The distribution of lung cancer mortality in Cape Town and related factors

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Summary

Lung cancer, a disease which primarily occurs in urban areas, caused 1 130 deaths during 1984 - 1986 in Cape Town. It is the most prevalent cause of cancer death in men and is second only to breast cancer in women. It was responsible for 22,9% of all cancer deaths in Cape Town during the 3-year period. The cartographic representation of standardised mortality ratios shows that the incidence of lung cancer mortality in Cape Town is appreciably higher in men than women, and in coloured people than in white people. Coloured men are the group most at risk. Despite the important role smoking habits play in the aetiology of lung cancer, the results of the ecological analyses show that environmental factors are partly responsible for the incidence of the disease. In the case of white people demographic as well as socio-economic variables, such as age, home language, religious affiliation and level of education, were identified by the multivariate statistical techniques as associated variables. In the case of coloured people the factors that play a role are chiefly socio-economic ones, such as unemployment, home owner status and type of housing. Positive relationship with low socio-economic status pertains only to coloured people.

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Geographers by their training are fully acquainted with the broad spectrum of environmental factors, their spatial distributions and associated processes and are able to contribute a distinctive and different approach from the medical scientist to the unravelling of the aetiology of the cancers or other diseases. — G. M. Howe[1]

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Lung cancer is responsible for most cancer deaths worldwide[2-4] and 'the toll continues to rise'.[5] Some researchers view lung cancer as a disease that is assuming epidemic proportions[6,7] and Stanley *et al.*[8] even go so far as to say that 'the fight to control this disease world-wide is currently being lost'.

Lung cancer is seen as a disease which predominantly occurs in urban areas[9] and is therefore related to urbanisation and an urban lifestyle.[4,7,10-12] Explanations for the high incidence of lung cancer in urban areas may lie in greater air pollution because of the concentration of industries and cars, the large number of cigarette smokers, and the modern lifestyle, as well as the tendency for some cancer patients to move to cities to be nearer to modern medical facilities.[11,13,14] As most cancers, lung cancer does not have a single causal factor; there are a number of external variables involved in combination with one another. However, it is estimated that between 80% and 90% of all lung cancer deaths can be attributed to cigarette smoking.[8,10,15] Other factors, such as air pollution, when combined with cigarette smoking have a significant effect on the incidence of lung cancer.[4,10,16] The same is true of low socio-economic status,[16,17] race[2,3] and gender.[4,10,11,18,19] According to the findings of Yach,[20] the relationship between socio-economic status and tobacco consumption among South African whites is a negative linear association, but in the case of coloureds the association is curvilinear. In view of the role played by urbanisation and environmental variables — whether socio-economic, demographic or physical — in the aetiology of lung cancer, geographers with their strong interest in the relationships between people and the environment as well as their knowledge of geographical, cartographic and statistical techniques, can make significant contributions to both the spatial representation of this cancer and the search for relationships between cancer and environmental factors.

With this challenge in mind, this sought to (*i*) depict cartographically the intra-urban distribution patterns of lung cancer mortality in white and coloured people in Cape Town; and (*ii*) find an ecological relationship between the spatial occurrence of lung cancer mortality and certain aggregated population features (socio-economic, demographic, housing and physical).

Methods

Area studied

Since the investigation concerned the incidence of lung cancer deaths in white and coloured people, Cape Town — as the only South African city with a large coloured population — was chosen as the study area. Metropolitan Cape Town is defined here as the white and coloured built-up residential space in the following municipalities: Cape Town; Milnerton; Pinelands; Goodwood; Parow; Bellville; Brackenfell; Durbanville; Kuils River; Kraaifontein; Fish Hoek; and Simon's Town. In order to illustrate the incidence of lung cancer mortality in Cape Town cartographically, a residential map, consisting of 70 residential sub-areas combined on the basis of homogenous population features, was compiled using a statistical technique known as factor analysis.[21] All subsequent cartographic and statistical calculations were based on these sub-areas.

Data sources

The mortality data used included all white and coloured deaths from lung cancer during 1984 - 1986 in Cape Town. Information on individual deaths was obtained from the Department of Community Health, University of Cape Town, which in turn received the data from the Cape Town City Council as well as the Cape Regional Services Council. For each death, information about race, gender, age, cause of death and last place of abode was abstracted. Residential addresses were given a sub-area code on which all further spatial and statistical analyses were based. Population statistics from the official 1980 Population Census* were used to ascertain the relationships between the spatial distribution of lung cancer mortality and certain pre-selected environmental variables within an ecological framework. Variables such as race, gender, age, home language, religious affiliation, nationality, marital status, educational level, literacy, occupation, profession, job status, income, home-owner status, type of housing, residential mobility, and density of occupancy were used as independent variables in multivariate statistical analyses conducted on a residential sub-area basis. Smoking was excluded from the ecological analysis because no personal data on smoking habits of whites and coloureds in Cape Town was available on a suburb basis.

Cartographic and analytical techniques

The cartographic representation of lung cancer mortality was based on age-adjusted standardised mortality ratios (SMRs)† calculated per race and gender for every residential sub-area, using the indirect method of standardisation.[22] The entire Cape Town white and coloured population over the age of 20 years (in terms of the 1985 Census) was used as the standard population, since lung cancer rarely affects people under the age of 20 years. The choropleth maps were constructed with the aid of the UNIRAS computer mapping program[23] and uniform quartiles were used as the class limits. In the ecological analysis multivariate statistical techniques, such as stepwise multiple regression analysis and canonical correlation analysis,[24] were used to identify the cancer-related variables.

* The 1980 Census data were used because a wider variety of information was provided by this census than the 1985 Census. Since residential features are relatively stable, it was assumed that no significant changes took place in the 5-year period between the two censuses.

† The SMR is the ratio between the recorded or actual number of deaths and the expected number of deaths expressed as a percentage. The national norm is 100 and areas with SMR values higher than 100 are over-represented areas where the actual number of deaths is higher than would be expected from national norms, even when the influence of age is eliminated by means of standardisation. SMR values lower than 100 indicate the opposite situation (under-represented areas).

Results

In keeping with findings world-wide, lung cancer in Cape Town is the most prevalent cause of cancer death, being responsible for a total of 1 130 deaths among the white and coloured populations during 1984 - 1986. This represents 22,9% of all cancer deaths in these groups in the 3-year period. This cancer is the primary cause of cancer mortality in men and it is second only to breast cancer in women. In addition, there is a higher mortality rate for coloured men than white men and white women have a higher mortality rate than coloured women.

Spatial analysis

The spatial distribution of lung cancer deaths among *white men and women* depicted in Figs 1 and 2 show a clear dominance of lung cancer in men (Fig. 1). There were approximately 26 residential areas in which the SMR for men was higher than 100, as opposed to only 2 for women. Zonnebloem/Woodstock, Sun Valley, Kommetjie, Constantia/Wynberg and Plumstead/Diep River featured most strongly in the case of men (Fig. 1), whereas Simon's Town and Marina da Gama were the areas with the highest SMR values in the case of women (Fig. 2). The high mortality ratio in Marina da Gama should be interpreted cautiously because the relatively small population of this residential area could cause the SMR value to be unrealistically high. It is significant that all the abovementioned residential areas are situated in the southern suburbs.

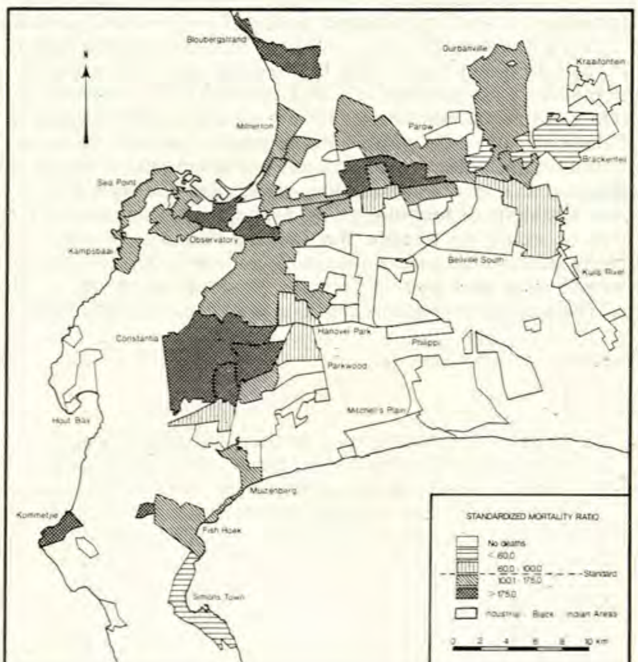

Fig. 1. Lung cancer mortality — white men.

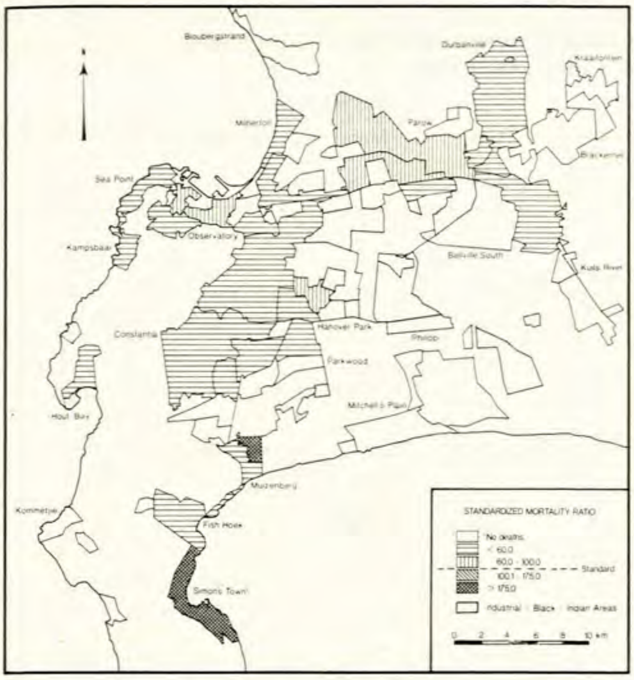

Fig. 2. Lung cancer mortality — white women.

The distribution pattern of lung cancer mortality of *coloured men and women* is shown in Figs 3 and 4, respectively. Clearly the disease has more serious dimensions among coloured men than white men, the incidence of this type of cancer being very high (SMR values > 175) in virtually every residential area where deaths were reported. The highest SMR values for men were recorded in Mandalay, the Pinelands/Mowbray/ Rosebank/Rondebosch area, Ruyterwacht/Riverton/Valhalla/Elsies River, Cape Town City centre and Hout Bay Harbour (Fig. 3). Coloured women appear to be at less risk with only 2 residential areas, Cape Town City centre and Hout Bay Harbour, being recorded in the highest category (Fig. 4). The other residential areas either had lower SMR values than the standard population or no reported deaths.

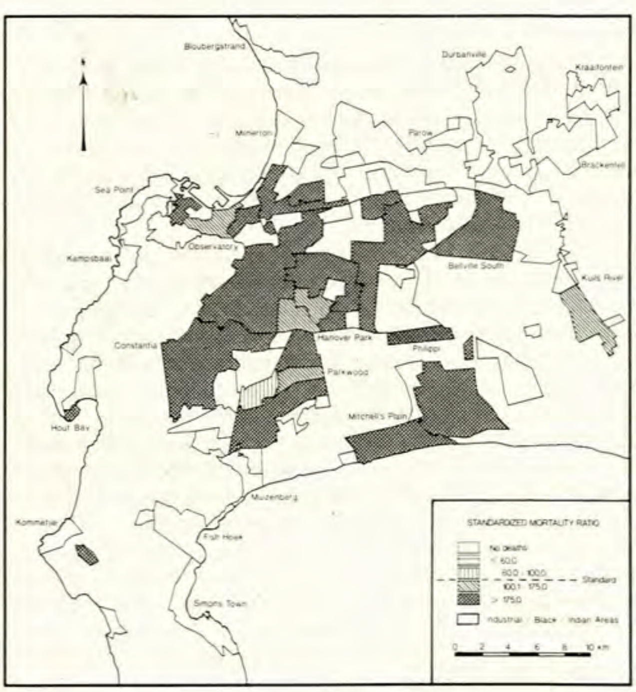

Fig. 3. Lung cancer mortality — coloured men.

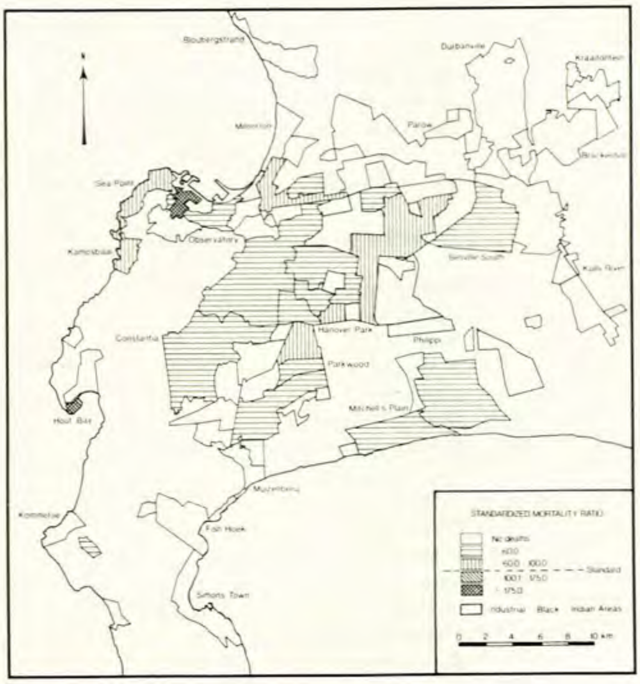

Fig. 4. Lung cancer mortality — coloured women.

The significantly higher incidence of lung cancer deaths among men than among women (regardless of race) in Cape Town accords with published findings of epidemiologists and geographers and supports the Lilienfeld *et al.*[11] assertion that 'lung cancer shows a marked predilection for males, both white and non-white'. In addition, the exceptionally high mortality ratio for coloured men in the city accords with the findings of Bradshaw and Harington,[2] Epstein *et al.*[3] Wyndham[25] and Yach and Townshend,[26] about the incidence of lung cancer in South Africa.

The question arises why men generally have a higher lung cancer mortality ratio than women, and why lung cancer is responsible for the death of so many coloured men. Cigarette smoking is without doubt the major culprit but the question remains whether the high incidence of lung cancer in coloured men is caused solely by heavy cigarette smoking, or whether there are other causal factors for lung cancer deaths?

Ecological analysis

Within an ecological framework * two multivariate statistical techniques, stepwise multiple regression and canonical correlation analysis, were used to explore possible explanations for the spatial pattern of lung cancer mortality in Cape Town. The summarised results in Table I clearly show that the canonical correlation analysis, except in the cases of the total white population and white men, were not successful in identi-

* 'Although ecologic studies have many shortcomings and problems mainly due to depending on routinely available population data aggregated for groups and not depending on data of individuals (ecological fallacy), it remains a useful study design with two major aims: (*i*) to generate or test etiologic hypotheses, i.e. to explain disease occurrence; and (*ii*) to evaluate the effectiveness of population interventions, i.e. to test the application of our knowledge for preventing disease and promoting health.'[27]

TABLE I. LUNG CANCER — SUMMARISED RESULTS OF STEPWISE MULTIPLE REGRESSION* AND CANONICAL CORRELATION† ANALYSIS

Environmental variables (%)	Whites			Coloureds		
	Total	Male	Female	Total	Male	Female
Whites		(+) 12,51				
	−0,770	*−0,877*				
Male						
Mean age		*+ 0,726*				
> 64 yrs	(+) 3,12	(+) 7,29	(+) 8,70			
35-64 yrs	(−) 5,63					
	−0,900	*−0,908*				
Afr. speaking	(−) 14,10	(−) 11,88				
	− 0,669	*− 0,704*				
Protestants	(+) 6,14					
	+ 0,910	*+ 1,079*				
Immigrants						
Never married						
With std. 6	(+) 5,66	(+) 8,36			(+) 8,43	
With std. 10+						
Literates						
Non econ. active						
Blue-collar	(+) 8,65					
Mining and factory					(+) 8,69	
Employers						
Unemployed				(+) 13,44		(+) 14,07
Mean family income	(+) 10,13		(+) 7,09			
Flat occupants						(+) 10,21
Single house occupants				(−) 14,16		
Home owners	*+ 0,539*	*+ 0,506*			(−) 14,37	
Movers	(−) 3,34					
	− 0,730	− 0,763				
Total	56,77%	40,04%	15,79%	27,60%	31,49%	24,28%
	35,44%	*48,75%*				

* Multiple regression analysis: relative % explanation of variance (beta-value) per environmental variable with direction of relationship in brackets.
† Canonical correlation analysis: standardised canonical loadings per environmental variable in italics.

fying correlated variables (no canonical loadings in the last four columns of Table I).

In the case of lung cancer mortality in *white men*, there were only two variables which were fairly significant in both statistical analyses: race and home language. This suggests that there are high lung cancer mortality rates in areas with a large number of English-speaking people as well as many whites. Other variables that related to lung cancer mortality in white men were Protestantism and advanced age. In contrast to white men, the incidence of lung cancer in *white women* was very low and only a mere 15,8% of the spatial variation of lung cancer mortality could be explained by two of the environmental variables that were selected. Simon's Town and Marina da Gama, the two residential areas with SMR values > 100 for white women, not only had high death ratios, but they also had a large number of old people and a high average family income. When the incidence of lung cancer in *the whole white population* was considered, Table I shows a wide variety of variables which had a relationship with this disease. The relatively high variance resolution (56,8%) in the multiple regression analysis suggests that smoking habits were not wholly responsible for the high incidence of this cancer, but there were also environmental variables that should be considered in the search for causal factors. Thus four variables, age, home language, religion and residential mobility, were identified by both techniques as being related to the lung cancer death patterns. The analyses showed that areas with high incidences of lung cancer deaths among whites had few Afrikaans-speaking people, a large number of Protestants, few middle-aged people (35 - 64 years of age) and few movers — making them stable communities. In addition, lung cancer was associated with both a high family income and a high concentration of blue-collar workers.

In the case of *the total coloured population*, the residential areas with high SMR values were characterised by high rates of unemployment and low proportions of single-dwelling occupants. This points to a relationship between low socio-economic status (true of many coloured areas) and lung cancer mortality. According to Buffler *et al*,[28] low socio-economic status often goes hand in hand with stronger smoking habits, as well as with poor, more polluted residential areas that in combination, add to lung cancer figures. Three environmental variables explain 31,5% of the spatial variation in lung cancer mortality in *coloured men*, Cape Town's high-risk group. All three variables reflect low socio-economic status, namely few home-owners, high concentration in the mining sector or manufacturing industry and low educational level, and they are associated with high SMR areas. As in the case of white women, the environmental variables included in the analysis did not provide an adequate explanation (24,3%) of the spatial variation of this cancer in *coloured women*. The two residential areas with SMR values > 175 (Fig. 4) were characterised by a high level of unemployment and a high percentage of flat dwellers.

Conclusion

Judged on the spatial distribution patterns in Cape Town, lung cancer mortality has more serious dimensions among the coloured than the white population and significantly higher SMR values for men than for women of both races. Cigarette smoking is probably the most powerful contributory factor in accounting for these findings. Multivariate statistical techniques show that environmental factors may also provide part of the explanation for the incidence of this cancer. The extent to which the pre-selected environmental variables relate to lung cancer mortality varies with regard to race and gender. It seems that lung cancer mortality is associated with a separate set of variables in the case of each subgroup of the population. There is no so-called 'master variable' which has a strong relationship with this type of cancer regardless of race or gender. In the case of white people, the incidence of lung cancer mortality is linked to demographic as well as socio-economic variables (home language, age, religious belief, and educational level), while in the case of coloured people only socio-economic factors, such as unemployment, home-owner status and type of housing, form part of the explanation for spatial variations of this disease. The expected positive relationship with low socio-economic status was found to hold true only for coloured people. Environmental variables offer less of an explanation for the incidence of lung cancer mortality in women, whether white or coloured, than they do in men. The reason for this is not clear and further research in this direction is essential.

Although the relationships identified here between the spatial incidence of lung cancer mortality in Cape Town and aggregated population features are not necessarily causal, the study does contribute to the struggle '. . . to narrow down the number of factors which might be investigated by the medical men for finding out the causal relationship'[29] and consequently towards eliminating some of the relevant risk factors, of which smoking certainly is the most important.

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