	4	5	
1 year survival (2000 cohort)						
Rate	26.71	23.03	22.66	29.39	24.31	25.49
95% CI	23.48 - 30.04	20.28 – 25.88	20.12 – 25.3	26.67 - 32.16	21.91 - 26.78	24.27 - 26.73
5 year survival (1997 cohort)						
Rate	7.43	7.11	6.9	7.94	6.45	7.49
95% CI	5.56 - 9.64	5.34 – 9.19	5.31 - 8.77	6.27 - 9.86	5.05 - 8.07	6.71 - 8.33

Figure 22: Time trends survival by deprivation quintile 1991 - 2000



The one-year survival graph shows a gradual and significant improvement in the percentage of people surviving one year from 18.6% (95% CI 17.6% - 19.7%) in 1991 to 25.5% (95% CI 24.3% - 26.7%) in 2000. Despite fluctuations over time, this improvement can be seen across all deprivation quintiles. However, these data do not show an obvious relationship between deprivation and one-year survival over the period.

There also appears to be a small but significant improvement in five-year survival over time, from 5.8% (95% CI 5.2% - 6.6%) in 1991 to 7.5% (95% CI 6.7% - 8.3%) in 1997. Again, this improvement can be seen across all deprivation quintiles. The graph does not show a large difference in survival between the deprivation groups; however, survival was generally better for deprivation quintile 1 than for deprivation quintile 5.

Conclusions

There are marked relationships between population indicators of deprivation (or affluence) and observed patterns in the incidence of and mortality from cancer, and in the survival of those with cancer.

These are not necessarily the same for different diseases or between men and women.

Neither are they static and immutable, but show significant changes over time, and in relation to each other. For example, trends in the incidence of cancer show an important recent change, suggesting that there may now be greater incidence in the more affluent. The determinants of such a change require further study.

Both mortality and survival reveal the expected gradients, with the more deprived generally faring worse than the more affluent. However, the causal influences that give rise to the observed position for particular combinations of disease, age and sex are likely to be varied and complex.

This report has concentrated on examining the overall picture, as large numbers are needed to reveal underlying trends. NYCRIS is also able to provide information in greater detail or for specific populations within its area through its Cancer Information Service (CIS), or in response to specific requests.

Appendix 1 Methods and Resources

Calculating Townsend Material Deprivation Index[1] by 1991 ward for the NYCRIS area

The Townsend Material Deprivation Index is made up of the following 4 Census 1991 variables:

Unemployment	unemployed residents over 16 years as a % of all economically active residents aged over 16.
Overcrowding	households with 1 and over persons per room as a % of all households.
Non-car ownership	households with no car as a % all households.
Non-home ownership	households not owning their own home as a % of all households.

The percentages produced for unemployment and overcrowding are transformed using the natural log function and each of the variables are then standardised using Z scores (observed value – mean value divided by standard deviation) using the mean and standard deviation for the whole area. The resulting z scores are added together to produce the Townsend Index score.

[1]Townsend P, Phillimore P, Beattie A (1988) Health and Deprivation: inequality and the North.

Generating NYCRIS ward level scores.

There are 1,150 1991-based wards within the NYCRIS area.

Census information for the NYCRIS area used to calculate the 4 variables above were obtained from MIMAS. Values for unemployment and overcrowding were transformed by applying the natural log function (i.e. Ln(value)).

Standardised z scores were calculated by applying the mean and standard deviation %'s, for the whole NYCRIS area, for each of the variables, to each of the wards. The 4 z scores obtained were added together to obtain the Townsend Material Deprivation Index score for each ward.

The resulting ward scores range from -8.33 to 9.88, with the mean score equal to 0. Positive scores indicate greater levels of deprivation.

Additional Tables are also available from NYCRIS and PHO websites

The contents follow the structure of the main document and provide tabulated data to support the graphs and figures used. Thus three sections cover incidence, mortality and survival for:

All malignant cancers excluding non-melanoma skin (C00-97 excl C44)
Female breast cancer (C50)
Colorectal cancer (C18-C20)
Lung cancer (C33-C34)

A fourth section provides additional information on incidence and mortality combined and the influence of specific cancers on socio-economic differences in mortality. The final section lists Townsend Material Deprivation Index Scores by Ward, sorted by Deprivation Quintile and Ward name.