The Spatial Association of a Doctor and His Patients in Hamilton City

Being a Dissertation
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MASTER OF SOCIAL SCIENCES
in
GEOGRAPHY

E. W. Bruce Judd
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T. W. Fookes
Supervisor

ABSTRACT

Information which has been diffused through a population about an idea has been accepted, and the idea adopted, by some members of the population under some circumstances (Hägerstrand, 1967.)

The spatial relationship between a doctor and his patients in Hamilton City were examined to see if information about this particular doctor, when diffused through the urban residential area, had been the basis for a significant number of his patients attending his surgery rather than the surgery of the doctor nearest to them.

Acknowledgements.

I wish to acknowledge the assistance I have received from many people during the course of this study. Without the information, encouragement, and practical assistance that has come from various sources it could not have been undertaken.

Particularly I would like to thank the following:

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My daughter Paula who typed the preliminary drafts and Mrs. M. Puriri who typed the final draft.

My wife Robin and my other children who assisted and encouraged me throughout and my mother whose prayers have been answered.

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G L O S S A R Y

C.B.D.	Central Business District
C.B.D. Surgery	Unless specifically stated otherwise this statement refers to the C.B.D. surgery of the doctor supplying the data.
Doctor	In this dissertation the word doctor refers to a General Medical Practitioner.
F.S.P.	Female Solo Parent
Headway	The time interval between one public transport vehicle and the next on any specified route.
Partnership	Doctors in New Zealand often locate their surgeries in groups of two or more surgeries at the same address. They may also treat each others patients when their collegues are absent. They may also consult each other professionally on aspects of case treatment. They will share the expenses of rental, receptionist services, and the cost of heat, light and phone, but they do not have a formal financial arrangement for the sharing of amalgamated incomes. Each doctor keeps his own accounts, charges and receipts the patients that he treats, this keeps his gross and nett income separated from his partner or partners.

Suburban Surgery	Unless specifically stated otherwise the statement refers to the suburban surgery of the doctor supplying the data.

INTRODUCTION

Earickson (1970.) developed a study based in Chicago USA which brings to light many of the factors that govern the selection of hospitals by patients in that area. Although the factors governing the selection of a doctor and hospital admission differ between Chicago and New Zealand, the principles of geographical location are readily applicable to the programme outlined. It is apparent in this study that many patients do not chose the hospital that is located closest to their residence, or even to their doctor's surgery, but in fact the actual choice of a hospital can depend on factors as varying as the racial origin of the patient and the religious affiliation of their doctor.

In New Zealand the choice of a hospital for medical treatment is much more likely to be regulated by the patient's medical, surgical, or psychiatric needs, but the choice of a doctor by an individual is open to a wider range of influences. This investigation examines the hypothesis "that within Hamilton City the selection of a doctor is not a direct function of the distance from a patient, but is dependent upon the information about the doctor that is received by the patient."

Information Dissemination.

Information about a doctor must be disseminated to be accepted. In the general process there are several distinct mechanical steps and three categories of receptors of information. 1. Those who have the information. (These people may or may not be converted to accepting the implications

of the message they have and becoming the adoptors of it.)
2. Those who carry the information and pass it on to others.
3. Those who accept and adopt the information and, as a result, change the pattern of a particular part of their lives.

Hägerstrand (1967, p.7) has shown that information on a new idea does not immediately or ever cause the adoption of it. Nevertheless, "information is so important that an understanding of the geographical structure of social communications is a prerequisite for diffusion models including the space aspect."

In addition to personal contact, information about an idea can be disseminated by mass media: newspapers, magazines, radio, television. In all cases when information is being disseminated its acceptance and spread is dependent upon persons who actually do something as a result of the information they have accepted. Marble and Nysteun (1963) have discussed this process in the context of a Mean Information Field.

Mean Information Field.

"The Mean Information Field is designed to express the spatial extent of an individual's non-migratory contacts." (Marble & Nysteun 1963, p.100) Hägerstrand (1967) examines this process as a purely person-to-person contact which disseminated information about an agricultural programme in Sweden. His work showed a slow but steady acceptance and adoption of the Swedish Government Programme in a "long, rather isolated peninsula in rural Sweden." (Hägerstrand

1967, p.5) Here the influence of mass-media was negligible and the slow spread and adoption of the innovation was attributed to lack of this influence and the relative stability of the rural population. Information dissemination was restricted to pair-wise exchanged by word of mouth. The population was not migratory and therefore the spread of the information was slow and acceptance and adoption slower still.

Neighbourhood Effect.

It was clearly shown that as a result of these constraints the adoptors were in close physical contact with each other. Isolated adoptors were in evidence but not in a greater number than would be expected. It can be expected that initial acceptors of a new idea will be those who are either more liberal minded, or are in possession of a combination of factors such as financial security, more than average education, or are conveniently situated to introduce a new programme. The more conservative neighbours will be inclined to watch the progress of the innovation and assess its value to them before they become adoptors. However, those in close neighbour association with the new adoptor will have the best information about the new idea and be more likely to adopt it more readily than those at a distance from him. Hägerstrand calls this physical process "Neighbourhood Effect." (1966, p.4)

Effects of Mass Media.

Other authors (Rogers 1962 and Katz 1960) have assessed the effect of mass media in disseminating information about a new innovation and its effect on those who will become acceptors and adoptors.

Rogers (1962) feels that mass media sources are most important at the awareness stage of the dissemination process but that personal sources are most important as individuals evaluate the information that is being disseminated. (Quoted in Marble & Nysteun 1963, p.99) Katz (1960) stresses the importance of person to person contact in transferring information, even when the society involved may be nearly saturated by the various mass media with this information. (Quoted in Marble & Nysteun 1963, p. 99)

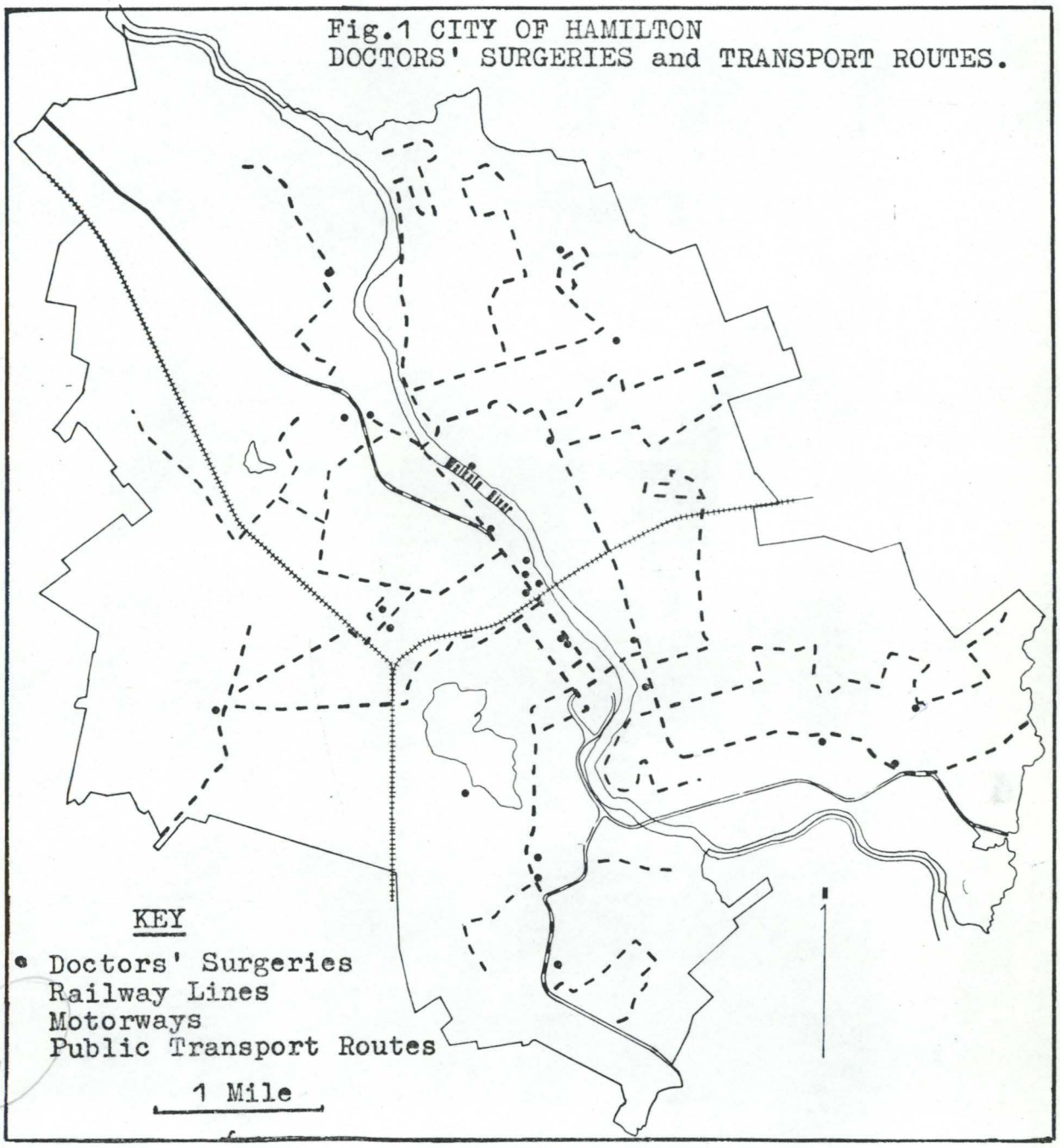
For ethical reasons doctors do not advertise in New Zealand, so that any information about a doctor will be transferred by word of mouth and disseminated through a society by personal contact of those with the information to the non-informed.

Outline of This Investigation.

To investigate the process of dissemination of information about a doctor and to try to evaluate the effect of this information on his patients, it will be necessary to discuss the following topics.

1. The spatial location of the doctor's patients.
2. The effect of distance or patient numbers.
3. The pair-wise association of patients.
4. The origin-destination patterns, patients and surgery.

5. The significance of this data.
6. The significance of particular subsections of the data.
7. The effect of information in a Mean Information Field.



incomplete key

Chapter 2: THE SPATIAL LOCATION OF A DOCTOR AND HIS PATIENTS.

On the 31st March 1971 there were 37 doctors practising in Hamilton City. Because several of these doctors were in some form of partnership or located their surgeries in the same building, there were 27 separate surgery addresses. Figure 1 shows the location of these surgeries. It will be noticed that there were two distinct surgery locations, the Central Business District (CBD) and Suburban. The suburban surgeries were well distributed in most suburbs although some areas appear to be less well serviced than others.

The Hamilton City population in March 1971 was 74,762 (Census, 1971). Most of these people were assumed to attend a Hamilton City doctor if they needed medical treatment. In addition to this population, an unknown number of people came into Hamilton from the surrounding urban and rural areas for medical treatment.

The spatial dimensions of Hamilton City are such that people using private transport as a travel mode can readily attend a doctor of their choice because the distance factor is not excessive (Fig. 1). People who are captive to public transport may be limited by either a cost or time factor so that they are forced to choose a doctor in those areas readily accessible to this travel mode. Figure 1 shows that no resident in Hamilton City has to walk more than half a mile to a public service, so that some transport is available to almost any doctor in the city. Infrequent headways on some

routes and the cessation of some night and weekend services will be a constraint in the choices available to those captive to public transport.

Some Characteristics of Doctors in Hamilton.

Personal investigation has shown that the following characteristics are exhibited by Hamilton doctors. In the case of one doctor a combination of these factors may be in evidence.

1. Have consultations by appointment only/do not keep appointment books.
2. Discourage weekend contacts and housecalls.
3. Discourage/encourage particular socio-economic and/or racial groups.
4. Work in isolation from other doctors' surgeries/work in loose association with partners/work out of more than one surgery.
5. Accept the social security fee, but in addition to this individuals may charge high fees, medium fees, low fees, no fees.
6. Have a full practice and will not accept new patients/ will accept new patients/ will accept selected new patients.
7. Are/are not interested in group practice.
8. Will/will not prescribe oral contraceptives to unmarried females.
9. Engage in civic activities and/or team and individual sports that bring them into contact with particular groups of the population.

10. Have an age group/ethnic group relationship with sections of the population.
11. The location of the doctor's surgery (C.B.D., suburban or both).

Combinations of many of these characteristics will be the hallmark of the individual doctor. This information is disseminated by carriers throughout the population.

Doctor Patient Association.

People who have a satisfactory professional association with their doctor will not be readily stimulated to change doctors even though they change their address within the city or to the immediate environs,unless transport becomes a serious problem. Those who are dissatisfied with their doctor or who move into Hamilton from outside ares will be encouraged to make their first new medical contact by assessing information they receive about a doctor from an informant. This informant may be a friend, relative, neighbour, professional or business contact, or a sporting associate. Recommendation may come from a doctor who cannot offer the required service when called, or hospital or health department official. Or they may arrive in Hamilton with an introduction to a certain doctor from their previous doctor.

The medical practitioners' section in the telephone book is also a guide to who is practicing and where their surgeries are located. Prospective patients may also notice a doctor's name plate when passing.

Medical health, and the treatment of problems in this field, are services which most members of the population need to avail themselves of at some time or other. Such

services would usually be classified in a different category to the supply of food, toiletries or household hardware, but the association between a doctor and his patient may well be of such a personal and satisfying nature that the professional and personal characteristics of the "family doctor" can be a topic of social conversation. Special services either medical counselling, sociological or psychological that a particular doctor may offer might also be of particular interest to some sections of the community. Persons enjoying these special services can be expected to tell others who indicate that they are in need of such services.

As a result of these and similar contacts information about a doctor can be disseminated through the population.

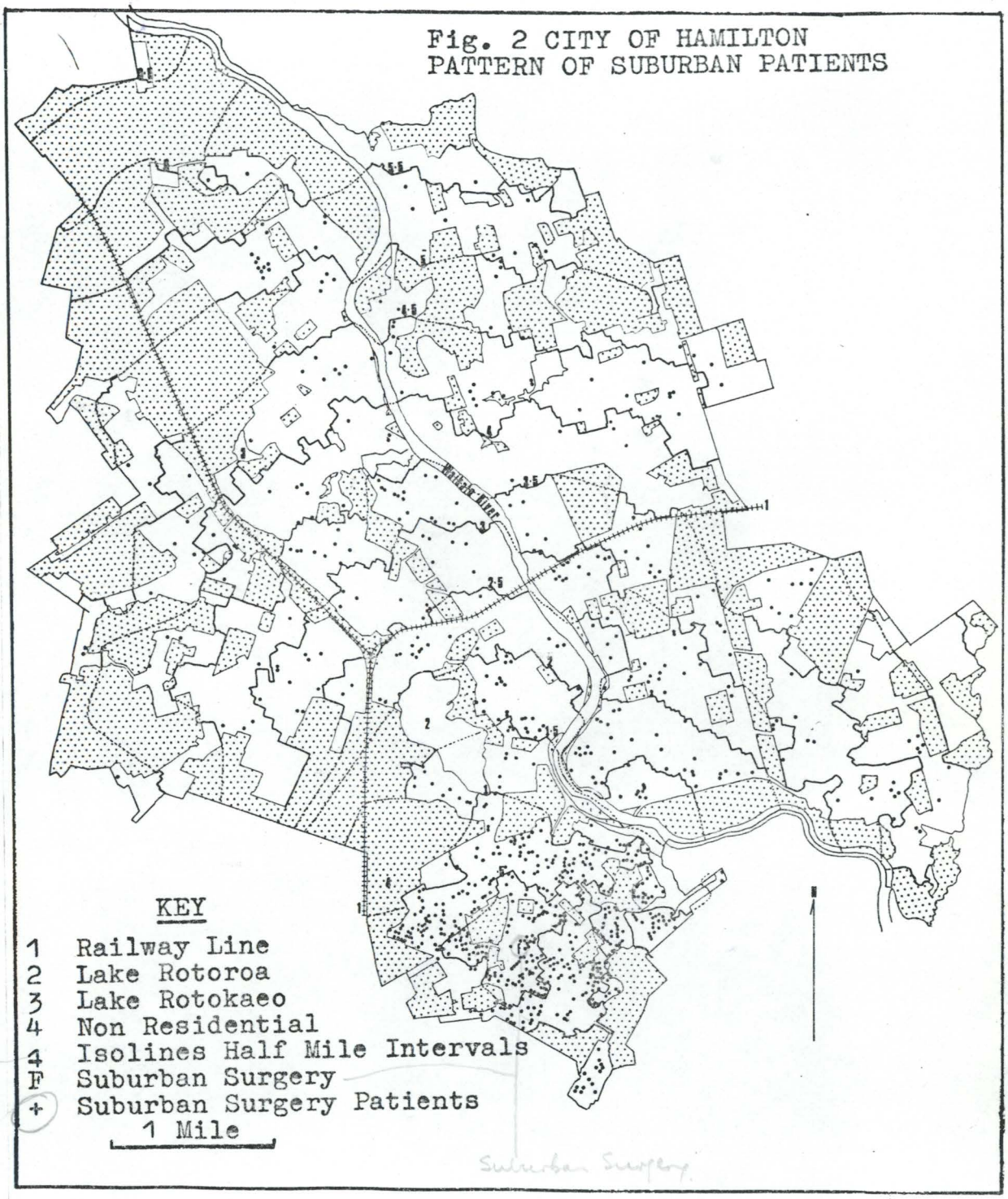


Fig. 2 CITY OF HAMILTON
PATTERN OF SUBURBAN PATIENTS
KEY
1 Railway Line
2 Lake Rotoroa
3 Lake Rotokaeo
4 Non Residential
4 Isolines Half Mile Intervals
F Suburban Surgery
+ Suburban Surgery Patients
1 Mile

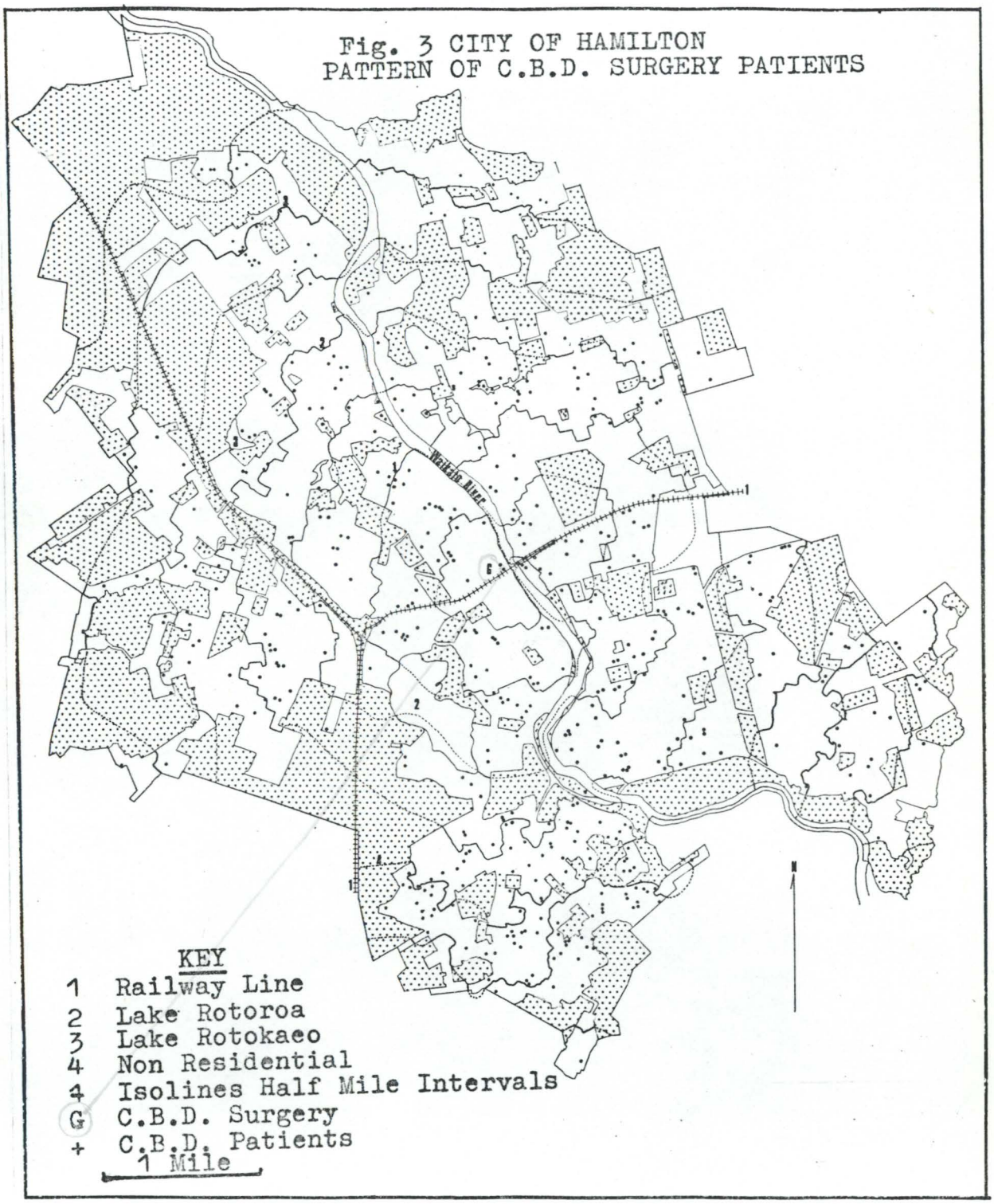


Fig. 3 CITY OF HAMILTON
PATTERN OF C.B.D. SURGERY PATIENTS
Waikato River
KEY
1 Railway Line
2 Lake Rotoroa
3 Lake Rotokaeo
4 Non Residential
4 Isolines Half Mile Intervals
G C.B.D. Surgery
+ C.B.D. Patients
1 Mile
N

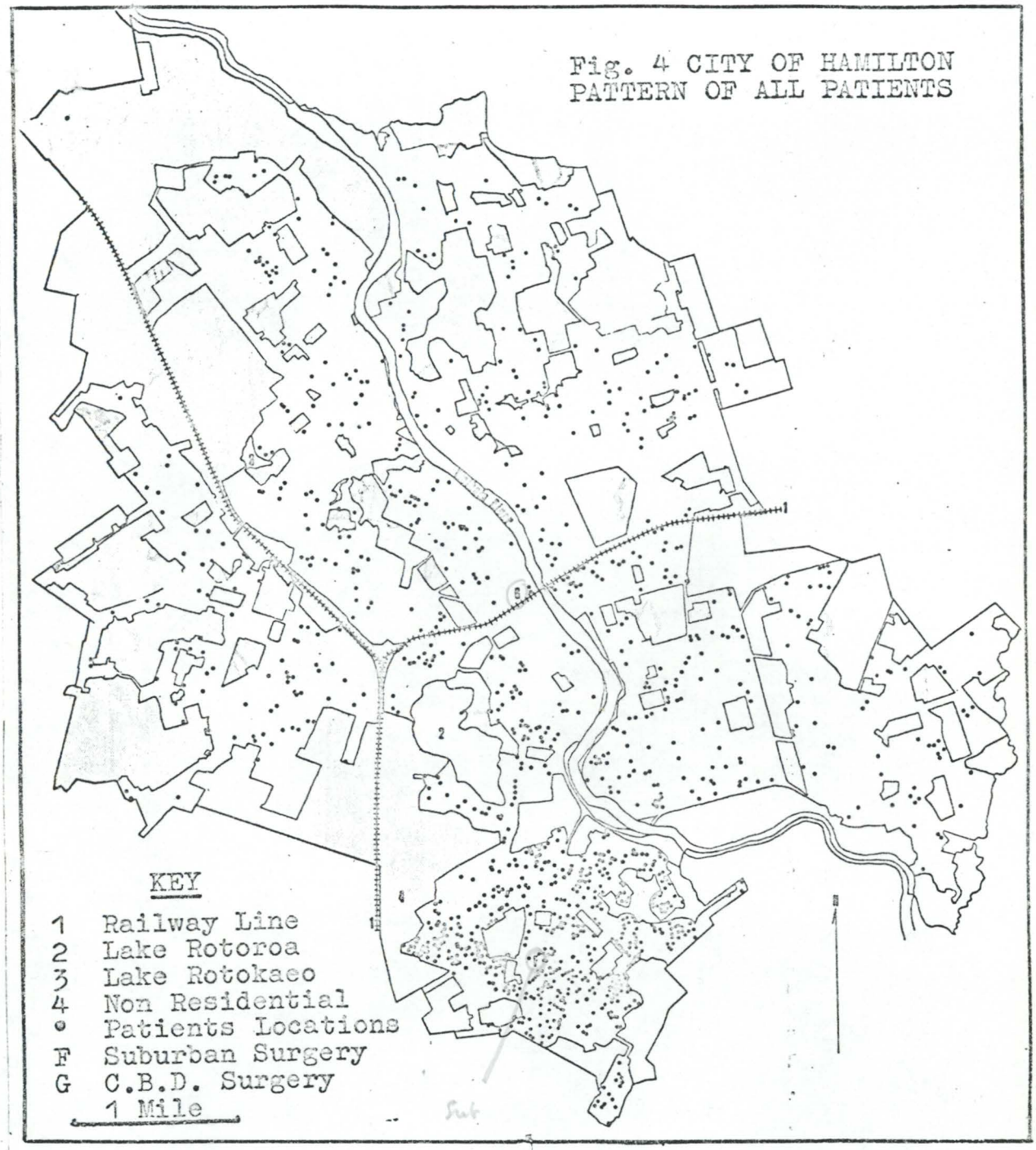


Fig. 4 CITY OF HAMILTON
PATTERN OF ALL PATIENTS
KEY
1 Railway Line
2 Lake Rotoroa
3 Lake Rotokaeo
4 Non Residential
• Patients Locations
F Suburban Surgery
G C.B.D. Surgery
1 Mile

Medical Centre.

Increasing publicity in mass media reports is making the public more aware of a facility known as a medical centre. Here several doctors will have their surgeries and in the same building physiotherapist, guidance counsellor, laboratory, x-ray and professional nursing services will also be available. Visiting psychiatrists and social security officers mean that the whole range of human needs in the physical, mental, emotional, and social spheres can be administered to.

Information about such a facility will be best transmitted by mass media, but acceptance of the service offered, and adoption of this form of health care, will best be promoted by the personal diffusion of individual acceptance and adoption of the idea.

If a significant number of people, who have chosen a doctor because of information received about him, are visiting this doctor rather than the one nearest their home, then it is possible that a medical centre would be in demand even if there was a travel time, or mode of travel, constraint for many prospective patients.

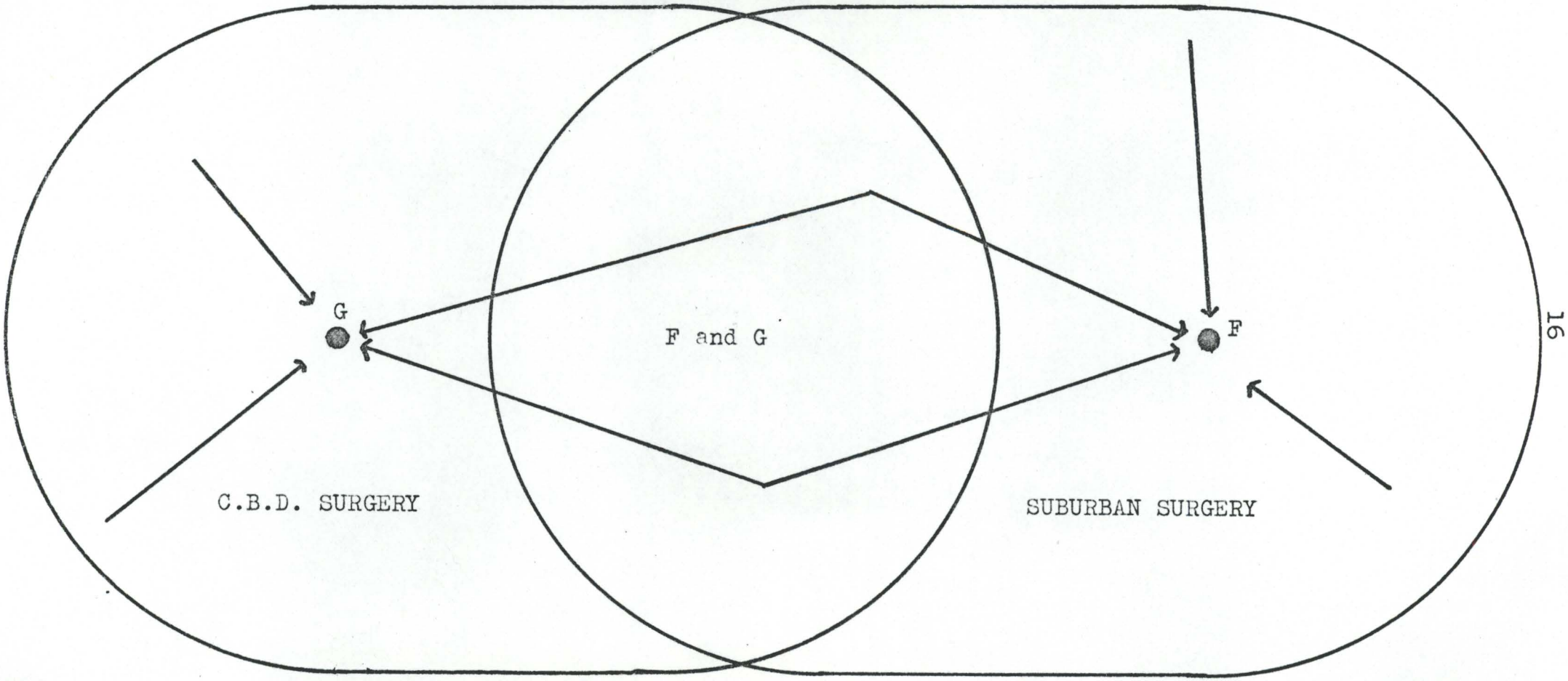
Location of a Doctor's Patients.

By accurately locating the addresses of city patients who attended one doctor between the 1st of July and the 31st of December 1970, it has been possible to establish a base from which this investigation of the spatial relationship between a doctor and his patients in Hamilton City could

proceed. No account has been kept of the number of visits from each address or the names of those who visited the doctor or who were visited by him. This doctor has a surgery in a suburb of Hamilton and one in the C.B.D. He and his partner visit each surgery each day alternating a.m. and p.m. hours; it was found that some patients attended the suburban surgery (F), some attended the C.B.D. surgery(G), and some attended both surgeries (F and G). The maps Fig. 2, Fig. 3, and Fig. 4 locate the addresses of the doctor's patients, and Fig. 5 shows a Venn Diagram representation of the information.

In the six month period examined there were 708 F, 315 G, and 215 (F and G) patient addresses listed. A total of 1239 separate addresses. These addresses are located in all sections of Hamilton City, although it is obvious that some areas are more heavily populated with this particular doctor's patients than others.

FIG. 5. VENN DIAGRAM SHOWING F, G, F and G.



Chapter 3. GRAVITY MODEL

The notion that the probability of human interaction that is likely to occur between individuals and a potential destination varies directly with the size or attraction of the destination is the basis of the gravity concept. (Huff, 1965)

This concept is designed to account for the behaviour of large groups of people; group behaviour is considered to be predictable on the basis of mathematical probability.

In this instance the number of individual addresses will be accumulated in groups and the distance from the destination will be measured in half mile steps. As only one type of journey to one destination is being investigated, there is no need to make allowances for different types of trips to different destination.

Setting Up The Model.

Figure 2 shows the suburban surgery's location and the addresses of each of the patients who attend that surgery. This map also shows the areas of Hamilton City that are non-residential in character: parks, schools, reserves, land not sub-divided into residential sections, large areas of industrial land, and the Waikato river. Roads are not included in the non-residential areas because they are considered residential access by the Hamilton City Council. (Mr. Keys, Hamilton City Council Chief Planning Officer, pers. comm.) The railway lines and marshalling yards that run north and south, and east towards Cambridge have been

included in the non-residential limits.

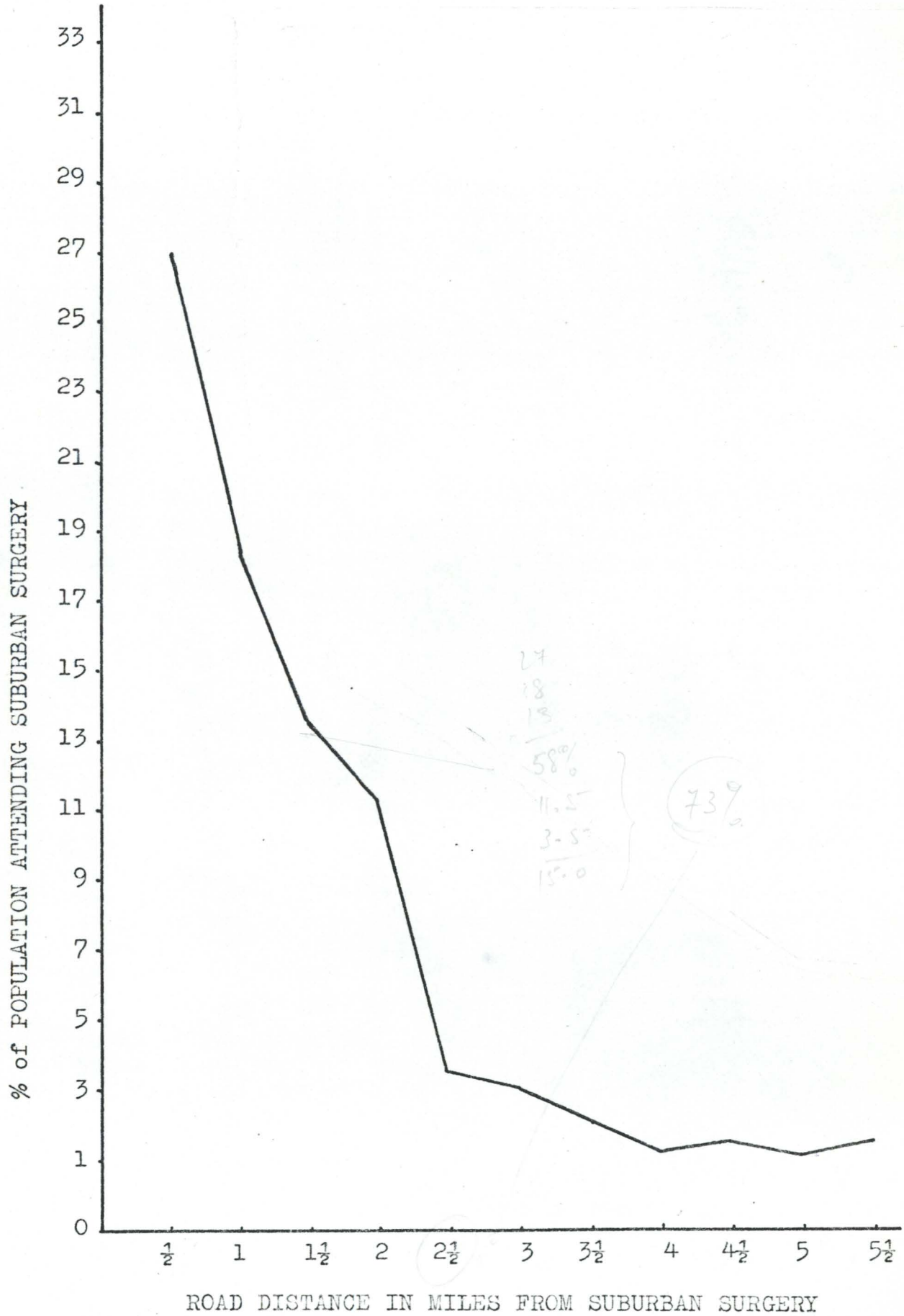
Isolines have been drawn each half mile of road distance from the suburban surgery. When non-residential land has intruded this constraint has caused a deformation in the isoline. Because there are only four river crossings, this constraint has also added to the irregular shape of the isolines east of the river. Figure 3 shows similar isolines from the C.B.D. surgery.

The number of patients' addresses between each isoline was counted and recorded, and the number of residences in each area was calculated from the census Mesh Blocks. (Census 1971) The percentage of patients who made up the total population in each isoline area was calculated. This was done for both surgeries, any address that attended both surgeries was counted both times, so that all addresses that attended the suburban surgery were included in calculations for Fig.6.

The Graph, Fig. 6 shows road distance each half mile against percentage of the population in that area who attend the suburban surgery.

FIG. 6

GRAPH SHOWING PERCENTAGE OF POPULATION ATTENDING SUBURBAN SURGERY AGAINST DISTANCE



Suburban Surgery Gravity Model.

The graph for the suburban surgery (Fig. 6) shows that a fairly high percentage of the available population inside the first half mile isoline attended the doctor. But that the percentage of the population who made up his patients decreases rapidly as each half mile isoline is crossed until a road distance two and a half miles from the surgery is reached. Between two and a half miles and five and a half miles the graph almost flattens out showing that over this distance the percentage of the population who attended the suburban surgery has become reasonably constant.

The greatest number of intervening opportunities for service from other doctors at their suburban or C.B.D. surgeries has been reached by the time the three and a half mile isoline has been crossed. It would appear that from nil to two and a half miles the gravity model concept has been shown; a rapid decrease in attendance at the destination as the distance from it increases. From two and a half to four miles this decay is arrested and from four to five and a half miles the adverse distance factor does not appear to decrease the attraction of the suburban surgery.

C.B.D. Surgery Gravity Model.

When the percentage of the population and distance from the surgery figures for the C.B.D. surgery were plotted the gravity model concept was not apparent, the result-

ing graph did not show a decay with distance. In fact, after one and a half miles there appeared to be an increase in the percentage of the population attending this surgery. Two factors seem to cause this departure from the expected result.

1. The difficulty in accurately determining the number of people who reside in the C.B.D.
2. The lack of information showing how many of the patients who attended this surgery were permanently employed in the C.B.D. during the day but gave their suburban home address to the C.B.D. doctor.

In the first instance the number of permanent residents may have been lower than calculated, and therefore the percentage of patients higher.

In the second instance a more accurate assessment of the gravity model's significance would have been obtained if those who were permanently employed in the C.B.D. had given their employment address instead of their home address. This would have increased the number of C.B.D. residents and decreased the number reporting in various suburban locations. It would have been necessary to calculate the number of patients attending the C.B.D. surgery from an employment address as a percentage of the total of C.B.D. employment and residential population. Under these circumstances a more accurate analysis of the C.B.D. population distance ratios would have been achieved.

No equivalent graph or explanation why it was excluded

p.17

The original postulation that the attraction of a destination varies proportionately with size or appeal of the destination and inversely with the distance from the destination appears to be shown with regard to the sub-urban surgery, at least within the first two and a half miles. It is possible that a similar condition would also exist with the C.B.D. surgery if calculations were made under the conditions outlined above.

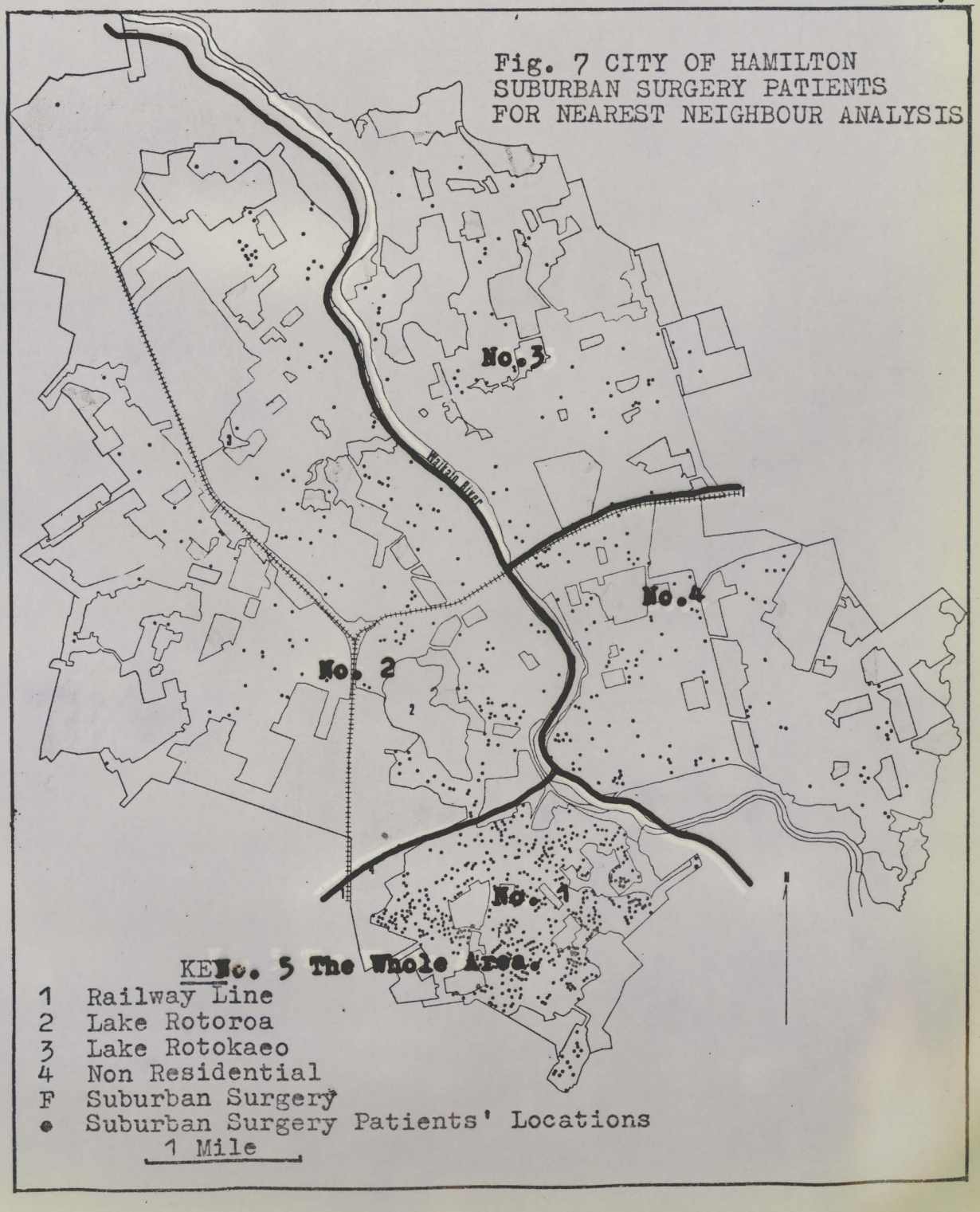


Fig. 7 CITY OF HAMILTON
SUBURBAN SURGERY PATIENTS
FOR NEAREST NEIGHBOUR ANALYSIS

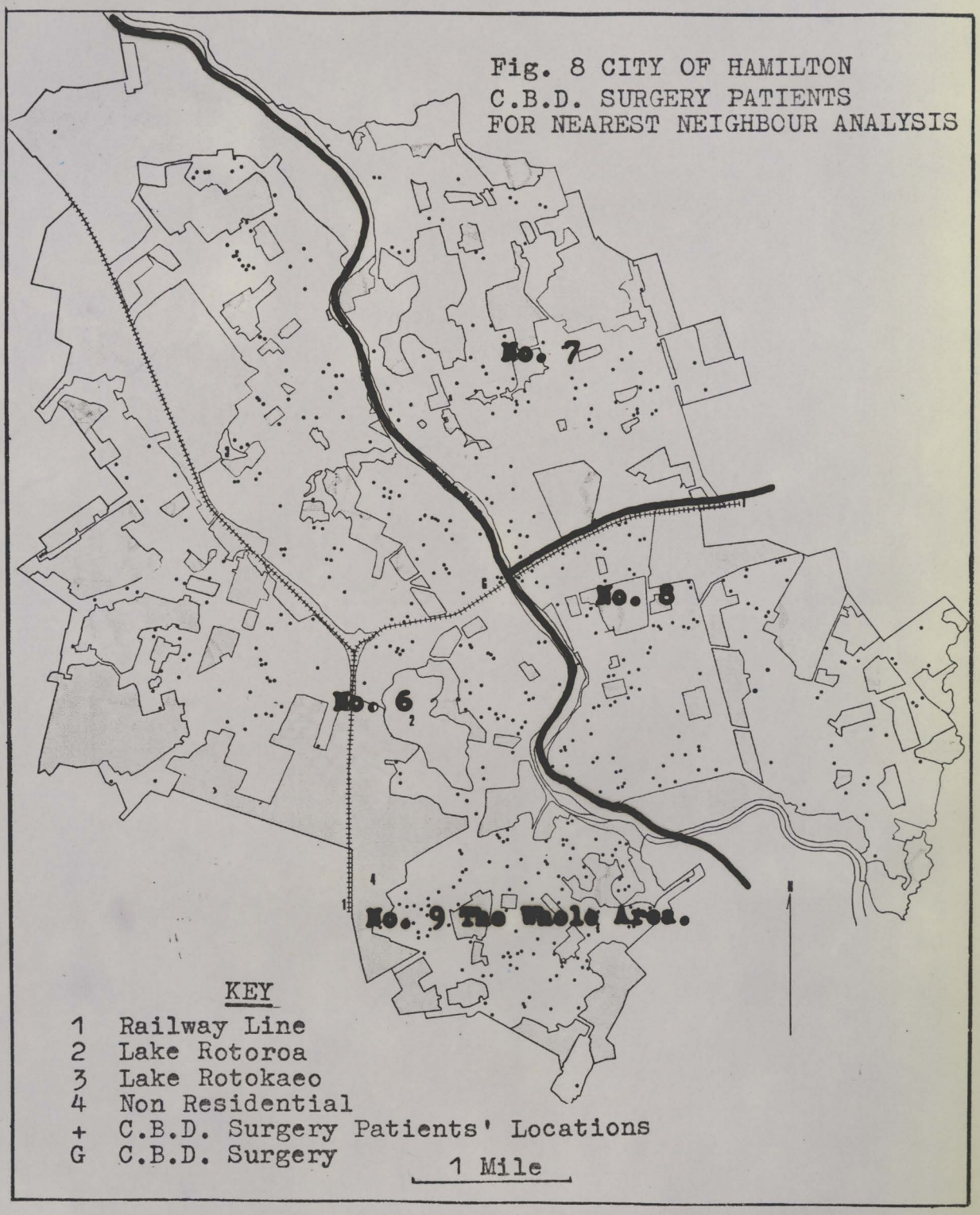


Fig. 8 CITY OF HAMILTON
C.B.D. SURGERY PATIENTS
FOR NEAREST NEIGHBOUR ANALYSIS
No. 7
No. 8
No. 6
No. 9 The Whole Area.
KEY
1 Railway Line
2 Lake Rotoroa
3 Lake Rotokaeo
4 Non Residential
+ C.B.D. Surgery Patients' Locations
G C.B.D. Surgery
1 Mile

Chapter 4: NEAREST NEIGHBOUR ANALYSIS

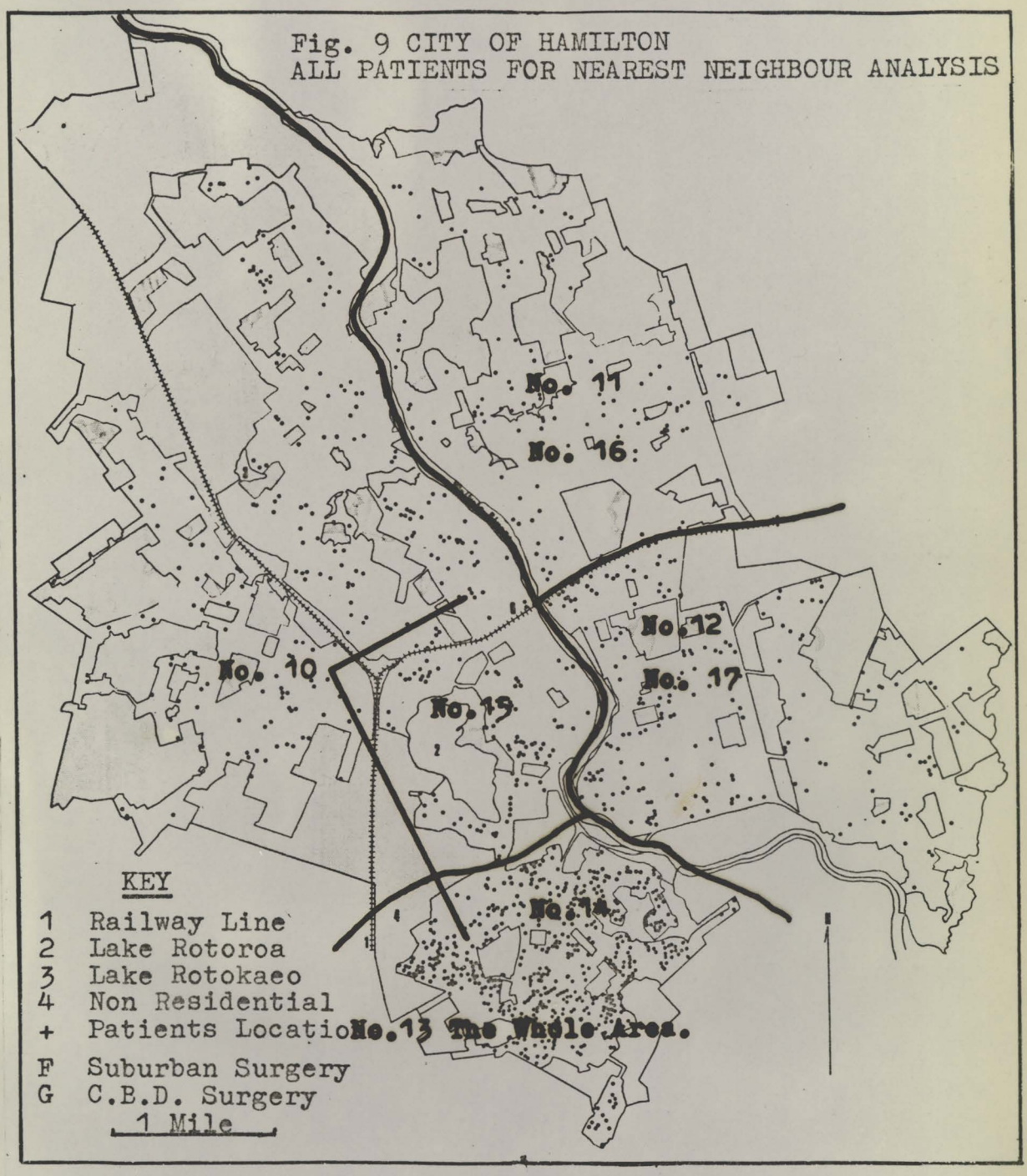
Philip J. Clark and Francis E. Evans (1954) have discussed a method describing the pattern of distribution of a population. This description is such that any two different patterns can be compared either descriptively or by reference to a numerical scale. Their method compares the observed pattern with that which would occur if the settlement was a completely random one. On their scale 0 represents a distribution with maximum aggregation, 1 represents random distribution, and 2.1491 represents distribution which is evenly and widely spaced as possible. The significance of departure from random expectation on the part of a given population can be calculated. This calculation results in an expression called the nearest neighbour statistic "R".

By calculating the statistic "R" for the population patterns shown by plotting the position of the patients' addresses on maps of Hamilton City (Fig. 7 and Fig. 8 and Fig. 9) a comparison and contrast of these patterns can be established.

Population Settlement Patterns.

There are 932 points locating patients who visit the suburban surgery and 531 points locating patients who visited the C.B.D. surgery. Each of these patient populations have been further dissected so that natural boundaries enclose a section of them. The sections can then be

compared with each other and with the whole area. In addition the two populations can be compared.



Delimiting The Population Patterns.

Table 1. Hamilton City Delimited for Nearest Neighbour Analysis. Fig. 7, 8, 9.

No. of Nearest Neighbour Area	Reference to City Area	No. of Nearest Neighbour Area	Reference to City Area
1.	Fig. 7 Section 1.	10	Fig. 9 Section 1 and 2
2.	Fig. 7 Section 2.	11	Fig. 9 Section 3.
3.	Fig. 7 Section 3.	12	Fig. 9 Section 4.
4.	Fig. 7 Section 4.	13	All patients in Fig. 9
5.	All patients in Fig. 7.	*14	Fig. 9 Section 1.
6.	Fig. 8. Section 1.	*15	Fig. 9 Section 2.
7.	Fig. 8. Section 2.	*16	Fig. 9 Section 3.
8.	Fig. 8. Section 3.	*17	Fig. 9 Section 4.
9.	All patients in Fig. 8.		

Total number of surveyed sections in Hamilton City equals 22763. *A equals 2 x 22763

Nearest Neighbour Statistic.

The Nearest Neighbour Statistic "R" is calculated from the formula:

$$R = \frac{\bar{D}\ obs}{De}$$

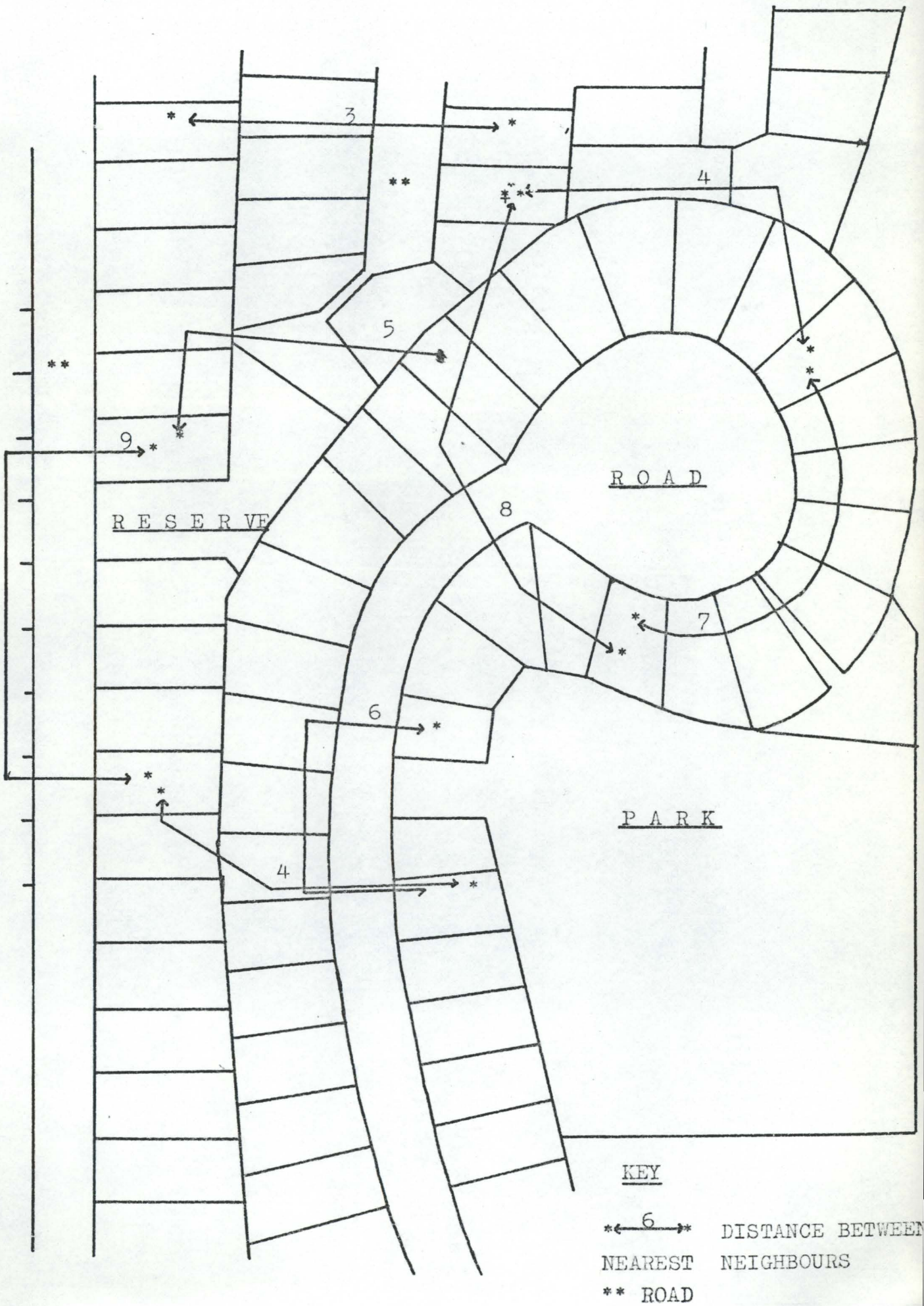
$$\frac{\text{observed mean distance}}{\text{expected mean distance}}$$

De is calculated $2\frac{N}{A} = \frac{\text{Number of sections in an area}}{\text{the area of a section}}$

A = 2 X 1 Section

Because the surveyed housing sections of Hamilton City have a variety of physical dimensions, and because there are large and small areas of land disperesed throughout the city which are not used for urban settlement, the unit of measurement between addresses has been fixed and "1 section" rather than a linear unit of measurement.

FIG. 10. DIAGRAM SHOWING METHOD OF MEASURING DISTANCES BETWEEN NEAREST NEIGHBOURS



A pair of nearest neighbours are always located on two surveyed sections of land. By counting the number of sections which separate the neighbours a unit of distance was found. Adjacent sections were one unit of distance apart, if there was one section between neighbours they were two units apart. Streets were always crossed at right angles and the street counted as one unit of distance. Distance could be measured in any direction as long as adjacent sections were traversed and counted. Non non-residential land could be crossed. (Fig. 10.)

It was assumed that all patients lived in houses but that as a house may theoretically occupy any location on a section no attempt was made to differentiate any part of a section. For the purpose of this measurement the dwelling was given as occupying the whole of the section. This meant that distances could be measured across sections on either side of a location point, at right angles across any road or street, but not across any park, river, or similar non-residential land, directly out of the back of any section and across any section adjacent to any section. (Fig. 10.)

Calculations of the Nearest Neighbour Statistic are for each of the numbered sections of Fig. 7, 8, and 9 and for the whole area of each figure, and also for the total number of patients in each section against the total number of sections in Hamilton City are shown in Table 2.

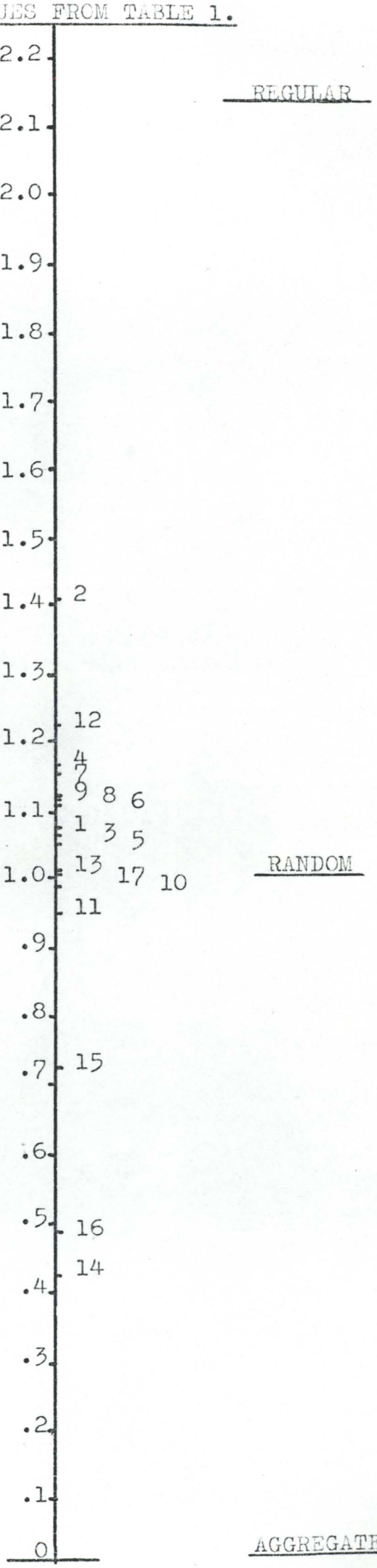
Table 2. Table of Statistics for Nearest Neighbour "R" Values.

SECTION	NO. OF PATIENTS	"R"
Suburban Surgery Patients Only		
1	546	1.067
2	183	1.4124
3	127	1.077
4	499	1.197
5	923	1.055
C.B.D. Surgery Patients Only		
6	259	1.1096
7	74	1.1677
8	98	1.1276
9	531	1.1204
All patients in each section		
10	1088	.9930
11	201	.9529
12	165	1.229
13	1454	1.0069
All patients in each section A = 2x22763		
14	567	.4274
15	1088	.7227
16	201	.4889
17	165	1.0076

A as defined in Table 1.

22763 = the number of housing sections in Hamilton City.

FIG. 11 GRAPH OF "R" VALUES FROM TABLE 1.



Comparison and Contrast of the Population Patterns

The "R" value of the pattern of population distribution of the doctor's patients can be seen graphically illustrated in Fig. 11. These values range from 1.055 to 1.4124 for C.B.D. and suburban surgery addresses. This difference is wide enough to show a variation in the individual patterns analysed. The area Fig. 7, number 2, has the pattern that is least random of those investigated while the area Fig. 7, number 1, is closest to random. There is not sufficient difference between the "R" values of all other patterns on the two figures to show a striking contrast between one pattern and the other.

When the addresses for both surgeries are combined in one map and treated as a single population, there is considerable difference between their "R" values. This is especially emphasized when the figure for A as used in the formula $2\frac{N}{A}$, is increased. The value of A is now twice the total number of residential sections in Hamilton City instead of twice the number of residential sections in a delimited area of the city. (Table 2)

When the total number of sections in Hamilton City is used to calculate A and all the patients who attend both surgeries are included to calculate the oberved mean distance, an "R" value is obtained which shows a much greater difference between the population patterns being investigated.

Number 14 (Fig. 9. Section 1.) now has the "R" value 0.4274 which is moving away from randomness towards aggregation. This area has the heaviest patient population and on the map appears visually to be the most clustered.

Number 13 (Fig. 9 Section 5) and number 17 (Fig. 9 Section 4) and number 10 (Fig. 9 Section 1 and 2) have "R" values which almost achieve the ramdom state. These three populations can be said to be comparable in their settlement patterns.

The population patterns shown by number 8 (Fig. 8 Section 3) and number 9 (All patients in Fig. 8), "R" values 1.1276 and 1.1204 respectively, are comparable. They have statistical values that are very similar and, although not close to randomness, are at a similar distance from the value for this state.

Other values showing some similarity are exhibited by number 1. (Fig. 7 Section 1) number 3 (Fig. 7 Section 3) and number 5 (all sections of Fig. 3). These values 1.067, 1.077 and 1.055 are close to random and close to each other. The two extremes shown when all values of "R" for all sections of Figures 7, 8, and 9 are compared are 1.4124, number 2. (Fig. 7 Section 2) and 0.4274 number 14 (Fig. 9 Section 1). These two populations are in the greatest contrast as regards settlement pattern.

Results indicated by this "R" value calculated show that in some areas of Hamilton City the doctor's patients live in closer pair-wise association than in others. The greatest clustering of patients would mean a greater concentration of acceptors of a disseminated idea and therefore a more powerful total carrier force and a better opportunity for the characteristics of the doctor to be further disseminated to those who do not know about him or those who knew but were not yet acceptors. A powerful node of acceptors in one area of Hamilton does not necessarily

mean a greater dissemination of information elsewhere in the city. But as the population of Hamilton City is extremely mobile (Hamilton City Council, 1968) and 91% of the city homes have a telephone (Mr. Mollar, N.Z. Post Office Engineers Dept, pers. comm.) there are opportunities for this large cluster of acceptors to influence non-acceptors who are not only their immediate neighbours but also their contacts in other parts of the city.

There are 2449 houses in number 1 (Fig. 7 Section 1). Five doctors have surgeries in this area so that an average of 490 patients per doctor could be expected if each doctor treated his share of the patients available. The doctor in this study treated 538 patients, which is 2% more than his share of the population.

Figure 1 will show that the 5 doctors surgeries are dispersed throughout this area, and that this doctor's patients (Fig. 9.) come from all over the area. It can be shown that some patients in the suburban surgery area of Hamilton do not go to their nearest doctor but pass intervening opportunity to visit the doctor in this study.

Every city patient who comes to the suburban surgery from outside the suburban surgery area must pass an increasing number of other doctor's surgeries as the distance from their origin to the suburban surgery destination increases.

West of the river, Fig. 9 Number 15, there are 7,393 houses, 2.57 percent attend the suburban surgery and 3.3 percent attend the C.B.D. surgery. East of the river and north of the railway line, Fig. 9 Number 16, there are 5,167 houses and 2.55% of these residents attend the suburban surgery while 1.4% attend the C.B.D. surgery. East of the

river and south of the railway Fig. 9 Number 17, there are 5,575 houses, of which 1.2% attend the suburban surgery while 1.85% attend the C.B.D. surgery.

A slightly greater percentage of the population attend the doctor from addresses west of the river, but east of the river the patients live closer to each other in a nearest neighbour relationship.

Transportation routes leading to the C.B.D. and the traditional association of Frankton with the C.B.D. may account for the relatively low attendance of these residents at the southern suburban surgery. It is noticed that the highest attendance at the C.B.D. surgery comes from the Frankton area. Patients from the northern areas west of the river would move south on transport routes that enter the C.B.D. and therefore provide a number of intervening opportunities for professional attention.

In the area east of the river and north of the railway line, transportation routes lead to the C.B.D. but good quality bypass routes, Heaphy Terrace, Grey Street and River Road all join the motorway south. This motorway south provides rapid access to the suburban surgery Fig. 1. It is possible that people requiring professional attention and being able to travel find it more convenient to travel by the motorway route to the suburban surgery than they do to a C.B.D. surgery. The distance is greater but parking will be much easier.

Patients in the area east of the river and south of the railway have several choices available to them. The transport routes go directly to the C.B.D., access to the southern motorway is good, and several intervening opportunities

for professional service are available in this area.

The reduced percentage attendance of the population in this area to the suburban surgery can be accounted for in some measure by better transport facilities to the C.B.D. surgery and more intervening opportunities.

As has been pointed out in Chapter 3. there is no way of isolating the C.B.D. surgery patients who work in the C.B.D. from those who travel in to this surgery especially for professional treatment.


Fig. 12 CITY OF HAMILTON
DESIRE LINES TO SUBURBAN SURGERY
1Mile

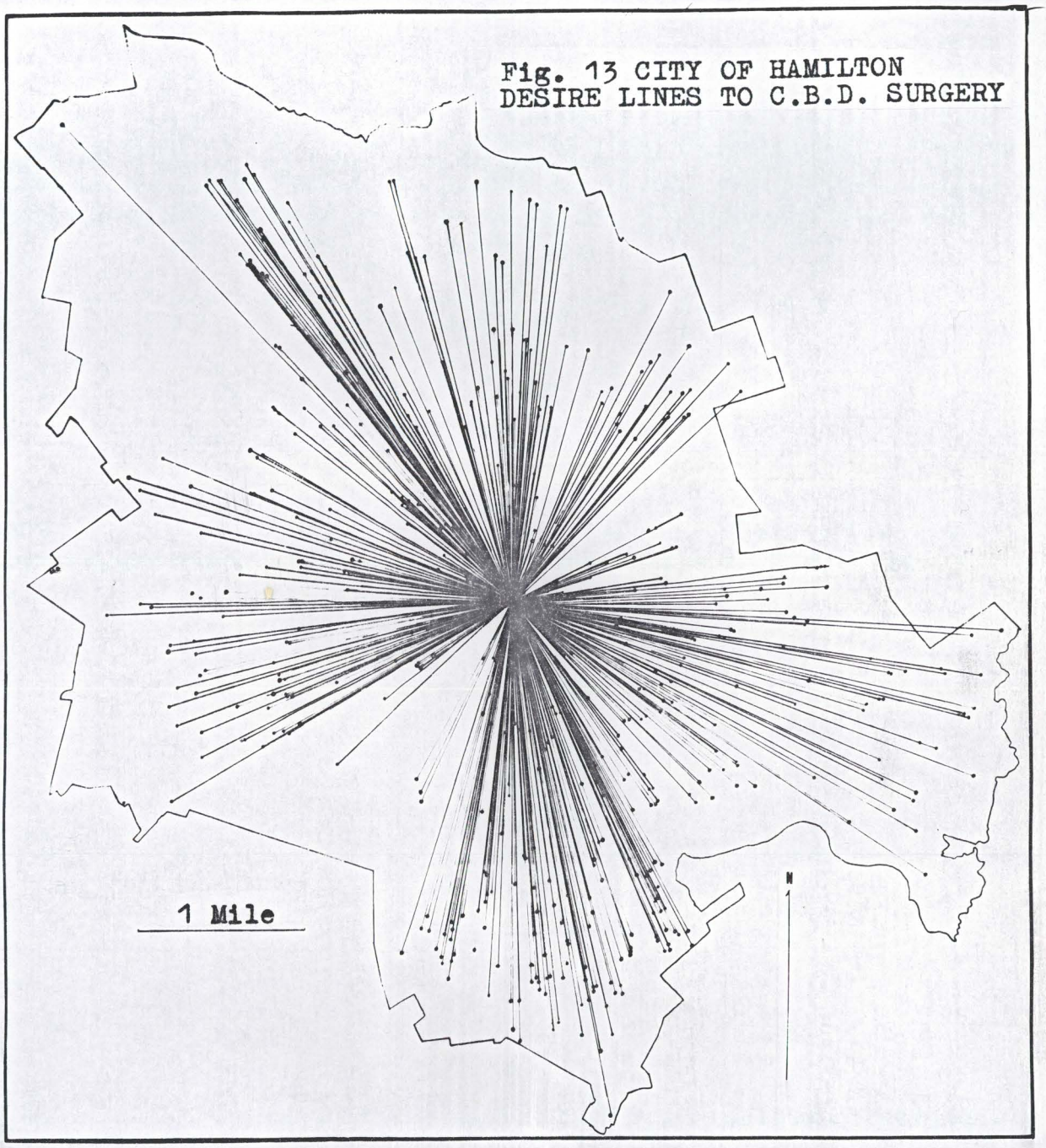


Fig. 13 CITY OF HAMILTON
DESIRE LINES TO C.B.D. SURGERY
1 Mile
N

Chapter 5. DESIRE LINES.

Lines joining the patients' home addresses to the surgery they visit indicate the origin-destination patterns of this study. In Fig. 12 the suburban surgery and patients are shown and in Fig. 13 the C.B.D. surgery and patients are shown. In each case the patients who attend both surgeries have been located in each figure. Each address is joined to its appropriate surgery by a "desire line".

The pattern of these desire lines which emerges in each case is basically descriptive. It provides a visual check on movement from residence to surgery. Berry (1967) and Berry & Horton (1970) use this method for comparing and contrasting the patterns exposed by origin destination movements from a residence to different markets for different commodities.

In comparing and contrasting Fig. 12 and Fig. 13, the following points should be noticed.

Comparison.

1. Both figures have a destination point with a radiating pattern of desire lines to origin points.
2. Both patterns show up areas where the patient population is dispersed or absent. This is particularly noticeable in Fig. 13.
3. Both figures illustrate the widespread nature of the patient pattern in Hamilton City.
4. Both figures illustrate the distance travelled

by those who attend this doctor's surgeries from north of the C.B.D.

Contrast.

1. Figure 12 has a greater number of origin points and therefore a denser desire line pattern.
2. Figure 12 has a very heavy concentration of patients located close to the surgery. Figure 13 shows addresses dispersed from the surgery. If the location of employment addresses had been mapped this pattern may have been considerably altered. (Chap. 4)
3. The pattern of settlement exposed supports the statements in Chapter 4 that more people attend the C.B.D. surgery (Fig. 13) than the suburban surgery (Fig. 12) from areas West of the C.B.D. and South East of the C.B.D.
4. South West and North East of the C.B.D. surgery there are spaces void of patients. These spaces probably exist for the suburban surgery also but they are not obvious because of the masking nature of the dense lines in Fig. 12.

These movement patterns, taken in conjunction with the material presented in preceeding and succeeding chapters, will help to illustrate the range of the doctor's urban practice and the varied location of his patients.

Chapter 6. TESTING THE HYPOTHESIS.

In order to test the hypothesis that the selection of a doctor in Hamilton City is a function of knowledge about him rather than distance from his surgery, it was decided that data was to be obtained from the patient population by a postal questionnaire. Information from the responses was to be tested so that a possible relationship between the doctor attended and the head of the household could be established. (The questionnaire is discussed in Appendix 1.)

The relevant data from the questionnaire was classified so that there were four basic variables, with a total of 13 sub-divisions.

Table 3. Classification of Variables for Chi-Square Analysis

The Choice of Doctor (W)		Mode of Transport (Y)	
W_a	Nearest Doctor	Y_a	Private Car
W_b	Doctor chosen from verbal information received.	Y_b	Public Transport
		Y_c	Walk
W_c	Doctor chosen from Non-verbal information received		
		Age of Head of Household (Z)	
Head of Household (X)		Z_a	Under 25 years
X_a	Male	Z_b	25 - 44 years
X_b	Female solo parent	Z_c	45 - 64 years
X_c	Female	Z_d	Over 65 years

The Chi-Square test for independance was applicable to this study as each of the four variables could be classified into discrete categories. (Siegel, 1956). The symbol χ^2 refers to the quantity which is calculated from the observed

data when a χ^2 test is performed. "The words Chi-Square will refer to a random which follows the Chi-Square distribution" (Siegel, 1956 p. 43.) While constructing the four dimensional contingency table (Table A1) it was found that insufficient information existed to establish values for each of the surgeries classified, F, G, and F and G, so that the total attendance at the surgeries was used. That is, the values of F, G, and F and G, were added together to make one matrix total which obviously reduces the analytical value of the study and the possible applicability of the results of this section.

Testing the Four Variables.

The Null Hypothesis. H_o: the four variables W, X, Y, Z, are independent. H_o: There is dependence between the categories W, X, Y, Z, but the nature, direction, and strength of this dependence is unspecified.

Significance Level: The null hypothesis was tested at

$\alpha = 0.05$ with $N = 288$.

Sampling Distribution: Under the null hypothesis, χ^2, as computed from the formula: -

$$\chi^2 = \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{p} \sum_{l=1}^{q} \frac{O_{ijkl}^2}{E_{ijkl}} - \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{p} \sum_{l=1}^{q} O_{ijkl} \qquad \text{(Equation 1)}$$

Where O = the observed frequency

E = (product of intersecting co-ordinate marginal totals of responses) divided by (total of valid responses)

i refers to W_i

j refers to X_j

k refers to Y_k

l refers to Z_l

is distributed approximately as chi-square with degrees of freedom,

$$df = (n - 1)(m - 1)(p - 1)(q - 1)$$

The probability associated with the occurrence under H_o of values as large as an observed value of χ^2 is shown in Pierce (1970, p. 279).

Rejection Region: The region of rejection consists of all values of χ^2 which are larger than the tabled values for the specified number of degrees of freedom at $\alpha = 0.05$

Decision: The calculated value of the four dimensional χ^2, using the formula above, is 172.0, which greatly exceeds the value of 49.73 that is critical for an α level of probability of 0.001 which is < 0.05. Consequently at $\alpha = 0.05$ H_o was rejected and the alternative hypothesis, H_1, was accepted although the nature of the dependence was unspecified.

Two dimensional and three dimensional chi-square tests were applied to establish which combinations of the four variables revealed significant dependence and which were statistically independent at $\alpha = 0.05$. The thirteen possible combinations of the four variables, the calculated values, and the acceptance or rejection of the null hypothesis are presented in Table 4.

The results presented in Table 4 indicate possible sources of dependence between the four variables. Further investigation of this dependence is outlined in Chapter 7 where certain detected patterns of the observed and expected frequencies are compared. By χ^2 testing the possibility of

dependence between any two of the variables further information was obtained which helped to direct the inquires in Chapter 7.

Table 4. Chi-Square Tests for Independence Between Variables W, X, Y, Z, at $\alpha = 0.05$.

COMBINATIONS OF VARIABLES	DIMENSION OF TEST	df	χ^2	RESULTS
(W,X) (Y,Z)	2	88	105.8	accept H_o
(W,Y) (X,Z)	2	88	55.6	accept H_o
(W,Z) (X,Y)	2	88	119.9	accept H_o
(W) (X,Y,Z)	2	70	56.1	accept H_o
(X) (W,Y,Z)	2	70	84.2	accept H_o
(Y) (W,X,Z)	2	70	73.4	accept H_o
(Z) (W,X,Y)	2	70	113.2	accept H_1
(W) (X) (Y,Z)	3	44	128.5	accept H_1
(W) (Y) (X,Z)	3	44	108.5	accept H_1
(W) (Z) (X,Y)	3	44	140.8	accept H_1
(X) (Y) (W,Z)	3	44	147.2	accept H_1
(X) (Z) (W,Y)	3	48	190.0	accept H_1
(Y) (Z) (W,X)	3	48	148.3	accept H_1
(W) (X) (Y) (Z)	4	24	49.7	accept H_1

H_o: At $\alpha = 0.05$ the relevant variables are independent.

H_1: At $\alpha = 0.05$ there is some dependence between the variables.

W is the choice of doctor.

X is the head of household.

Y is mode of transport.

Z is age of head of household.

df = degrees of freedom

Chapter 7. ANALYSIS OF INDIVIDUAL CELL VALUES

By examining the observed and expected values of individual cells, it may be possible to indicate more clearly the sources of the significance of the χ^2 tests undertaken. Where the value of the observed frequency, O, greatly exceeded the value of the expected frequency, E, or vice versa, some explanation of this difference was attempted.

Calculation

The figures for O and E in each cell of each of the 13 χ^2 tests were compared by the formula:

$$S = \frac{(E - O)^2}{E} \qquad \text{(Equation 2)}$$

Where O and E are as previously defined in Equation 1.

Squaring the difference between E and O eliminates any negative quantity and the ratio, in terms of the expected value, isolates instances where the difference is large enough for further investigation. Cells in which E was less than twice the frequency of O or O was less than twice the frequency of E were ignored in this calculation being regarded as not having values sufficiently different to the expected. In all cases that were accepted for further study O and E had values less than 6.

All cells extracted were listed with their X, Y, Z, descriptions and their S value. Separate lists for values associated with W_a, the nearest doctor and W_b, the doctor of choice accounted for all values of W.

Table 5. Number of χ^2 Tests in Which $S \geq 2$ / $S \geq 4$ for Individual Cells in the Four Dimensional χ^2 Contingency Tables.

		Y_a			Y_b			Y_c		
		X_a	X_b	X_c	X_a	X_b	X_c	X_a	X_b	X_c
Z_a	W_a	14 4			4 -			3 3		1 -
	W_b			9 9		12 -	11 -			12 11
	W_c									
Z_b	W_a								9 9	
	W_b					6 -	1 -	8 3	6 1	
	W_c									
Z_c	W_a							2 -		
	W_b				1 -			2 -		
	W_c									
Z_d	W_a									
	W_b				9 9			1 -		
	W_c									

$S \geq 2$ Top Line
$S \geq 4$ Bottom Line

W_a Nearest Doctor
W_b Doctor of Choice evaluation of verbal information received.
W_c Information from non-verbal sources: e/g telephone book.

Y_a Private Car
Y_b Public Transport
Y_c Walk

X_a Male Head of Household
X_b Female Solo Parent head of household
X_c Female head of household

Z_a Under 25 years
Z_b 25 - 44 years
Z_c 45 - 65 years
Z_d Over 65 years

Analysis of Calculations

Table 5 shows the total number of times the value of S for individual cells was ≥ 2 in all the 13 χ^2 calculations (Table 4.) It also shows the number of times $S \geq 4$. Where $1 \leq S < 2$ no anomolies were apparent and the data were discarded. All values of S for each cell for each calculation in Table 4, are shown in Table A2 in the Appendix. Those cases where Observed responses were much less than Expected are marked with an asterisk.

Nearest Doctor (W_a) Female heads of household in both categories ($X_{b,c}$) and in the under 45 years age group ($Z_{a,b}$) walked to the nearest doctor more often than expected. However, with the exception of the F.S.P. in the 25 - 44 years age group who walked to the nearest doctor ($W_a X_b Y_c Z_b$), each of these results showed a low value of S and the number of values of $S \geq 2$ was limited. The ($W_a X_b Y_c Z_b$) cell was an extreme case with ten values of S between 4.0 and 12.5.

In each case where the selection of the nearest doctor (W_a) has resulted in a critical value of S $O \geq E$, the mode of transport has been walk. Many of the young unmarried female heads of household who walk to their nearest doctor are student nurses who are treated by the doctors at the Waikato Hospital but who may also use the services of a private doctor (doctor of choice) for special medical needs. F.S.P. in the 25 - 44 age group are usually not in a financial position to own a car and visit their nearest doctor for this reason. Four of the ten F.S.P. respondents indicated that the nearest doctor was also the doctor who had been recommended by a friend. In this age group many F.S.P. also walk and travel

by public transport to the doctor of their choice.

Males in the under 25 years age group did not travel by private car as often as would be expected. The number of times a critical value of S appeared in this cell was high and the value of $S \geq 2$ was also high in each case. In every case the frequency of the Observed responses was much less than the Expected.

It is possible that male heads of household in the under 25 age group do not have private cars readily available to them. In many cases the financial strain of marriage and setting up a house will preclude the purchase and operation of a car at this age level. No other cells in the W_a category appeared to require further investigation.

Doctor of Choice(W_b) Female heads of household in both categories, and using all modes of transport made an informed choice of doctor much more often than the Expected values in the contingency tables have indicated. (The variable combinations $W_b\ X_{b,c}\ Y_{a,b,c}\ Z_{a,b}$). More males in the over 64 age group travelled by public transport to the doctor of their choice ($W_b\ X_a\ Y_b\ Z_d$) than was Expected. Males in the 25 - 44 years age group did not walk to the doctor of their choice as often as expected ($W_b\ X_a\ Y_c\ Z_b$). Generally the critical values of S for attending the "doctor of choice" were high (Table A2) and in all cases except the ($W_b\ X_a\ Y_c\ Z_b$) cell the Observed responses exceeded the Expected frequencies.

Unmarried females using all modes of transport who

visit the doctor of choice more often than expected are usually in some tertiary education and flatting with others of similar age. They have contact with other flat mates and their educational peers. They are usually financially independent so that private transport is available if necessary but they may choose to use public transport or walk if the doctor's surgery is within walking distance.

F.S.P. have contact with each other through their Solo Parents Club and can gain information about a doctor that is satisfactory to other F.S.P. from this source and through other friends.

In cell ($W_a X_a Y_c Z_a$) the three critical values of S all equal 4. In cell ($W_a X_b Y_c Z_b$) eight of the values of S equal 4 but only two are significantly higher than 4.

It would appear that although attraction of the nearest doctor is strong at a critical S value of $\geq$ 2 this attraction declines rapidly when the critical S value is raised to $\geq$ 4.

Doctor of Choice It should be noted that although two cells ($W_b X_{b,c} Y_b Z_a$) have at least eleven values $2 \leq S < 4$ and one cell ($W_b X_b Y_b Z_b$) has six values of $2 \leq S < 4$ the high number of values of S in this range is significant because it shows that there is an increased weighting towards a conscious choice of doctor.

In the four cells where individual values of $S \geq 4$ are isolated these values make up a high percentage of the total number of individual values of $S \geq 2$. These four cells are

as follows: (W_b X_a Y_b Z_d) (W_b X_b X_c Z_b) (W_b X_c Y_a Z_a) (W_b X_c Y_c Z_a).

By referring to Table A2 it will be seen that for these cells the individual values of S are often very high and that in no case is the Expected frequency greater than the Observed frequency. The highest and most numerous values of $S \geq 4$ are found in the cell (W_b X_c Y_c Z_a). Young unmarried females walking to the doctor of their choice. Similar females who use private transport to the doctor of their choice (W_b X_c Y_a Z_a) and men over the age of 65 who use public transport to the doctor of their choice (W_b X_a Y_b Z_d) also are shown to have significantly high values of $S \geq 4$ in their respective cells.

Chapter 8. INFORMATION AND THE MEAN INFORMATION FIELD.

The findings of the preceeding chapter were discussed fully with the doctor. Some attempt was made to extract from the list of characteristics (Chapter 1) those that were exemplified by the doctor in an attempt to find what information about the doctor was being diffused through the population. It was felt that the areas in Chapter 7 that showed observed frequencies significantly higher than expected frequencies could be explained in the light of results from information about the doctor being diffused, accepted and adopted in a certain pattern.

Information about the doctor himself, his extra professional activities, and his special interests and qualifications was found to be relevant to this study.

Doctors Characteristics.

1. The doctor is a young man in the 25 - 35 yrs. age group.
2. He has taken over the practice of a long established doctor who had retired.
3. In taking over this practice he has built it up to include many more patients. A younger more active man has been able to handle, and is desirous of handling, more patients than a doctor near retiring age.
4. He is involved in a community service club, the Solo Parents Club.
5. He actively plays two sports. Indoor basketball and squash.

6. He belongs to an ethnic group that is traditionally felt to be patient and considerate in associating with people of all age groups.
7. This doctor had built up a reputation, particularly amongst younger women, for sympathetically listening to personal and emotional problems and offering counsel in such cases.
8. In common with some other doctors in Hamilton this doctor has prescribed oral contraceptives to unmarried females.

Response to These Characteristics.

Each of these characteristics has been influential in attracting more than the expected number of patients in some cells of the matrix.

1. There is a pair-grouping affiliation between younger people and a younger doctor. This is borne out by the number of unmarried females and the young female solo parents who visit in excess of the expected numbers. Young single males did not respond to the questionnaire. They may or may not have had the same need for professional attention and they may or may not feel the same age-pair-grouping affiliation.
2. The previous doctor had been in practice for over 30 years and had not only a solid core of older people who had established a close doctor-patient relationship, but also the children of these people were happy to continue this relationship. When the practice changed hands, most of the established patients continued their association with the new doctor and so did their children who were liv-

ing in the area.

3. Because the new, younger doctor could handle more patients, new patients could establish that association which was not possible with some other Hamilton doctors whose practices were already "full". Several Hamilton doctors do not accept new casual patients because they have established professional relationships with sufficient people to keep them busy. Only as regular patients move out of town are there vacancies for new patients, and these are usually accepted from amongst new arrivals to the city who have a note of reference from their previous doctor in another area. People moving into Hamilton without such a reference may find it difficult to find a doctor who will accept them as a patient.
4. Because of an interest in social welfare, this doctor has become associated with a Solo Parents Club of which he is a Patron, and in this capacity is identified among the members of the club, and other solo parents who are in communication with club members, as a young doctor interested in their problems.

Many female solo parents have great difficulty rearing their younger children because of the lack of help from a husband. The emotional strain caused by widowhood, divorce, or separation, together with that which may occur when a new male interest is cultivated can lead to difficulties which are not medical but which can be alleviated if discussed with a sympathetic listener. This alleviation is much more effective if the sympathe-

tic listener is a doctor who has an interest in, and training in, the field of family counselling.

5. Active participation in a team sport such as indoor basketball will give further opportunities to cement understanding and confidence with other participants who will be in the age group 16 - 25. The squash club association may mean a different association with a different set of young people in a different socio-economic group and perhaps in an older 20 - 35 age group.
6. In addition to the female solo parents, many younger females have emotional problems as a result of pre-marital sexual activities. They are no longer able to communicate with their parents, because of mutual misunderstandings or absence from home, but can establish a productive communication with a doctor who has the professional and personal characteristics described here. Many unmarried females participate in sexual relationships with the attendant physical, medical, and emotional problems of pregnancy, venereal disease, or the fear of either or both of these occuring. Girls suffer from unwanted pregnancies and tend to worry more about the occurence of pregnancy or venereal disease than do boys. (Louglin, 1969). Consequently girls, more than boys, will seek medical advice in this health area. Some medical practitioners do not prescribe oral contraceptives to unmarried females, but this doctor has a different approach to this problem. He feels that he has no control over the sexual activities of his patients, but is required to treat the problems resulting therefrom. As

a result, he is prepared to prescribe oral contraceptives in counsel with his patients.

7. Ethnic group membership was given by a number of respondents to the questionnaire as the reason for choosing this particular doctor. He appears to have the characteristics traditionally associated with his ethnic group, and he states that many people come to him for treatment because of this factor.

Mean Information Field.

The information being diffused about this doctor is not propogated by the mass media. Doctors in New Zealand do not advertise and the ethics of their profession prohibit any form of business promotion. The definition stated by Marble & Nysteun (1963, p.100) that the "Mean Information Field is designed to express the average spatial extent of an individual's short-term (i.e. non-migratory) contacts," does not completely fit this case as the population of Hamilton is highly mobile and also able to use a comprehensive telephone system. However, the definition is applicable to this case in that all information diffusion takes place by word of mouth.

Chapter 9. CONCLUSION

This Hamilton study has shown that a significant number of people with some particular characteristics of sex, head of household status, and age go to the doctor of their own choice rather than their nearest doctor.

In some instances these patients have been made aware of information about the doctor by word of mouth from any one of, or a combination of several sources. In other more specialized cases immigrants to Hamilton have been introduced to a certain doctor by their previous doctor.

Analysis of the attraction of the doctor's surgery as a destination shows that in one case over about half the possible urban distance a decay of patients with distance occurs, but that after this half way point has been reached the inverse variation with distance declines rapidly.

In comparing the patient population settlement pattern of various sections of Hamilton City, it can be shown that individual sections have patterns close to random in most cases but that when the pattern of each section is compared with the total City pattern a wide divergence of nearest neighbour "R" values result These values reveal the relative proximity of pair-wise neighbours. Where the "R" values is lowest the clustering of patients is highest and the number of patients per unit area is greater.

Desire lines illustrate movement. The movement of people from their homes, in this case, to the location of the doctor's surgery. The patterns outlined by the two maps (Fig. 12 and Fig. 13) emphasize the overall attraction of each surgery and compares the density of patients going to

each surgery.

When the data collected from the postal survey is subjected to statistical testing a comparison of the observed and expected frequencies associated with a wide variety of combination of patient characteristics can be examined. Their variations, both more than and less than expected, provide the basis for examining the stated hypothesis.

Information about the doctor has been diffused by verbal pair-wise contact to acceptors and adoptors. Some of these people feel they have a need for the special services that the doctor appears to them to have. Because they are prepared to travel past their nearest doctor to procure these services they help to increase the number of observed frequencies in relation to those expected.

This increase eventually becomes sufficiently great in some cases so that the hypothesis; "that within Hamilton City the selection of a doctor is not a direct function of the distance from a patient, but is dependent upon the information about the doctor that is received by the patient" can be accepted.

Appendix 1. THE RESEARCH SURVEY

The Design of the Questionnaire

A decision was made to survey the patient population by postal questionnaire. It became necessary to design a questionnaire that could be easily understood by a cross section of the population and would also provide the researcher with sufficient valid information to enable the research programme to be completed.

A personal interview can be lengthy and complicated because the interviewer can help the respondent to understand obscure questions. In this method a wide range of topics can be covered in an atmosphere of social hospitality.

Such an atmosphere is not present when a postal questionnaire is used to gather the information sought and even carefully worded questions can be misunderstood. However, in any given time interval, and under conditions of cost restraint, a postal questionnaire can be administered to a greater number of people and will return an acceptable number of valid responses. (Selltiz, Jahoda, Deutsch, Cook, 1965).

Because respondents are not under any compulsion to answer a postal questionnaire, its form and the number of questions, and the type of questions, have to be carefully selected so that a potential respondent, who is indifferent to the whole matter, will not be completely dissuaded from answering the questions and posting the reply. Questions were to be limited in number and simply phrased to encourage potential respondents to reply to them.

Such a questionnaire would need to return 300 valid replies (Mr. B.R. Stokes, Hamilton Teachers College pers. comm.) to provide a sufficient data base from which acceptable calculations could be made. No information regarding postal questionnaires in Hamilton City was available, but it was eventually decided that at least 900 questionnaires would need to be posted out to return the required number of responses. (Mr. T.W. Fookes, Geog. Dept., University of Waikato pers. comm.)

Contents of the Questionnaire.

The contents of the questionnaire were compiled after discussion with several interested parties. A discussion with the doctor who supplied the patient addresses established what he thought should be included in the questionnaire. Result:

1. Age of respondent.
2. Marital status of respondent.
3. Dependent relatives, aged or young in the household.
4. How many doctors the family called on.
5. What professional services associated with the doctor and working in the same building would the respondent prefer.
6. Frequency of house calls.

A further discussion with the lecturer in charge of the project was held to establish what he thought should be included.

esult:

1. How long has the patient been visiting the doctor.
2. How was the doctor chosen.
3. What mode of travel is used to visit the doctor's surgery.
4. In any change of address, was the doctor changed.
5. If the doctor was changed, why.

After these discussions a questionnaire was designed which included questions that were to elicit the above information.

Test the Questionnaire.

72 copies of the test questionnaire were distributed to households in Temple View. The householders were asked to answer the questions and the papers were collected the next day.

On the next day 43 complete replies were collected. Householders who did not respond were either not interested in replying, absent from home when the collector called, had misplaced the questionnaire, or were inconveniently situated when the collector called.

The response information which this test questionnaire brought forth showed that some changes were necessary in the wording of some of the questions and this was carried out.

Revise the Questionnaire.

1. Investigation of the responses showed that some adjustments to the form of some questions was necessary.
2. Rephrasing of several questions to make them unambiquous

was the main change necessary. In other instances questions were rewritten so that yes - no answers could be checked, or the question was provided with a series of standard answers, one or several of which could be checked in the box provided.

3. Because several respondents wrote in items that had been ommited from question 16, this question was expanded to include the items ommited.
4. The questionnaire was completely rewritten and submitted to the following persons for comments.
   a. The Reader in Geography at the at the University of Waikato.
   b. Seventh Form students at the Church College of New Zealand.
   c. The typist for typing.

In each case, a, b, c, some further minor changes were made in the questionnaire as a result of comments made by these parties. The final draft of the questionnaire was retyped Fig. 14.

The Questionnaire.

1. The heading. It was necessary to address the questionaire to a person, the wording was "To The Head of The Household." This address was satisfactory in most cases, but in about 5% of the responses the wording was objected to. It was possible that others too objected to the wording and therefore did not respond. Typical objections, "Partnership of marriage, there is no head in our household."

In any further questionnaire this heading and question one need to be phrased differently so that it will be non controversial.

FIG. 14. THE QUESTIONNAIRE

THESE QUESTIONS RELATE TO THE HEAD OF THE HOUSEHOLD.

Q.1. Male/Female

Q.2. Which age group is the head of the household in:

_____ under 25

_____ 25 to 44

_____ 45 to 64

_____ over 65

Q.3. How many permanent residents are these living in your home at present: _____

Q.4. How many children are there in the household:

_____ under 10

_____ 10 & over

Q.5. Are you a solo parent: YES/NO

Q.6. Do you have any elderly parents or elderly relatives living with you permanently: YES/NO: If yes, how many _____

Q.7. How many family doctors (not specialists) do you go to: _____ none

_____ one

_____ more than one

Q.8. Do you go to one family doctor more than another: YES/NO

Q.9. How long have you been visiting your family doctor:

_____ less than 6 months

_____ 6 months to 1 year

_____ 1 to 2 years

_____ more than 2 years

Q.10. How did you choose your family doctor. You may check more than one of these: ____doctor nearest my home

____doctor recommended by friend

____doctor suggested by another doctor

____found name in telephone book

____saw name while passing

____other. Please state_____

Q.11 How do you usually travel to your doctor's surgery:

_____by own car

_____friends car

_____bus

_____taxi

_____walk

_____other (please state)_____

Q.12. Do you have your doctor make house calls:

_____ never

_____sometimes

_____frequently

_____always

Q.13. Have you changed your address in the last 12 months: YES/NO. If yes, was the change outside Hamilton City _____ or inside Hamilton City _____

Q.14. Have you changed your doctor in the last 12 months: YES/NO

Q.15. If you changed your doctor was it because of:

_____increased travel required

_____no appointment available at usual doctor

_____fees too high

_____dissatisfied with usual doctor

_____other (please state) _____

Q.16. Would you like any of the following who work with your doctor to be in the same building as your doctor:

_____physiotherapist
_____psychiatrist
_____social security officer
_____counsellor
_____Professional nurse employed by doctor
_____laboratory
_____x-ray
_____don't know

Thank you for answering this questionnaire. Will you please put it in the envelope provided and post it as soon as possible.

e.g.

1. Is the head of the household male, female, joint partnership, other please state.
2. Is the person filling in this form male, female.

Question 2. No problem with this question. It was designed to classify the population into groups.

a. Young, unmarried males or females, or the young married couples with no children or very young children.
b. Married couples with young families.
c. Couples with older families.
d. Retired couples, no dependant children.

Question 3. A question to check the answers in questions 1, 2, 4, 5, 6.

Question 4. This question was designed to find out whether any children or children of a certain age group had any bearing on doctor choice.

Question 5. Solo parents were considered to be a special case as most of these were thought to be younger women. In fact, all respondents were women under 45. The question was designed to find out whether there were any special factors involved in solo parent medical care.

Question 6. How many homes had elderly relatives living in them and what special services may be sought in these cases. Fewer than five respondents had elderly relatives living in their homes.

Question 7. It was thought that some individuals may attend more than one doctor and question 7 and question 8 were designed to test this. The questions were ambiguous and con-

fusing to some respondents. A person could attend only one doctor, but answer yes to question 8 and be correct. This was not intended. The question would need rephrasing in a future questionnaire.

Question 9 establishes the length of association between doctor and patient.

Question 10. The response to this question was very good but it has been found that multiple responses are hard to work with if they are not ranked in importance. The same applies to questions 11 and 16. However, any answer that was not "doctor nearest my home" could have been interpreted as a choice resulting from information received about a doctor.

Question 11. Mode of transport. Responses to this question shows a high percentage of car ownership.(Census, 1971.)

Question 12. Almost every respondent answered "sometimes". This question could have been rephrased to elicit the reason for housecalls or the period of day or week when housecalls were in greatest demand.

Question 13, 14, and 15. If people changed their address within the city, did they then change their doctor and why. If people had changed their doctor then why. Most changes were caused because of address transfer from out of the Hamilton area to within Hamilton City so that a change of doctor was a result of the patient moving completely out of the range of service of their previous doctor.

Question 16. The doctor was anxious to see what services a possible medical centre would need to offer. Professional nurses employed by the doctor to handle some medical needs like injections, dressings, routine visits to the invalids

were in popular demand as were the services of a laboratory and x-ray clinic. Some few respondents checked all 7 items.

PREPARE THE QUESTIONNAIRE FOR POSTING.

930 copies of the questionnaire were printed, (Fig. 14) and a similar number of envelopes, addressed to the Geography Dept. University of Waikato, reply paid.

A similar quantity of a letter of introduction written on the University of Waikato letterhead and signed by Mr. T. W. Fookes, lecturer in charge of the project was also printed.

The addresses obtained from the doctor's records were listed alphabetically by street name and numerically by house number. This was done separately for F, G, F and G, and each address was numbered. Each section F, G, F and G, was randomly sampled from a list of random numbers (Gregory 1963, p.91) until there were 517 addresses obtained from F, 235 addresses obtained from G and 164 addresses obtained from F and G, giving a total of 916 randomly selected addresses.

These addresses were then alphabetically and numerically numbered. Those in F and G were numbered consecutively starting from 401 to 564, those in F were numbered consecutively from 565 to 1081, those in G were numbered consecutively from 1082 to 1317. The letters were then addressed to the head of the household at each address randomly selected, and the reply paid envelope enclosed was stamped with the address number. The addressed envelopes enclosing a copy of the questionnaire, the letter of introduction, and the reply paid return addressed envelopes were posted in Temple View on the 28th of October 1971.

RESPONSES TO THE QUESTIONNAIRE.

By Friday the 12th of November, 301 valid replies had been received. 59 envelopes were returned from the Post Office stamped "no such address", further replies totalling 37 were received over the next month, but only those received on or before the 12th of November were included in the research investigation.

The responses were divided into groups F, G, F and G and further classified according to status of the head of the household, male, female solo parent, female. Three charts were drawn up, one for each head of household classification, which detailed each question across the top and the individual responses down the side.

The 301 replies received can be broken down as follows. Section F, the suburban surgery, 517 questionnaires sent out 162 replies received, 31.33%. Of the replies received, 84.46% were from male head of household, 6.74% from female solo parent head of household and 8.48% from female head of household.

Section G, central business district. 234 questionnaires were sent out and 85 replies received, that is 36.32%. Of these 80.2% from male head of household, 13.95% female solo parent head of household, 5.81% female head of household.

Section F and G attendance at both surgeries, 164 questionnaires sent out and 54 replies received, 32.92%. Of these 76.36% were from male head of household, 7.27% from female solo parent head of household, 16.36 percent from female head of household.

Data used in all of the chapters of the research have been drawn from this data bank.

Appendix 2. Preparation For The χ^2 Calculation

Assembing The Data

As there were four discrete variables to be used in the calculation, the data for each of these had to be isolated and then a four dimensional χ^2 contingency table designed. (Table 3.)

A matrix was made so that each of the itemized sections of the classification would have an individual cell. (Table A1) The information from the questionnaire was then recorded in each cell.

Where a question offered a choice of responses and more than one response could be checked by the respondent, multiple choices were credited on the table in proportion to the number of choices selected. Each cell being credited with its proportion of the response. In each age group the total for each cell was recorded. Each row and column for each age group selection was then summed and the total of the marginal totals summed.

Because some sections of the questions were not answered and some were invalid the total of this summation was 288 instead of 301, the number of valid questionnaire responses.

Table A1. TABLE OF EXPECTED AND OBSERVED VALUES FOR FOUR DIMENSIONAL χ^2 CALCULATION

		Y_a			Y_b			Y_c	
		X_a	X_b	X_c	X_a	X_b	X_c	X_a	X_b	X_c
Z_a	W_a	9.24	0.9	0.9	1.5	0.1	0.1	2.13	0.2	0.2
		1.5	0.5	.0	1.5	0.5	.0	3.0	.0	0.5
	W_b	13.22	1.3	1.3	1.65	.16	0.16	3.05	0.3	0.3
		9.5	0.5	5.0	1.0	1.5	1.5	3.0	0.0	4.0
	W_c	1.41	0.13	0.13	0.18	0.02	.0	0.3	.01	.0
		1.5	1.0	.0	0.5	0.5	.0	1.0	0.5	.0
Z_b	W_a	35.64	3.4	3.4	4.4	0.4	.4	8.2	.8	.8
		36.0	1.5	2.5	4.5	.0	.0	7.5	3.0	1.5
	W_b	50.99	4.8	4.8	6.4	.6	.6	11.76	1.12	.12
		61.00	4.5	3.5	4.5	1.5	.5	4.5	2.5	1.0
	W_c	5.43	.5	.5	.7	.06	.06	1.25	0.12	.12
		5.0	.0	1.0	.0	.0	.0	1.5	1.0	.0
Z_c	W_a	20.6	2.0	2.0	2.6	.24	.24	4.76	.45	.45
		32.5	1.0	.0	1.0	.0	.0	6.5	.5	1.0
	W_b	29.5	2.8	2.8	3.7	.35	.35	6.8	.65	.65
		32.5	2.0	2.0	1.5	.0	1.0	2.5	.5	.0
	W_c	3.15	.3	.3	.4	.04	.04	.73	.07	.07
		2.5	.0	.0	1.0	.0	.0	.0	.0	.0
Z_d	W_a	3.6	.3	.3	.45	.04	.04	.8	.08	.08
		2.0	.0	.0	1.0	.0	.0	2.0	.0	.0
	W_b	5.15	.5	.5	.64	.06	.06	1.2	.11	.11
		5.5	.0	.0	3.0	.0	.0	1.5	.0	.0
	W_c	.55	.05	.05	.07	.0	.0	.13	.0	.0
		.0	.0	.0	.0	.0	.0	.0	.0	.0

Expected values on the top of each cell; observed values on the bottom of each cell.

W_a Nearest Doctor
W_b Doctor of Choice evaluation of verbal information received.
W_c Information from non-verbal sources: e/g telephone book.

Y_a Private Car
Y_b Public transport
Y_c Walk

X_a Male Head of Household
X_b Female Solo Parent head of household
X_c Female head of household

Z_a Under 25 years
Z_b 25 - 44 years
Z_c 45 - 65 years
Z_d Over 65 years

Table A2 Values of $S \geq 2$ from χ^2 Tests Table 4.

Cell	No. of test	S.
W_a X_a Y_a Z_a	1	3.84*
	2	3.37*
	3	2.45*
	4	2.45*
	6	2.00*
	7	6.73*
	8	3.84*
	9	3.84*
	10	7.22*
	11	2.00*
	12	6.25*
	13	7.22*
W_a X_a Y_b Z_a	2	2.00
	3	2.00
	6	2.00
	11	2.00
W_a X_a Y_c Z_a	3	4.00
	6	4.00
	11	4.00
W_a X_a Y_c Z_c	4	2.57
	8	2.57
W_a X_b Y_c Z_b	1	12.50
	2	4.00
	5	4.00
	6	4.00
	8	4.00
	9	4.00
	11	4.00
	12	4.00
	13	12.50
W_a X_c Y_c Z_a	1	2.00
	6	2.00
	9	2.00
	13	2.00
W_b X_a Y_b Z_c	6	2.46*
W_b X_a Y_b Z_d	2	4.00
	3	12.50
	6	4.00
	7	12.50
	9	4.00
	10	12.50
	11	12.50
	12	12.50
	13	12.50
W_b X_a Y_c Z_b	1	3.02*
	3	2.63*
	6	4.68
	8	3.42
	9	4.26*
	10	2.63*
	11	2.63*
	13	4.26*

Cell	No. of test	S.
W_b X_a Y_c Z_c	6	2.04*
	13	2.46*
W_b X_a Y_c Z_d	7	2.00
W_b X_b Y_b Z_a	1	2.00
	2	2.00
	3	2.00
	5	2.00
	6	2.00
	7	2.00
	8	2.00
	9	2.00
	10	2.00
	11	2.00
	12	2.00
	13	2.00
W_b X_b Y_b Z_b	5	2.00
	8	2.00
	9	2.00
	11	2.00
	12	2.00
	13	2.00
W_b X_b Y_c Z_b	1	2.25
	2	2.25
	5	8.00
	8	2.25
	12	2.25
	13	2.25
W_b X_c Y_a Z_a	1	16.00
	3	16.00
	5	8.16
	7	16.00
	8	16.00
	10	16.00
	11	8.16
	12	8.16
	13	8.16
W_b X_c Y_b Z_a	1	2.00
	2	2.00
	3	2.00
	5	2.00
	7	2.00
	8	2.00
	9	2.00
	10	2.00
	11	2.00
	12	2.00
	13	2.00
W_b X_c Y_b Z_b	1	2.25
W_b X_c Y_c Z_a	1	9.00
	2	24.50
	3	24.50
	5	24.50
	6	2.00

Cell	No. of test	S.
	7	24.50
	8	24.50
	9	9.00
	10	24.50
	11	8.16
	12	24.50
	13	24.50

* $E > O$

W_a	Nearest Doctor	Y_a	Private Car
W_b	Doctor of Choice evaluation of verbal information received.	Y_b	Public transport
W_c	Information from non-verbal sources: e/g telephone book.	Y_c	Walk
X_a	Male Head of Household	Z_a	Under 25 years
X_b	Female Solo Parent head of household	Z_b	25 - 44 years
X_c	Female head of household	Z_c	45 - 65 years
		Z_d	Over 65 years

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