CHAPTER 5

MORTALITY, CAUSE OF DEATH AND SOCIAL CLASS IN THE BELFAST URBAN AREA, 1970

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First published in *Ecology of Disease* (1983), 2(1), 1-8.

Following a reduction in the number of deaths from infectious diseases during the past 100 years, most of the major causes of death in developed countries can be classified as degenerative diseases. These diseases, however, are not a simple by-product of the ageing process. Numerous studies have shown that there are significant spatial variations in the incidence of major degenerative diseases, suggesting that there must be something causing these geographical inequalities. To be more precise, there must be factors which are unevenly distributed over space which either result in spatial inequalities in the incidence of degenerative diseases or which influence a person's chances of surviving a degenerative disease once contracted. In either event, a correct identification of the factors might enable preventive measures to be taken to reduce mortality from degenerative diseases.

This is the logic underlying many spatial analytical studies of disease by medical geographers. These studies have been conducted at a variety of scales, but studies at international and inter-regional scales predominate. Studies at an intra-urban level are less common, possibly because mortality data are not routinely published for urban subdivisions [1]. In addition, many studies at intra-urban level investigate mortality from one selected disease rather than mortality from all causes; consequently important relationships between the mortality rates for different diseases may be overlooked. Given that the factors likely to be hypothesised as causes of mortality in a spatial analysis are to some extent a function of the scale of analysis, the relative scarcity of studies of mortality from all causes at intra-urban level may result in important causal factors being overlooked. This study is therefore intended as a supplement to the relatively small number of intra-urban studies which already exist [e.g. 2. 3]. However, it is believed that it also raises a number of questions of broader methodological interest.

Using data on mortalities in Belfast in 1970, this study is an attempt to answer three questions:

(1) Are there significant spatial disparities in life expectancy (measured indirectly using age-sex standardised mortality ratios for deaths from all causes) within cities?

(2) What is the relationship between the spatial variations in total mortality and the spatial variations in mortality for each of the major causes of death? The answer to this question should cast further light on the answer to Question 1. For example, if it is found that there are no significant spatial variations in total mortality, it is useful to establish whether this is because there are no significant spatial variations in any of the major causes of death, or whether it is because areas having a high incidence of one type of disease tend to be 'compensated' by having lower incidences of other types of disease (in which case important spatial variations in mortality might easily be overlooked if one was only to examine the pattern of total mortality). Alternatively, if it is found that there are significant spatial variations in total mortality, it would be useful to know whether these variations are caused by spatial variations in the mortality rate for a single cause of death, or whether they reflect the cumulative effect of several diseases with similar spatial distributions.

(3) Is there a relationship between mortality and social class? If certain social classes are more adversely affected than others by a particular disease, an understanding of why may enable preventive measures to be taken. Such measures, if implemented, might not only prove beneficial to the most disadvantaged classes, but also to society as a whole.

The analysis is conducted at two scale levels. Each of the three questions is first examined at an ecological level (i.e. using aggregated data which refer to spatial subdivisions of the study area). The relationship between mortality and social class is then examined at the individual level (i.e. using data which refer to the deceased individuals, irrespective of their normal place of residence). Many geographical studies tend to confine themselves to an ecological analysis, whereas many epidemiological studies confine themselves to an individual level analysis and thereby exclude the spatial dimension. It is argued here, however, that the relationships between mortality and hypothesised causal factors should, if possible, be analysed at both scale levels – the results at one scale level may provide a partial confirmation or aid a fuller understanding of the relationships observed at the other scale. This argument is developed in the discussion at the end of the paper.

The data

The Belfast urban area (i.e. continuous built-up area) was selected as the study area because of the availability of data extracted from 6,060 death certificates as part of an earlier study of social malaise in the city [4, 5]. The data represent a 100% sample of all those who died in 1970. The civil disturbances were directly responsible for only 17 deaths in 1970 and therefore do not seriously distort the analysis of the major causes of death.

Each mortality was assigned to one of 97 zones depending upon the normal address of the deceased. The zones were delineated in the social malaise study to contain at least 750 households and to be as socially homogeneous as possible. People who were recorded as living in hospitals or other institutions, or for whom no address was recorded, were excluded from the data set. The analysis is based on the remaining 5940 deaths.

Data on the social class, age and sex composition of each zone were derived from the 1966 Northern Ireland census. The four year time lag between the census and the mortality data introduces a possible source of error into the ecological analysis. The ecological analysis may also be misleading because the zone of residence at the time of death is not necessarily the zone in which the fatal disease was originally contracted due to population movements. However, neither of these problems arise in the analysis of the data at the individual level because this uses information on the age, sex and occupation of the individuals extracted from the death certificates. The results of the individual level analysis may therefore be used as a partial verification of the findings of the ecological analysis.

Results

Intra-urban variations in total mortality

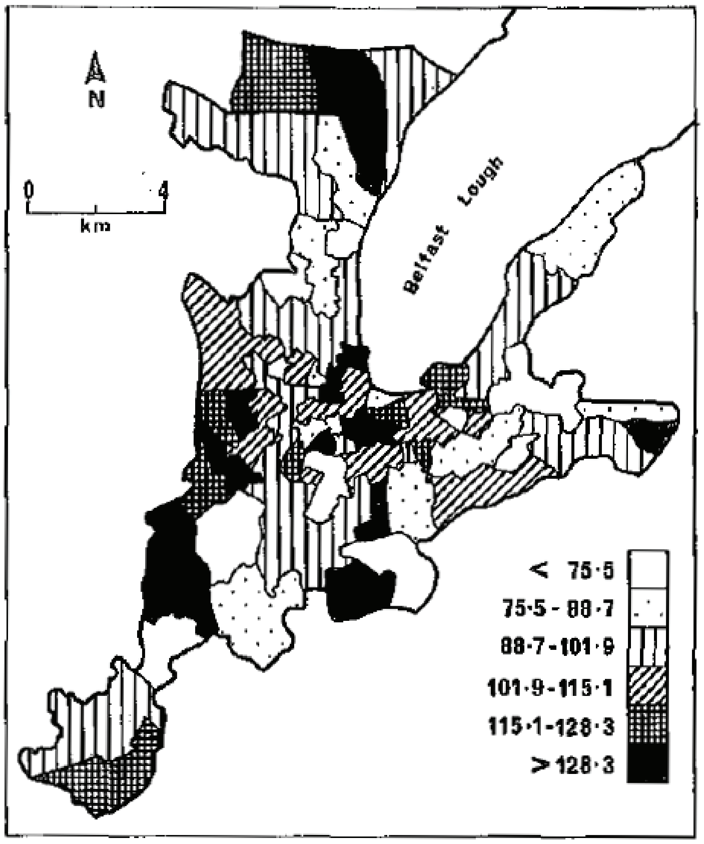
Crude death rates obviously provide a poor basis for comparing mortality in different parts of a city because there are very large variations between areas with respect to age and (to a lesser extent) sex composition. Age-sex standardised mortality ratios were therefore calculated, using the indirect method, for each of the 97 zones to facilitate direct comparison. The indirect method is preferred to the direct method because it is less susceptible to spurious fluctuations when dealing with small numbers.

The values of the SMR's were found to vary from 49.1 to 201.6, suggesting that there are major intraurban differences in total mortality. These extreme values need to be interpreted with caution because they are based on relatively small numbers of deaths (49 and 42 deaths, respectively). However, statistical support is provided by a comparison of the actual numbers of deaths in each of the 97 zones against the numbers expected, given their age and sex compositions, using a chi-squared test. This produces a chi-squared value of 306.0, which is significant at the 99.9% confidence level. It would therefore appear reasonable to conclude that, even allowing for differences in age and sex composition, there are significant spatial variations in mortality rates at the intra-urban level.

A similar result is found if SMR's are calculated for males and females separately. The spatial variations in the SMR values for each sex are found to be statistically significant. The SMR values for males are also found to be significantly correlated with the SMR values for females (i.e. both sexes have a similar spatial distribution of mortality).

The map of the SMR's of both sexes together does not, on first impression, appear to exhibit a high degree of spatial order (Fig. 1). However, closer examination reveals that most of the areas with SMR's greater than 100 are either located in the inner city or else contain high percentages of public sector housing. This suggests that there may be an association between mortality and social class, although it should be noted that some inner city areas with a similar social composition also have low SMR values.

Figure 1. Age-sex standardised mortality for deaths from all causes, 1970.



The major causes of death

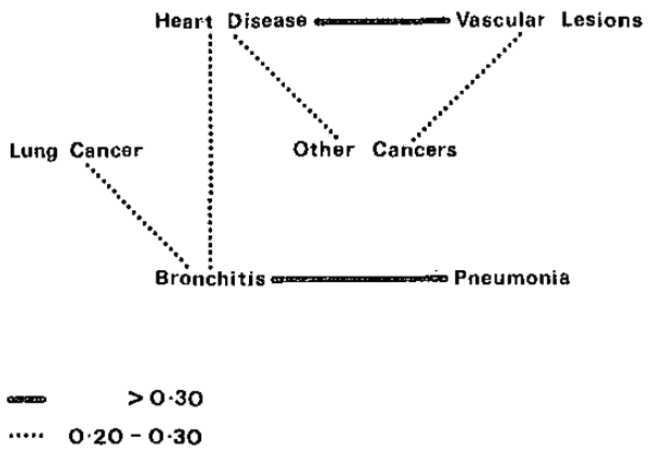
The major causes of death (as classified in the Registrar General's Abridged List) in Belfast in 1970 are similar to those found in most developed countries (Table 1). Heart diseases accounted for almost one third of all deaths, followed by vascular lesions, cancers and respiratory diseases as the next most important causes.

Age-sex standardised mortality ratios were calculated for each of the major causes of death. The correlations between each of the resulting sets of SMR's and the SMR's for deaths from all causes are shown in the first column of Table 2. All correlation coefficients are positive and significant at the 95% confidence level. Further, the lowest correlations are for the two diseases which accounted for the least numbers of deaths, suggesting that the strength of the relationships between these two causes of death and total mortality may in fact be underestimated because of the low number of cases involved. It would appear reasonable to conclude that the intra-urban variations in total mortality are caused by intra-urban variations in all of the major causes of death rather than simply one or two diseases.

Table 1. Principal causes of death, 1970

Arteriosclerotic and degenerative heart diseases	31.2%
Vascular lesions of the central nervous system	15.2%
Cancers (excluding lung cancer and leukaemia)	13.6%
Bronchitis	8.4%
Lung cancer	4.5%
Pneumonia	3.9%
All other causes	23.2%

Figure 2. Diagrammatic representation of correlations between SMR's for major causes of death.



Examination of the correlations between the major causes of death in Table 2 suggests that they can be subdivided into two groups according to the spatial distributions of their SMR's. This becomes clearer if the higher correlations are shown diagrammatically (Fig. 2). Heart diseases and vascular lesions form the core of one group, with cancers of sites other than the lung associated; and bronchitis and pneumonia form a core of the other group, with lung cancer associated. The two groups are linked by a moderately high correlation between heart disease and bronchitis. A similar clustering effect would be produced if the correlation matrix was analysed using high powered multivariate techniques, such as canonical analysis (e.g. [6]) or factor analysis (e.g. [7]). Using such techniques, one would conclude that the major causes of death in Belfast divide into two discrete disease syndromes: one roughly corresponding to diseases of the circulatory system, and the other to diseases of the respiratory system.

Table 2. Ecological correlations between SMR's for major causes of death

	All causes	*Bronchitis*	*Pneu-monia*	*Lung cancer*	*Other cancers*	*Heart disease*	*Vascular lesions*
All causes	1.00	0.48	0.31	0.21	0.53	0.72	0.59
Bronchitis	0.48	1.00	0.31	0.23	0.02	0.20	0.02
Pneumonia	0.31	0.31	1.00	-0.04	0.01	0.07	0.03
Lung cancer	0.21	0.23	-0.04	1.00	0.02	0.05	0.01
Other cancers	0.53	0.02	0.01	0.02	1.00	0.25	0.28
Heart disease	0.72	0.20	0.07	0.05	0.25	1.00	0.32
Vascular lesions	0.59	0.02	0.03	0.01	0.28	0.32	1.00

The relationship between mortality and social class

The correlations between the SMR's for deaths from all causes and the percentage of households in each social class (as defined in the Northern Ireland census) are shown in the left hand column in Table 3. The SMR's are significantly and negatively correlated with the two highest social classes, and are significantly and positively correlated with the two lowest social classes. In other words, people living in areas with a high percentage of households in the lower social classes have a higher mortality rate than people of similar age and sex elsewhere.

Table 3. Ecological correlations between SMR's for major causes of death and social class

	All causes	*Bronchitis*	*Pneu-monia*	*Lung cancer*	*Other cancers*	*Heart disease*	*Vascular lesions*
Social class I	-0.35	-0.42	-0.17	-0.22	-0.05	-0.11	-0.09
Social class II	-0.21	-0.45	-0.08	-0.21	-0.05	0.07	-0.06
Social class III	0.09	0.26	0.02	0.12	0.02	-0.06	0.00
Social class IV	0.37	0.50	0.25	0.20	0.09	0.09	0.10
Social class V	0.33	0.45	0.11	0.26	0.05	0.02	0.10

The remainder of Table 3 shows the correlations between social class and each of the major causes of death. The correlations for each cause of death generally have the same sign as those for total mortality, indicating that people living in areas with a high percentage of households in the lower social classes have a higher risk of mortality for every major cause of death *vis-à-vis* people of a similar age and sex living elsewhere. This is consistent with the finding in the previous section that spatial disparities in total mortality reflect similar spatial disparities in each of the major causes of death. However, the strength of the relationship between social class and mortality would appear to vary between causes of death: the correlations between social class and the SMR's are generally much stronger for diseases in the respiratory disease syndrome (as identified above) than for those in the circulatory disease syndrome.

An individual level analysis
The results of the ecological analysis, with respect to the three questions outline above, may be summarised as follows:

(1) There are statistically significant intra-urban disparities in mortality.

(2) Each of the major causes of death exhibit similar spatial disparities. The spatial distribution of total mortality is a composite of these mutually reinforcing distributions.

(3) The standardised mortality ratios are higher in areas with higher percentages of households in the lower social classes. This relationship, however, is more pronounced for diseases of the respiratory system.

If the mortality data used in this study had been derived from published sources (e.g. reports on vital statistics), one would probably have been obliged to terminate the analysis at this point. However, given that the data were derived directly from death certificates, and then aggregated according to the 97 zones, it is possible to analyse the relationship between mortality and social class at a disaggregated (i.e. individual) level. Although the ecological analysis indicates that there is a relationship between social class and mortality from each of the major causes of death it does not provide any information on the nature of these relationships. A more penetrating analysis of the relationship between mortality and social class is facilitated by an examination of the social class of the deceased at the individual level. This enables the relationships observed above between mortality and social class at the ecological level to be decomposed into two components.

The research design is based on the premise that people living in an area are disadvantaged if either of two conditions exist:

(1) If people living within the area have a greater likelihood of contracting a given disease than people living in other areas. This could be termed the 'incidence' component.

(2) If people living within the area are, for one reason or another, more likely to die at an earlier age from a given disease than people contracting the same disease in other areas. This might arise, for example, if people living in the area contract the disease at a younger age or, if having contracted the disease, they are less likely to survive for a given length of time. This could be termed the 'age' component.

The analysis of the mortality data at the individual level is an attempt to gauge, albeit rather crudely, the relative importance of each of these two components to an understanding of the relationship between mortality and social class for each of the major causes of death.

The percentage of people dying from each of the major causes of death for each social class is shown in Table 4. Social classes I and II are combined because of the small number of people in social class I. The figures in each column total 100% , and indicate the percentage of people in a given social class who die from each of the major causes of death. Thus, it may be seen from the first column that 5.2% of the mortalities in social classes I and II were caused by bronchitis, 3.9% by pneumonia, and so on. By examining the figures in any given row it is possible to compare the relative incidence of a given disease as a cause of death between different social classes. Bronchitis and lung cancer both have a higher incidence amongst the lower social classes: the percentage of people in social class V who died from bronchitis is more than twice that in social classes I and II, while the percentage who died from lung cancer is about 1.5 times higher. In contrast, heart diseases and vascular lesions have a higher relative incidence in the higher social classes. Pneumonia and cancers of sites other than the lung show a slight tendency in the same direction but it would probably be more accurate to regard these results as inconclusive.

Table 4. Percentage of deaths attributed to each cause for each social class

	Classes I and III	*Class III*	*Class IV*	*Class V*	*Total*
Bronchitis	5.2	8.3	8.5	11.4	8.4
Pneumonia	3.9	3.6	3.9	3.5	3.9
Lung cancer	3.7	4.7	4.9	4.8	4.5
Other cancers	14.0	13.9	13.3	13.5	13.6
Heart diseases	34.3	31.4	30.5	29.4	31.2
Vascular lesions	16.6	15.1	15.1	14.9	15.2
Other causes	22.3	23.0	23.8	22.5	23.2
Total	100.0	100.0	100.0	100.0	100.0

The age component may be gauged by calculating the mean age at death for each cause of death and social class (Table 5). For example, the mean age at death of people in social class V who died of bronchitis was found to be 68.50. This underestimates the true mean age at death by about 6 months due to the fact that the death certificates record the age of the deceased at the time of their last birthday rather than at the time of their death, but as each cell in the table is underestimated by a similar magnitude this should not seriously distort comparisons between cells.

Looking first at the mean age of death from each cause for all classes together (i.e. the right hand column in Table 5), it will be noted that deaths from cancer generally occurred about 4 years earlier than deaths from bronchitis or heart diseases. Deaths from these causes, in turn, occurred on average 4-6 years earlier than deaths from vascular lesions or pneumonia. A person's age at death, therefore, is clearly influenced by the cause of death but variations between social classes in the percentages of deaths attributed to each cause would not by themselves explain the differences between social classes in the mean age at death from all causes (as shown in the bottom row of Table 5).

Table 5. Mean age at death for each cause by social class

	Classes I and II	*Class III*	*Class IV*	*Class V*	*All classes*
Bronchitis	74.48	70.37	68.87	68.50	70.04
Pneumonia	81.69	74.84	78.28	76.03	76.89
Lung cancer	66.01	63.86	66.20	64.15	64.55
Other cancers	66.88	66.75	66.00	67.41	66.84
Heart diseases	73.30	69.75	69.65	69.20	70.26
Vascular lesions	76.85	73.89	73.14	72.75	74.08
All causes	73.12	69.96	69.84	69.46	70.36

Comparison of the figures in each row reveals that there are substantial differences in the mean age at death between social classes for certain diseases. People in the higher social classes who died from bronchitis or pneumonia lived approximately 6 years longer than people in the lower social classes who died from the same causes. There was a similar but smaller disparity of about 4 years for people who died from vascular lesions or heart diseases. However, major differences in the age at death were not apparent for people who died of cancer.

Synthesis

The results of the individual level analysis help to explain the results of the ecological analysis. The major findings of both types of analysis are summarised in Table 6. The strength of the ecological correlations between the SMR's for each cause of death and social class are given in the first column. These may be 'decomposed' into 'age' and 'incidence' components as indicated in columns 2 and 3. This suggests that the nature of the relationship between mortality and social class is different for almost every major cause of death.

The high ecological correlation between deaths from bronchitis and low social class is due to the fact that people in the lower social classes not only have a greater likelihood of dying from bronchitis but they are also likely to die at a younger age compared to people in the higher social classes who die of bronchitis. Pneumonia and lung cancer each record moderately high ecological correlations with social class but the individual level analysis suggests that they do so for totally different reasons. There is little difference in the percentage of people dying from pneumonia between the classes, but people in the lower social classes who die of pneumonia tend to die at a younger age. Conversely, there is little difference between classes in the ages at death of people dying from lung cancer but there is a relationship between social class and the likelihood of dying from lung cancer as opposed to other causes. Given that deaths from lung cancer occur generally at a younger age than deaths from other causes, this would suggest that people in the lower social classes are more likely to contract lung cancer.

Table 6. Summary of the relationships between cause of death and social class

	Ecological correlation	*Lower age at death*	*Higher incidence*
Bronchitis	High	Lower classes	Lower classes
Pneumonia	Moderate	Lower classes	---
Lung cancer	Moderate	---	Lower classes
Other cancers	Weak	---	---
Heart diseases	Weak	Lower classes	Higher classes
Vascular lesions	Weak	Lower classes	Higher classes

Similar variations are found for the causes identified in the ecological analysis as forming a circulatory disease syndrome. Cancers in sites other than the lung have a weak ecological correlation with social class because of the absence of any major disparities between the social classes in either the likelihood of dying from these cancers or in the mean age at death. There would appear to be at best only a very weak relationship between these cancers and social class. However, this category contains a variety of different types of cancer and it is possible that a strong relationship may exist between some of them and social class.

The ecological analysis suggests that there is only a very weak relationship between social class and both heart diseases and vascular lesions but analysis at the individual level suggests in each instance that this conclusion is misleading. Both diseases are related to social class at the individual level with respect to both age and incidence components but the relationships operate in different directions. People in the higher social classes are more likely to die from heart diseases or vascular lesions than from other causes whereas people in the lower social classes who die from these diseases are more likely to die at a younger age. The age and incidence components therefore tend to cancel each other and so create the illusion that there is no relationship between these diseases and social class when examined at the ecological level whereas, in fact, there are important relationships which only become apparent when analysed at the individual level.

Discussion

The results of this study should be regarded as tentative rather than definitive. The methodology used does not allow the full complexity of the relationship between the age and incidence components to be disentangled whilst the fact that data are only available for a single year limits the confidence which one may place upon the results because of a problem, in certain instances, of small numbers. Nevertheless, it is believed that this study raises a number of methodological and empirical points worthy of further consideration. For example, the study reaffirms the importance of treating the results of an ecological analysis with extreme caution. If taken in isolation, results of the ecological analysis would have led to the conclusion that the major causes of death form two clusters or syndromes, one of which (i.e. diseases associated with the respiratory system) reflects spatial variations in social class more closely than the other. This, in turn, may have led the researcher to seek reasons why there should be a strong relationship between these diseases and social class but not between social class and the diseases falling into the other cluster.

On the other hand, analysis at the individual level suggests that this line of research might not be particularly productive. The three diseases in the respiratory disease cluster lack a similar type of relationship with social c1ass -- i.e. they relate to social class in different ways, presumably reflecting different causal mechanisms. For analytical purposes it would be futile, therefore, to seek common causal mechanisms by clumping the three diseases together as, for example, in some of the studies which use such techniques as factor analysis. The individual level analysis also suggests that it would be wrong to assume that diseases which do not exhibit a strong ecological correlation with social class (or any other factor) are thus totally unrelated to social class. Heart diseases and vascular lesions were found to have very weak ecological correlations with social class but to have strong but opposite relationships with social class at the individual level. This may well explain why studies of the relationship between cardiovascular diseases and social class have frequently produced contradictory results [8J.

These observations should not be regarded as argument in favour of an individual level analysis instead of an ecological analysis. Ecological analyses obviously entail limitations but so also do individual level analyses. For example, many certificates do not contain information on social class (especially if the deceased was a housewife or retired). Individual level analysis must, of necessity, therefore entail considerable data wastage, and in consequence, possible bias. An ecological analysis may be used to test for bias because the housing market tends to sort people into different residential areas according to social class. This enables one to make an inference about the social class of a deceased person from their normal address. Thus, in addition to providing information about the spatial dimension of mortality, which, in turn, may facilitate an identification of important environmental factors, an ecological analysis may be regarded as a partial test of the validity of the results of an individual level analysis. Ecological and individual level analyses should therefore be regarded as complementary rather than as alternatives. Where possible, mortality data should be analysed at both levels.

Adopting a two-level approach to the analysis of mortality in Belfast in 1970 reveals that the relationships between mortality and social class vary considerably between the major causes of death. This suggests that different causal mechanisms may be involved. Social class, as analysed in this study, may probably best be regarded as a surrogate measure of a wide variety of related phenomena, such as type of occupation, income, housing tenure, housing conditions, education (in the broadest sense), and a wide variety of lifestyle phenomena which may include diet, drinking and smoking habits. The list is virtually endless. Clearly further research is required to establish which particular aspects of 'social class' explain the observed relationships with each of the major diseases, although the findings of the individual level analysis (as summarised in Table 6) may provide some clues.

The age component, for example, may reflect differences in education or in access to medical attention, i.e. people in the higher social classes may have a greater awareness of health risks or be able to take better preventive action in response to early warning symptoms. This might explain why, for most causes of death, people in the higher social classes die at a later age than people in the lower social classes. The major exceptions are cancer victims. The absence of any significant class differences in the age at death of cancer victims might indicate that early identification of symptoms and medical treatment make very little difference to a cancer patient's chances of survival.

The incidence component may reflect class differences in living conditions and lifestyles. People in lower social classes had a greater likelihood of dying from bronchitis or lung cancer (possibly reflecting a higher incidence of smoking), whereas people in the higher social classes had a greater likelihood of dying from heart diseases or vascular lesions. These findings need to be interpreted with care due to the problem of closure, i.e. everyone in the data set died of something so if people in a given social class have a lower incidence for one type of disease they must by necessity have a higher incidence for at least one other type of disease. A detailed interpretation of the incidence component cannot be made without taking into account the age component. The fact that people who die from lung cancer and bronchitis generally die at a relatively young age suggests that people in the lower social classes have a higher incidence of these diseases because they are exposed to factors which cause them, whereas the higher incidence of heart diseases and vascular lesions amongst people in the higher social classes may to some extent reflect the fact that they have a lower incidence of other diseases which generally result in death at an earlier age. In other words, the higher incidence of heart diseases and vascular lesions amongst the higher social classes may be due to a 'residual effect'. These interpretations are highly speculative and more research is required before more substantive conclusions are reached. Nevertheless, the analysis has revealed a number of empirical findings which need to be accounted for in any theory which attempts to relate mortality and social class. It is hoped that this study may encourage further research in what may well prove a fruitful line of enquiry.

Acknowledgements This paper is a slightly modified version of a paper read at the Conference of the Institute of British Geographers in Edinburgh, January 1983. I would like to thank Dr. Fred Boal and Dr. Paul Doherty for the use of data extracted from the records of the Registrar General as part of a project conducted on behalf of the Northern Ireland Community Relations Commission. I would also like to thank Prof. Richard Preston and Dr. John Sweeney for their many useful comments on an earlier version of this paper.

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