The accessibility of primary care to urban patients: a geographical analysis

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SUMMARY. Techniques of analysis now used in geography can be applied to general practice. They show that the locations of general practitioners' premises are not randomly distributed and are not related to the sites of populations or to patients in greatest need of medical services. The findings suggest a concentration of surgeries in middle class areas and lack of surgeries in areas of low social class.

Introduction

PROBABLY the most complex and important of all tasks facing those concerned with the provision of any social service is the two-fold challenge of organizing a limited set of resources in a way which is efficient and yet equitable. In practical terms, this inevitably reduces to the fundamental dilemma of having to rationalize the supply of services whilst at the same time maintaining or improving the accessibility of these services to the consumer.

The problem of accessibility is particularly acute in the provision of primary care, where the quality of community care is clearly dependent on the physical accessibility of doctors to patients, where the nature and magnitude of the doctor's workload is, conversely, dependent on the relative geographical dispersion of patients. Both are also increasingly dependent on the financial and organizational economies of larger partnerships operating from fewer surgeries.

Although journal correspondence, published papers, and administrative reports all reflect a vigorous interest in the spatial organization of primary care, most locational analyses have tended to be concerned more with the accessibility of patients to physicians than *vice versa* (Vaughan, 1967; Richardson and Dingwall-Fordyce, 1968; Hopkins *et al.*, 1968).

From any perspective, health is a fundamental component of quality of life, and there should be no need to stress the importance of primary care in improving and maintaining levels of individual and community health. However, although it is generally accepted that there are almost enough practitioners in Britain to provide adequate care, there have for many years been gross regional disparities in their distribution which even substantial controls and incentives have failed to eradicate (Butler *et al.*, 1973).

Accessibility to general practitioners is also extremely variable at neighbourhood level because of the tendency for surgeries to be clustered in one particular part of a town (Sumner, 1971). This can often leave large numbers of people with long and time-consuming journeys to their nearest surgery—journeys which are especially critical for the aged and for mothers with pre-school children, for whom the maximum tolerable walking distance is only half a mile (Hillman, 1973). Recently, local accessibility has become increasingly important to most groups of people as there is less home visiting by family doctors in towns (Richardson and Dingwall-Fordyce, 1968) and the trend towards the centralization of general practice in large partnerships and in health centres has gathered momentum (RCGP, 1977). Yet, for the most part, the present system of controls and incentives for the location of general practitioners overlooks intra-urban disparities because of the rather coarse scale—family practitioner committee districts—at which the policy is operated.

Aim

In this paper I attempt to examine the distribution of general practitioners from the point of view of the consumer, treating the availability of primary care as one particular aspect of the geography of social or community wellbeing. I also attempt to show how the question of the relative accessibility of physicians to patients extends well beyond the basic issue of equity to encompass substantial issues involving community health, professional workloads, and the strategic

policies involved in locating and allocating health service resources.

My central concern is to illustrate the extent of the intra-urban variation in accessibility to general practitioners' surgeries and to examine the implications of such disparities in relation to urban social structure.

Method

The location and accessibility of general practitioners in one city, Aberdeen, is studied using a relatively simple method which could easily be extended to planning and analysing the location of all kinds of health care facilities in urban areas.

Results

The distribution and ecology of general practitioners in Aberdeen

Soon after the initial reorganization of the health services in 1948, the distribution of general practitioners in Aberdeen was highly localized near the geographic centre of the city (Figure 1a), reflecting the need under the old free-enterprise system for each practitioner to locate his surgery so as to be as accessible to as many people as possible, thus attracting as many patients as possible and so maximizing income. In 1950, there were 78 general practitioners operating from 64 surgeries (including nine branch surgeries), over one third of which were located in the half square mile near the city centre. A comparison of this pattern with that in 1973 (Figure 1c) shows that, despite the long absence of the locational considerations associated with private competition, there remained a remarkable degree of localization of medical manpower in the city. This locational inertia can be almost certainly attributed to the absence of suitable sites and premises for surgeries in both planned local authority housing schemes and speculatively-built suburban estates, as well as to the high capital costs of opening a new surgery anywhere. Whatever the reasons, the same small area now contained about 40 per cent of the city's general practitioners, and the earlier spatial pattern had been somewhat reinforced by the rationalization and consolidation of practices and surgeries which had taken place. The net result was to leave only two thirds as many surgeries as in 1950, despite a 13 per cent increase in the number of general practitioners, with the only notable spatial change since 1950 being the introduction of two local authority clinics bringing general practice to the western suburbs of the city.

The obvious question to ask of such a pattern is: what kinds of neighbourhood are worst affected by this uneven distribution of resources? Figure 2 attempts to provide an answer. It is based on the results of an analysis of 19 social, economic, demographic, and housing characteristics of each of the census enumeration districts in the city (Scottish Development

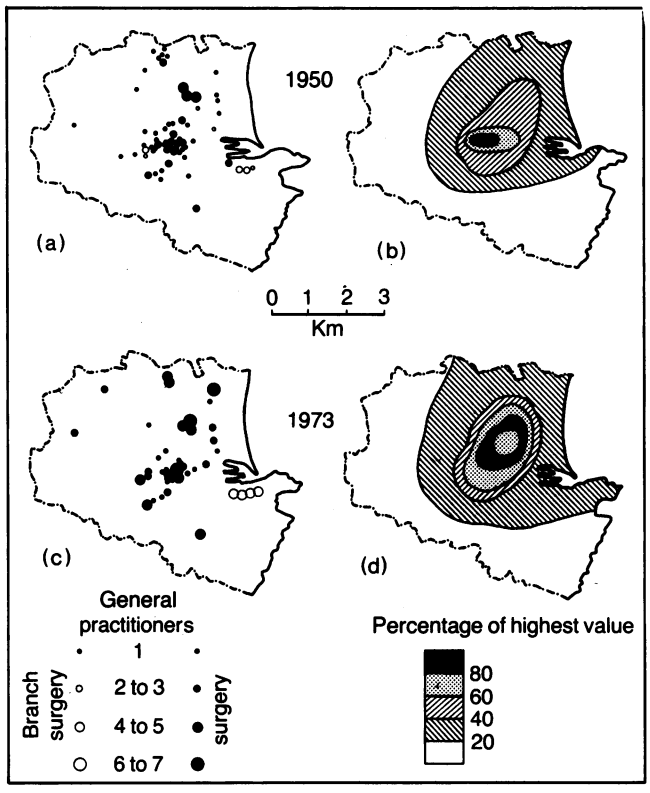

Figure 1. *Surgery location and relative levels of accessibility in 1950 and 1973.*

Department, 1977). Six objectively quite different types of neighbourhood emerged from the analysis and these are shown with an indication of their salient characteristics in Figure 2. Plotted in relation to these districts, the location of doctors' surgeries in 1973 is clearly seen to favour the longer-established middle-class districts of the city.

Although the residents of such areas do tend to make greater demands on general practitioners' services (Cartwright, 1967; Townsend, 1974), there is no reason to believe that they need medical care more than the residents of less well-off areas. Indeed, the aetiology associated with the social ecology of peripheral local authority housing estates, with overcrowded accommodation and a relatively high level of socio-economic deprivation, is likely to generate much more need for the services of general practitioners than any other part of the city. Yet these areas are served badly by the location of general practitioners' surgeries. Within the two square miles of the Garthdee and Kincorth estates in the south-west of the city, which contain 19,000 people, there is only one surgery, thus leaving large numbers of people—including many mothers with young children—with journeys of more than a mile to the nearest family doctor.

To a very large extent, then, it seems that the location

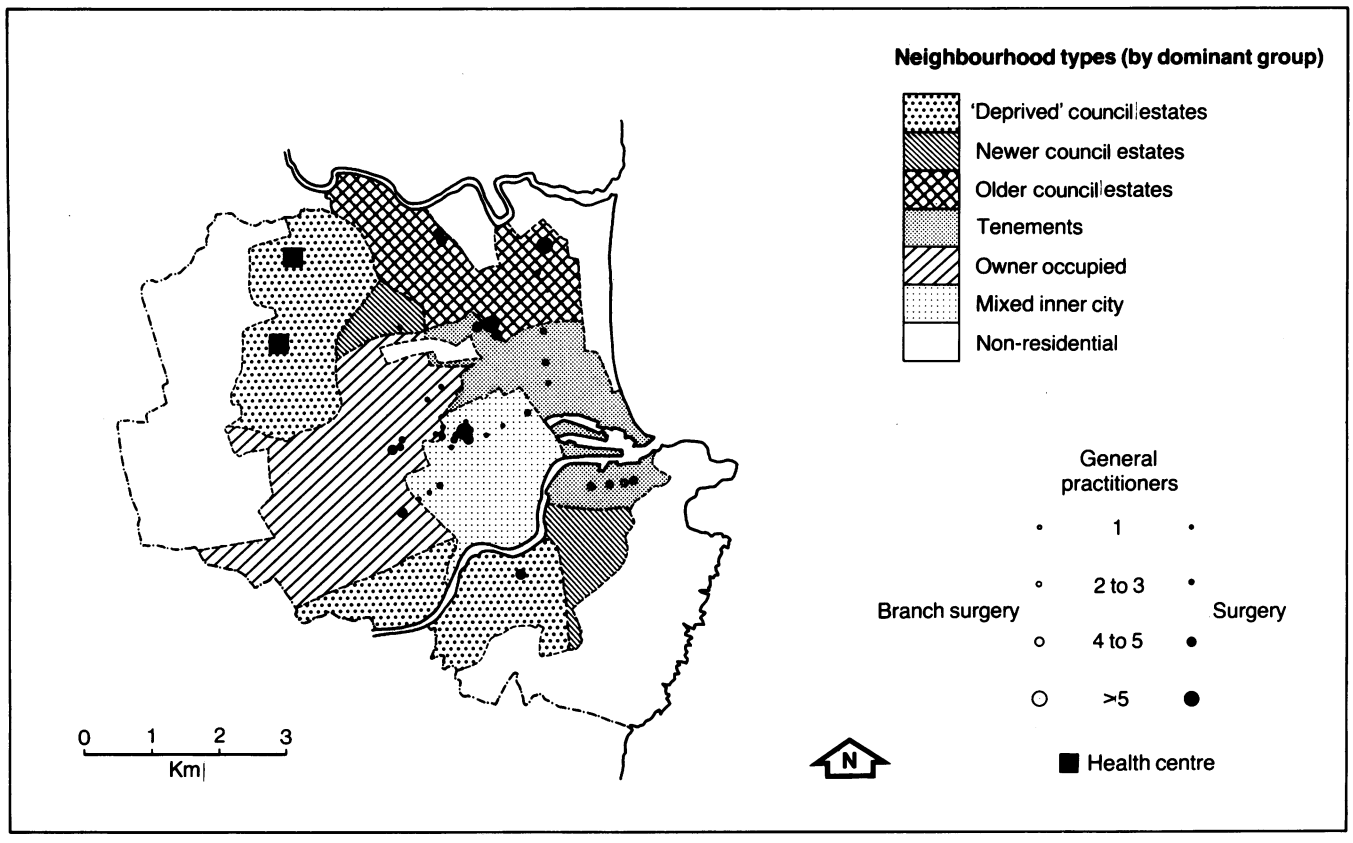

Figure 2. *The social ecology of general practitioners' surgeries in Aberdeen in 1973.*

of surgeries in Aberdeen may sustain the idea of an "inverse care law" (Hart, 1971), with the availability of good medical care varying inversely with the need of the population served. In this context, the inaccessibility of primary care facilities may be seen as yet another layer of relative deprivation, reinforcing the geography of urban socio-economic malaise as well as further intensifying the cycle of poverty (Raynor *et al.*, 1974). Locating more surgeries in districts such as Kincorth would clearly help to break, or at least weaken, such cycles of poverty and to dissolve such concentrations of multiple deprivation. However, in order to formulate and pursue rational policies of this kind it will be necessary to go beyond the mere description of location patterns to more precise measures of accessibility.

Measures of accessibility

Geography as a social science has provided a reasonable degree of sophistication in constructing models to deal with the variable effects of distance. Models initially used to evaluate the catchment areas and 'spheres of influence' of cities, shopping districts, and individual shops and services (Reilly, 1929; Haggett, 1965) have recently been adapted to provide a useful quantitative measure of accessibility (Symons, 1971; Smith, 1977).

For any of the n neighbourhoods in a city, accessibility to the city's physicians may be computed as:

$$A_i = \sum_{j=1}^{n} \left(\frac{S_j}{D_{ij}k}\right) \quad (1)$$

where A_i = accessibility in neighbourhood i

S_j = total general practitioner surgery consultation time available in neighbourhood j

D_{ij} = distance between neighbourhood i and j

k = a function representing the deterrent effects of the costs of travel: known as a 'distance-decay function'

and $\sum_{j=1}^{n}$ = the summation of the term across all neighbourhoods, from the first *(j)* to the last *(n)*.

In using this model with data for Aberdeen, the distance-decay parameter has been calculated to be a negative exponential function (1·52) from a regression analysis of the actual fall-off in registration with distance from surgeries (data were drawn from

Hopkins *et al.*, 1968), and the 'neighbourhoods' employed are the 24 zones used by the Scottish Development Department (1977) as a basis for the census analysis outlined above.

The pattern of accessibility to doctors' surgeries in Aberdeen in 1950 and in 1973 is shown by Figures 1b and 1d respectively. On these maps, the A_i values have been scaled to produce percentages of the highest computed A_i value in each year for ease of comparison. The most striking feature of these two maps is how steeply levels of accessibility fall off with distance from this small core area: for neighbourhoods only half a mile away, physical access to the city's doctors is less than 50 per cent of the maximum. Nevertheless, a comparison of the data for the two years shows that the slight shift of locations away from the main cluster of surgeries which accompanied the rationalization of practices and surgeries has increased relative accessibility in all except two of the 24 neighbourhoods.

It may be argued, of course, that disparities in accessibility may be cancelled out by other aspects of the city's geography. If, for instance, suburban areas are shown to be relatively well off in terms of personal mobility, then the disparities illustrated on Figure 1d may be considered to be more apparent than real. It is possible to modify the basic model (1) in order to take such factors into account:

$$TA_i = C_i\left(\frac{A_i}{4.25}\right) + (100 - C_i)\left(\frac{A_i}{16.75}\right) \qquad (2)$$

where TA_i is a new, time-based index of accessibility for neighbourhood *i*, C_i is the percentage of car-owning households in neighbourhood *i*, and the values of 4·25 and 16·75 represent the average time (in minutes) taken to travel one mile in Aberdeen by private car and public transport respectively.

This methodology, then, provides us with a reasonably sensitive and yet robust evaluation of the relative accessibility of different neighbourhoods to a given distribution of doctors. It could be argued, however, that *places* with low accessibility are not at a disadvantage if they contain relatively small numbers of people.

In order to take account of the variable distribution of population in the city, it is possible to weight the *TA* index according to the potential number of patients living in—and travelling to—each neighbourhood. This figure is generally known as the 'population potential' of a place (Smith, 1975) and is computed as:

$$PP_i = \sum_{j=1}^{n} \left(\frac{P_j}{D_{ij}^{1.52}}\right) \qquad (3)$$

where PP_i is the population potential of neighbourhood *i*, and P_j is the total population of neighbourhood *j*. Scaling population potentials to percentages of the highest value enables a final index of accessibility (I) to be computed as:

$$I_i = \left(\frac{TA_i(\%)}{PP_i(\%)}\right) \times 100 \qquad (4)$$

so that values greater than 100 indicate a relative local over-provision of doctors, whilst values less than 100 indicate relative local under-provision.

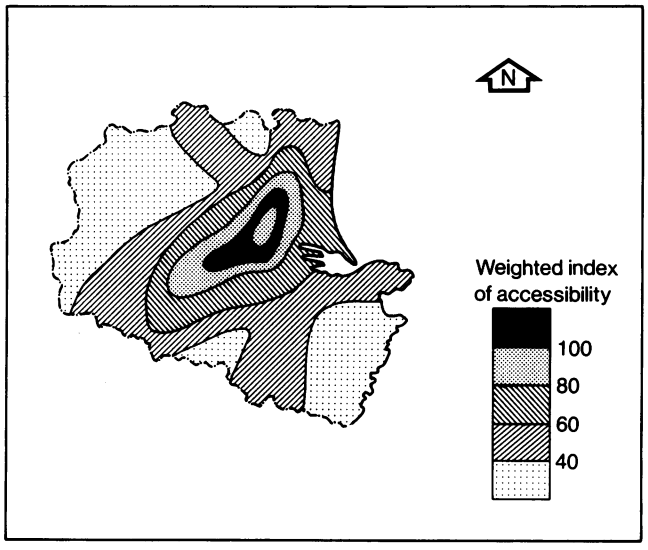

Figure 3. *Relative levels of accessibility in Aberdeen, taking car ownership and population densities into account.*

Discussion

Actual values have been mapped on Figure 3, where the resultant spatial pattern is more complex than on previous maps. Nevertheless, the location of the most favoured areas is the same, and it is clear from this map that they are getting more than their share of accessibility to primary medical care. Outside this small, fortunate territory, most people get rather less than their full share.

There is a broad tendency for levels of provision to fall off rapidly towards the suburbs, but on this map the case for an inverse care law is more conclusive, since relatively high levels of accessibility extend quite markedly to embrace the owner-occupied sector of the city (Figure 2), whilst the very lowest levels of accessibility are founded in the 'deprived' local authority estates.

Inequality of access

Some inequality in geographical access to primary medical care is inevitable, if only by virtue of the discrete location of surgeries amongst a virtually continuous population. The example of surgery locations examined here, however, has revealed

disparities which are disturbing not only because of the consequent inequalities in a supposedly egalitarian health service, but also because these disparities compound the existing geographical patterns of socio-economic disadvantage in the city. Moreover, there is no reason to believe that Aberdeen is atypical of British cities in this respect. Indeed, the preliminary results of similar analyses of three other Scottish cities—Dundee, Edinburgh, and Glasgow—suggest that a comparable situation exists in most large cities.

Notwithstanding the equity of differential access to medical care, the practical implications of these disparities are several. From the doctors' point of view, clustered location patterns, despite minimizing the aggregate travel involved in visiting patients at home, will inevitably leave a few practitioners with an excessive load of longer-distance visiting. With between 20 and 40 per cent of general practitioners' time already being consumed, on average, by visiting patients at home (Cartwright, 1967; Vaughan, 1967), the extra demands of unnecessarily large catchment areas are clearly undesirable.

More important from the medical point of view is that the under-doctored areas of the city are of the type normally associated with above-average rates of morbidity across a wide range of disorders (especially infectious diseases) and with high rates of infant and perinatal mortality. Although statistical correlations between morbidity and mortality on the one hand and accessibility to doctors on the other have not been attempted in the present example, there is every reason to expect a high positive correlation, given a working knowledge of intra-urban patterns of physical and mental health.

In addition, there is some evidence to suggest that the availability and accessibility of medical services may have a direct effect on spatial patterns of disease. Besides the differential effects of education, religion, and class on 'illness behaviour' (Mechanic and Volkart, 1962), it has recently been demonstrated that 'therapeutic behaviour'—behaviour relating to the decision to seek medical care once it has been recognized that a state of illness does exist—is often negatively affected by distance (Girt, 1972). Thus, because of the costs (financial, physical, or psychological) of travelling to the surgery, patients living further away will more often make light of symptoms or put up with discomfort and uncertainty, perhaps gambling that their problem is not related to any serious condition.

This kind of behaviour clearly runs directly against the basic principles of primary care, and could offer a partial explanation for at least some of the marked intra-urban variations in morbidity (and, indeed, mortality) from more serious disorders. An obvious example for investigation in this respect would be the behaviour, and its consequences, of mothers living in areas without good access to maternity services. Without any immediate problems to prompt a visit to

their doctor, women living in remote under-doctored areas may be less likely to attend prenatal and postnatal courses, thus leading to an increased probability of perinatal or infant mortality.

Health service planning

It must be accepted that ensuring adequate accessibility to general practitioners for all is by no means the only criterion involved in running a satisfactory health service. Economic, environmental, behavioural, and administrative factors must also be given proper weight in the planning and evaluation of any health care delivery system. The results outlined here must be qualified by stressing that they are the product of a method which could be improved by using better data. The sensitivity of the model could be increased, for example, by incorporating variables for age structure, morbidity rates, and mortality rates, as indicators of 'need', and by increasing the level of resolution to that of a finer mesh of 'neighbourhood' units. In addition, better estimates of travel times could be achieved by accounting for the proximity of car-less households to public transport routes and that of car-owning households to major city thoroughfares. The model discussed here deals with average travel times, although in practice some temporal variations in accessibility will inevitably occur, as a result, for example, of traffic congestion. In this case, the relative advantage of inner city areas may well be narrowed considerably during peak traffic periods (which are also the most popular times for surgery consultations).

If one accepts equality of opportunity as at least one of the legitimate objectives of the British health service, the disparities outlined here present a strong case for investigating the possibility of extending the present system of controls and incentives for doctors to a finer geographical scale, perhaps by creating restricted areas and designated areas within family practitioner committee districts at the neighbourhood level. Measures of accessibility of the kind used here would be invaluable in formulating and monitoring such policies, providing particularly useful information about the effectiveness of such strategies. The index of accessibility (I) provides a clear picture of relative levels of under-doctoring and over-doctoring, whilst the coefficient of variation calculated from the vector of these values would provide a useful summary measure of the equity of surgery locations in an urban system. In addition, it is possible to compute a summary measure of the efficiency of the same location pattern (in terms of aggregate patient travel) by accounting for the distribution of population in the city (Smith, 1977). In practice, such measures would probably be of most use in gauging the effectiveness of alternative locations for new resources: for example, health centres or clinics. The results would clearly provide only the broadest idea of the possible outcome of policy-induced changes, and would clearly have to be judged alongside parameters of cost and organizational efficiency. They would, however, provide at least some insurance against the regressive effects of inertia in the location of primary medical care.

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