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AN EPIDEMIOLOGICAL STUDY OF VARYING EMERGENCY MEDICAL ADMISSION RATES IN GLASGOW

BY

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ABSTRACT

Background. Emergency medical admissions in the United Kingdom have been rising for many years. This rise has resulted in increasing pressures on hospitals' resources, with consequent difficulties in coping with peaks of admissions. This rise has not been intended or planned. The epidemiology of emergency medical admissions is poorly understood.

Aims. To investigate the epidemiology of emergency medical admissions in Glasgow in terms of time, person and place. To explore variations in Glasgow's general practices' and hospitals' emergency medical admission rates.

Literature review. Articles relating to variations in emergency medical admission rates were identified by searching bibliographic databases, cross referencing from known articles, consulting other researchers and hand searching of journal indexes. Relevant articles were included in a systematic review of the epidemiology of varying rates of hospitals' emergency admissions. Articles that postulated causes of the rise of emergency admissions or factors associated with varying admission rates were also reviewed. A summary of mechanisms whereby hospitals might cope with pressures of emergency admissions concluded the literature review.

Published evidence of variations of rates of hospital emergency admission was limited. Most articles were found to contain postulated associations with variations in hospitals' emergency admissions. While many published mechanisms for hospitals to adapt to pressures from emergency admissions were identified, only a minority of these had been formally evaluated.

Setting. Greater Glasgow Health Board residents (813,029 adults at June 1997). Data obtained from the Health Board's Community Health Index (CHI).

Subjects. 537,798 Greater Glasgow Health Board residents admitted to Glasgow hospitals' medical beds between 1980 and 1997 (43,236 patients in 1997). Data obtained from Scottish Morbidity Record database one (SMR1).

Methods. Anonymised CHI and SMR1 datasets linked by patients' general practitioners' codes, using a computer database package. Standardised emergency medical admission rates were calculated by the database. Computerised maps of standardised emergency medical admission ratios were plotted for Glasgow's postcode sectors to show geographical variations. Correlation and logistic regression were used to explore variations in standardised emergency medical admission ratios.

Outcome measures. Crude emergency medical admission rates. Standardised emergency medical admission ratios adjusted for patients' age, sex and Carstairs' deprivation categories.

Results. The numbers of emergency medical admissions doubled between 1980 and 1997. Emergency medical admission rates increased steeply with increasing age of patients, more than doubling for every two decades. Men above 40 years had approximately 20% higher age specific emergency medical admission rates than women. Emergency medical admission rates were more than twice as high amongst patients from Glasgow's most deprived areas, compared with the most affluent.

Cardiovascular disease (ICD10 chapter IX) discharge diagnoses were commonest (27.2% in 1997), followed by the non-specific diagnoses in ICD10 chapter XVII (21.0%). The non-specific diagnoses mainly comprised chest pain (9.6%) which was the commonest reason for admission. Between 1980 and 1997, non-specific diagnoses (ICD10 chapter XVII) increased at twice the rate of all other ICD10 chapters of diagnoses.

There were two areas of Glasgow that had raised standardised emergency medical admission ratios (adjusted for patients' ages, sex and deprivation). These corresponded to the catchment areas of two acute hospitals, which had substantially higher adjusted emergency medical admission ratios than had the other three.

There was a 2.51 fold variation between the top and bottom deciles of Glasgow's general Practices' crude emergency medical admission rates. After adjustment for their patients' age, sex and deprivation characteristics, this reduced to a 1.87 fold variation. Additional adjustment for general practices' admitting hospitals (along with their patients' age, sex and deprivation) accounted for a total of 84% of the inter-practice variation in crude emergency medical admission rates.

Fundholding general practices had modestly raised emergency medical admission rates (odds ratio 1.06.) There were no associations between practices' rates of emergency medical admissions and any other measured practices' characteristics (including numbers of partners, practices' sizes or dispersions, immunisation and cytology rates).

Conclusions. This large study discovered epidemiological associations between emergency medical admission rates and patients' sex and socio-economic deprivation that had not previously been shown. It showed that emergency admission rate variations between general practices were only partly accounted for by patient characteristics. Apart from fundholding status, difference between practices were not related to variations in their rates of emergency medical admissions. However, a substantial part of the variation between general practices could be attributed to differences between their admitting hospitals.

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This thesis and the research it describes are entirely my own work. The following publications have been based on parts of the research contained in this thesis:

1. Blatchford O, Capewell S. Emergency medical admissions: taking stock and planning for winter. *BMJ* 1997; **315**: 1322-3.

2. Blatchford O, Capewell S. Emergency medical admission rates: general practices vary despite adjustment for age, sex and deprivation. *J Epidemiol Comm Hlth* 1998; **52**(10): 689.

3. Blatchford O, Capewell S, Murray S, Blatchford M. Emergency medical admissions in Glasgow: general practices vary despite adjustment for age, sex and deprivation. *Br J Gen Pract* 1999; **444**: 551-4.

4. Blatchford O, Capewell S, Blatchford M. Are hospitals rather than general practitioners the "gatekeepers" for emergency medical admissions. *J Epidemiol Comm Hlth* 1999; **53: 655.**

5. Blatchford O, Capewell S, Blatchford M. Trends in emergency admissions: Rise has been real in Glasgow [letter]. *BMJ* 1999; **319**: 1201. This was also published as: Blatchford O, Capewell S, Blatchford M. In Glasgow the rise in emergency medical admissions has been real [letter]. *eBMJ* 1999; http://www.bmj.com/cgi/eletters/319/7203/158#EL2.

The following paper has been submitted to the *BMJ*.

1. Blatchford O, Blatchford M. Fundholding practices had higher emergency medical admission rates in Glasgow.

Elements of the research reported in this thesis have been presented at the following meetings:

1. "Emergency medical admission rates: general practices vary despite adjustment for age, sex and deprivation." Blatchford O, Capewell S. Oral presentation at the September 1998 meeting of the Society for Social Medicine in Cardiff.

2. "Emergency medical admissions in Glasgow." Blatchford O, Capewell S, Blatchford M. Poster presentation and abstract at the 1998 meeting of the Society for Social Medicine in Cardiff.

3. "Are hospitals rather than GPs the "gatekeepers" for emergency medical admissions?" Blatchford O, Capewell S, Blatchford M. Accepted for plenary presentation at the September 1999 meeting of the Society for Social Medicine in Sheffield.

While I am solely responsible for the contents of this thesis and the views expressed therein, the co-operation of many others was invaluable in carrying out this work. I am therefore indebted to the many people who have made constructive comments, supporting and encouraging me while I was conducting my research and during the writing of this thesis.

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AUTHOR'S NOTE

This thesis has been written and laid out to conform to British Standard number BS4821. [1] This standard states (section 4.2) that, where the use of colour in illustrations is essential, a method of printing that would also allow monochrome reproduction should be employed, thereby facilitating microfilming of the thesis. Colour pages in this thesis have appropriate captions drawing the attention of readers of microfilmed copies of this thesis to the probable loss of information on those pages. The loss of resolution resulting from the BS4821 recommended use of monochrome shading and cross-hatching rendered the maps and several of the graphs in this thesis almost unintelligible.

To overcome this limitation of microfilm, I should be happy to provide a copy of this thesis on an appropriate electronic medium to interested readers, subject to normal copyright requirements. This would probably be in the form of a portable document file (PDF) on a CD-ROM. I shall investigate the possibility of publishing this thesis on the World Wide Web using either the Hypertext Markup Language (HTML) format or as a portable document file. The former format would have the advantage of enabling indexing of the thesis on the World Wide Web while the latter would accurately preserve document layout. Any publication would only follow the University's acceptance of this PhD thesis. The probable Internet site at which this thesis would be published would be linked to the home pages of the University of Glasgow's Department of Public Health (http://www.dph.gla.ac.uk/).

Electronic publication of this thesis will make my research findings and my review of the literature of emergency medical admissions available to a wider audience beyond the universities. Such an audience could include public health practitioners and health service managers at both hospital and health authority levels. I have therefore tried to minimise my use of an "academic" style of writing, preferring instead a simpler, more direct use of language. This is consistent with the recommendations of several medical writers. [2] (Personal communication, Tim Alberts, 1999.) I have also tried to include short explanations of the relevance of certain sections and of the relationships between other sections. I believe that this style makes my thesis easier to read and more straightforward to understand.

I shall not reserve my copyright in this thesis if I publish it electronically. I shall continue to assert my moral rights of authorship. In particular, I assert the rights of paternity (that I am always known as the author) and of integrity (that any copies of this thesis must always be complete and not modified in any way without my prior agreement).

DEFINITIONS OF TERMS AND GLOSSARY

Because there has been so little written in the field of emergency hospital admissions, this area of study has been relatively spared from the emergence of a specialised jargon. Where this has been possible, I have tried to avoid such language. In particular, epidemiological terms have been used within their conventional meaning, which should be found in a standard dictionary such as Last's.[3] A few terms used in this thesis are clarified for the reader at this point.

This thesis is about emergency admissions to hospitals. It is standard practice to count patients' discharges from hospital, as their discharge marks the point at which their care has been completed. The term discharges may therefore be more accurate. Nevertheless, I have followed convention and called them admissions in this thesis. This is consistent with the observation that every discharge must have a matching preceding admission. Patients experience admissions to hospital.

Emergency (or acute) hospital admissions are those that are not planned, but are required for the urgent clinical management of patients' illnesses. These are distinct from with elective hospital admissions, which are planned and booked in advance.

The medical specialties include several sub-specialties, such as cardiology, neurology, care of the elderly and so forth. When the term medical is used in the context of admissions, it should be understood that this includes these sub-specialties. In this context, medical admissions should be seen as distinct from, say, the surgical or gynaecological specialties.

I have referred throughout to standardised ratios when discussing the results calculated by the method of indirect standardisation. These ratios are these are the result of dividing an observed count of events by a calculated expected number of such events. Many others refer to these as rates, however, they are clearly not rates as they are not measured in events per unit time. The results from indirect standardisation procedures are dimensionless ratios.

Most of the results in this thesis are based on 1997 data. For the sake of brevity, I have not restated the year with every new finding. I have noted the year to which findings apply for years other than 1997. The reader should assume that where a year is not stated with a result, it applies to 1997.

Lastly, I have tried to avoid using abbreviations in the text of the thesis. However, I have used the widely used abbreviations of the Scottish Health Service datasets. In addition, the need for brevity in tables, figures and captions has necessitated some abbreviations.

95% CI	95% Confidence Interval.
A&E	Accident and Emergency department.
CHI	Community Health Index (a database).
COPPISH	Core Patient Profile Information in Scottish Hospitals (a new set of Scottish databases).
DEPCAT	Carstairs' Deprivation Category.
DHA	District Health Authority (in England or Wales).

EMA	Emergency medical admission.
GGHB	Greater Glasgow Health Board.
GEMS	Glasgow Emergency Medical Service
GP	General Practitioner.
ICD9 / ICD10	World Health Organisation International Classification of Diseases (ninth or tenth revision).
RHA	Regional Health Authority (in England or Wales).
SIRS	Scottish Immunisation Recall System (a database).
SMR1 / SMR01	Scottish Morbidity Record number 1 (a database).
SQL	Structured Query Language (a computer database programming language).
SSIC	Symptoms, Signs and Ill-defined Conditions (ICD10 chapter XVIII).
URL	Uniform Resource Locator (an address on the Internet).

CHAPTER 1 —

INTRODUCTION

1.1 BACKGROUND TO THIS STUDY

Emergency admissions to hospital have been rising across the United Kingdom for at least two decades.[4, 5, 6, 7] In Scotland, the number of emergency admissions increased by almost 50% between 1981 and 1994.[4]

The rise in emergency hospital admissions has been mainly a problem in the medical specialties.[4, 8] The surgical specialties have seen little growth in bed demand and they do not suffer to the same extent from seasonal peaks in numbers of admissions.

The rise in numbers of emergency medical admissions has caused pressures on hospitals' acute admission beds. This has led to instances when hospitals have failed to cope with peaks of demand for emergency admissions. These failures have attracted intense and often sensationalistic coverage in the news media. Such stories typically describe patients spending extended periods waiting for beds to become available while they are lying on trolleys in hospital corridors.[9] Other effects of these peaks in admissions have included the cancellation of elective admissions, the temporary closure of casualty units and hospitals to emergency admissions and lengthy inter-hospital transfers of severely ill patients because local intensive care facilities are full.[10, 11]

Many strategies have been suggested to enable hospitals to cope with the increased numbers of emergency medical admissions.[12, 13, 14] There has however been very little basic research showing that these measures are effective.[8, 15, 16, 17]

There has not been any specific central policy initiative that might account for this rise in emergency medical admissions. There have been many suggested explanations for the rising numbers of emergency medical admissions. Several authors have identified the need for research into factors associated with emergency medical admissions in order to enable an understanding of this rise.[8, 15, 16] However, despite these authors' calls and despite the extensive media coverage of the many problems hospitals have experienced coping with peaks in demand, there is a lack of basic descriptive epidemiological studies of emergency medical admissions.

General practitioners have been recognised as having different rates of referrals of their patients to hospitals for some time.[18] Studies of these differences have mainly focussed on general practitioners' elective referrals to hospital outpatient clinics.

Recently, the Accounts Commission for Scotland has published recommendations that hospitals should monitor general practitioners' emergency medical admission raising any resulting concerns about inappropriate referral rates directly with the referring practices.[19] This report implies that practices with higher rates of emergency medical admission have a greater proportion of inappropriate referrals. However, this report cites no evidence that practices with lower emergency medical admission rates have different clinical outcomes (i.e. they practice better medicine) than practices with higher rates. Moreover, the report does not consider whether patient factors may affect practices' referral rates.

This variation between general practices' rates of emergency admissions has been recognised since 1985. Donald Acheson, then Chief Medical Officer for England, commented that "the huge variation between GPs' rates of referral to hospital is so important that it must be explained, yet so far there are no clues," ... "The variation is, to put it mildly, hard to explain – certainly on morbidity" [grounds].[18]

While the general practice fundholding scheme has recently been discontinued, there was the possibility that differences in general practices' rates of emergency medical admissions might have arisen between fundholding practices and those practices outwith the fundholding scheme. It might seem that fundholders' emergency medical admissions should not be affected by membership of the scheme because their funds were allocated to pay for their patients' elective hospital admissions. However, the non-chargeable nature of emergency medical admissions could result in a subtle pressure encouraging fundholding general practitioners to refer relatively more patients as emergencies rather than as elective admissions compared with non-fundholders. The fundholding scheme therefore required to be investigated as a possible explanation for the variation between general practitioners' rates of emergency medical admissions.

Some authors have raised the possibility that where hospital beds are more available, emergency admission numbers may expand to maintain bed occupancy.[17] This is known as supply induced demand and in the context of hospital admissions, it has been called Roemer's law, which states that "a bed built is a bed filled".[20] It is therefore possible that part of the differences between general practitioners' acute admission rates might be explained by variation between hospitals' rates of emergency admissions; this too required investigation.

This project was conceived in response to the identified need to provide information that might help to illuminate some of the above areas. An understanding of factors associated with variations in emergency medical admission rates could provide a better understanding of some of the many possible factors driving the overall rise in emergency medical admissions.

1.2 STRUCTURE OF THIS THESIS

This thesis reports on two closely related areas of research. Firstly, it describes the epidemiology of emergency medical admissions in Glasgow. Then it describes emergency medical admission rate variations between general practices and between hospitals in Glasgow. These distinct themes therefore have separate chapters which present their results and for discussion of these findings.

Because the research for both of these themes was conducted using similar methods, there is a single chapter describing the methods used. There is likewise a separate chapter containing a discussion of the methods employed in the research.

The thesis contains a single chapter reviewing the literature relating to emergency medical admissions. This has several sub-sections in which different aspects of the literature relating to emergency medical admissions are considered.

To avoid excessive fragmenting of text in the chapters of results, most of the tables and figures presenting these results have been located at the ends of these chapters. In other chapters, figures and tables have been inserted near the relevant text. Computer programme codes have been located at the end of the thesis in Appendix 1.

CHAPTER 2—

AIMS AND OBJECTIVES

2.1 STUDY AIMS

An initial literature review showed that published evidence about the epidemiology of emergency medical admissions was very scanty. This study was planned to use an epidemiological approach in investigating variations in emergency medical admissions. In doing this, two broad aims were developed. These were:

The first aim was to describe the epidemiology of emergency medical admissions in Glasgow in terms of time, person and place related factors.

The second aim was to use this epidemiological information to investigate variations between the rates of emergency medical admissions of Glasgow's general practices and hospitals.

This thesis has two chapters of results, each relating directly to these two aims.

2.2 STUDY OBJECTIVES

This study had seven objectives. These objectives were developed from the study aims. The first two objectives relate to the first aim while the remaining five objectives address the second aim of the study. The objectives of this study were:

1. To determine the major demographic, socio-economic and geographic factors associated with variations in patients' emergency medical admission rates in Glasgow

2. To ascertain the principal diagnoses of medical patients admitted as emergencies in Glasgow and whether these have changed over time

3. To determine whether Glasgow's general practice partnerships had different rates of emergency medical admissions

4. To identify the principal patient factors associated with variations in general practices' emergency medical admission rates

5. To investigate whether residual variations in general practices' emergency medical admission rates were related to other available practice data

6. To describe variations in diagnoses and rates of emergency medical admissions between Glasgow's hospitals

7. To investigate whether the variation between general practices' emergency medical admission rates was associated with variations in their hospitals' admission rates

2.3 STUDY HYPOTHESES

A limited set of hypotheses was developed from the above objectives. These have been expressed as experimental hypotheses. It is straightforward to recast these as null hypotheses for the purposes of statistical testing. However, as experimental hypotheses are more readily intelligible, I have presented them in this form. Again, the first two hypotheses address the first aim of the study, while the remaining five hypotheses focus on the second aim. The study hypotheses were:

1. Rates of emergency medical admissions in Glasgow vary with differences in patients' age, sex, socio-economic status and they vary in different geographical areas of the city

2. The principal diagnoses of patients admitted as medical emergencies to Glasgow hospitals will change over time

3. Glasgow's general practice partnerships have different rates of emergency medical admissions

4. Patient factors including age, sex and socio-economic deprivation are associated with variations in general practices' emergency medical admission rates

5. Variations in Glasgow's general practices' emergency medical admission rates, adjusted for age, sex and socio-economic deprivation, are related to other available practice data

6. Glasgow's hospitals have different patterns of diagnoses and varying rates of emergency medical admissions

7. The variations in Glasgow's general practices' emergency medical admission rates are associated with variations in their hospitals' admission rates.

CHAPTER 3 —

EMERGENCY MEDICAL ADMISSIONS:

A CRITICAL LITERATURE REVIEW

3.1 INTRODUCTION

Many articles have been written about emergency hospital admissions. Most of these have not differentiated between the emergency admissions of the different clinical specialties in hospitals. Few have focussed specifically on acute medical admissions.

This review discusses emergency admissions generally, as well as emergency medical admissions because in general hospitals, most patients that are admitted as emergencies are admitted to acute medical beds.[4, 21] I have excluded publications relating exclusively to emergency admissions in other clinical specialties (for example, emergency admissions to paediatrics, psychiatry or for trauma). I have only included those reports exclusively relating to specific diagnoses (such as emergency hospitalisation for asthma) where they illustrate wider epidemiological associations with emergency admissions.

Whilst I was searching the literature, I found that many more articles have been written about the epidemiology of patients attending hospitals' accident and emergency departments than on emergency hospital admissions. Because accident and emergency attendances and emergency medical admissions present different problems, I have focussed on emergency hospital admissions. I have however included some references to accident and emergency department attendances where these help in illustrating analogous topics in the area of emergency admissions.

Many authors have highlighted the need for research into emergency admissions in general or specifically into emergency medical admissions.[8] I found that the following classification of reports about emergency admissions was helpful when reviewing the literature:

1. Publications that reported factors associated with variations of emergency admission rates. These contain original epidemiological findings

2. Publications that proposed possible causes of the rise in emergency admissions or suggested factors associated with variations in emergency admission rates. These may have been based on theory or on anecdotal evidence but do not contain fresh epidemiological findings

3. Publications that addressed issues of the appropriateness of emergency hospital admissions

4. Publications that considered the ways hospitals themselves could influence their rates of emergency medical admission. These included discussions of the effects of hospital bed availability. This in turn was related to the roles of doctors as gatekeepers. Strategies for hospitals to cope with rising demand for emergency admissions and reported evaluations of any implementations of these strategies have been included here too.

These categories provide the basic structure of this review. The initial section of the review contains a description of the methods used in searching, summarising and indexing the literature.

A section examining published literature on the epidemiology of emergency admissions follows. This review section discusses factors associated with variations in rates of emergency medical admissions. These factors include both those based on evidence and those that are more speculative. A brief subsection on the appropriateness of emergency admissions follows this. While appropriateness of admission was not an objective of this study, issues of appropriateness warrant consideration, as variations in the levels of appropriateness of admissions could explain variations in admission rates.

The final section provides an overview of literature that describes ways in which hospitals may affect emergency admission rates. This includes a sub-section that discusses hospitals' possible mechanisms for coping with rising emergency medical admissions. This sub-section also contains a review of evaluations of these strategies. While the original research reported in this thesis was not concerned with differences between hospitals' emergency admission practices, the current study does suggest that there may be substantial differences between hospitals' emergency admission rates. This finding suggested that hospitals might be able to influence their rates of emergency admissions. A review of mechanisms whereby secondary care providers themselves may affect their emergency admission rates is therefore pertinent.

3.2 METHODS USED IN REVIEWING LITERATURE

3.2.1 Literature searching

Several strategies were employed to identify relevant literature for the project's literature review. This was necessary as the various approaches enabled the identification of different selections of potentially relevant literature items. Approaches used included searching electronic databases, searching the Internet, hand searching journal indices, examination of cross-references from relevant literature and consultation with other researchers.

3.2.2 Electronic bibliographic databases

Two major on-line electronic databases were searched. These were Medline [22] and Embase [23]. Both of these were accessed using the Ovid database search engine [24] via the British Medical Association's library. [22] These two databases are substantially different both in the journals they index and because the systems of keywords used to construct the indices are quite distinct. Because of this, separate search strategies were required for each database.

The search strategies were refined incrementally. Initially the bibliographic entries of some articles already known to me were retrieved from each database. The keywords of these database entries were then inspected to determine which keywords might be helpful in the identification of further similar articles. The hierarchies of keywords in each database were inspected to determine whether keywords from other levels in the hierarchies might be more efficient at obtaining the relevant references. These search strategies were then further refined by the use of text word searches from the title and abstract fields of these databases. During this process of refinement, relevant literature items that were identified were obtained from the University library and their reference lists were inspected to determine whether the search strategies were effectively locating the cross-references of these papers. The Ovid commands used in the final search strategies used are shown for Medline in Text Box 1 and for EMBASE in Text Box 2.

Text Box 1 — Ovid script used to search Medline

```
1  *"health services needs and demand"/
2  exp *hospitalization/
3  exp *emergency medical services/
4  exp family practice/
5  1 and 2
6  1 and 3
7  1 and 4
8  2 and 3
9  2 and 4
10 3 and 4
11 5 or 6 or 7 or 8 or 9 or 10
12 limit 11 to english language
```

Text Box 2 — Ovid script used to search EMBASE

```
1  exp Primary medical care/
2  exp Patient referral/
3  exp Hospital admission/
4  exp emergency medicine/
5  1 and (2 or 3 or 4)
6  2 and (3 or 4)
7  3 and 4
8  5 or 6 or 7
9  limit 8 to english language
```

These search strategies were executed on-line using the Medline database from 1966 [to March 1999] and the EMBASE database from 1988 [to March 1999]. The references obtained were then downloaded using an Internet email address to copy these to a personal computer.

Initial processing of the electronic bibliographic records was performed by filtering the downloaded files through a word processor (Microsoft Word [25]) to reformat them. The fields of the bibliographic reference data file were rearranged from the relatively unstructured "Ovid download format" into a data format suitable for import into a specially written Microsoft Access [26] database. Because of the lengthy and highly repetitive nature of this process with consequent liability to error, a specially written Microsoft Visual Basic[27] programme was used to control the word processor's reformatting actions. This programme is shown in Text Box 9 (see Appendix 1).

The references and abstracts were then imported into Microsoft Access. [26] They were then displayed on a computer using a set of electronic forms within Microsoft Access for review. This enabled the selection of those that were potentially relevant for the literature review. The data records of the selected items were then flagged so that the original literature items could subsequently be retrieved. Lists of the relevant references were then printed out. These were sorted into alphabetical order by journal name so that the location of the original journal articles in the library would be more efficient.

In addition, searches of four other databases were undertaken.

The first of these was Justis Parliament. The database is drawn from the established POLIS database prepared by the House of Commons library. This contains a bibliography and index to the proceedings and publications of both Houses of Parliament from 1979 to the present day. The bibliographic entries refer to articles and reports drawn from many sources, which have been of interest to Members of Parliament in the United Kingdom. This database was accessed using a set of CD-ROMs in the University Library.[28] While most of the citations it produced were already known to me, some unknown ones were located and the articles referred to were subsequently obtained.

The second database accessed was SIGLE (System for Information on Grey Literature in Europe).[29] This is a database containing reports and so-called grey literature items. It is collaboratively produced by the major European national libraries and includes the British Library's National Reports Collection.[30] Although the database is available on-line,[29] the University's library did not have a licence permitting users to access it themselves. I discussed my search requirements with a librarian who then accessed the database for me. Again, while many of the citations were known to me, a few new ones were discovered and retrieved.

A search was also conducted of the UK Theses database. This contains details of all theses for higher degrees that have been submitted to universities in the United Kingdom.[31] Despite using several different possible keywords, only one thesis dealing with emergency admissions was located.[32] This thesis used an operation research method to propose a reconfiguration of emergency hospital services in the Birmingham area.

The Internet itself was the final database to be searched. Two data sources were searched. Firstly, the Usenet discussion forums were searched for relevant postings. This was done with the Altavista[33] search engine. No relevant Usenet postings were found. Secondly, the World Wide Web was searched using the Altavista,[33] Yahoo[34] and Alltheweb[35] search engines.

These yielded only three citations that had not already been discovered from other sources.

3.2.3 Retrieval of literature

The reference lists of the relevant papers identified from the above electronic searches were then also reviewed. Citations, which were apparently relevant to this thesis but which were not already known, were then further screened. Additional relevant grey literature, already known to me was also included. Consultation with other researchers with an active interest in emergency medical admissions was undertaken to identify further grey literature items that I did not already know.

The citations obtained from all sources other than Medline and EMBASE were manually entered into the Microsoft Access database of references. This was used to track all of the source documents used when compiling this literature review. It was also used to automate the correct formatting of Vancouver style references.

Where neither the University library nor the hospital and health service libraries in the West of Scotland held the items sought, these were obtained from the document delivery service (formerly the inter-library loan service) of The British Library.

While the final draft of this thesis was being written, several further relevant articles were published. For completeness, references to these were included.

3.3 THE EPIDEMIOLOGY OF EMERGENCY MEDICAL ADMISSIONS

Despite calls for research into emergency medical admissions,[8, 16, 36] surprisingly few published research reports concerned with the epidemiological aspects of emergency admissions were identified. However, these publications do contain report several epidemiological factors associated with emergency admissions to hospital (Table 1, page 114).

The majority of reviewed publications relating to emergency admissions only suggested epidemiological associations possibly associated with variations in emergency admissions to hospitals. These suggestions were not supported by evidence. Some appeared to have a theoretical basis,[37] many relied on anecdotal evidence. Many of these potential associations could not be disproven, as they were post hoc explanations rather than testable theories. In other instances, it would not be practical to obtain evidence to test the postulated epidemiological association. These suggested associations are useful because they reveal gaps in our knowledge about emergency medical admissions, indicating possible areas for future research.

Despite this lack of evidence, these postulated associations factors may add to our understanding of the complex issues relating to the acute admission process. This understanding may assist in the development of strategies to cope with pressures from rising numbers of emergency admissions.

Most of our epidemiological knowledge of emergency (medical) admissions has been derived from routine sources of data. These must be approached with care.[38, 39, 40] Emergency admission episodes must be correctly identified in the routine data in order for them to be correctly counted.[21] During the last decade, there has been a change in the system used for recording in-patient episodes in British hospitals. The older system was based on recording admissions (where an admission ended with a patient's discharge from or transfer out of hospital). The newer system records completed episodes of care. In this system, in-patient investigations and treatments carried out by different consultants within the same hospital are counted as separate episodes. Because several episodes of care may make up one complete admission, many emergency admissions could be liable to be counted more than once.[41] An episode base of counting may inflate the true number of emergency admissions by as much as 17%.[21] It is important therefore to avoid over-estimating the numbers of emergency admissions when data are recorded using systems based on the completed episode of care.[15] Jones has argued that because of problems with using an episode basis of counting emergency admissions, it would be better to use bed occupancy levels to assess need for emergency admission services.[42]

A substantial part of the published epidemiological research into emergency admissions has been Scottish. Because the system used in England for recording hospital activity changed during the 1980s, there is no consistent data series enabling analyses of emergency admissions for that country.[43] Scotland on the other hand has had its own, stable system of hospital activity recording since the late 1960s.

The Scottish record linkage system makes it possible to analyse emergency admissions at the level of individual patients' complete admissions, or episodes of care as required.[44] In particular, by linking separate episodes of care, it is possible to calculate patients' total lengths of stay in hospitals. It is also possible to identify patients who have been readmitted to the same or to different hospitals in Scotland.[44, 45] A similar project using record linkage has been operating in the Oxford region in England.[46, 47]

I have used the approach of "time, place and person" in this review to group together factors associated with variations in emergency admission rates. This scheme is commonly used in descriptive epidemiology as it provides a clear and simple structure for these associations. Factors applying only at the level of hospitals are discussed in the next section. Within this section, I have distinguished between those associations based on research findings and others with a more speculative foundation. This section concludes with an examination of the literature reporting studies of the appropriateness of emergency admissions to hospital.

3.3.1 Time factors

Time factors may be divided into two groups; the first group represents long term trends while the second group of time factors comprises short term, often cyclical, variations in emergency admissions.

Long term trends

Kendrick and co-workers have shown that emergency admissions rose by 49.2% in Scotland between 1981 and 1994. [4] During that period, emergency admissions comprised almost one half of all hospital admissions (47.1% in 1981, peaking at 51.1% during 1982 and thereafter steadily reducing to 43.6%). The number of elective inpatient admissions was almost static during this period although there was a substantial rise in elective day case admissions. Therefore, as a proportion of the total number of admissions, elective admissions fell between 1981 and 1994 while there was a substantial rise in the proportion of day case admissions.

A recent report by Morgan *et al* [48] has suggested that the rise in emergency admissions is an artefact that has arisen from the use of the hospital consultant episode basis of hospital activity recording. They found that if admission episodes were considered in isolation removing the inflating effects of transfers of patients' care, then emergency admission numbers had been static in their area. Kendricks'[4] study however used the Scottish linked data set[44] which overcomes this problem, yet he found that emergency medical admissions were rising in Scotland.

The rise in day cases was a direct result of changes in clinical practice, with more day case investigation and (especially surgical) treatment.[4] These changes were driven by the need to contain hospitals' hotel costs. Unlike elective day case admissions, the rise in emergency admissions was not a planned aspect of health care delivery in the National Health Service.

The Audit Commission examined the rising trend in emergency medical admissions in the Birmingham area. It then extrapolated these data to predict that emergency medical admissions in Birmingham would double between 1987 and 1996.[49]

In both Scotland and England, emergency admissions to the specialties of adult medicine and geriatrics have risen much faster than in other specialty groupings, such as surgical emergencies.[4, 21, 49] In Scotland, Kendrick showed that 44% of the total increase in emergency admissions was to adult medical beds, while geriatric admissions quadrupled, accounting for almost 12% of the rise in emergency admissions. Taken together, general medical and geriatric admissions accounted for 56% of the total rise in emergency admissions, while they comprised only 36% of emergency admissions in 1981.[4]

Another time factor of major relevance to the rise in emergency hospital admissions is that patients' length of stay in hospitals has been steadily reduced over time.[5, 21] The fall in in-patient's lengths of stay has balanced the long-term rise in the numbers of emergency hospital admissions.[21]

Consequently, in Scotland, the overall bed occupancy for patients admitted as emergencies has remained almost static between 1982 and 1995. [5]

This reduction in length of stay may even have contributed to the increase in emergency medical admissions. Such an association could be indicated by the substantial increase in the numbers of patients who have been readmitted to hospital as emergencies within 28 days of discharge from their previous admission. [4, 50]

Many other authors have noted the widespread rise in emergency admissions. Despite this, they have not quantified the extent of the increase but have taken the long-term trend as given. They use this premise as a point from which to proceed to discussion of aspects of emergency admissions. [16, 36]

Shorter period fluctuations

There is a marked seasonal variation in emergency medical admissions with increased numbers of admissions in the winter months. Peak admission numbers may be up to double the numbers of admissions during trough periods. [5] Peaks in admissions are mainly due to increased numbers of admissions with respiratory and cardiovascular diagnoses. [4, 5] In Scotland, the annual number of admissions for respiratory illness has risen steadily over the period 1981 to 1994. [4] A notable peak of admissions in the year 1993 probably reflects the fact that there were two influenza epidemics during that one year. [4, 51]

Although there may be seasonal variations in numbers of emergency admissions, these are subject to substantial variation, particularly in response to outbreaks of infectious diseases in winter. Peaks in admissions do not occur at exactly the same time every year. Comparisons of numbers of admissions from the same months of different years would therefore not be useful. [5]

Variation in the numbers of admissions from day to day during the week was shown in one English region where emergency admissions were significantly more common on Mondays than other weekdays. [52] Weekends had lower numbers of emergency admissions with Sundays having the fewest emergency admissions of the week. Since there was no reason to believe that acute illnesses occurred with different frequencies through the week, this observation suggested that acutely unwell patients delayed seeking help until the weekend was over. [52]

Cyclical variations in patients' lengths of hospital stay have also been noted. During the winter peaks in admissions, lengths of stay have also been shown to be consistently greater. [5] Kendrick *et al* speculated that this may be due to case mix variation through the year. This would be explained by both different illness patterns and differing groups of patients being admitted. [5]

3.3.2 Place factors

There are four "place" factors that may be related to emergency admissions; local incidence of diseases may differ, leading to variation in patterns of emergency admission. In the same way, socio-economic deprivation, accessibility of health care and the differences between urban and rural populations are place-related factors that may affect acute hospitalisation rates.

Care to avoid ecological bias should be exercised whenever considering area based risk factors. Ecological bias (also known as the ecological fallacy) is defined as:

> The bias that may occur because an association observed between variables on an aggregate level does not necessarily represent the association that exists at an individual level. [3]

In general terms, care must be taken in the interpretation of studies showing the associations between geographical risk factors and any individual outcome.

Local incidence of disease

The first place factor that may affect rates of emergency admissions to hospital is variation in local incidence or prevalence of diseases. Variation in local disease incidence would lead to different needs for emergency admissions in different areas. It should be self-evident that such a variation in need will result in varying rates of hospitalisation. No reports found for this literature review discuss this. A brief discussion of incidence related variation in emergency hospitalisation rates is however appropriate.

For example, it is possible that deprivation will be a proxy for the incidence or prevalence of many diseases. Tobacco smoking is well known to be more prevalent amongst those populations that are socio-economically less well off. [53] Smoking has been shown to be a risk factor in illnesses such as cardiovascular disease (leading to myocardial infarction) and chronic chest disease. These are amongst the most common reasons for patients to be admitted as emergencies to hospital. [4] Analyses showing associations between socio-economic deprivation and emergency admissions will therefore probably reflect genuine differences in need for emergency hospital admission, due to an underlying related difference in disease incidence. In this example, socio-economic deprivation is a confounding variable.

Socio-economic deprivation

This thesis has treated socio-economic deprivation as a place factor. This is appropriate because almost all of the measures of socio-economic deprivation are area-based scores. Therefore, these proxy measures do not directly measure individuals' material wealth. They are really indices of the relative levels of disadvantage of different geographical areas.

As noted above, applying such area-derived scores to individual members of a population may introduce a possible ecological bias. However, within urban areas, materially disadvantaged people tend to live in poorer neighbourhoods because they would experience financial barriers to obtaining housing in more affluent areas. It should also be remembered that not all individuals living in an area of material disadvantage would be equally disadvantaged.

Several measures have been used to quantify material socio-economic deprivation.[54] In Scotland the Carstairs' score [55, 56] has been most widely used. This score has been derived for individual small areas (typically postcode sectors) from a composite score based on four census variables:

- The proportion of all persons in private households not owning a car
- The proportion of all persons in private households with an economically active head of household in social class 4 or 5
- The proportion of economically active males seeking or waiting to start work
- The proportion of all persons living in households with a density of more than one person per room.

These variables were selected from the census dataset because they were shown empirically to be good indicators of material disadvantage and were not directly related to health or illness.[55, 56] The score itself is commonly divided into seven bands which are then known as Carstairs' deprivation categories (DEPCATs).

Carstairs' score has been found to be consistently and strongly associated with adverse health outcomes.[57, 58, 59, 60, 61, 62] It has however been suggested by Davey Smith *et al* that attention should be paid to the possible need for adjustment for individual economic status as well as using area based proxy measures.[63] Other writers have disagreed, suggesting that area based measures may be useful as proxy markers for individual socio-economic status.[64, 65]

The Townsend score[54] is related to Carstairs' score. It also uses four census-derived components to produce a score that is used for small area analyses. It substitutes a factor based on the proportion of housing that is not owner occupied for Carstairs' factor based on the proportion of all heads of households in social class 4 or 5. For historical reasons, the Townsend score is more commonly used in English studies. It too has been associated with adverse health outcomes.[66, 67]

The Jarman score is also commonly used as a marker of area based socio-economic deprivation.[68, 69] This score is also based on census variables, but is intended to reflect variations in general practitioner workload, and has therefore been used as a proxy measure of need for healthcare.[65, 70]

Although the three deprivation indices have different derivations, they are highly correlated with each other. Using English ward data, their correlation coefficients are about 0.85.[71] There have been some concerns that, despite these high correlations, the scores may not concur in their identification of the most deprived areas.[72]

Table 1 summarises the published evidence base of a possible association between socio-economic deprivation and emergency medical admissions.

Chishty and Packer showed that socio-economic deprivation was associated with greater risk of emergency medical admissions in an English district.[73, 74] They measured deprivation using a locally standardised Townsend score. Variations between general practices' levels of deprivation accounted for 23% of the differences in emergency medical admission rates between these practices. However, because they used practice aggregate data, this evidence is valid only at the level of general practitioners' patient lists rather than at the level of individual patients.

In Round's study of supply side factors influence on emergency medical admission rates, she used logistic regression to adjust for significant factors acting at the patient level. Socio-economic deprivation (measured using the Townsend score) was found to be positively associated with increased admission rates.[75]

One study has reported contradictory findings. Duffield *et al* studied acute referrals to Edinburgh's accident and emergency departments. They found that while deprivation was associated with increased numbers of general practitioner referrals to the hospitals' accident departments, deprivation was not associated with an increased likelihood of admission to hospital.[76]

Only one other study containing a reported association between socio-economic deprivation and emergency admissions was found. This was Smith and Bernard's recent report of an association between material deprivation and emergency medical admissions amongst people aged over 65.[77] They also used the Townsend score and showed that patients aged 65 to 74 from the most deprived areas were more likely to be admitted than patients from the most affluent areas. Their odds ratio was 2.06 (95%

confidence interval 1.86 to 2.29). Slightly smaller odds ratios were found for older patient groups. Unlike Chishty and Packer,[73,74] Smith and Bernard's analyses were at the level of individual patients' risks of admission rather than at the group level (in this case, general practices' emergency admission rates).

Reid *et al*[78] recently examined the emergency and elective admission rates of general practices' in the Merton, Sutton and Wandsworth area of London. They showed these were strongly associated with practices' Jarman and Townsend scores, as well as being associated with most of the individual census variables which were components of these scores.

No other reports of an association between socio-economic deprivation and emergency medical admissions were found during the literature searches. This was unexpected, given the number of reports associating socio-economic deprivation with the incidence of a whole range of diagnoses and adverse events. In particular, given the number of Scottish studies of socio-economic deprivation and the breadth of the Scottish studies of emergency admissions, it was surprising that there was no Scottish study showing a link between the two.

There have been some reports of associations between emergency admissions of specific diagnoses and socio-economic deprivation. These serve to suggest that there may be a broader association between socio-economic deprivation and emergency admissions generally.

Watson *et al* showed that an acute admission rates for asthma (adjusted for age and sex) were significantly associated with socio-economic deprivation. They found a correlation coefficient of $R = 0.76$ ($p = 0.004$) between standardised admission rates and Townsend indexes in the areas of the English Midlands they studied.[67]

Smith found that emergency admission rates in the Tayside region of Scotland for self-poisoning and self-inflicted injury were three times higher amongst the most deprived group than amongst the most affluent. Smith compared groups of Carstairs' deprivation categories. [79] He also showed that for these diagnoses, there was a similar association with male unemployment rates of postcode sectors. (Male unemployment is only one factor of the four comprising the Carstairs' index). [79]

In a recent publication, Giuffrida *et al* [80] studied admission rates of English family health service authorities. They examined isolated census variables that were markers of socio-economic status and showed significant associations with admission rates for asthma, diabetes and epilepsy.

It might be expected that more patients attending at hospitals' accident and emergency departments might tend to come from areas of socio-economic deprivation. Distance from hospital might however show confounding effects. Campbell found that distance and deprivation together explained 44% of the differences between the accident and emergency attendance rates of general practices in West Lothian. [81] The effects of deprivation and distance was almost equal, with an inverse association for distance and a positive association with deprivation. [81] Hull *et al* conducted a similar study and found that deprivation accounted for 48% of the differences between practices attendance rates in an area of east London. They found however, that distance was not associated with attendance rates in multivariate analyses. [82] McKee *et al* used logistic regression to show that, after adjustment for patients' residential distance from an accident and emergency department, socio-economic variables were not significantly associated with different attendance rates. [83] Their study was based in Northern Ireland and used isolated census variables as markers of socio-economic deprivation instead of the widely established Carstairs' or Townsend scores. The variables they used were: the proportion of households without access to a car, the proportion in overcrowded accommodation, the proportion in social class 5, the proportion lacking an indoor toilet or bath and the proportion of residents aged under 5 years.

Accessibility of health care services

The distances sick patients have to travel to reach their nearest hospitals or to get to their general practitioners' surgeries could influence emergency admissions. The relative proximity of each may also affect patients' decisions as to whether they should attend their general practitioner or attend hospital directly. Some reports of studies investigating the relationships of distance with emergency admissions were found. There were no reports of studies that considered the distance between patients' homes and their general practitioners' surgeries.

Chishty and Packer's work in Redditch used distance between general practices' surgeries and their local admitting hospital as a proxy for patients' distances from hospital. They found an inverse relationship between this distance and practices' emergency admission rates. Using multivariate analysis, they showed that this distance accounted for 11% of the variation in emergency admission rates (Table 1). [73, 74]

A study in the West Lothian district of Scotland used the "crow's flight" distance between general practices' surgeries and their local admitting hospital. [84] It showed that this distance was inversely correlated with practices' accident and emergency attendance rates for self-referring patients. Interestingly, there was no association between this distance and the rates of general practitioner initiated referrals to hospital. Reid *et al* [78] however found no relationship between practices' distances from their nearest hospital and their emergency admission rates.

McKee's Northern Ireland study of patients attending an accident and emergency department also showed that patients who lived closer to their hospital were more likely to attend the accident department than those living further away.[83] While accident and emergency attendance rates are not the same as emergency admission rates, this study serves to support the possibility that geographical distance may represent a barrier for some patients. The converse interpretation is also plausible; patients' proximity to hospitals may make their self-referral easier.

These findings are contradicted by Round. She also found an association with distance, although, as with patient's sex, she did not report the direction of this association.[75] However, she has subsequently confirmed that in her study, patients who were further from hospitals were more likely to be admitted to hospital. (Personal communication, Ali Round, 1999.) Both Round[75] and Chishty and Packer[73, 74] had adjusted for adjusted for markers of patients' socio-economic status, as well as their age and sex. Their contradictory findings suggest that there may have been other, possibly complex, local confounding factors.

The proximity of general practitioner's surgeries to their local hospital may affect the expectations of practitioners as to whether they or their hospitals should see patients presenting with certain conditions. Peppiatt surveyed a group of general practitioners asking them whether they should be first to see patients with a range of specified conditions or whether the local accident and emergency department should see them initially. He found that those practitioners closer to hospital felt that significantly more of the patients should be initially seen in hospital. Practitioners further from their hospital felt that they should see the patients first for more of the surveyed conditions.[85]

While general practitioners' expectations may differ, this does not imply that their workload will vary with distance from hospitals. Carlisle *et al* showed using multivariate (linear) regression in Nottingham that 58% of the variation in general practice out of hours activity was explained by differences in the practices' Jarman scores. Distance from hospital was not a significant factor, after adjustment for deprivation. [86]

A recent Glasgow study has found those patients from more deprived areas were more likely to use a transport service to access an out of hours emergency primary care treatment centre when this became available. [87] This suggests that transport may also be an issue for more deprived patients at the point that they require emergency admission to hospital as well. No evidence was available however about emergency admissions and transport.

Rural factors

The urban – rural divide represents a special case of the accessibility factor already discussed. Because most hospitals are in urban areas, patients living in rural areas already have a greater distance to travel should they require hospital admission. Some specific issues pertaining to rural health care may be relevant for emergency medical admissions.

Because mortality rates are generally lower in rural settings, it is commonly assumed that rural people are healthier. This argument is used to support the increasing urbanisation and centralisation of hospitals and general practitioners' surgeries. This centralisation potentially reduces the accessibility for rural patients of both hospital and general practice care [88] and could lead to fewer emergency admissions from rural areas. [73, 84]

No published research work containing any evidence of differences between urban and rural patients' emergency admissions was found for this review.

3.3.3 Person factors

Many different persons may be involved in the emergency admission process. These include patients, their relatives and informal carers, general practitioners and other formal providers of community care and lastly, hospital staff. Many factors may operate in similar ways for community and hospital care providers. These factors are discussed here but factors that are specific for hospital staff are discussed in a subsequent section (page 96).

Patients

I shall discuss the main demographic factors of patients' age and sex in this sub-section. Socio-economic deprivation, which may be regarded as a person factor, has already been considered above in the sub-section on place factors.

Age

Elderly patients form a substantial proportion of all emergency medical admissions. In 1994, patients aged over 65 comprised only 15% of the Scottish population [89] yet they accounted for 37.3% of all emergency admissions. [4] This increased number of emergency admissions amongst the elderly is consistent with the fact that people in the later phases of their lives will experience more (fatal and non-fatal) illness, so will have more emergency admissions to hospital. Thus, we should expect a positive association between age and emergency medical admissions. This has been the most commonly reported epidemiological finding. Table 1 summarises the published evidence for this association. [4, 5, 21, 45, 73, 74, 75, 77, 90, 91, 92]

Kendrick showed that 49% of the total (49%) increase in Scottish emergency admissions was among those patients aged over 65. The greatest age specific rises in emergency admission rates in this period were for very elderly patients. These grew by 75% for patients who were aged 85 to 89 years and by 100% for patients aged over 90 years. [4]

Life expectancy has increased in most western countries. This has resulted in an increased proportion of elderly people in these populations. It may be supposed that this demographic change has been responsible for the rise in emergency admissions. Kendrick however, demonstrated that between 1981 and 1994, only 5.6% of the total (49%) increase in emergency admissions in Scotland could be attributed to the increased proportion of the elderly in the population. [4]

During the winter peaks in hospitals' emergency admissions noted above, the proportion of elderly patients admitted increased. [5] Moreover, during these peaks, patients' mean lengths of stay in hospital increased as well. It has been suggested that the elderly patients' higher levels of dependency was responsible for this increased length of stay. [4, 5]

Sex

A recent multifactorial analysis in Trent, England has shown that male sex is a risk factor for emergency medical admission. After adjustment for age and socio-economic deprivation, elderly men were more likely to be admitted to hospital medical wards than women. [77]

This finding is not altogether surprising; women have greater life expectancies than men do in western industrialised societies. While broadly similar numbers of men and women may be admitted acutely to hospital, the fact that men die younger than women would reduce their denominator in the calculation of age- and sex-specific emergency admission rates. The effects of this, as the results of Smith and Bernard's study showed, [77] are that men's age-specific admission rates were higher.

Round reports that patients' sex was significantly associated with variations in emergency medical admission rates. Hers was a report of a study concerning hospital bed supply factors. She used logistic regression to adjust for patients' age, sex and deprivation factors. While it is clear from her report that patients' sex was a significant factor, the report is not explicit as to whether men or women had increased admission rates. [75] She has subsequently confirmed that women had an adjusted admission odds ratio compared with men of 0.77. (Personal communication, Ali Round, 1999.)

Table 1 summarises the limited published evidence base of a possible association between patients' sex and emergency medical admissions. It is perhaps more remarkable that other researchers have not reported an association between patients' sex and rates of emergency admissions. Data on patients' sex are as readily available as information on their age and other socio-economic markers, so investigations of this factor might reasonably be expected.

Readmissions

Patients being readmitted to hospital more often could explain a part of the rise in emergency hospital admissions.

The reduction of patients' lengths of stay in hospitals could suggest that they were being discharged sooner back into the community. This in turn might imply that patients might not have fully recovered from the illness for which they were initially hospitalised at the point when they were discharged. If some of these were inappropriately shortened inpatient stays, a rise in the emergency readmission rate could be expected. Earlier discharge, therefore, may be associated with earlier re-admission. [15, 191]

The study of readmissions is complicated in the National Health Service because of the way that admissions are recorded as single episodes. In order to investigate readmissions, a record linkage system must be implemented.[44, 47]

Many authors have suggested that, because of the link between readmissions and excessively short inpatient stays, readmission rates should be used as an outcome measure for the quality of hospitals' practice.[38, 47, 93] Sandler and Mayer pointed out that readmission rates are a poor outcome indicator because they may be subject to potentially confounding perverse incentives in the form of admission or discharge controls.[94] Clarke *et al* noted that that readmission rates do not measure improvement in health status and are therefore not useful as outcome indicators.[95, 96] Goldacre *et al* noted that they do show differences between health care providers, indicating areas for further investigation.[46]

Readmissions may be divided into two groups. The first group comprises those patients who are readmitted soon after they have been discharged from hospital. Patients in this group will mostly have had either a relapse or a complication arising from the illness for which they were recently hospitalised. Readmissions of this type have been referred to as the "revolving door" phenomenon.[15, 97] Readmissions within 28 days are conventionally used as a measure for this category as most readmissions occur within this time period.[50, 96, 98]

The second group of readmissions comprises patients who have multiple admissions over a longer time period. These patients may have more chronic illness. The number of times these patients are admitted in a longer time period (such as one or five years) may be a useful marker here.

In Scotland, while the number of emergency admissions increased by 49% between 1981 and 1994, the number of patients admitted as emergencies increased by only 35% confirming that the number of patients who had multiple admissions increased during this period. [4]

The 28-day crude emergency readmission rate rose in this time from 4.2% to 6.7% of all emergency admissions. This increase represents only 14% of the (49%) total rise in emergency admissions seen in Scotland. [4] On the other hand, the number of patients having four or more admissions in five years rose by 53% between 1981-5 and 1990-4. [4]

Kendrick suggests that the rise in readmissions may, at least partly be explained by the change from long-term inpatient National Health Service care for elderly patients to the community care system. Patients receiving long-term care in the community would now require occasional urgent hospital admission for exacerbations of illnesses that would previously have been managed within a long-stay National Health Service facility. He describes this as "parcelisation" of their care. [4]

Interestingly, the 1985 General Household Survey suggested that the proportion of the British public using in-patient hospital services has remained almost constant, at about 10% per annum. [99] This would be consistent with the rise in emergency admissions only if there was a rise in the number of individual patients who were having multiple admissions in the course of single illnesses, or if the number of times these patients were readmitted had increased. [41, 15]

Social factors

It has been suggested that patients and their families or carers have rising expectations of the service they will receive from all aspects of the National Health Service. These expectations may include a greater expectation of hospital referral from their general practitioners and an expectation of hospital admission following attendance at hospital. [100] An Oxford survey found that 47% of general practitioners considered that their patients had become less willing to accept home based treatment of acute illness. 43% reported that patient's attitudes were unchanged while only 8% believed their patients were more willing to have home-based care. [21]

Government initiatives such as the recent "Patients' Charter" may have further increased their expectations of treatment under the National Health Service. [101] Watson demonstrated that general practice and hospital accident and emergency workload levels were rising at similar rates, suggesting that patients had rising expectations of both primary and secondary care services. [102] Armstrong has demonstrated that patients may exert considerable pressure on general practitioners to refer them to hospital. He found that doctors who had higher referral rates reported greater pressure to refer patients.[103] While his study concerned all referrals, in the absence of evidence to the contrary, similar pressures probably affect general practitioners decisions about emergency referrals.

Several authors have suggested that changes in modern society could be associated with the increase in emergency admissions. For example, the increasing fragmentation of family units may have resulted in the erosion of the social support functions that were provided in extended family groups. People living alone, particularly those with frail health would therefore have increased risks of admission. [4, 104, 105] Other forms of social exclusion and isolation might also be associated with emergency hospital admissions. Unemployment, for example was shown by Roberts *et al* to be associated with poorer social support in Nottingham. [106]

Emergency admission lies at one end of a continuum of forms of support and care for people in the community who are at risk of medical crisis. At the other extreme is family support and in between are the community health services and caring agencies.[45] Thus, particularly for the elderly, hospitals may well be the only realistic option for providing care for these patients when our social care systems are under siege. Two authors have noted this, describing the hospital as the "carer of last resort".[4, 107]

Self-referral

In the United Kingdom, between 18% and 51% of all patients admitted as emergencies were not referred to hospital by their general practitioners.[21, 38, 74, 90, 100, 108, 109] A further study, restricted to the elderly, found that 58% of emergency medical admissions had referred themselves.[110] An even greater proportion, as much as 88%, of those patients who attend hospitals' accident and emergency departments may have referred themselves directly without having seen their general practitioners beforehand.[90, 111]

Hobbs *et al* showed that elderly patients were more likely to be admitted following referral from their general practitioner than younger patients who were more likely to have referred themselves.[109] A study of emergency admissions for asthma found that asthma self referrals were from more deprived areas than those emergency admissions referred via their general practitioners.[67] It is possible that this finding could be due to selection bias: they also found increased rates of asthma admissions amongst the more deprived. It is possible that general practitioners were treating patients who were more affluent in the community, thereby avoiding their need for emergency admission.

Patients decide whether they need medical care; they then choose where and when to seek this care. However, viewed from the perspective of hospital medical staff, those patients who refer themselves directly to hospital are "resented as 'trivia'...".[112] They are perceived as evidence that some general practitioners are "lazy, incompetent or simply unavailable, leaving their patients no choice but to go to hospital...". [112]

Many studies have sought to understand the reasons patients refer themselves directly to hospital rather than first seeing their own general practitioners. These reasons are summarised in Text Box 3 below. [90, 91, 112, 113, 114, 115, 116, 117]

Text Box 3 — Patients' reasons for self-referral to hospitals' A&E departments

Patients saying that the accident and emergency department is more convenient to attend and always open.

Patients' belief that their condition was too serious for their general practitioner.

Patients' desire for immediate attention.

Patients' belief that their general practitioners would not have the necessary facilities or expertise.

Patients' lack of confidence in their own general practitioner.

Patients wish for a second opinion having already seen their general practitioner.

Patients not wishing to bother their general practitioner.

Patients not realising their general practitioner was available out of hours.

Difficulty in getting an appointment to see their general practitioner.

Advice from friends or others to attend accident and emergency department.

Patients' expectation of an X-Ray.

Diagnoses

A consideration of the diagnoses for which patients required emergency hospital admission is relevant for two reasons. Firstly, to appreciate the spectrum of illness giving rise to such admissions. Secondly, comparisons between different hospitals or different general practices require that either similar spectrums of illness are examined, or that adjustments are made for these differences.

None of the studies that examine emergency admission rates undertakes such a case mix adjustment. Such adjustment may affect interpretations of outcomes data [118] as well as process data such as admission rates. Kendrick's is the only large-scale study reporting the diagnoses with which patients were discharged following emergency admission. [4, 5] The diagnoses he examined had been coded using the World Health Organisation's Ninth revision of the International Classification of Diseases (ICD9). [119]

He showed that between 1981 and 1994, the commonest group of diagnoses (for emergency admissions to all hospital specialties in Scotland) was a miscellaneous "other" group. This comprised infectious diseases, endocrine, metabolic, haematological, mental, nervous system and musculoskeletal disorders as well as congenital anomalies. The second largest group comprised injuries. The third largest grouping in 1981 had the highest rate of increase, and was overtaking the "other" group by 1994. This was the group of "Symptoms, signs and Ill-defined conditions" which principally comprised the specific diagnosis of chest pain. [4]

Admissions for diseases of the urinary, gastrointestinal, circulatory and respiratory systems all rose too, but to much lesser extents than the "Symptoms, signs..." group. Within the circulatory system group of diagnoses, most of the rise was due to an increased number of diagnoses of angina pectoris. [4]

It is widely accepted that the incidences of myocardial infarction [120], stroke [121] and circulatory system disorders in general are falling. Kendrick's report of rising rates of admission for these conditions is therefore unlikely to be due to an increased burden of disease. [4] The alternative possibilities are that clinicians have improved their rates of diagnosis of these conditions, or that clinicians' admission thresholds have fallen so they are admitting to hospital patients who would previously have remained in the community. Such a reduction in thresholds is supported by the findings of an Oxford survey that found that 27% of general practitioners were more likely to seek admission for patients with acute illness than three years before. Only two percent were less likely to seek admission. [21]

Kendrick reports elsewhere that emergency admissions for asthma have been rising in Scotland. [122] It is not possible to ascertain whether this is due to more illness in the community, or due to improved diagnosis and the availability of more effective treatments.

Hobbs *et al*'s smaller study reported that respiratory problems accounted, at 30%, for the largest number of emergency medical admissions. Cardiovascular disease, mainly myocardial infection or angina, accounted for 13% of admissions. Their commonest single diagnosis was drug overdose at almost ten percent. [109] Mair's Liverpool study, by contrast, found that cardiovascular diagnoses were the commonest reason for admission. [123]

Medical practitioners

In this sub-section, I first discuss issues that relate to all medical practitioners, whether they are practising in hospitals or in the community. I then discuss matters specifically pertaining to general practitioners (in primary care in the community). I shall deal with issues relating only to hospital medical staff in the hospital section later in this chapter.

All clinicians

In the United Kingdom, there is the view that general practitioners are the gatekeepers of the National Health Service [112] and in some health systems abroad. [124] This is because everyone in the population of the country is supposed to have their own general practitioner who will refer them to hospital when necessary. Hospitals will not offer patients out-patient or elective in-patient treatment unless their general practitioners have referred them to hospital in the first instance. However, as discussed above, when patients are acutely ill, they may refer themselves directly to hospitals' accident and emergency departments or they may taken there by the ambulance service. Because these patients have not been seen by their general practitioners during the emergency admission process, the gatekeeper function (deciding whether the patient should be admitted) must be operating within the hospital.

It might be expected that when doctors are deciding whether to refer or to admit patients to hospitals, they would be responding to those patients' clinical needs for care. There is little evidence of this in the National Health Service. Round showed that general practitioners' admission rates were related to availability of hospital beds in an English district. Bed availability remained a significant factor after adjustment for practitioners' patients' characteristics including age, sex, deprivation and standardised mortality rate. (Bed availability was measured by general practitioners' access to beds in local community hospitals.) Her study implied that factors other than patients' immediate clinical needs could influence decisions about hospitalisation. [75]

Hospitals also have an active gatekeeper function which operates in their Accident and Emergency departments. Here, the final arbiter of admission is the hospital's admitting doctor, often very junior, relatively inexperienced and possibly suffering through working in inadequate conditions. [8, 125, 126] Junior medical staff are unlikely to decline a local general practitioner's request lightly. [127] Indeed, junior doctors may themselves be practising defensive medicine by admitting all patients referred by general practitioners. It is also they who usually have to decide whether to admit self referrals to hospital. [112]

Rosenblatt and Moscovice's study in the United States (where primary care physicians and family practitioners had direct access to hospital beds) used multivariate regression to relate admission rates (emergency and elective together) to several measurable aspects of the doctors' practices. [128] As noted, they found that patients' socio-economic status was the biggest determinant of variation between doctors' admission rates. Admission rates also rose with increasing poverty, with greater bed availability, more children or elderly on the practices' lists and with more services offered by practices. Surprisingly, admission rates were lower in busier practices and in single-handed practices. This study suggested very strongly that doctors adjust their admission thresholds in response to bed availability as well as to patients' clinical needs. The study does not discuss possible reasons for the lower admission rates of busier practices. However, one may speculate that while patient factors and bed availability might be relevant, doctor related factors would be more significant. Such factors might include a greater willingness to accept more clinical responsibility amongst single handed doctors and a better ability to work under pressure amongst busier doctors. Because of the different health care system in Britain, these findings may not be applicable in the United Kingdom. This variation between gatekeepers will be discussed under the section on hospitals' supply side factors.

In the United Kingdom, an increase in medical litigation may have encouraged doctors in both primary care and in hospital medicine to practice defensive medicine. The need for general practitioners to reduce the risk of litigation by "playing safe" may have reduced many practitioners' thresholds for referring their patients to hospital for admission.[127, 129] Surveys suggest that as many as 70% of general practitioners feel that the risk of litigation was an important factor in deciding to refer patients.[21, 130] A similar need to avoid clinical risk taking may have likewise reduced hospital doctors' (especially juniors') thresholds for admission of patients.[125, 131] This would be most relevant when hospital medical staff are taking management decisions for those patients who have referred themselves directly to hospital. Reduced admission thresholds may partly explain the downward trend in case fatality amongst emergency admissions.[16]

According to Andrews,[126] this threat of litigation extends beyond affecting doctors' thresholds for admitting patients. Pressures on acute beds may lead to middle of the night "musical beds" in an attempt to find an appropriate high dependency bed for an acute admission. Patients may thereby suffer physically or psychologically. The doctor ordering such transfers would be sued for negligence, although the hospital's lack of resources would have been the cause of the need for transfer. Similar liabilities could apply when an acutely ill patient has been transferred to another hospital because of a local lack of beds. Long waiting periods in casualty departments could give rise to similar unanticipated legal actions against medical staff during periods of acute admissions. [126]

Recent years have seen the introduction of new clinical treatments for several conditions. For example, thrombolysis has been widely adopted in the management of acute myocardial infarction [132, 133] and many specialist stroke units have been established on the basis of evidence of their effectiveness, [134] although some doubts about this effectiveness have been expressed. [118] The availability of such new treatments has meant that several conditions have become much more treatable than they were before. This (coupled with increased litigation) may have provided an incentive for doctors to offer in-patient care to patients with these conditions. [8] As a result, more patients with less serious disease may be admitted to hospitals. This has been described as "pulling patients through the door". [97] Kendrick's finding that the group of diagnoses labelled as "Symptoms, signs and Ill-defined conditions" was rising faster than other diagnoses would support this. [4]

There have also been changes in the non-clinical aspects of medical practice in the United Kingdom. These have included substantial changes in junior medical staff training and patterns of work. For example, changing rota patterns and the move towards shift working have reduced individual doctors' continuity of clinical care and thereby reduced their clinical responsibility. Pre-registration house officers also now require the authorisation of a fully registered doctor before discharging any patient from hospital. This means that patients seen in accident and emergency departments by a pre-registration house officer are more likely to be admitted, pending review by a more senior colleague, resulting in greater numbers of admissions.

Patients' expectations may also have an effect on doctors' role as gatekeepers.[100] When patients expect to be admitted, it is much more difficult for hospital doctors or general practitioners to refuse admission, especially in an increasingly litigious health care system. Survey data suggested that 72% of Oxford general practitioners considered patients expectations when they were deciding about an emergency hospital referral.[21] The same study found that general practitioners believed that patients expectations of hospital admission had risen.[21]

General practitioners

The Chief Medical Officer for England, Dr. Donald Acheson, commenting about variation between general practices' referral rates said in 1985 "I find it hard to accept that a phenomenon so gross can continue to defy analysis".[18] Despite Acheson's comment, there are few published reports of investigations of factors relating to these variations between general practitioners. There have been several suggestions of general practitioner factors that might have contributed to the rise in emergency admissions. It is essential however that in reading about variations between general practitioners that none of these articles concerned with variations in admission rates suggest what these rates should be.[135] Formal needs assessment studies may be the best way to approach this issue.

Patients' age, sex and socio-economic deprivation have been shown, in papers discussed above, to be associated with variations in emergency hospitalisation rates. It follows than that if general practices' lists of patients differ in these factors, they will also have differences in rates of emergency admissions to hospital. Therefore all comparisons should contain adjustments for these potential confounding factors.

Chishty and Packer's study of admissions to the Alexandra Hospital, Redditch confirmed that difference in practices' socio-economic deprivation accounted for 23% of the variation between practices' emergency medical admission rates. Likewise, differences in practices' proportions of patients aged over 65 years accounted for 2.5% of the difference between practices' emergency medical admission rates. [73, 74] When these factors were taken together in a multivariate regression analysis that also included practices' distances from hospital, 55% of the emergency medical admission rate variation between practices was accounted for.

The relationship between patients' socio-economic status and practices' admission rates has been found in other countries. Rosenblatt and Moscovice showed that in an area of the United States, this was the biggest factor associated with differences between doctors' admission rates (emergency and arranged admissions together). [128]

Round showed that general practices that had access to higher numbers of hospital medical beds had higher crude rates of emergency medical admission than practices with lower bed numbers. This finding remained true, after adjustment for patients' ages, sexes, deprivations, distances from hospitals and proxy measures for mortality and long-term morbidity. [75]

No other studies examining a link between general practices and emergency admission rates were found. In particular, when this literature review was conducted, there were no studies reporting possible associations between emergency admissions and types of general practices (other than fundholding, discussed below) or levels of practitioners' experience or postgraduate training. The very recent paper by Reid *et al* [78] did examine this possibility. They found that, apart from fundholding, there were no practice level indicators that were related to variation in practices' rates of emergency or elective admissions.

Many other suggestions about links between general practice factors and emergency admissions were found. At best, some of these were supported by indirect evidence.

It would seem reasonable that the quality of general practices would affect their hospital emergency admission rates. Such quality issues could be broadly grouped under two headings: clinical expertise and practice organisation.

Good clinical management should, intuitively, reduce the numbers of patients requiring emergency hospitalisation, as general practitioners would manage more acute illnesses in the community. The converse view could be proposed: that good clinical practice would enable the identification of more illness requiring referral to hospital. Clearly, research would be required to illuminate this area of uncertainty. No research directly linking quality of clinical practice with rates of emergency medical admissions was found, however some articles that might indirectly illuminate this area were discovered.

Duffield showed that patients whose general practitioners had telephoned the hospital before referring their patients to the accident and emergency department were more likely to be admitted when they attended hospital. [76] Such telephone calls could be seen as a marker of good clinical practice, but they may simply be an indicator of ease of communication.

Hull *et al* found that practice quality markers (including partnership size, female partner, practice manager, practice nurse, training status and computer use) were not predictive of practices' accident and emergency attendance rates. Their study used a multivariate analysis, adjusting for distance and socio-economic deprivation. [82]

It might be expected that general practitioners providing specialist care for certain patient groups might be expected to have lower emergency admission rates for problems in which they have specialised. During the last decade, many general practitioners in the National Health Service have been providing such specialist care in primary care clinics for specific problems such as diabetes or hypertension.

A British study of general practitioners providing their own structured diabetes care found no associated reduction in the emergency admission rate of these diabetics when compared with practitioners who did not provide such care. [136] These findings are at odds with the report of an American hospital based asthma outreach programme that provided care in the community and reduced emergency admissions almost five-fold. [137] This wide discrepancy between these findings may arise from differences between the two clinical conditions, or from confounding due to population or health care system differences.

Alternatively, these contradictory findings may simply reflect different overall levels of provision of primary medical care in different health care systems. In the United Kingdom universal access to primary care is the norm unlike the United States where hospitals' emergency departments often provide primary medical care, especially for the least well off. An American randomised controlled trial, conducted by the United States Veterans' Department randomised patients to receive an increased access to primary care. Patients in the control arm of the study received normal care. Despite the additional primary care resources used in the treatment group, patients in this group also had a higher rate of hospitalisation, suggesting that more, or better primary care may increase emergency medical admission rates. [138]

Good practice management could also possibly lead to reductions in the numbers of patients requiring emergency admission to hospital. For instance, if general practice appointments are readily available to patients, they might be less inclined to refer themselves to accident and emergency departments. (Open-access consultation systems could be an alternative.) Under such a system, general practitioners would become the effective gatekeepers of emergency hospital referrals rather than less experienced junior hospital medical staff. [125]

The only research article found which appeared relevant was Campbell's which explored (amongst other things) the potential relationship between the availability of general practice appointments and practices' self referral to a hospital's accident and emergency department. [84] Campbell found that, after adjustment for practice socio-economic deprivation and distance from hospital, there was no relationship between self-referral rates to hospital and general practice appointment availability. [84]

British general practitioners within the National Health Service are responsible for providing care for their patients throughout the 24-hour day. General practitioners provide this care in different ways: some are continually "on call", always available to their patients. Others will share responsibility with other general practitioners using an on call rota arrangement. Until recently, many urban British general practitioners used commercial deputising organisations to provide out of hours care for their patients.

These differing after hours practice arrangements could be expected to affect practices' emergency hospital referral rates. General practice principals visiting their own patients would be expected to know their patients and their problems well. This would facilitate managing their own patients at home. Conversely, other general practitioners from an on call rota, or commercial deputising doctors neither know, nor have access to the notes of, the patients they are seeing out of hours. The resulting uncertainty may make them more likely to refer these patients for hospital management. One study was located which compared referrals from commercial deputising doctors with another group of patients referred by their own general practitioners. This found that both groups of patients were equally unwell, as they had similar adjusted case fatality rates. This suggested that similar referral thresholds were operated by both groups of doctors. [139] Another, more recent study found similar admission rates for deputising doctors and patients' own general practitioners. [140] Patients in this study however were less satisfied following visits from deputies than were a control group seen by their own practitioners. [141]

In the last three years, there have been many changes in general practice out of hours care in the British National Health Service. [142, 143] The most widespread innovation has been the introduction of out of hours general practitioner emergency treatment centres. These have had organisational differences, but essentially, instead of being seen in their homes outside normal hours, patients are seen in these centres by one of a group of doctors co-operating on a rota. While these centres are relatively new in the United Kingdom, the benefits they may deliver have been discussed for a while. [144] Similar centres have operated for many years in some European countries [145] and aspects of a Glasgow general practice emergency treatment co-operative service have been evaluated. [87]

Service provision has varied with most centres offering telephone advice to patients and having nursing support. [146, 147, 148, 149] Concerns about this innovation have been expressed by some hospital based doctors [150] and others. [148] Some of these are located adjacent to hospital accident and emergency departments which has been suggested might provide better integrated clinical care for patients. [151] In some instances, transport is provided for patients to get to these centres.[87] Thus far, only one paper has investigated the effect of out of hours co-operatives on emergency admissions to hospital. Salisbury found that patients of doctors visiting from a co-operative were more likely to be admitted to hospital than those visited by deputising doctors (odds ratio 1.30; 95% confidence interval 1.05 to 1.61).[152] There has been some evidence that these centres have improved general practitioners' quality of life while maintaining the standards of patients' care[153] and that doctors prefer to practice in such arrangements after hours.[154]

Some reports of studies of general practitioners elective referrals may be cautiously generalised to the emergency referrals. Knottnerus and colleagues undertook a retrospective comparison of the quality of patient referrals from high referring and medium referring practices in an area of Holland. They showed that there was no difference in referral quality between these groups and concluded that referral rates should not be used as an indicator of practitioners' competence.[155] Hippsley-Cox *et al*, also in Nottinghamshire, showed that there was a strongly positive association between standardised outpatient referral rates and area based socio-economic deprivation, using the Jarman score. Using multivariate regression, they showed that single handed general practitioners referred more outpatients while fundholding general practitioners referred fewer. These latter effects however were barely significant.[156] Carr-Hill and others showed that general practices in deprived areas themselves have higher consultation rates.[157]

In another study, Hippsley-Cox showed that patents presenting late with advanced breast or bowel cancer were no more likely to be registered with general practices with low referral rates than patients with earlier staged cancers. This multivariate analysis implies that these low referral rates are not a useful marker of good clinical practice.[158]

Coulter *et al* compared general practitioner's outpatient referral rates and their admission rates (including both emergency and elective admissions). This study showed that practices with high outpatient consultation rates had high admission rates. The authors concluded that that the correlation between admission rates and outpatient consultation rates suggested that practices with higher rates were simply making appropriate referrals for greater numbers of patients.[159] This was based on the premise that hospital specialists were concurring with referring general practitioners in broadly similar proportions of referrals.

General practitioners' workload has increased substantially over the last decade.[99] This has been reported to have had negative effects on the morale of general practitioners.[129,] The workload increase was partly a consequence of various reforms including the 1990 "new contract".[160] This contract led to changes in general practices' organisation and remuneration.[127, 161] These changes were also resented by general practitioners because the contract was imposed on general practitioners against their will by the then government. This imposition further reduced morale in primary care. This reduction in morale may have lowered general practitioners' referral thresholds.[129, 127]

General practitioners' morale might be expected to relate to the level of their practice's area deprivation. Surprisingly, Grieve found that these were unrelated in her London survey.[162]

One of the major changes introduced into primary care at the start of the 1990's was the General Practice fundholding scheme.[163] This scheme allowed larger general practice partnerships to control their own budget of funds to be used for the purchase of clinical care for their own patients. The scheme was later extended to smaller practices. The aim was to encourage general practitioners to scrutinise and improve the efficiency of their prescribing and referral patterns. Fundholding general practices could use funds that remained unspent to purchase improved facilities for their patients. In practice, many chose to use such surpluses to improve their surgery premises, which had the effect of increasing the value of these premises. These fundholders therefore had a personal stake in minimising the cost of their patients' care to increase the value of their capital assets.

Fundholding has been criticised because the predominant factor used to calculate fundholders' budgets was the pattern of health service use by these practices before they joined the fundholding scheme. Alternative schemes of setting budgets based on an age and sex weighted capitation scheme have been suggested.[164] These more equitable schemes were never implemented.

Most general practices joined a fundholding scheme that covered only elective clinical care. Fundholding might therefore be expected to have no impact on emergency admissions. Keeley observed that "for fundholding practices, urgent admissions are not charged to the fund, so that urgent admissions may result in savings to the fund for investigations and elective hospital work". He then concluded that this may also affect non-fundholding practices "... whose access to elective procedures may be poorer, consequently [facing] greater pressures to reclassify problems as urgent".[165]

Chappell noted that there was no significant difference between fundholders and non-fundholders rates of emergency medical admissions to his hospital.[100] Duffield *et al* likewise found no association between admission rates and general practice fundholding[76] as did Bogg *et al* in Aintree, Liverpool.[166] Boersma however found that while fundholders in Worcestershire had higher rates of emergency admissions than non-fundholders, their emergency admission rates were rising less rapidly than non-fundholders.[167] None of these studies has apparently adjusted for practices' patients' ages, sex or deprivation characteristics. The very recent report of work by Reid *et al*[78] did adjust for these; they showed an inverse relationship between fundholding and both emergency and elective admissions. A slightly higher rate of emergency admissions, especially amongst later fundholders in the scheme, was apparent in Wakefield.[168] Dixon and Glennerster's extensive review of the effects of fundholding does not mention any possible relationship between fundholding and emergency admissions.[169]

3.3.4 Appropriateness of hospital admission

When examining differences in admission rates of different general practitioners or hospitals, it is important to ensure that appropriate comparisons are made.[118] Factors that may contribute to variations in admissions rates, such as patients' age and sex, socio-economic deprivation, case mix and different medical staff behaviour have been considered above. The question of how appropriate were patients' emergency admissions to hospital deserve consideration. Ideally, the appropriateness of a patient's admission can only be determined in the light of existing evidence of the effectiveness of the treatments of the illness for which the patient was admitted. Information about patients' outcomes is clearly also a necessary part of the information base required to assess appropriateness.

Despite the existence of a substantial body of literature on the appropriateness of admissions, not one of the published studies that undertakes any comparison of emergency admission rates deals with the issue of appropriateness of those admissions. I shall briefly discuss some of the other literature of indirect relevance for appropriateness and emergency hospital admissions.

Most of the studies of appropriateness of emergency admissions have reported small case series.[170] Many of these have used standardised assessment tools such as the Appropriateness Evaluation Protocol (AEP)[171] or the Oxford bed study instrument.[172] Such studies usually use clinical grounds to assess appropriateness, concluding that inappropriateness is associated with social factors such as homelessness and difficulties with arranging care in the community.[173] Other studies have reported that inappropriate days stay in hospitals are mostly due to organisational issues within the hospital, including the discharge process.[174]

Many studies of appropriateness have used a hospital perspective, often relying on the judgement of the hospital doctors to decide upon the appropriateness of general practitioner referrals.[175, 176, 177, 178] The assumption that hospital doctors decisions about patients are necessarily better than general practitioners' should be questioned.[179, 180] An alternative approach has been to ask hospital doctors following their decision to admit patients whether they might have chosen to follow a different course of action, had alternatives been available. One study in Aintree, Liverpool showed that admitting junior doctors asked this question might have taken different admission decisions in approximately one fifth of cases.[166]

Duffy *et al*[181] found that there were fewer inappropriate emergency medical admissions amongst those patients referred by their general practitioners than amongst patients who had referred themselves directly to hospital. She concluded that exclusion of general practitioners from the admission process was associated with unnecessary admissions to hospital.[181]

Some studies have examined and classified the reasons for general practitioners' referrals. A case note review conducted by a panel which included hospital and primary care clinicians suggested that between 10% and 40% of admissions were unnecessary, but alternative forms of care would have been required.[182] Denman-Johnson *et al* used a similar peer review approach on the Isle of Wight with review groups which also contained both hospital doctors and general practitioners. They found that 9.5% (95% confidence interval 6.3% to 13.5%) of short term admissions were potentially avoidable.[183] A similar study in Dundee in the 1970s reported that approximately one patient in four could have been managed in the community.[184]

Coast et al compared general practitioner and hospital consultant panels reviews of patients identified as potentially being inappropriate admissions. The two general practitioner panels estimated that 8 to 14% of all admissions could have received alternative forms of care, other than hospital. The hospital consultant panel estimated that 5.5% to 9% of patients could have had alternative forms of care.[202] They concluded that lower technology, more cost effective means of providing care may be substituted for about 10% of hospital admissions. Sylvester, using a general practitioner fundholding base, has contested this finding, suggesting that only two percent of their emergency admissions might have been accommodated in alternative provision.[185] In New Zealand, similar findings were made about the possibility of substituting alternative modes of care for the elderly.[186] These substitutes may be more cost effective.[187] However, these alternatives must be available when they are needed. In their absence, hospitals may be the only appropriate means of delivering care, therefore discussion of inappropriateness may only be hypothetical.[170]

In a separate study, Coast and colleagues used logistic regression to analyse inappropriateness of emergency admissions measured using standardised criteria based on the intensity-severity-discharge review system with adult criteria (ISD-A) in two hospitals in south west England. They found that types of inappropriateness may vary widely from one hospital to another. They concluded that there was a complex interplay between the characteristics of patients, referrers, alternative forms of care and the acute hospital which could result in different types of inappropriate admissions in different locations.[188]

Hobbs discussed whether inappropriate admissions might be (at least partially) responsible for the rise in emergency medical admissions. He concluded that because the variations in emergency medical admission rates between general practitioners was proportionally less than other differences between practices (such as prescribing differences), there was no evidence that the rising trend was unjustified. [38]

Bunker considered appropriateness of elective admissions in the context of wide variations of admission rates in local areas in parts both of Britain and the United States. [189] Americans have substantially higher admission rates than British ones. He suggested that American patients were relatively over-treated while the British might be under-treated. There was no discernible relationship between these variations in treatment levels and indicators of mortality or longevity. American consensus conferences using panels without any apparent personal stake have been established to advise on appropriateness and address the shortfall of appropriateness information. Bunker discussed variations in elective admissions but his comments are relevant for emergency medical admissions as they highlight the absence of appropriateness data. [189]

Studies of appropriateness, even if they do use general practitioners' views, are still hampered by the fact that appropriateness is nevertheless defined by doctors rather than by patients. [112] Walsh cautions against viewing inappropriate attenders at accident departments as malingerers and notes that appropriateness has very different interpretations for patients, hospital and community staff. [113]

Murphy reviewed all publications of appropriateness of accident and emergency department attendances, commenting that there was no standard definition of appropriateness. He concluded that the fact that all definitions of appropriateness of attendance relied on implicit and subjective retrospective judgements. [117] Consideration of inappropriate attendance by patients at accident and emergency departments does relate to emergency admissions as it is the role of the hospital gatekeepers to admit these self referrals appropriately to the hospital. However, it may be that self referral may be the most appropriate action for patients with acute illnesses such as myocardial infarction. [133]

Inappropriate admissions, however defined, happen because the gatekeepers of a health care system admitted them to hospital in the first place. It therefore merits considering whether the term inappropriateness is attractive to doctors who can apply this label to patients to whom they can offer little treatment. This makes the patients or community staff responsible for these admissions when in reality the gatekeeper has failed.

As with variations in general practitioners' admission rates, it is important that one does not imply that higher or lower rates are better. [135] Formal needs assessments may assist here too, but rates may still vary although clinically effective treatment is being delivered.

3.3.5 Summary

Emergency admission rates may vary in response to many extrinsic factors. They have been shown to be rising over time as well as having short-term variations. Evidence has also been presented of variation between emergency admission rates with patient factors such as their age and sex. They have been shown to be associated with the area in which patients live, where such areas have been characterised as being affluent or deprived. Much of the literature about emergency admissions is based on speculation rather than on substantial evidence. Despite the importance of obtaining a greater understanding of emergency admissions, most of the evidence is from small, local studies. This evidence may not generalise to larger regional or national populations. None of the epidemiological studies of admissions can deal with the issue of appropriateness of hospitalisation.

3.4 HOSPITAL EFFECTS ON EMERGENCY ADMISSION RATES

Individual hospitals' emergency admission rates may vary substantially. In addition, the rates of rise in emergency admissions has been different from one hospital to another.[12, 190] Viewed nationally, these differences have been masked by aggregation when calculating national statistics.[12]

An examination of how hospitals' rates of emergency admissions may vary is important firstly to gain a general understanding of emergency admissions. It is also important, because if hospitals do vary widely, it is useful to consider why this is so in order that interventions to manage the problem of rising emergency admissions can be planned.

3.4.1 Hospitals' interventions for managing emergency admissions

There are two categories of interventions used by hospitals as responses to long-term rises in emergency admissions and peaks in the numbers of such admissions. Acute responses form the first group. The other group comprises planned responses that are implemented before emergency admissions reach a peak. These planned responses should improve hospitals' ability to cope with the anticipated increase in emergency referrals.

Acute responses are usually short-term actions that are necessary reactions to crises. The range of acute responses includes the measures in Text Box 4.[191] These responses are usually highly visible outside hospitals because of their impact on other patients through the cancellation of elective admissions and often apparently inappropriate boarding of patients and the effects on staff patterns of work. They are therefore commonly reported by the news media.[192] Such stories often receive sensationalistic coverage.[10]

Text Box 4 — Hospitals' main short term responses to emergency admissions peaks

Cancellation of previously arranged elective hospital admissions.
Hospital ward closures with temporary redeployment of staff elsewhere in the hospital.
Boarding patients out. (e.g. placing medical patients into the beds normally used for elective orthopaedic patients).
Short term redesignations of hospital wards. (e.g. from gynaecological to medical).

Many authors have suggested methods whereby hospitals may be able to plan to cope better with both the rise in emergency admissions and with peaks in admission demand. These measures have been described as forming a "well-known menu" of hospital responses.[17] While the measures on this menu may be attractive and seem intuitively to be effective, we need to be sure that they really do work in practice.

In planning hospitals' possible responses to enable them to cope with the pressure from emergency admissions, it is helpful to consider the three major components of the hospital admission process.[12]

Patients are firstly assessed before they are admitted. A working differential diagnosis may be achieved, or it may be decided that the patient merits further inpatient investigation or observation. During the above steps, a decision as to whether the patient requires admission will be taken. A management plan will be formulated whether the patient is admitted or sent back into the community. The second phase of a patient's emergency admission to hospital follows the clinical management plan, which may possibly be modified, until it is decided that the patient should be discharged. The final phase begins at that decision and lasts until the patient leaves hospital.

Each of these three phases provides opportunities for hospitals to improve their management of emergency admissions. There have been several publications discussing variations of approaches suitable for each of these three phases.[193, 194,] Despite the number of reports, there is no standard terminology for these three phases of an admission.

The following three subsections are titled "pre-admission management", "admission management" and "discharge management".

Edwards and Hensher developed an explanatory model that may be helpful in understanding hospitals' management strategies.[193, 194] They suggest that it is artificial to divide general practice from hospital care. In reality, patients' medical care takes place along a continuum, ranging from general practice, through specialist outpatient care, through to in-patient hospital management, as shown in Figure 1. Over time, patients will have varying levels of care need. As patients' needs increase, they may cross the thresholds between different healthcare sectors. Threshold A represents the need for specialist outpatient care and threshold B represents the point at which a patient would be admitted.[193, 194]

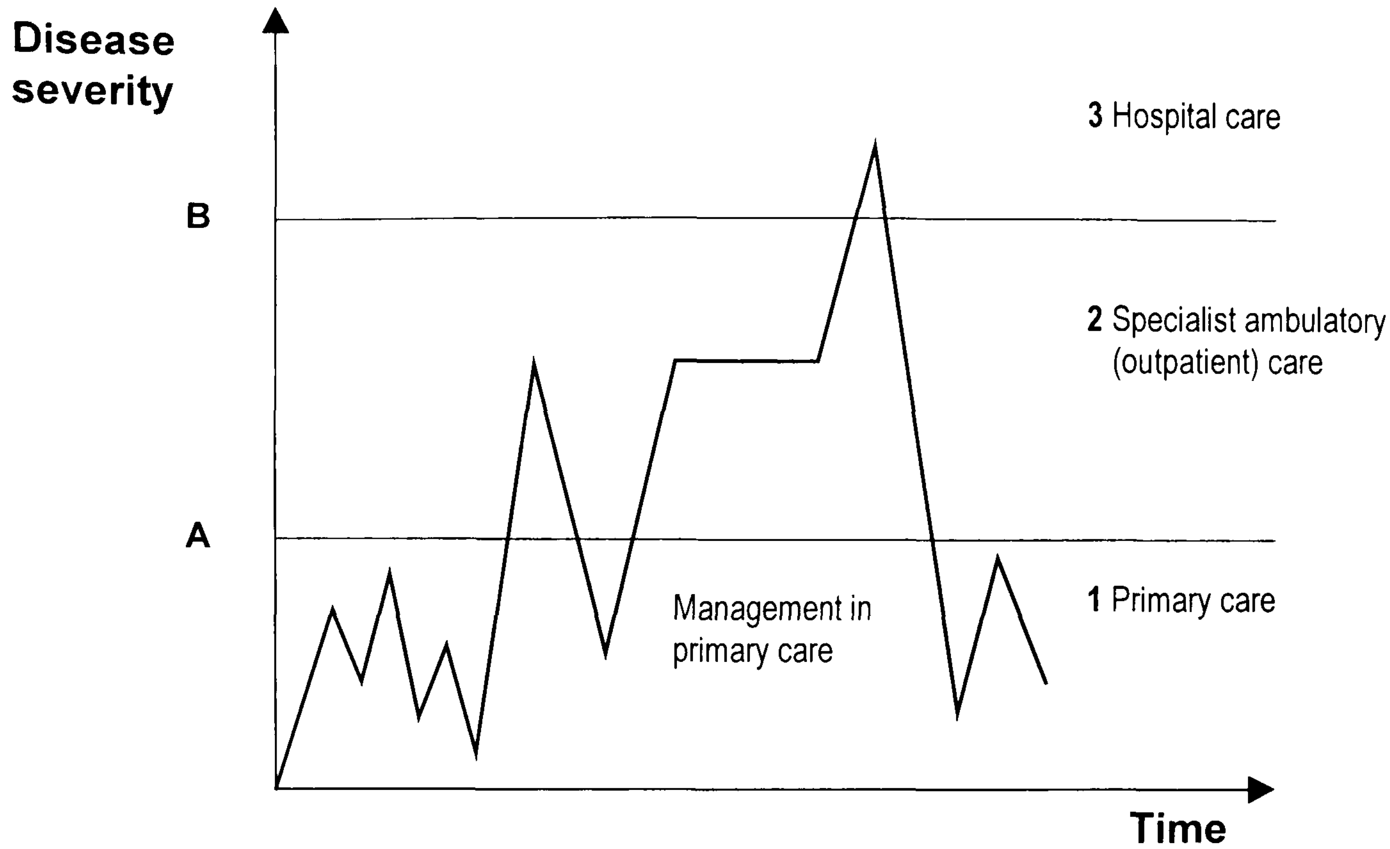

Figure 1 — Edwards and Hensher's model of disease severity and care thresholds

Edwards and Hensher suggest that these thresholds may be increased, so reducing the numbers of admissions. This change may also reduce patients' lengths of stay, since the raised threshold will also be effective in speeding patients' discharges from hospitals. [193, 194] Such changes in thresholds rely on the ability of primary care to provide a replacement for secondary care services. [195] An expansion of primary care would be a necessary consequence of any change in thresholds.

There have been several publications presenting management approaches that are appropriate within each of these subsections. Rather than have a lengthy repeated list of references for each strategy, I have referred here to the major documents that relate to all three subsections. [12, 13, 14, 19, 193, 194, 196, 197] References within the following subsections relate to specific discussion points.

None of these publications presents a formal evaluation of any of these strategies. Only a limited number of such evaluations appear to have been published. These documents do indicate that these strategies have been used, citing as examples, the hospitals where the strategies have been used (see [193]). In one instance, giving them the aliases of well-known artists has been used to prevent these hospitals from being identified. [14]

Possible reasons for this lack of publications include the following: [193]

1. Such interventions are to some extent "self evaluating". That is to say, either they solve the problem as intended or they do not. There may be little incentive to evaluate those that succeed. Likewise, documenting those that fail may not be attractive

2. Environmental noise in hospital systems may make before and after designs problematic. The "Hawthorne" or "halo" effects may make it difficult to assess changes

3. Many interventions have simply been introduced without any initial consideration of formal evaluation.

It is therefore probable that the literature on hospital interventions to cope with pressure from emergency admissions will continue to comprise mainly suggested strategies. Formal quantified evaluations of these strategies will remain sparse.

Pre-admission management

Hospitals may use several strategies to improve the pre-admission management of patients admitted as emergencies. These will mostly be designed to reduce the number of admissions, although some improvement in the admission process could also benefit hospitals. [193, 194]

Practically, these strategies usually involve the establishment of rapid assessment outpatient clinics to which general practitioners may refer patients urgently, patients usually being seen on the day they are referred. These enable senior hospital clinicians to assess the referred patients, conduct initial investigations and plan appropriate management. Having excluded diagnoses requiring admission, these clinicians can then decide whether admission or outpatient care is more appropriate.[198] In recent years, several United Kingdom hospitals have established chest pain[199] or respiratory outpatient assessment clinics.[198] Such clinics may also improve the efficiency of in-patient management by allowing patients to be triaged directly to the ward of the specialty appropriate to manage their conditions.[200]

Another strategy is to increase the availability of consultants and senior doctors for admissions consultations with both the admitting junior medical staff, and for referrals from general practitioners. This entails freeing up consultants from other duties during their team's rota turn "on call".[200] The system introduced at the Royal Alexandra Hospital in Paisley included an on call consultant regularly available within the hospital for telephone discussion with general practitioners.[190] This contact could potentially have diverted some admissions although this was not evaluated.

A survey of general practitioners in the Aberdeen area found that only 6% of general practitioners would be happy with pre-admission medical triage decisions being taken by a registrar who had already passed his membership examination of the Royal College of Physicians.[201] This suggests that such pre-admission management decisions that may lead to patients' deflection back into the community might be taken at a more senior level. However, a survey at Aintree showed that junior doctors may have altered up to a fifth of their admission decisions had they had better access to urgent investigations, senior opinions and alternative accommodation outwith the hospital.[166]

This pre-admission stage response may result in doctors formulating better clinical management plans, and initiating investigations before the patient's admission. These could lead to reductions of patients' lengths of stay in hospital (affecting the second phase of admissions).

As noted above, hospitals may be "the carers of last resort" when social support has failed.[4, 107] As many as ten percent of patients may be suitable for alternative accommodation,[202] so improved pre-admission assessment may allow some patients not requiring admission to be identified. These could then be deflected back into the community. This is only possible if alternative appropriate forms of care are available.[12, 202] This may require improved local liaison with community care agencies to ensure the provision of appropriate community support. This could take the form of using nursing home beds for those 'unable to cope at home'[203] or it could involve improved hospital at home schemes with rapid response community nursing.[204] These changes require closer co-operation between hospitals, their referring general practitioners and community care agencies.[9, 10, 196] This might reduce general practitioners' traditional gatekeeper role but they would stand to gain a greater role in the management of potentially more significant disease. Hobbs reported that for 15% of a group of emergency medical admissions who had been referred to hospital, the patients' general practitioners felt that the patient could have been managed at home given an appropriate environment.[109] This suggests that admission deflection is perceived as reasonable from the general practitioners perspective.

Admission management

As noted, more effective planning of clinical care including earlier booking of investigations may shorten the admission phase. Admission assessment units may also be used. These lead to improved bed utilisation, allowing staff to develop specialist skills while relieving the stress on other hospital wards. Whilst specialist coronary care units have been established at many hospitals, admission assessment units have only been a feature of some of the larger, usually inner city hospitals.

Another group of admission management strategies relies on improved allocation of hospital beds. Amongst the varieties of bed allocation has been the use of a central bed bureau, with control of all beds in the hospital. Under such a scheme, hospital consultants lose their "own", or their units' beds while the bed bureau manager has the responsibility of allocating all beds from a central pool. Such a bed bureau must be staffed for 24 hours per day and it must have accurate, up to date information on bed occupancy throughout the hospital.

Improving the planning and co-ordination of patients' clinical investigations and treatments has been used to reduce the amount of time patients spend in hospital. Similarly, the adoption of protocols and guidelines for the management of specific conditions has also been used to improve clinical management.

East Glamorgan Trust [205] and the Royal Alexandra Hospital [190] in Paisley have both reported successful reorganisations of their emergency admission procedures, introducing admission assessment units. Both hospitals reported a reduction in patients' transfers between wards or hospitals and a reduction of patients boarding in inappropriate wards. Patients' mean length of stay in medical beds was reduced by one day in

East Glamorgan [205] while Paisley also reported an increased medical bed occupancy (84 to 88%). [190] However, East Glamorgan reported that staff on other wards had felt a degree of deskilling as a result of no longer managing acutely unwell emergency admissions [205] and in Paisley nursing staff reported increased stress levels following the reorganisation. [190]

Paisley's on-call consultant also undertook twice daily ward rounds and was available for consultation with junior medical and nursing staff. These activities may also have improved in-patient management, seen in the reduced length of stay. (The consultant may have may also have facilitated earlier discharge planning as discussed below). [190]

Redgrave has also reported on the implementation of a similar acute admissions assessment unit. He found that they were able to save up to 9% of the occupied bed days, although the comparison was retrospective, so it is not clear that sufficient adjustment may have been made for the secular trend in reductions in patients' lengths of stay. [206] A Nottinghamshire trust has reported better management of peaks in demand following the introduction of such a unit [207] as has a Scottish trust. [208]

Short stay wards may appear to present a compromise between outpatient rapid assessment units and emergency admission units. The allow the assessment of comparatively minor problems such as intentional drug or alcohol overdose. [200] In Scotland, while 18 out of 26 acute hospitals now use admission assessment units, only five out of 26 use short stay wards (three of these have both). [200] Because of the short stay observation nature of these wards, the admission process for going to patients to these wards may be streamlined and simplified. Making it easier for doctors to admit patients to these wards may reduce admission thresholds. According to Edwards and Hensher's model [194] (Figure 1) this may result in an increase in the numbers of admissions. Short stay wards may consequently fail to produce any benefit for emergency admissions. An American study has suggested that the cost savings achieved using short-stay observation units to reduce in-patient medical admissions did not justify these units. [209]

Another way in which admissions may be more efficiently managed is to have better liaison with the geriatric services, with either direct triage of appropriate elderly admissions directly to the geriatric wards or for the geriatrician to visit the acute assessment unit daily. [200]

A Birmingham trust has reported a novel approach to admission management. Consultants were provided with unanonymised data on their patients' median lengths of stay. This was followed by a fall from a median of 6 to a median of 5 days in the medical units overall. [210]

Discharge management

The final group of strategies to improve the management of emergency admissions to hospital revolve around improving the discharge process. Since the decision to discharge a patient is usually only taken when the patient does not need further care, it should not be necessary for most patients to spend much time in hospital after this decision has been taken. The simplest approach to resolving the discharge management problem is to improve liaison between hospitals and community care providers such as nursing homes. In many instances, nursing homes have available places while hospitals have blocked acute beds, occupied by patients awaiting assessment for transfer into the community. It has been suggested that a unified budget for health care and social work (similar to that in Northern Ireland [211]) might speed up this process. [203]

"Discharge planning" has received considerable attention in some hospitals. The principle underlying discharge planning is that a patient's discharge should not be an unexpected event occurring at the end of a stay in hospital. Rather, it should be the planned final phase of an admission. Planning for a patient's discharge should therefore begin from the time of a patient's admission. This may involve better liaison with community staff so that appropriate community services are restarted on time. Earlier discharge may therefore require more community resources to implement successfully. [212] An American randomised controlled trial of early discharge planning showed that it increased the probability of dependent patients successfully returning home and reduced the nine month readmission rate. [213] However, this study did not find that the use of discharge planning led to a reduction in patients' lengths of hospital stay.

A "departure lounge" has been introduced by several hospitals. This usually comprises a comfortable area for patients who are waiting for the hospital to complete their discharge processes such as dispensing discharge medications. Discharged patients awaiting transport from relatives or the ambulance service would also use it. It has the benefit of freeing up a hospital bed several hours sooner than under older systems where patients waited in hospital wards until their medication and transport had arrived. Only when they had left the hospital could their beds be used for an admission. With a discharge lounge, beds can be filled much earlier.

Earlier discharge, as noted above, may be associated with earlier re-admission. [15, 191] However, one study using a community programme which included visiting patients at home immediately after they had been discharged from hospital showed that a reduction in readmissions could be achieved. [214]

Summary

While each of these strategies appears distinct, implementing improvements in one phase of the admission process will probably have effects on other stages. For example, earlier discharges resulting from discharge planning may improve bed availability and hence improve rational bed utilisation.[185] Consultant availability throughout the day may allow deflection and allow all stages of an admission to be better managed.[190] Most implemented strategies designed to assist in the coping with emergency admissions have combined elements of admission deflection, improved bed utilisation and expedited discharges.[200]

Many hospitals have adopted variations of these measures, according to their specific local needs.[200] Despite the need for greater knowledge of the effectiveness of these hospital responses, there are few published formal evaluations of these local implementations and knowledge of the effectiveness of these interventions is patchy.

3.4.2 Supply side factors

While the above hospital interventions may assist in the management of emergency admissions, it is also possible that hospitals themselves may affect their admission rates. Such supply side factors may well contribute to the rise in emergency admissions.[75] Supply side factors may have been overlooked as a cause of rising emergency admissions because highly publicised reductions in total bed numbers may have made this seem implausible. Edwards has pointed out that because patients' lengths of stay have fallen faster than numbers of hospital beds, there has been a relative increase of bed availability.[16] Such supplier-led demand could be reinforced by reduced admission thresholds, resulting from fears of litigation and the introduction of new treatments.[16]

The effects of hospitals' bed availability have been known since 1959 when Milton Roemer wrote that "a bed built is a bed filled".[215] This instance of supplier led demand has come to be known as "Roemer's law"[75, 216] although he denies it. He later wrote that "We have even been accused of discovering a new scientific 'law', and of concocting, what is worse, a hospital modification of Parkinson's law...". [217]

Roemer showed that when the supply of beds in a New York county was increased following a change in hospitals between 1957 and 1959, there was a rise in admissions to match the increased bed availability. [217]

Petty and Gumpel described the effects on the numbers of acute medical admissions to Northwick Park Hospital following a sudden reduction in bed numbers. The hospital had closed fifteen beds (out of 104) owing to financial pressures. They found that the hospital was closed to admissions on substantially more nights but there was also a reduction in the rate of emergency referrals from general practitioners. Despite the loss of beds, the number of admissions rose during the three year study. [218]

Kirkup and Forster used multiple regression analysis to investigate English hospital utilisation at the level of district health authorities. They showed that for the specialty of general medicine, differences in the availability of hospital beds explained 49% of the variation in admission rates between districts. Differences in bed availability also accounted for 90% of the variation in districts' hospitals' bed occupancy (measured in bed-days). [219] This finding was supported by Carr-Hill *et al* who showed that bed supply had a substantial effect on hospital utilisation. [220] Recent work by Giuffrida *et al* [80] suggested that at the level of family health service authorities in England, variations in hospital supply side factors were associated with admission rates for asthma, diabetes and epilepsy. The factors they examined were numbers of hospital beds and general physicians.

Edwards has suggested that the above findings could provide a novel approach to managing rising emergency admissions. He suggests closing hospital beds; thereby limiting supplier led demand, as a tool to manage the rise in emergency admissions. This, in itself, would not be enough. Protocols for admission, senior staff on duty in admissions and alternative care provision would also be required if emergency admission numbers for this strategy of limiting emergency admission numbers.[17] He said elsewhere that this measure is the "least sophisticated" of a hospital's possible responses.[194]

Caution should be adopted in using this approach. While supply side factors are associated with variations in admission rates, restriction of supply may not be an adequate tool for the management of admission numbers. Bagust *et al*[221] have developed a model that that shows the importance of reserve capacity, suggesting that when average occupancy levels rise above 90%, beds crises will occur regularly.

The role of gatekeepers

If gatekeepers for admissions are acting solely on patients' clinical needs when taking admission decisions, then bed availability should not affect admission rates. However, it has been suggested that when more beds are available, more patients will be found to occupy them.[222] This suggests that doctors' admission thresholds may be affected by the availability of beds for their patients and that medical judgements may be affected by external factors.[223]

In another study, Roemer compared admission rates of different conditions in Saskatchewan in 1956. He showed that there while there was an almost threefold difference in doctors admission rates for "nature generated" conditions (accidents and obstetric admissions). There was a much higher rate of variation for "physician generated" admissions, which required a relatively refined medical or surgical diagnosis, relying on the doctor's judgement. Such diagnoses included appendicitis, pneumonia and pharyngitis (including tonsillectomy). These had matching variations between doctors of 9, 12 or 27 fold. He concluded that physicians were hospitalising patients at rates higher than could be justified by their objective health needs. [223]

As discussed, Round used multiple logistic regression to show the effects, at the level of general practitioners, of differing levels of bed availability on their emergency admission rates in south west England. She showed that general practitioners with access to more beds had significantly higher emergency admission rates than those with fewer available beds. Those with more beds also had the fastest rises in emergency admission rates. [75]

Rosenblatt and Moscovice's study, discussed above, showed that the hospitalisation rates of doctors in Washington State varied widely. One of the most significant factors associated with this variation was the occupancy rate of the hospital to which they admitted their patients. They concluded that many admissions were discretionary. [128] Nightingale expanded this research, showing that doctors' admission rates related to their preference for taking risks or playing safe, when faced with a set of clinical scenarios. [224]

In the National Health Service, because hospital based junior doctors are the final gatekeepers for admission, they must be the mediators of supply-side effects seen as differences in hospital emergency admission rates.

There are many other factors acting directly or indirectly on the admitting doctor. Supply side factors may originate within the hospital. Community factors may be found outwith the hospital. These will include pressures operating on patients and general practitioners.

These differences between clinicians, apparently in response to difference in the supply of hospital beds, confirm that clinicians do have different admission thresholds. Thus, while the model developed by Edwards and Hensher [193, 194] (Figure 1) was developed at the level of provider hospitals, or the wider level of the health service, it remains consistent at the level of individual clinicians.

Edwards and Haycock report the findings of a health economists' study group conference which considered the relationships between many of these factors. [16] This is shown in Figure 2. This contains boxes representing several factors. These all have arrows leading away from them, pointing to their effects. A negative feedback loop in the model could have the effect of stabilising it. However, the authors note that there is such corrective mechanism in their model and conclude that "this suggests that without the introduction of such corrective measures, the NHS internal market will self perpetuate its current state of disequilibria" (sic). Edwards and Haycock suggest that seven consequences of their model's failure to have a corrective mechanism might be seen: [16]

1. An increased number of 'less serious' admissions, associated with an increased proportion of patients with a very short length of stay

2. More admissions in diagnostic categories expected to be sensitive to ambulatory intervention (i.e. could be managed as outpatients)

3. An increase in the number of patients with complicated discharge arrangements

4. An increase in general practitioner referrals per practice

5. An increase in the proportion of emergency admissions

6. The appearance of conditions, generally treated as elective admissions, as emergencies in a worse clinical condition [paraphrased]

7. Increases in providers' costs and activity related expenditure.

Their paper was published in 1994. It may be difficult or even impossible to investigate all of the predictions that derive from their model. However, Kendrick's Scottish work shows that at least some of their predictions may be correct. For example, the first prediction may be considered in the light of Kendrick's report that the fastest growing diagnostic category was the ICD9 chapter of "Symptoms, signs and ill-defined conditions".[4] More detailed consideration of this observation of Kendrick's might also confirm their second prediction. Evidence supporting their fifth prediction may be found in Kendrick's paper, if one considers only emergency versus elective admissions, ignoring day case activity. Otherwise, emergency admissions as a proportion of all admissions have remained relatively static.[16] Kendrick has also discussed how in-patient lengths of stay have fallen,[5] lending more weight to Edwards and Haycock's first prediction.[37]

Edwards and Haycock's model does not consider the use of pre-admission outpatient assessment clinics, such as chest pain clinics. The introduction of these could provide an, albeit limited, negative feedback loop within their model, by being one factor that might increase the propensity to reduce admissions (Figure 2).

3.4.3 Conclusion

The observation that hospitals' rates of emergency admissions may vary is important. It suggests that hospitals are not necessarily identical. This should not be surprising, but it does have three important implications.

Firstly, because in examining general practitioners' emergency admission rates, it becomes essential to consider hospitals as a factor, as they are the final gatekeepers of emergency admissions under the National Health Service. Hospitals could be a confounding factor for differences between general practitioners' emergency admission rates, especially because general practitioners tend to refer most of their patients to one, or a small number of hospitals.

Secondly, it is important because if hospitals have different emergency admission rates, some of the factors discussed above may already be in place in these hospitals causing reduced or increased admission rates. These factors may have been explicitly adopted (an admissions assessment unit for example) or they may be operating implicitly (bed availability may be reduced for example). It might be possible to identify how such hospitals differ.

Lastly, it is also important because, if the factors causing differences in hospitals' emergency admission rates are identified, this would suggest further ways in which hospitals and secondary care providers might affect their rates of emergency admissions. This may then lead to the development of interventions that improve the management of rising emergency admissions. The effectiveness of such interventions should be formally evaluated.

This literature review has identified a substantial lack of published epidemiological research into emergency medical admissions. Given the resources consumed by emergency medical admissions and the consequent pressures within the National Health Service, this lack of empirical findings is surprising. The research reported in this thesis was conducted in order to provide an evidence base that would partly address this shortfall.

Table 1 — Reported factors associated with emergency admission variations

Year	Study type	Study size	Study findings							
							Patient factors			
			Time factors	Place factors	GP Factors	Hospital factors	Age	Sex	Deprivation	Comment
1973 [139]	Controlled study	459 deputy vs. 1,224 GP referrals			X					No differences in adjusted outcome (case fatality) or length of stay; suggesting similar referral thresholds for deputising doctors and general practitioner principals
1976 [108]	Case surveys	2,511 patients			X					1720 patients admitted. 50.9% referred by GPs. 37.3% self referred. Comparison with patients not admitted (19.0%, 20.7% respectively)
1979 [52]	Routine data analysis	4,500,000 population	X							Emergency admissions more common on Monday. Admissions trough at weekends, smaller peak on Fridays.
1989 [91]	Prospective survey	180 A&E attendances			X		X			Survey showing variation between GP's patients in numbers seeking second opinions at accident and emergency by age, GPs.
1993 [90]	Case series	3,039 A&E attendances			X		X			Comparison of emergency admissions in inner London and a town outside London. Admission rates similar inside and outwith London.
1994 [92]	Interviews	175 admissions			X		X			Interviews with 158 GPs and 31 patients. 53% referred by GP, GP referral more common amongst elderly. Reasons for admission. GP views.
1995 [73, 74]	Routine data cohort	3,925 admissions		X			X		X	55% of variation in emergency medical admission rates explained by GP practice distance from hospital, deprivation (Townsend) and proportion over 65 together (multivariate analysis). (univariate 11%, 23%, 2.5% respectively).

(continued)

Table 1 (continued) — Reported factors associated with emergency admission variations

			Study findings							
							Patient factors			
Year	Study type	Study size	Time factors	Place factors	GP Factors	Hospital factors	Age	Sex	Deprivation	Comment
1995 [100]	Survey?	Catchment population 140,000			X		?			42% rise in emergency medical admissions 1986 to 1994. 85% GP referrals; self-referrals increasing. Variation in GP referral rates (1.66% to 4.85%). No differences with fundholding.
1995 [21]	Routine data cohort; GP interviews	Oxford RHA (population?)	X		X		X			Admission growth greatest amongst elderly. Emergency medical admissions rising by 4% yearly. Lenth of stay falling to match. Patients' expectations, defensive practice, GP workload and demand for GP night visits rising.
1996 [4, 45]	Routine data cohort	≈ 5,000,000 (Scottish population)	X				X			Long term trends in emergency admissions by age, groups of diagnoses and specialties. Discussion of possible mechanisms behind the long term rise.
1996 [138]	Randomised controlled trial	1,396 patients randomised			X					Increased provision of primary health care for medically unwell patients associated with increased hospitalisation rates.
1997 [5]	Routine data cohort	≈ 5,000,000 (Scottish population)	X				X			Long term trends in emergency admissions by time of year, age. Discussion of winter surges in demand and age effects.
1997 [152]	Comparative	5,812 patient contacts			X					Comparison of a GP co-operative with a commercial deputising service. Higher hospital referral (admission) rate from co-operative (adjusted OR = 1.30)
1997 [140]	Randomised controlled trial	2,152 patients			X					Practices randomised to provide their own out of hours care or use deputising services; randomisation by duty (time) periods. No differences in emergency admission rates.
1997 [76]	Retrospective cohort	2,303 A&E referrals			X				X	No association between patient admission rates and deprivation. No association with practice fundholding. Greater likelihood of admission following GP phone call to A&E.

(continued)

Table 1 (continued) — Reported factors associated with emergency admission variations

			Study findings							
							Patient factors			
Year	**Study type**	**Study size**	**Time factors**	**Place factors**	**GP Factors**	**Hospital factors**	**Age**	**Sex**	**Deprivation**	**Comment**
1997 [75]	Retrospective cohort	377,655 residents		X	X	X	X	X	X	Showed that general practitioners with access to more hospital beds had higher emergency admission rates. Also, age, sex, distance from hospital and deprivation effects (Townsend).
1998 [77]	Routine data cohort	134,608 Trent ≥ 65 yr					X	X	X	Increased admissions amongst older patients, men and patients from more deprived areas. Population base Trent residents ≥ 65 years.
1999 [80]	Routine data cohort	90 family health services authorities				X			X	Compraison of pooled FHSA data for admission rates for asthma, diabetes and epilepsy. Showed that rates varied form year to year and differences between FHSA admission rates were were substantially accounted for by socioeconomic and supply side variations.
1999 [78]	Routine data cohort	209,136 hospital admissions		X	X	X			X	Showed that general practices' admission rates (emergency and elective) were related to Jarman and Townsend scores. They were not related to other markers of practice structure, performance, quality or to distance from hospital.

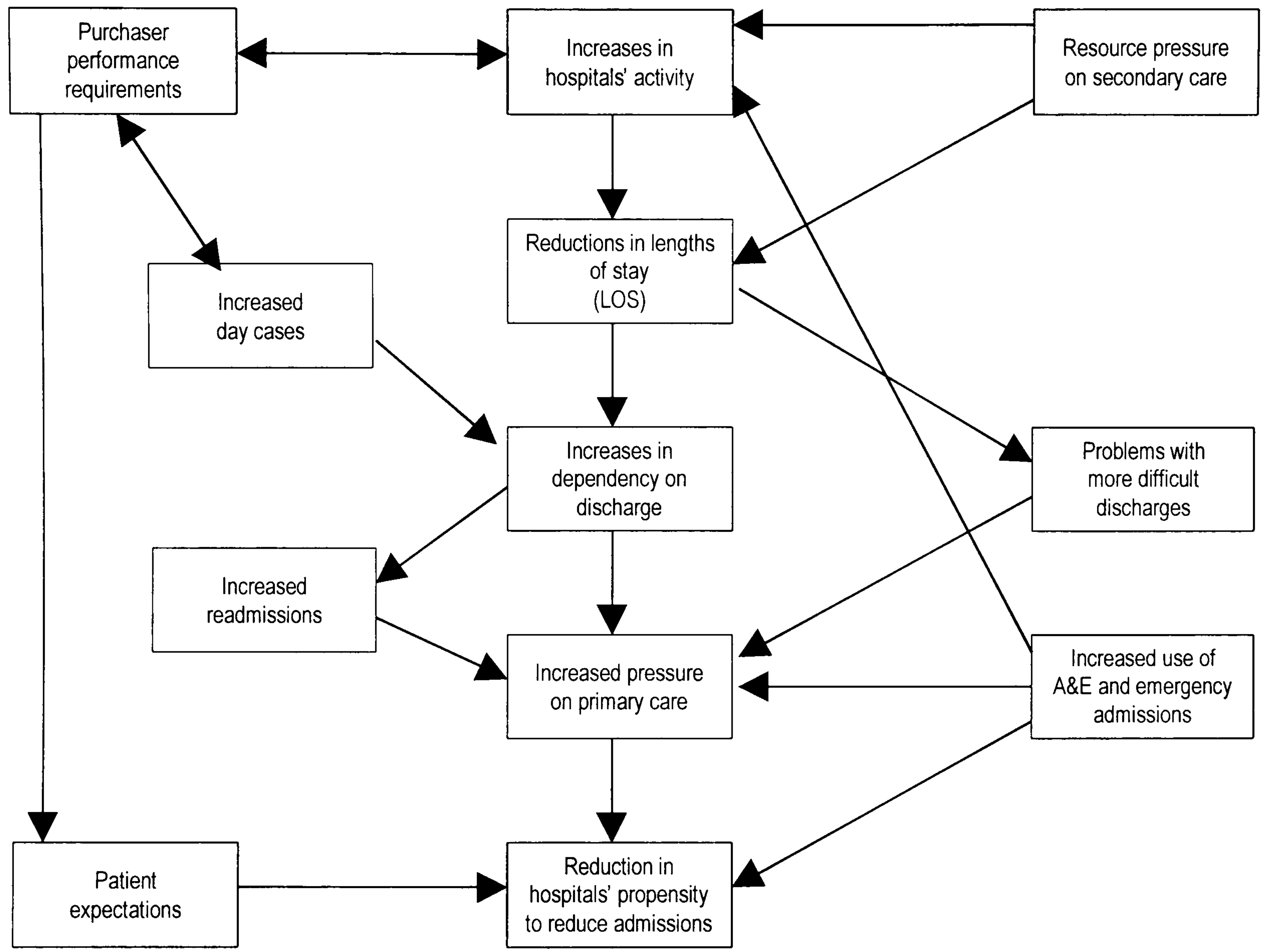

Figure 2 — Edwards and Haycock's explanatory model of emergency medical admissions growth

CHAPTER 4 —

STUDY DESIGN AND METHODS

4.1 THE SETTING OF THE STUDY

The study was carried out in the Greater Glasgow Health Board. This is one of fifteen Scottish health boards (Figure 4). While the Greater Glasgow Health Board is the smallest health board in terms of area, it has the largest resident population (Table 2). It is the biggest health authority in the United Kingdom.

Table 2 — Scottish health boards' populations and mean Carstairs' scores (1991)

Health Board		Population	Carstairs' score *
No.	Name	n	mean
1	Argyll and Clyde	429,396	0.42
2	Ayrshire and Arran	371,988	-0.08
3	Borders	103,881	-1.78
4	Dumfries and Galloway	147,805	-1.32
5	Fife	341,199	-0.81
6	Forth Valley	267,492	-0.80
7	Grampian	503,888	-1.99
8	*Greater Glasgow*	*894,332*	*2.68*
9	Highlands	203,757	-1.21
10	Lanarkshire	552,990	0.90
11	Lothian	726,010	-0.90
12	Orkney Islands	19,612	-1.69
13	Shetland Islands	22,522	-1.15
14	Tayside	383,848	-0.55
15	Western Isles	29,600	0.00

* Population mean Carstairs' scores; larger scores indicate greater socio-economic deprivation.

Several other characteristics of the Greater Glasgow Health Board's population are pertinent to the setting of this study.

Using Carstairs' deprivation categories (DEPCATs) as a measure of socio-economic deprivation, the Greater Glasgow Health Board is the most socio-economically deprived of Scotland's Health Boards (Table 2). 80.1% of the Scottish population living in areas in Carstairs' deprivation category 7 (the most deprived category) live in the Greater Glasgow Health Board area although deprivation category 7 accounts for only 16.3% of Scotland's total population (Figure 3). The two most deprived categories (6 and 7) together comprise 51.4% of the Greater Glasgow Health Board's population while in the rest of Scotland, they represent only 10.7% of the population. Of the 932 Scottish postcode sectors with over 500 residents each at the 1991 census, the nine most deprived are in the Greater Glasgow Health Board area and this area contains 28 out of the most deprived 32 Scottish postcode sectors. [55, 56]

It is should be noted that Scotland as a whole is much more deprived than England and Wales. Only 19% of the Scottish population live in areas with Carstairs' scores that are above the median Carstairs' score for England and Wales. More than one half of the English and Welsh populations live in areas in equivalent to Scotland's most affluent Carstairs' categories (DEPCATs 1 and 2). [55]

The Greater Glasgow Health Board's population lives in inner city areas and in peripheral housing estates and suburban housing schemes. Whilst there is significant socio-economic deprivation in the Greater Glasgow Health Board area, the population is quite mixed with deprived and affluent areas scattered across the city. Deprived areas are situated both in the inner city and in the peripheral housing estates. While areas that are more affluent are mainly suburban, some relatively affluent areas are located near to the city centre. (Figure 5)

The absence of a significant rural population reduces the potential of confounding arising from the use of ecological (area based) measures of socio-economic deprivation in rural areas. In rural areas, wealth and poverty are commonly in close proximity. Wealthy landowners and labourers will commonly share have the same postcode. Urban areas are relatively more homogeneous. [225]

The Greater Glasgow Health Board area is well circumscribed. There has been only a small cross-border flow of patients out of the city into other health board areas. Until fairly recently, the Greater Glasgow Health Board was a net provider of health care to surrounding areas. Several factors have acted to reduce cross-border flow into Glasgow's five acute provider hospitals. These have included the introduction of the SHARE formula in 1982 for the funding of Scottish health boards which has increased the availability of cash resources for surrounding Health Boards whilst reducing Glasgow's resources. The introduction of the internal market [163] has provided an added incentive for the local provision of health care through the contracting mechanism.

In Glasgow, unlike in many other areas of Scotland, the post office has not reallocated any residential postcodes or redefined postcode sector boundaries. This stability has been useful for social and geographical epidemiological studies as it enables the use of postcodes as indices to link into other databases of area based data (such as socio-economic deprivation or geographic location).

In 1996, almost all of Glasgow's general practitioners (>98%) formed a single co-operative (Glasgow Emergency Medical Service – known as GEMS) to provide out of hours care for their patients. This co-operative established six emergency night treatment centres to serve their patients in the city. The provision of this uniform service for all patients across the whole city ensured out of hours care would not be responsible for possible observed differences between general practices emergency admission rates.

The study was made possible by the existence of the two major routine datasets in Glasgow. The Community Health Index has been in use in Glasgow for more than 20 years, while it has only been introduced more recently in other Scottish health boards. Additionally, the Scottish

Morbidity Record databases systems have been running for more than 30 years. During this period, the quality of data in the Scottish Morbidity Record datasets has improved considerably.[39, 231] Both the Scottish Morbidity Record datasets and the Community Health index hold individual (patient level) data with patients' full residential postcodes.

There were three major reasons for choosing to undertake this study in the Greater Glasgow Health Board area. Firstly, both of the major datasets I needed to make this study possible existed locally in Glasgow. Secondly, it was hoped that Glasgow's large population size and the substantial heterogeneity of its population would provide sufficient raw data for the study to have robust findings. Finally, I had recently worked in the headquarters of the Greater Glasgow Health Board and hence had good personal relations with many senior medical, managerial and technical staff of the Board. This enabled me to have access to the data needed for the study.

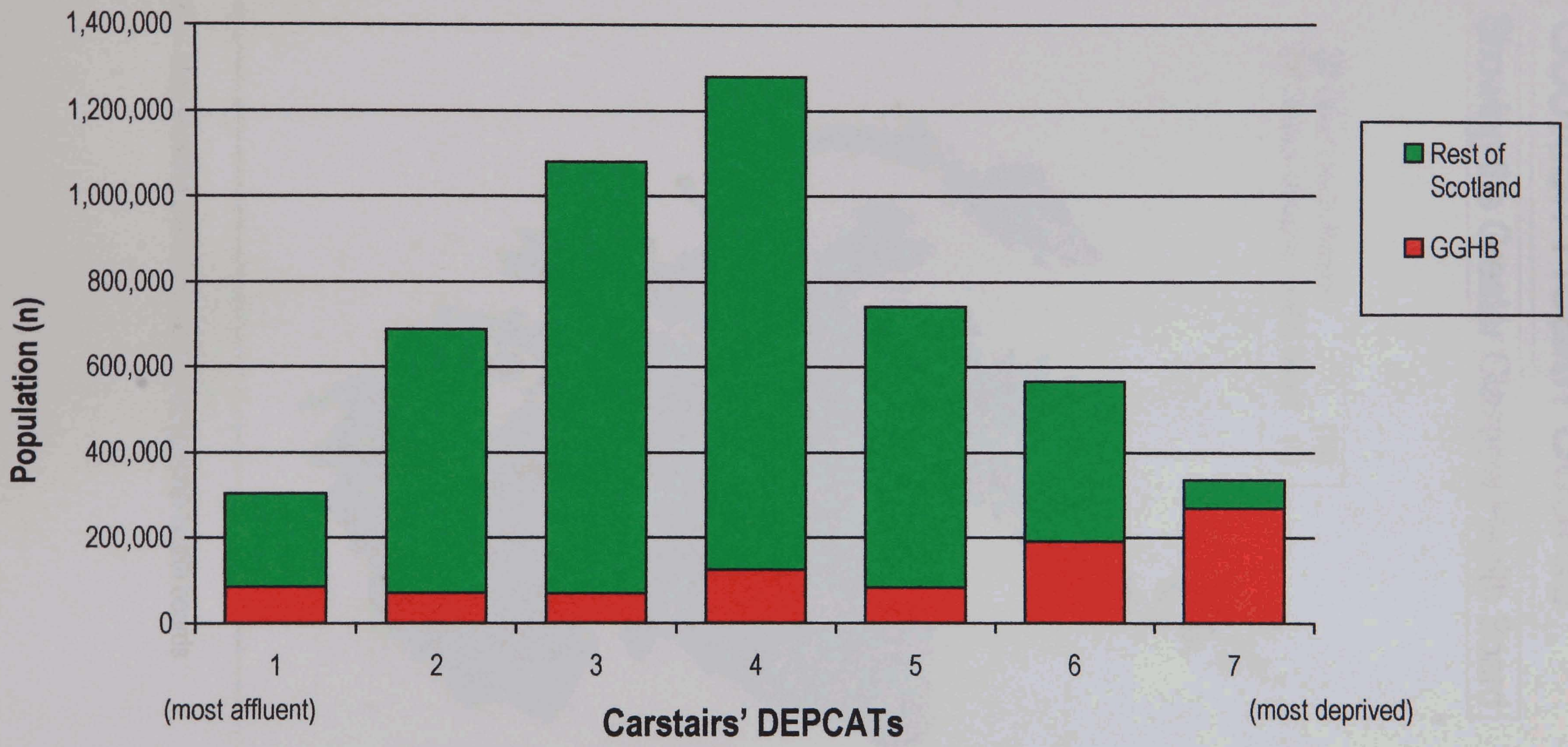

Figure 3 — Comparison of DEPCATs of GGHB and rest of Scottish populations (1991 census)

Original in colour

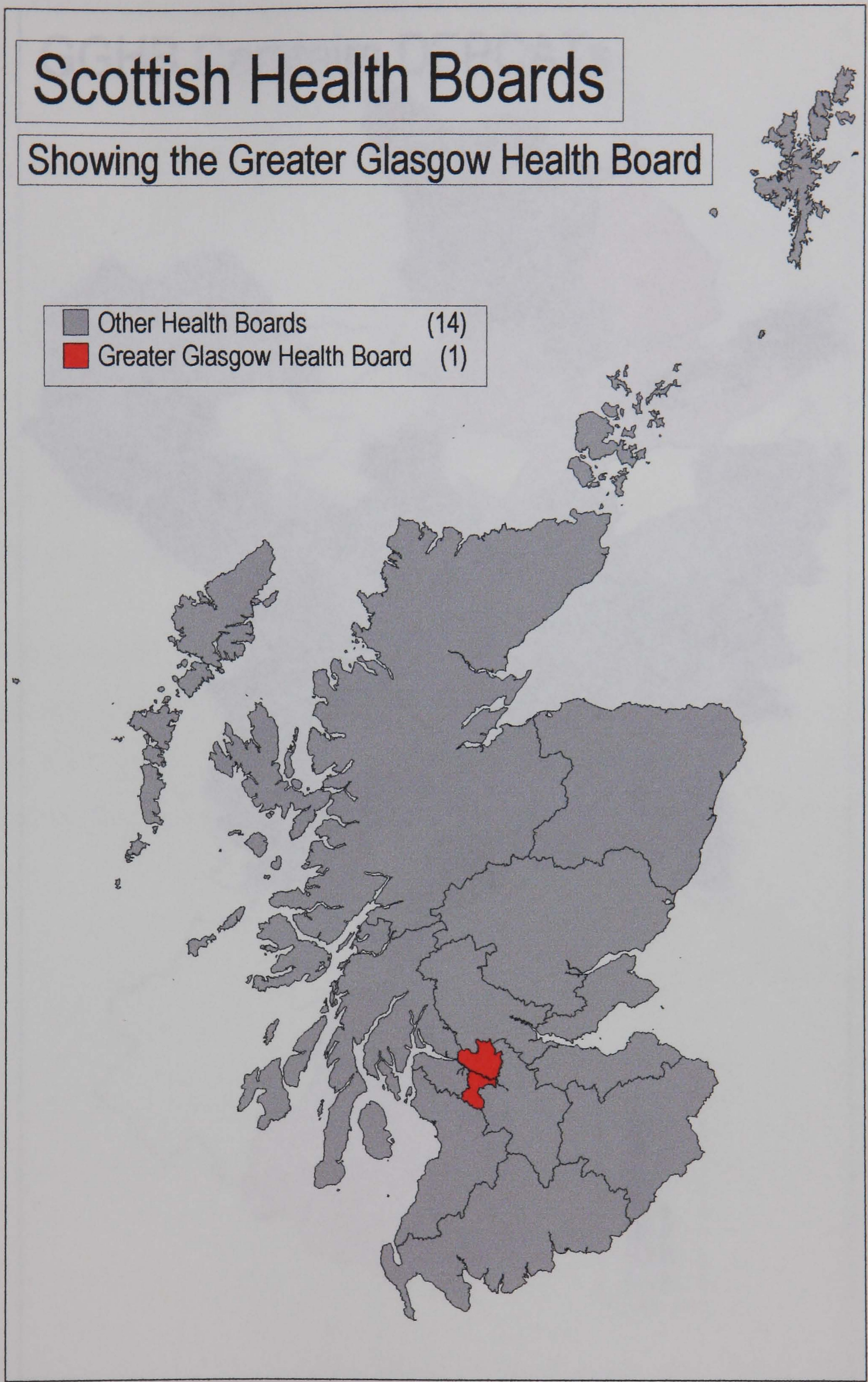

Figure 4 — Map showing the GGHB and other Scottish health boards

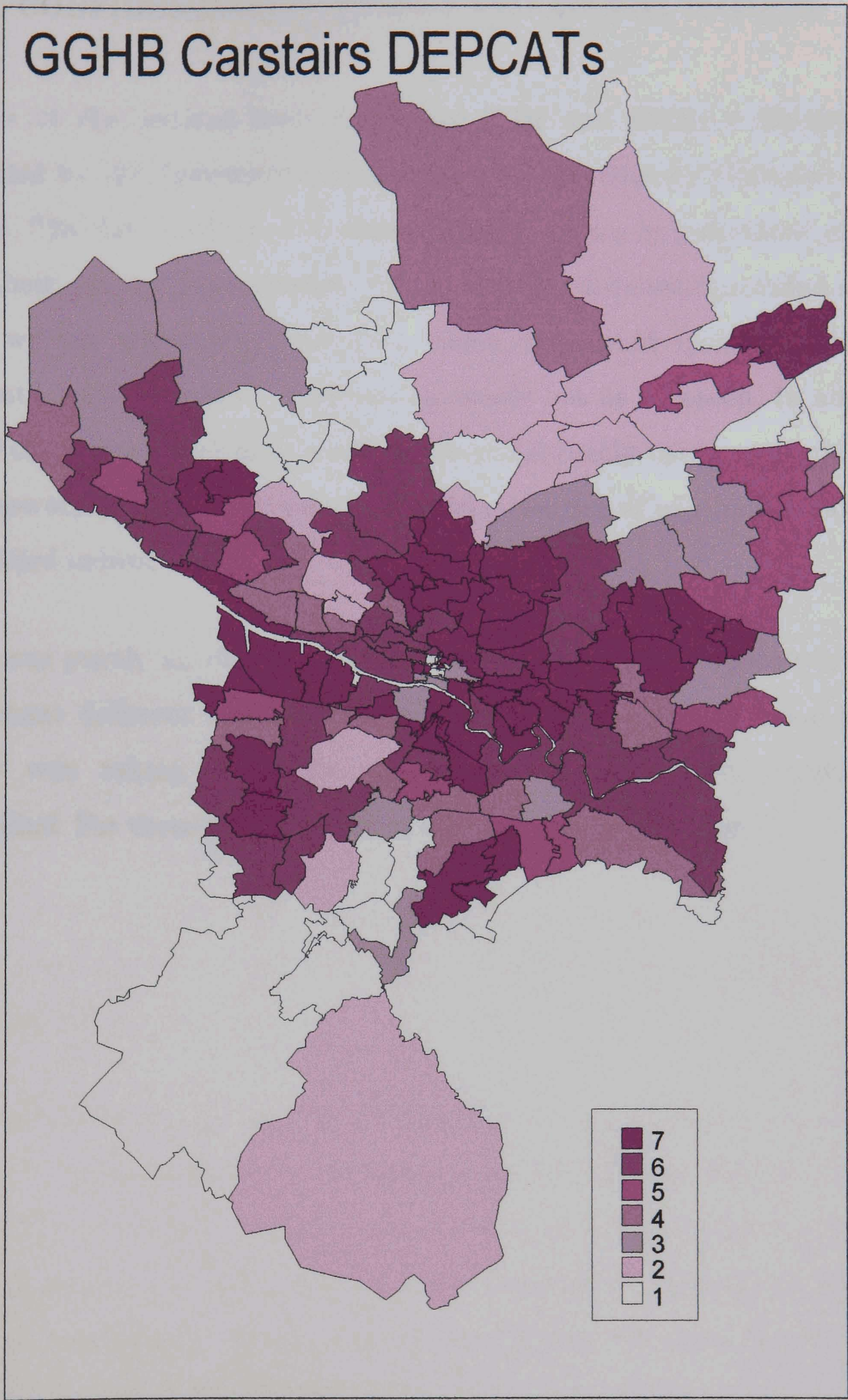

Figure 5 — Map showing GGHB Carstairs' DEPCATs

4.2 CONFIDENTIALITY, ETHICS AND ACCESS TO DATA

Access to the patient level databases (CHI and SMR1 / SMR01) was provided by the Information Department of the Greater Glasgow Health Board. The data contained in these datasets relate to individual patients and their general practitioners. Access to these data was provided subject to a written agreement that data items that could identify individual patients, such as names or addresses, would not be accessed. In addition, all of the anonymised data would be stored securely using multiple levels of password protection thereby minimising the risk of any individual being identified indirectly.

This was purely an observational study. No patient was subjected to any treatment different to his or her normal clinical treatment because this study was taking place. In addition, no patients were individually identified. For these reasons, ethical approval was not sought.

4.3 SOURCES OF DATA

Two major routine datasets were used together for the research in this project. These datasets were the Community Health Index (CHI) and the Scottish Morbidity Record database number one (SMR1). Several other sources of data were also used. These are all described below.

4.3.1 The Community Health Index (CHI)

This administrative dataset is now held locally by every Scottish health board. It contains individual records for all patients living in the health board area who are registered with a general practitioner in the National Health Service. CHI is primarily used for the administration of general practices' patient registrations and for the calculation of capitation based fee payments due to general practitioners for their registered patients. CHI holds detailed information such as patients' sex, date of birth, residential address (with postcode) and registered general practitioner for these tasks. Other datasets including mammography, cervical cytology and childhood immunisation and screening status are linked to the main CHI database in many health boards.

Because payments are made by patients' health boards of residence to their general practitioners, patients resident in the Greater Glasgow Health Board but registered to general practitioners on other health boards' lists will be recorded on the Glasgow CHI. Conversely, patients of Glasgow general practitioners living outwith the Greater Glasgow Health Board area will be recorded on the CHI of their health Board of residence.

An anonymised extract was taken from the CHI database at the end of June 1997. This was the mid-year point for the matching SMR1 / SMR01 data download. The extract was created and held on the Greater Glasgow

Health Board's main Unix based RS6000 computer system running the SAS database.[226] The fields that were extracted from the CHI database are shown in Text Box 5 and the SAS script used to create this extract is shown in Text Box 10.

Text Box 5 — Fields extracted from the CHI Database

Unique patient CHI identifier
Patient's date and century of birth
Patient's sex
Patient's full residential postcode
Registered general practitioner's code
Registered general practitioner's partnership code

This extract included data relating to all patients registered at that time with an NHS general practitioner. It excluded patients who were recorded as not having a current registration with a general practitioner. In practice, these patient records would have been marked as inactive on the CHI database because they related to patients who have moved out of the Greater Glasgow Health Board's area. (A patient's CHI identifier is a unique number and is never re-allocated. Should a patient subsequently return to the Greater Glasgow Health Board area and register with a general practitioner, his or her dormant CHI record would then be reactivated.)

The extract of the database was then downloaded from the Unix system using the `unixdos` command to copy the data over the health board's X25 network to a local MS-DOS based computer. This was then transferred to a portable computer using Laplink software. This was then used to copy them to the Windows NT based computer on which further data manipulation and analysis was performed.

The downloaded data were then imported into a specially constructed Microsoft Access database. A fully relational database structure was then created from the initial downloaded flat-file database structure.[227] Separate database tables were created containing information relating to patients, their registered general practitioners and the general practitioners' partnerships in the hierarchy shown in Figure 6.

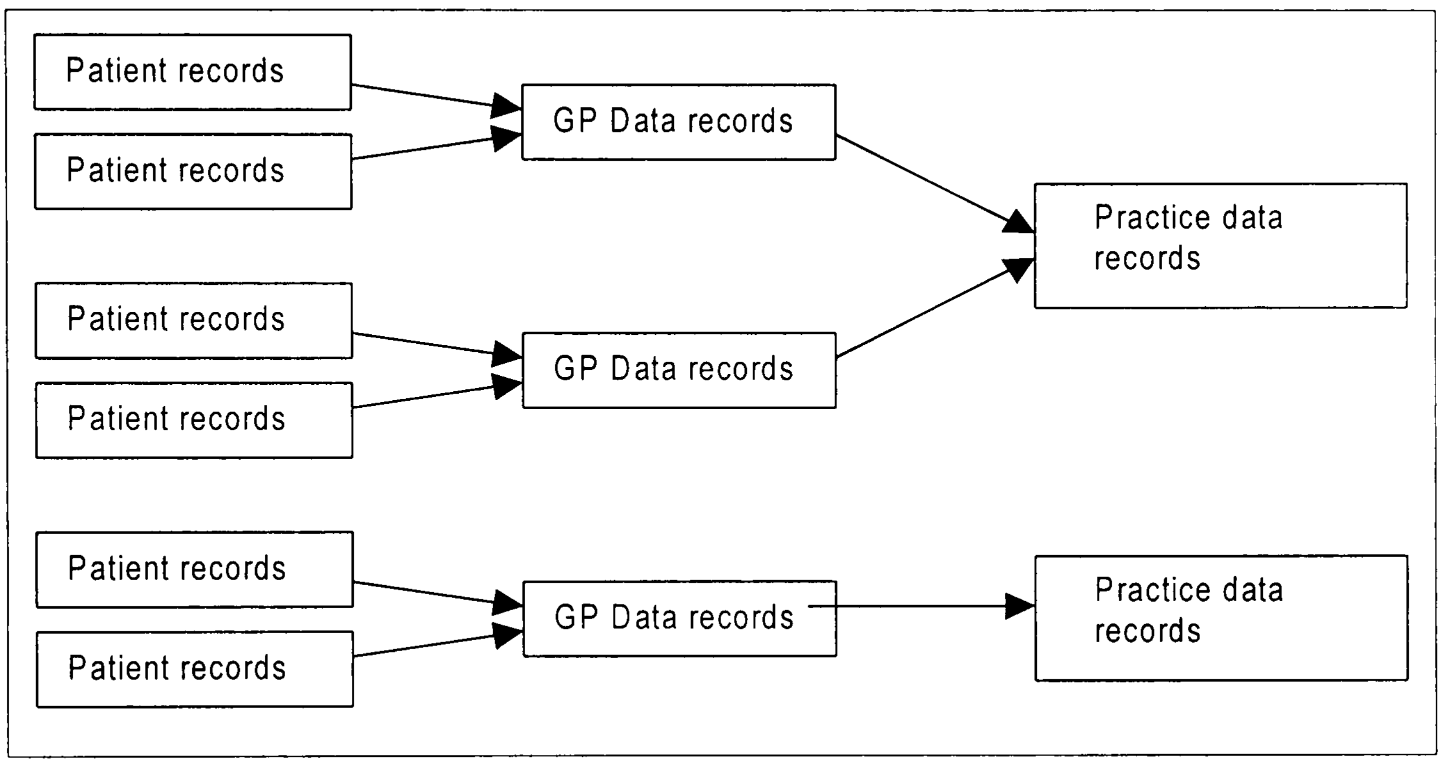

Figure 6 — Diagram illustrating relationships between patient, GP and GP practice data records

Data were recoded and cleaned to ensure compatibility of coding with the SMR1 / SMR01 database and other datasets such as the tables of deprivation scores geographical grid co-ordinates. This was particularly important for fields which were coded differently in different databases and which would be used to establish links between these datasets. These fields included general practitioner codes, patients' sex and postcodes. Derived variables were calculated. At the patient level, patient's ages at the mid-point of 1997 were calculated from their dates of birth. At the levels of general practitioners and their practices, the numbers of patients were calculated and at the level of the practice, the mean number of patients per practitioner were appended to the data hierarchy shown in Figure 6.

The small number of patients who, while resident in the GGHB area, were registered with general practitioners outwith Glasgow were excluded from subsequent CHI analyses. Similarly, patients with absent or invalid postcodes were excluded from those CHI based analyses of data dependent on postcodes. To ensure consistency with the SMR1 dataset, patients aged under 15 years were excluded from analyses. The numbers of records downloaded and those excluded are given in the results in Chapter 5.

4.3.2 The Scottish Morbidity Record dataset 1 (SMR1 / SMR01)

The Scottish Morbidity Record (SMR) datasets are centrally held databases that contain individual records for all episodes of care delivered in every Scottish NHS hospital. The SMR databases were established in the 1960s to record hospital activity in Scotland and are now used for many tasks including costing, planning, contracting, monitoring, health needs assessment and epidemiological research. [228] All SMR data are collected for central validation and processing by the Information and Statistics Division (ISD) in Edinburgh. Appropriate extracts of the complete national datasets are then made available to authorised parties.

The SMR1 database contains details of episodes of inpatients' and daycases' clinical care delivered in Scottish National Health Service general hospitals (Appendix 2, Figure 51 and Figure 52).. It does not include psychiatric, in-patient neonatal, geriatric long stay or obstetric and early pregnancy episodes, all of which are recorded in other SMR databases. The complete series of SMR databases is shown in Table 3.

The SMR1 database has been modified and its design has improved over time. The data capture for SMR1 was formerly based on paper forms which were subsequently centrally keyed in, has now been directly linked to the outputs from most hospitals' patient administration systems. This has improved the quality and timing of the availability of these data. On January 1st 1996, the coding system used for recording diseases, comorbidities and complications was changed from ICD9 to ICD10.[229, 230] The Information and Statistics Division undertakes regular evaluations of data quality by retrospective sampling to ensure the accuracy, consistency, completeness and timeliness of the SMR databases to ensure that targets for quality of coding are met.[231]

The SMR databases were also reviewed and redesigned as part of the Core Patient Profile Information in Scottish Hospitals (COPPISH) project.[232] The new (COPPISH) version of the SMR1 dataset was designated SMR01 (Appendix 2, Figure 53). SMR01 was introduced progressively across all of Scotland's hospitals during the year April 1996 to March 1997.

Table 3 — SMR series of databases showing new COPPISH designations

SMR database	COPPISH database	Description
SMR0	SMR00	General practitioner outpatient referrals
SMR1	SMR01	Hospital in-patient and day case care
SMR2	SMR02	Maternity (hospital and community) and abortion
SMR3		Waiting list census
SMR4	SMR04	Mental health admissions, discharges and day cases
SMR6		Cancer registration
SMR11	SMR11	In patient neonatal care
SMR13		Community Dental services
SMR20		Cardiac surgery register
SMR22 / 23		Drug misuse database
SMR44		Referrals to prosthetics services
SMR50	SMR50	Geriatric long stay
AAS		Notification of an abortion under the 1967 Act

Where it is not necessary to differentiate between the SMR01 and the SMR1 databases, the term SMR1 has been used in this thesis referring to either or both of these datasets.

While the newer dataset was being phased in, all data captured under the new SMR01 system was mapped backwards onto the older SMR1 dataset. From the first of April 1997, when all Scottish hospitals had converted to SMR01 systems, this backward mapping of the new database ceased and data were then only available in SMR01 format. In the Greater Glasgow Health Board area, all of the acute hospitals had converted to SMR01 by the end of 1996. Their SMR01 data was however only available in back mapped SMR1 format for the period January 1st. to March 31st 1997. From April 1st to December 31st 1997, all data were retained in the newer SMR01 database.

Consequently, in order to create a complete year's data for 1997, it was necessary to merge SMR1 data for the first three months of 1997 with the following nine months' SMR01 data. (The SMR1 data had already been back mapped from SMR01 in any event.) This enabled the use of a CHI download taken at the mid point of 1997 as the matching denominator data set.

An SMR1 record is generated at the conclusion of every episode of care for a patient. This occurs whenever a patient has been discharged from or transferred out of a hospital, or when their care has been transferred from one consultant to another within the same hospital. Patients' SMR1 records include details such as patients' dates of birth, sex, and residential postcode as well as information about the episode of care comprising details such as dates of admission and discharge and diagnoses and procedures undertaken. Table 4 shows details of the fields in the SMR1 dataset.

The SMR01 dataset contains fields containing data equivalent to all of those in Table 4. It also has many additional fields.[233] These contain data items relating to patients (ethnic group, patients' central index identification numbers that will enable linkage to patients' CHI records). There are also several fields for health care contracting (purchaser and provider data as well as contract information). Lastly, there are clinical fields for coding information indicating lifestyle risk factors, outcome measures and dependency/ severity measures.

Anonymised extracts of the SMR1 datasets were created using the Greater Glasgow Health Board's RS6000 computer running the SAS database.[226] These extracts were taken in May 1998. This was the point at which data collection for 1997 had been completed. Records were extracted for all emergency medical admissions to GGHB hospitals. The SMR1 datasets for Greater Glasgow Health Board residents admitted to other Scottish hospitals were also accessed. The fields extracted from the SMR1 and SMR01 databases are shown in Text Box 6.

Table 4 — SMR1 database fields

SMR1 Field	Description
Hospital code	National code identifying hospital
Hospital case number	Identifies patients within each hospital
Surname	Patients' details
Forenames or initials	"
Maiden name	"
Date of birth	"
Sex	"
Marital status	"
Postcode	Patient's full residential post code
GP Practice code	National GP practice code
Admitted / transferred from	e.g. Home, other hospital
Type of admission	e.g. Emergency, elective (see Table **6**)
Date on waiting list	
Date of admission	
Date of discharge	
Type of discharge code	e.g. Discharged, transferred, died
Patient category	e.g. NHS, overseas, fee paying
Type of facility	e.g. Inpatient bed, daycase
Specialty code	See Table **5**
Consultant code	Nationally allocated codes
Diagnostic codes	ICD9 until March 1996 ICD10 from April 1996 Maximum of 6 codes recorded
Operation codes	Maximum of 4 operation codes (OPCS)
Date of operation	Main operation (only)

A typical SAS script used to extract SMR1 data for a single year is shown in Text Box 12. An equivalent script for the SMR01 database may be seen in Text Box 11. Emergency admissions were obtained by selecting only those SMR1 records having a "type of admission" code with a value indicating an emergency admission (Table 6 and Table 7). Medical admissions were extracted by selecting only those specialty codes shown in Table 5. These specialty codes are used locally in the Greater Glasgow Health Board to define the group of acute medical specialties. Because the geriatric service has during recent years received emergency medical admissions (which it did not when the local acute medical codes group was defined) geriatric assessment was added to the list of codes for this study.

Table 5 — Medical specialty codes used for SMR1 and SMR01 extraction

Code		
SMR1	**SMR01**	**Specialty**
16	A1	General Medicine
17	A2	Cardiology
18	A8	Metabolic disease
21	A9	Gastroenterology
24	AG	Nephrology
25	AR	Rheumatology
28	AQ	Respiratory medicine
36	AC	Homoeopathy
41	C3	Pain control
50		Geriatric assessment
	AB	Geriatric medicine
62	J4	Haematology
IT	*	Intensive care (medical)
CU	†	Coronary care

* Medical intensive care is coded under the appropriate consultant specialty code in SMR01.

† Coronary care is coded as "cardiology" in SMR01.

Table 6 — SMR1 codes for 'type of admission' (showing all admission types)

Code	Admission type
0	Deferred admission
1	Waiting list / booked admission
2	Repeat admission
3	Transfer into hospital
4	Emergency – deliberate self inflicted injury or poisoning
5	Emergency – road traffic accident
6	Emergency – home accident
7	Emergency – other injury including accidental poisoning (other than in the home)
8	Emergency – other (excludes accidental poisoning)

Table 7 — SMR01 codes for 'type of admission' (emergency admission types only)

Code	Admission type
30	Emergency admission, no additional details recorded
31	Patient injury – self inflicted (injury or poisoning)
32	Patient injury – road traffic accident (any accident on public highway)
33	Patient injury – home accident (including accidental poisoning in the home)
34	Patient injury – accident at work
35	Patient injury – other injury (includes accidental poisoning other than at home)
36	Patient non-injury (e.g. stroke, MI)
38	Other Emergency admission (including emergency transfers)
39	Emergency admission, type not known

Text Box 6 — Fields extracted from the SMR1 and SMR01 databases

hospital code
patient's date of birth, sex and residential postcode
patient's GP's practice code
codes for the type, category and mode of admission
dates of admission (and of discharge or transfer out)
specialty code (Table 5)
up to six diagnoses coded to ICD10

As with the CHI database extracts, the extracts of the SMR1 databases for each year were then downloaded from the Unix system, copying the data to a local personal computer running under Windows NT for further data management and analysis.

The downloaded data were then imported into a specially constructed Microsoft Access database. The files for each year of SMR1 data from 1980 to March 1997 were merged with the SMR01 data for April 1997 to December 1997 into this combined SMR1 access database. The SMR1 and SMR01 data for those patients resident in the Greater Glasgow Health Board area but admitted to other hospitals in Scotland were also merged into this database. (These data were not available before 1990, so the merged SMR1 database excluded patients admitted during the 1980s to hospitals outside the Greater Glasgow Health Board area.) The small number of records of patients resident in the GGHB area but admitted to hospitals outwith Glasgow were excluded from analyses entailing linkage to the CHI database. Most of these admissions would have been of patients temporarily resident elsewhere; hence, their referrals would have been from general practitioners outwith Glasgow. The numbers of records downloaded and those excluded are shown in the results in Chapter 5.

A fully relational database structure was then created from the initial downloaded flat-file database structure. [227] Separate database tables were created containing information relating to patients and their diagnostic data. The use of a many to many linkage structure [227] considerably simplified the subsequent analyses of diagnoses as it became possible to simply select diagnostic codes at any or all of the six coding positions for analyses (Figure 7). This simplified the process of selecting patients starting with their diagnoses or diagnoses having started with selected patients.

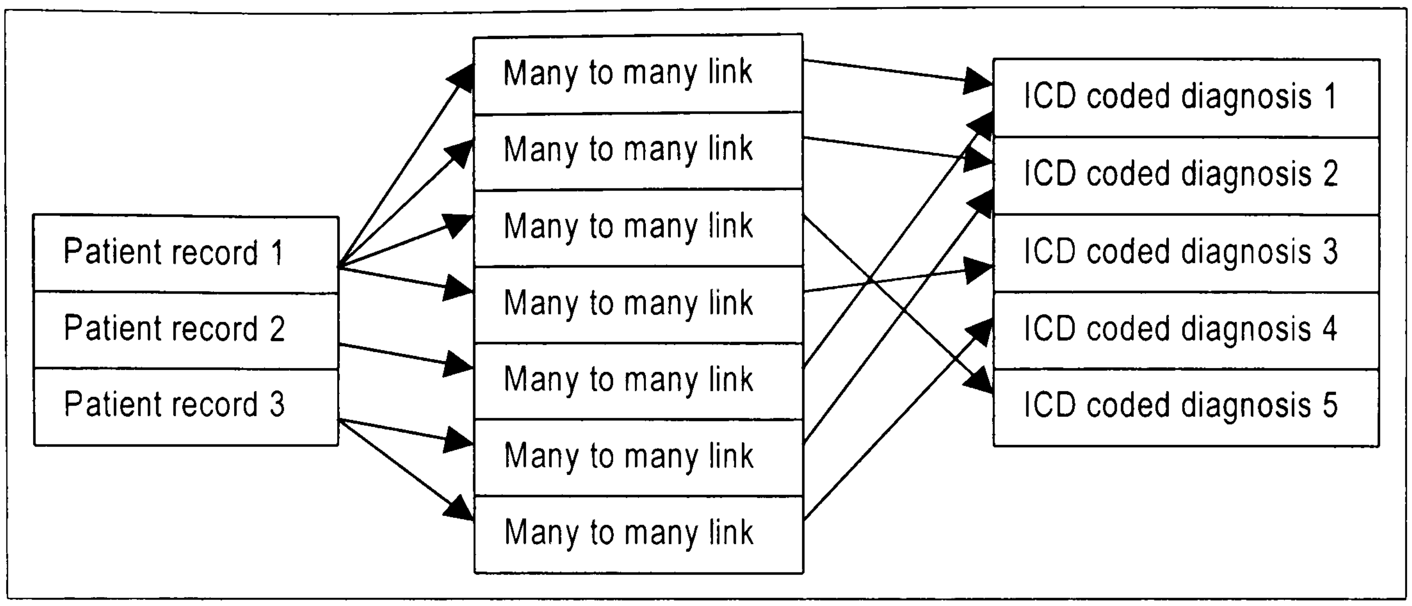

Figure 7 — Diagram illustrating many to many relationships between patients' and diagnostic records

As with the CHI database, data were recoded and cleaned to ensure compatibility of coding with the CHI database and the other datasets such as the tables of deprivation scores and geographical grid co-ordinates.

Patients aged under 15 years were excluded from subsequent analyses as most emergency admissions in this group were to the paediatrics group of specialty codes and only small numbers were admitted to adult specialties. The small number of patients who, while resident in the GGHB area, with registered with general practitioners outwith Glasgow were excluded from subsequent SMR1 analyses. Patients registered with Greater Glasgow Health Board general practitioners but resident outside Glasgow were also excluded from subsequent analyses. This was done for compatibility with the CHI dataset as access to the CHI datasets for other health boards would have been required to provide these matching denominator data. Greater Glasgow Health Board resident patients admitted to hospitals outside Glasgow were also excluded. Lastly, patients with absent or invalid postcodes were excluded from those SMR1 based analyses of data dependent on postcodes. The numbers of records downloaded and those excluded are given with results in Chapter 5.

4.3.3 Structure of postcodes

United Kingdom postcodes contain two parts, separated by a space (Figure 8. The initial part, preceding the space is known as the outbound postcode. This comprises an alphabetic character followed by one optional alphabetic character and one or two digits. This is used by the post office to sort outgoing mail so that it will be sent to the correct sorting office, prior to delivery. The part of the postcode preceding the space relates to areas known as postal districts.

Following the space, the second part of the postcode is the inbound postcode. This comprises a digit followed by two alphabetic characters. This enables sorting offices to sort incoming mail into the walks used by postmen for their deliveries. It may be divided into two parts. The first digit of the inbound postcode indicates a smaller area within the postal district code. This smaller area is known as a postal sector. The final two letters of a postcode define a much smaller area within the postal sector, known as the unit postcode. Typically, unit postcodes contain around 20 houses.

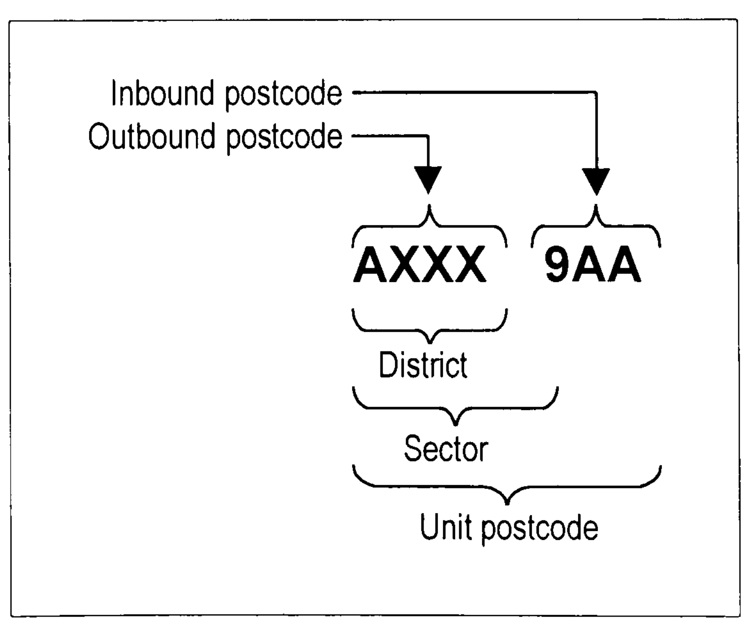

Figure 8 — Structure of United Kingdom postcodes

In Scotland, census enumeration districts are formed from groups of unit postcode areas joined together. Because unit postcodes map onto census enumeration districts, Scottish postcodes are the best index for census data. In England and Wales, enumeration districts are based on subdivisions of electoral wards and therefore postcodes are not an efficient index for mapping and analysing census data.

4.3.4 Carstairs' deprivation scores

The Carstairs and Morris deprivation score is derived from the four Scottish census variables shown in Text Box 7.[55] In deriving Carstairs' scores, the individual proportions shown in Text Box 7 are transformed into z scores (values based on a distribution with a mean of zero and a standard deviation of one) for each postcode sector. The z scores are then summed to produce the Carstairs' score which is an interval (numerical) scale. Carstairs' scores with high numerical values indicate greater socio-economic deprivation whilst increasing negative values indicate greater relative affluence.

Text Box 7 — Census variables in the Carstairs' score

Overcrowding: persons in private households living at a density of more than one person per room as a proportion of all persons living in private households.

Male Unemployment: Proportion of economically active men who are actively seeking work.

Social class 4 and 5: Proportion of all persons in private households in social class 4 or 5.

No car ownership: Proportion of all persons in private households with no car.

Carstairs' scores are then divided into seven ranges to produce Carstairs' Deprivation Categories (DEPCATs) which form an ordinal scale. These range from the most affluent category (1) to the most deprived category (7).

Carstairs' scores and their derived deprivation catogories, linked to postcode sectors, derived from the 1991 census were obtained as a Microsoft Excel [234] computer file from the Public Health Research unit. [56] These postcode sector based deprivation indices were then imported into a Microsoft Access [26] database so that the CHI and SMR1 databases could be linked to the deprivation data, enabling the analysis deprivation aspects of population and admission data.

Carstairs' scores, DEPCATs and deciles

The grouping of by Carstairs and Morris of Carstairs' deprivation scores into deprivation categories necessarily entailed the loss of some information. For this reason, this study undertook some analyses that used the Carstairs' score (which is a continuous variable) rather than Carstairs' deprivation categories. This had the advantage that the extremes of deprivation within deprivation category 7 would be have an appropriate effect within analyses.

Because the distribution of deprivation categories in Glasgow is so skewed, compared with the rest of Scotland, some analyses were undertaken using deciles of the Carstairs' scores for the whole population of Glasgow. These were compared with similar analyses which had used deprivation categories.

4.3.5 Mapping and UKBORDERS data

The UKBORDERS database [235] is a large set of research data containing digitised boundary data mapping the United Kingdom. It is held at

Edinburgh University and is accessible over the Internet to authorised users from British universities. Mapping data are held at several different levels for all parts of the United Kingdom.

Two sets of boundary data were created using the UKBORDERS system. The first comprised a map of the whole of Scotland showing the individual health boards. The second set of boundary data comprised the boundaries of all of the post code sectors in the Greater Glasgow Health Board area. These large datasets were then imported into MapInfo [236] which is a geographical information system (GIS) computer package. The geographical information contained in the datasets was edited in MapInfo to enable the use of postcode sector linkages of data to the boundary data. The linkable digital boundary data files were then transferred to the computer on which further analyses were conducted.

Map centroids for unit postcodes

The geographical centroids of individual unit postcodes were obtained by downloading the digitised boundary data for unit postcodes for the Greater Glasgow Health Board. This large data file was imported into MapInfo where the centroids of the postcodes were extracted. The boundary data were then discarded after calculation of the centroids of the 23840 unit postcodes in the Greater Glasgow Health Board area.

Mapinfo was then used to convert the raw centroid data to Ordinance survey grid references. The grid references contain coded information of rectangular distances in meters (North and East) from a defined reference point. The Ordinance Survey grid references were then exported in a plain text format from which they were imported into another Microsoft Access database. [26]

4.3.6 Census summary data

Population counts for each postcode sector at the last (1991) census were obtained from the Public Health Research Unit in the University of Glasgow. These were broken down into five year age bands and by sex for each sector. These had originally been extracted from the census small areas computer package (SASPAC).[237] These census summary records were imported into a Microsoft Access[26] database for linkage to other postcode based datasets. These records were also decomposed into a fully relational database structure within Access.

An estimate of the mid-year total population for the whole of the Greater Glasgow Health Board area was obtained from the information services unit of the Greater Glasgow Health Board. This too was broken down into five year age bands by sex.

4.3.7 Greater Glasgow Health Board General Practitioner Localities

In 1994, the Greater Glasgow Health Board divided the city into nineteen localities. Every general practice within the city was then allocated to one locality. These localities were used for local primary care needs assessment and locality based secondary care service contracting. General practitioners in these localities were expected, through their local knowledge to represent the needs of the local populations they served. It was expected that these localities should be approximately similarly sized and similarly resourced.

When the localities were planned, it was believed that, being area based, they would represent local communities. This did not account for some practices that had patient populations widely dispersed across the city while others' populations were tightly circumscribed. Moreover, many practices consulted on more than one site. Where these were located in two or more localities, the locality allocation was based on the practice correspondence address although these were not necessarily the premises at which the majority of their patients attended.

A list of individual general practices and their allocated localities was obtained from the Greater Glasgow Health Board and entered into a Microsoft Access [26] database. These data were also restructured and related to the CHI-derived general practice records.

4.3.8 General practitioner fundholder status

The 1989 Government White Paper [163] introduced the concepts of separation of purchasers and providers. With the introduction of the 1990 reforms based on this white paper, it became possible for general practices to become purchasers in the new system of contracting by becoming fundholders. It was believed that by giving them a financial stake in improving the efficiency of delivery of health care, that overall costs and utilisation of services would be reduced. [160] There have been suggestions that since the fundholding scheme did not cover emergency admissions, there may be a perverse incentive for fundholding general practitioners to maximise their numbers of emergency admissions to conserve their elective admission budgets.

A list of individual fundholding general practices was obtained from the Greater Glasgow Health Board and entered into a Microsoft Access [26] database for subsequent analysis. These were also restructured to fit into the general practice relational database.

4.3.9 Greater Glasgow Health Board health districts

The Greater Glasgow Health Board defined five health districts in the early 1980s. Each of these districts contained one of Glasgow's adult acute hospitals. These districts were therefore used as the population catchment areas of the five main hospitals. Acute admissions policies reflecting these acute catchment areas were enforced for general practitioner referred emergency admissions in the early 1980s. This policy did not apply to patients who referred themselves as emergencies or those who arrived at hospital following a '999' emergency ambulance call. These catchment areas were increasingly ignored for all emergency admissions from the mid 1980s. The health district based catchment areas have however survived, providing a population base for health needs assessment, service planning and contracting.

A list of postcode sectors and their associated Greater Glasgow Health Board health districts was obtained from the Greater Glasgow Health Board. This was also entered into a Microsoft Access [26] database.

4.3.10 General practices' performance data

Few outcome indicators directly relating to general practice are routinely collected. Where these exist, these datasets have initially been collected for other (usually administrative) purposes. The Greater Glasgow Health Board holds the following sets of data that might relate to the performance of Glasgow's general practices.

Child immunisation

The Scottish Immunisation Recall System (SIRS) database is linked to the main CHI database. It is used to generate invitations and appointments for children's immunisations in the Greater Glasgow Health Board area. It is also used to enable general practices to be remunerated for the immunisation work they undertake. General practices do have to encourage high rates of attendance and undertake the work of administering the immunisations. Immunisation rates for diphtheria, pertussis and MMR (measles, mumps and rubella) for each practice were all derived from the SIRS database.

Cervical cytology

In Glasgow, the cervical cytology ("smear") database is linked to the main CHI database. It is used to generate invitations and appointments for women to attend for cervical cytology. It is also used for calculation of the remuneration for general practices for their cervical cytology workload. General practices have to encourage high rates of attendance and do the work of taking the cervical smears. Cervical cytology rates for each practice were derived from this database.

Other performance datasets

Other datasets relating to general practitioners' performance are collected in Glasgow. These include information such as general practitioners' prescribing patterns, their staffing levels including their practice nurses and information about their premises. These data were felt to be sensitive and were therefore not available for use in this study.

4.3.11 General practitioners' postgraduate qualifications

Information on general practitioner's postgraduate qualifications were sought within the Greater Glasgow Health Board but were not available. I therefore attempted to obtain these from the Medical Register [238] and from the Medical Directory. [239] The postgraduate qualifications of a small test sample of general practitioners whose postgraduate qualifications were already known were sought in these two sources. The medical register listed no postgraduate qualifications for the majority of the test sample. The Medical Directory contained no entry for the majority of the sample of doctors and contained several errors for the remaining ones. This proposed analysis was therefore abandoned because of these difficulties.

4.4 DATABASE METHODS

The several datasets described above were all imported into Microsoft Access. [26] There were several reasons for importing them all into a single common database system. These included:

- Holding all data in a single system minimised the effort required for conversion of data between formats for analyses
- Large data tables could be efficiently stored
- Data could be indexed for faster searching and selection from very large tables
- Data tables could be linked enabling efficient "lookups" of related data contained in other joined tables.

Most of the analyses of this project required that data in one table were related to data in several other tables. The creation of dataset linkages was therefore essential. For example, patients' SMR1 and CHI records were linked to the table of Carstairs' deprivation scores. This enabled the rapid extraction of patients' deprivation scores when undertaking analyses of the SMR1 database. This linkage was achieved by creating a "join" between the postcode fields of the SMR1 and CHI datasets and the Carstairs' deprivation scores and deprivation categories table. Similar links were established using general practice partnership codes allowing analyses to be undertaken at the level of patients' general practices.

For these linkages to be effective, all of the data items used to join the tables must be in an identical format. The datasets in the underlying lookup tables (e.g. the deprivation category table) must also be complete.

4.5 STATISTICAL AND NUMERICAL METHODS

4.5.1 Distance calculations

The distances between unit residential postcodes to hospitals were calculated from the "easting" and "northing" components of ordinance survey grid references. For unit postcodes, these components were obtained by linking the unit postcodes to the Unit Postcode OS centroids table described above. Hospital grid references were obtained directly from the relevant Ordinance Survey Map. [240]

Estimated straight-line distances between these grid references were calculated by using Pythagoras' theorem method (Equation 1). An Access Basic compiled function was created in Microsoft Access [26] to enable the rapid calculation of many distances (Text Box 13).

$$distance = \sqrt{(H_N - R_N)^2 \times (H_E - R_E)^2}$$

where:

H_n, H_e

R_n, R_e are respectively the hospital's and residential postcode's north and east Ordinance Survey grid positions in meters.

Equation 1 — Calculation of approximate distances using Pythagoras' theorem

This Pythagorean method was an approximation that did not take the earth's curvature into account. The amounts of error that arose from using this approximation were assessed by comparing a series of Pythagorean approximated distances with the exact distances calculated using the MAP-INFO package. In the worst cases, these errors were less than 0.5% across the width of the whole city. (This amounts to an error of 50 metres over a distance of 10 kilometres; this maximum error is much less than the radius of a typical unit postcode.)

4.5.2 Hospital catchment areas

The hospital catchment areas used by Greater Glasgow Health Board's were based on administrative health districts that had been defined many years earlier. However, I knew that they did not reflect general practitioners' referral practice in the city. Therefore, because of my concerns about their validity, I decided to construct for this study an alternative simple arrangement of hospital catchment areas, based on first principles.

The first method considered would have defined hospitals' catchment areas by allocating postcode sectors to hospitals' areas according to which hospital admitted most patients from that sector. This attractive and simple idea was rejected after consideration, as this would entail a definition of the denominator (the catchment populations) in terms of the numerator (emergency medical admissions).

The method of defining hospitals' catchment areas used the following steps:

1. The distances between every CHI patient's residential postcode and each of the five acute hospitals was calculated using the Pythagorean method discussed above

2. The hospital closest to each patient postcode was thus identified and selected as that individual patient's hospital

3. Postcode sectors were then assigned to the catchment area of the hospital that was nearest to the greatest number of patients in the sector

4. These crude catchment areas were then adjusted to take account of those geographical features of Glasgow that I knew would affect admission patterns. Following this review, a number of postcode sectors north of the river Clyde were reassigned from the Southern General Hospital (which is on the south side of the Clyde) to the Western Infirmary.

These derived catchment areas were examined to assess how well they related to the numbers of emergency medical admissions to the different hospitals. These derived catchment areas were also compared with the catchment areas discussed above used by the Greater Glasgow Health Board before the introduction of Trust hospitals made these obsolete.

4.5.3 Tables and graphs

Tables summarising the study data were mostly generated in Microsoft Access. Two separate methods were used within Access. The first method used the SQL aggregate functions [241] which aggregate data by counting or summing together data items under some other control value. (Other simple calculations such as means or standard deviations are possible). The second method used the SQL transform function [241] which enables the production of summary cross tabulations, again with embedded calculations similar to those obtainable with the aggregate method.

Tables were also generated in SPSS for Windows [242] and in Microsoft Excel. [234] While the latter programs enabled some finer control of the formatting and some calculations on the output results, they were of limited value in producing summary tables from the larger datasets.

Every graph (bar one) was produced by importing the data tables generated by the above programs into Microsoft Graph 97. [243] This program could not generate two graphs (Figure 38 and Figure 49) which were created using Microsoft Excel.

4.5.4 Statistical tests

Data held in Microsoft Access [26] databases were exported to Microsoft Excel [234], and SPSS for Windows [242] and epi-info [244] for subsequent statistical analyses. Standard statistical methods were used. [245] These were:

- The Chi squared test, which was used to test null hypotheses on event frequencies when using nominal scales (e.g. comparisons of proportions between hospitals)

- The Chi squared test for trend, which was used to test null hypotheses on event frequencies using ordinal scales (e.g. comparisons across deprivation categories)

- Pearson's correlation coefficient was used to test null hypotheses of association between normally distributed interval valued scales (e.g. association between practice mean deprivation scores and crude emergency admission rates). Spearman's rank correlation was used where these scales were interval or not normally distributed

- Multiple logistic regression was used to derive admission odds ratios for individual factors in multivariate analyses

- Where relevant, 95% confidence intervals were calculated using standard methods. [246]

4.5.5 Calculation of standardised ratios

Standardised rates and ratios were calculated using a standard algorithm (Equation 2). [246]

$$standard\ EMA\ ratio = \frac{observed\ number\ of\ EMAs}{expected\ number\ of\ EMAs} \times 100$$

where:

observed number of EMAs is the actual number of emergency medical admissions

and

expected number of EMAs is the number of emergency medical admissions would be expected for the relevant population

Equation 2 — Calculation of standardised emergency medical admission ratios

The study design required that very large numbers of standardised ratios would be calculated. There was an excess of 200 Glasgow general practices, each of which would require the calculation of several standardised ratios following adjustment for a varying range related factors. For example, in standardising Glasgow's general practices for their patients' age and sex required standardisation using fourteen categories (two sexes X seven age bands). The addition of Carstairs' seven deprivation categories to the adjustment factors increased the number of adjustment categories to 98. When considering calculating standardised ratios for each of the Greater Glasgow Health Board's 216 general practices, it was realised that more than 21,000 intermediate results would be generated.

Analysis of this problem indicated that an automated solution to the calculation of standardised ratios was required. A series of spreadsheets to calculate these ratios would be unwieldy, if it could cope with this computation at all. Further analysis and experimentation showed that several linked Microsoft Access queries could efficiently perform the required vector and matrix calculations. A set of Microsoft Access SQL queries was constructed. The Access SQL code for this is shown in Text Box 14. This Access SQL code was innovative in using linked outputs from SQL select statements to hold the intermediate vectors for the required linear arithmetic calculations. This SQL code is declarative rather than procedural. That is to say that it declares what should happen to the data fields, rather than how the computer should calculate every individual intermediate result. Extending the Access SQL calculation engine to then derive appropriate 95% confidence intervals by using a table lookup approach was a natural use of database methods.

In the process of designing and testing this Microsoft Access SQL code, I realised that age, sex and deprivation categories should not be seen as separate factors indexed in a three (or more) dimensional array. Rather, this matrix should be decomposed into a single dimensioned array or vector. For example, a 1 x 98 vector combining age, sex and deprivation category could be used as the standardising factor. This considerably simplified the coding of the Access SQL standardised ratios calculator.

The Access SQL standardised ratios calculator was validated by using small sets of dummy test data and comparing the results generated by the database method with manually calculated standardised ratios.

4.5.6 Confidence intervals

The calculation of standardised rates and ratios required confidence intervals which were obtained by methods given by Gardner and Altman.[246] So that values for these confidence intervals could be rapidly calculated in Microsoft Access, a table of two-tailed inverse Poisson values was needed. This was generated for observed values from zero to 20,000 using probability values of 0.025 and 0.975 using the following methods.

For observed values from zero to 100, an iterative procedure (the solver macro) was used to derive values of the inverse Poisson function. This was performed in a specially constructed Microsoft Excel [234] spreadsheet as as the relevant functions and procedures were not available in Microsoft Access. [26] The calculated values were then copied into the Access lookup table.

For observed values greater than 100, an approximation formula was used to calculate appropriate values (Equation 3). [246] These values were then copied into through the Microsoft Access lookup table.

$$x_l = \left(\frac{1.96}{2} - \sqrt{x} \right)^2$$

$$x_u = \left(\frac{1.96}{2} + \sqrt{x} \right)^2$$

where x is the observed number of events

x_l is the Poisson lower 95% confidence interval number of events

and x_u is the Poisson upper 95% confidence interval number of events

Equation 3 — Approximations for 5% two tailed inverse Poisson distribution (for values >100)

4.6 GEOGRAPHICAL ANALYSES AND MAPPING

The creation of computer maps based on the imported digital boundary data was done using Microsoft Map.[247] This is the embedded mapping application contained in the Microsoft Office 97 package.[248] (Microsoft Map comprises a "stripped down" version of MapInfo.[236]) The use of Microsoft Map enabled the production of maps linked to underlying Microsoft Excel[234] postcode based data.

These computer-generated maps used shading and colouring to indicate the values of measures linked to individual postcodes. (See Figure 5 for example). Such maps showing the relative proportions of spatially referenced data are known as chloropleths.

An initial attempt at using epi-map[249] (public domain software from the Communicable Disease Control Centers in Atlanta) was abandoned following substantial incompatibilities with the other software being used.

4.7 FEASIBILITY (PILOT) STUDY

An initial pilot study was designed to assess the availability and quality of the large datasets required. Problems arising from the transfers of the large datasets between computer systems were addressed at this stage and the methods described were implemented to accomplish the reliable acquisition of data.

The feasibility of linking these large datasets and then accomplishing the proposed large-scale analyses was then assessed by performing several preliminary analyses. These initial analyses showed the anonymous database linkages to be practicable. Several of the analytic methods presented above were developed during this pilot phase.

One major data problem was identified during this initial feasibility study. An unexplained shortfall in emergency medical admissions was noted amongst the elderly. Investigation showed that the Greater Glasgow Health Board's definition of codes in the medical group of specialties had become inadequate since the management of acute medical admissions for elderly patients had been increasingly undertaken by Glasgow's geriatric assessment units.

This problem was addressed when the final SMR1 datasets were extracted by adding geriatric assessment to the list of specialty codes used for data extraction.

CHAPTER 5 —

EMERGENCY MEDICAL ADMISSIONS

IN GLASGOW – EPIDEMIOLOGICAL

RESULTS

5.1 INTRODUCTION

The first aim of this study was to describe the epidemiology of emergency medical admission in Glasgow in terms of time, place and person factors. This chapter presents results addressing this aim.

The first objective of this chapter is an investigation of patient factors associated with varying emergency medical admission rates. The second, more limited objective is an examination of the diagnoses with which patients were discharged. Fulfilling this objective may give some insight into the reasons for which patients were admitted.

As discussed in the preceding chapter, the analyses in the current chapter rely on the contents of two datasets. The chapter therefore commences by presenting results from the extracts of each of the datasets individually. Admission rates, which need denominator and numerator data, follow. Calculations of these rates require that both of the preceding datasets are used together.

5.2 CHI: PATIENT POPULATION DENOMINATOR

5.2.1 Numbers of patients

At the end of June 1997, the Greater Glasgow Health Board's Community Health Index (CHI) database contained active records for 977,171 patients. An anonymised extract of these CHI data records was taken using the methods described above.

The study was restricted to adults. Therefore 164,142 patients aged below 15 years were excluded. Of the remaining 813,029 records of adult patients, 2,606 (0.3%) were excluded because, whilst they were resident in Glasgow, these patients were registered with general practitioners outwith Glasgow. The remaining 810,423 patients formed the CHI denominator for analyses which were not dependent on postcode derived data (Figure 9).

For all analyses dependent on postcode related data (for example: deprivation categories or hospital catchment areas), the 4,630 patients (0.6%) having absent or invalid postcodes were excluded. Finally, since small area census data are suppressed for postcode sectors with fewer than 500 residents, 414 Greater Glasgow Health Board patients (0.05%) living in these small postcode sectors were also excluded from this postcoded denominator CHI dataset (Figure 9).

5.2.2 Patients' age, sex and deprivation indices

The sex and age distribution of adult patients on the Greater Glasgow Health Board CHI database (Figure 10) shows that the greatest numbers of both sexes were in the age group 30 to 39 and that the population decreased steadily thereafter. Overall, the Greater Glasgow Health Board CHI population comprised slightly fewer men than women (Table 8). There were however more young and middle-aged men than women of equivalent age whilst women predominated amongst older patients.

5.2.3 Carstairs' deprivation categories

Figure 11 is a map showing the geographical distribution of Glasgow's adult CHI patients in 1997. This demonstrates that the city centre had the greatest population density while the population density decreased travelling to the north or the south from the city centre. No areas were substantially unpopulated. Ten of the postcode sectors within the Greater Glasgow Health Board's boundary cross over into neighbouring health boards' areas. Figure 11 shows these postcodes. Some of these have very low populations as they are mainly waste ground or farmland.

The deprivation scores of patients on the Greater Glasgow Health Board's CHI database are shown in Figure 12 which suggests that there is a relatively uniform distribution of Carstairs' scores in Glasgow. This uniformity is quite untypical of the whole of Scotland, as previously shown in Figure 3.

Carstairs' deprivation categories, which are more widely used, are shown for Greater Glasgow Health Board's CHI patients in Figure 13 and Table 9. Patients living in areas that comprised the two most deprived deprivation categories (DEPCATs 6 and 7) accounted for 51.1% of Glasgow's CHI patient population.

Figure 14 shows the geographical distribution of postcode sectors' Carstairs' deprivation categories in Glasgow. This is a chloropleth showing deprivation categories, with a superimposed dot density map showing the population. This illustrates that the more densely populated inner city areas were also the more deprived areas, while the relatively less densely populated areas to the north and south of the city were more affluent.

5.2.4 Comparison with census data

At the 1991 census, the Greater Glasgow Health Board had a population of 727,330 residents aged 15 years and over. This is 10.3% less than the 810,423 patients who were on the Greater Glasgow Health Board's CHI at June 1997. A comparison of the age and sex distribution of CHI with the 1991 census is shown in Table 10. This shows that approximately three quarters of the excess in the 1997 CHI was due to both men and women aged from 30 to 49.

Table 11 contains an equivalent comparison between the June 1997 CHI database and the Scottish General Registry Office 1997 mid year census population estimate. This suggests that there may be a greater discrepancy in CHI, with a CHI inflation of 126,163 patients (15.5%). The age and sex breakdown of this CHI inflation however shows that the pronounced differences between the contributions of different age groups to this CHI excess have been reduced.

Table 12 compares the distribution of Greater Glasgow Health Board area residents' Carstairs' deprivation categories at the 1991 census with the CHI database. The row percentage differences show that there was no overall trend in deprivation categories contributions to the CHI inflation, suggesting that CHI inflation was not associated with deprivation. The difference between the overall 10.7% inflation seen here and the previously noted 10.3% inflation is due to the use of the slightly smaller postcoded CHI dataset in this comparison (Figure 9).

5.2.5 General practices' data

At June 1997, there were 626 general practitioners on the GGHB's medical list. Analysis of details of patients' general practitioner registration details contained in the CHI database shows that these general practitioners had a median of 1,544 patients per practitioner (range = 1 to 4,314). Considering only adult patients (those aged 15 years and over), the median was 1,284 (range 1 to 3831). Ten Glasgow GPs (1.6%) had fewer than 160 patients on their personal lists and five had fewer than 100 patients.

These 684 GPs formed 216 practices with a median of four (mean = 3.8) general practice principals per partnership (see Figure 15 and Table 13). These 216 practices had a median of 3,236 adult registered patients (range = 586 to 11,184; Figure 16 and Table 14).

5.3 SMR1: EMERGENCY ADMISSIONS

5.3.1 Numbers of admissions

Altogether, 615,190 anonymised records of emergency medical admissions, covering the years 1980 to 1997, were extracted from the GGHB SMR1 and SMR01 databases using the methods described above. Table 15 shows the numbers of records retrieved for each year.

The study design had been restricted to adult emergency medical admissions and therefore the SMR1 records of 12,645 patients aged below 15 years were excluded (Table 15). Of the remaining 602,545 records of adult patients, 51,789 were excluded because, although they were admitted to a hospital in the Greater Glasgow Health Board area, they were resident elsewhere. A further 7,140 were excluded because, although they were Greater Glasgow Health Board residents, they were admitted to hospitals outwith Glasgow. Another 7,140 admissions were excluded because the patients' general practitioners did not practice in Glasgow. Lastly, 591 were excluded as their postcodes were invalid or they resided in postcodes with fewer than 500 residents and hence their relevant census data and deprivation indices were not available. Figure 17 illustrates this SMR1 / SMR01 record selection process for 1997 data.

5.3.2 Time factors

Two time-related factors may be examined using the SMR1 emergency medical admissions dataset. Firstly, the long-term rise in the annual number of emergency medical admissions, which is illustrated by Figure 18 (Table 15). This shows that the numbers of emergency admissions doubled, rising from 21,612 in 1980 to reach 43,235 by 1997.

In the following results, unless otherwise indicated, all analyses of emergency medical admission data are based on the most recent year's SMR1 / SMR01 data (1997). The mid-point of this year corresponds to the time of extraction of the CHI database population denominator (end June 1997).

The second time related factor is the variation in numbers of emergency medical admissions during the week. Figure 19 shows that in 1997, the largest numbers of emergency medical admissions was on Mondays, with the lowest number on Sundays. Despite the rise in the numbers of emergency medical admissions, this pattern has been consistent over time, as shown in Table 16.

5.3.3 Patients' age and sex

The distribution of the sex and ages of medical patients admitted as emergencies in 1997 is shown in Figure 20 (Table 17). This shows there was a steady increase in the numbers of emergency medical admissions with increasing patient age up to the sixth and seventh decades. Beyond this point, the number of emergency medical admissions declined rapidly. While men had slightly fewer emergency medical admissions than women altogether (Table 17), more young men were admitted than young women, while women predominated amongst older patients ($p < 0.00005$).

5.3.4 Carstairs' deprivation categories

The distribution of Carstairs' deprivation categories of patients admitted as medical emergencies is shown in Figure 21 (Table 18). In Glasgow 51.1% of the CHI population lived in the two most disadvantaged deprivation categories (DEPCATs 6 and 7; Table 9) however these areas accounted for 61.8% of emergency medical admissions.

5.3.5 Patients' diagnoses

The ICD10 chapter groupings of the discharge diagnoses of emergency medical admissions in 1997 are shown in Table 19. The commonest group of admissions was for circulatory system disease (ICD10 chapter IX; 27.2%). Table 19 shows that the second commonest group of diagnoses was "Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified" (ICD10 chapter XVII; 21.0%) and that these two chapters together accounted for almost one half of all emergency medical admissions (48.2%).

Figure 22 shows that, while the proportions of other diagnostic groupings remained relatively constant, "Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified" proportionally doubled between 1980 and 1997 (rising from 10.1% to 21.0% of emergency medical admissions). Because emergency admissions overall doubled during this time, the absolute number of diagnoses of "Symptoms, signs..." quadrupled in this period, rising from 2,467 to 10,376.

Conversely, during this period, "Diseases of the circulatory system" fell from 33.9% to 27.2% of all diagnoses. This relative fall masks a 25.6% slight rise in absolute numbers, from 10,738 to 13,497 (Figure 22).

The commonest specific three character primary ICD10 diagnoses are shown in Table 20; these are grouped into their respective ICD10 chapter groups for comparison. The commonest specific ICD10 diagnosis was "Pain in throat and chest" 4,171 admissions (9.6%) followed by "Other chronic obstructive pulmonary disease" 2,432 (5.6%), "Angina pectoris" 2,327 patients (5.4%), "Heart failure" 1,758 (4.1%), "Acute myocardial infarction" 1,694 (3.9%) and "Poisoning by nonopioid analgesic antipyretic and antirheumatics" which accounted for 1,159 admissions (2.7%).

Chest pain is a common element in the symptomatology of the following three diagnoses: "Pain in throat and chest", "Angina pectoris" and "Acute myocardial infarction". Taken together, these accounted for 18.9% of all emergency medical admissions in Glasgow in 1997.

Similarly, the three commonest ICD10 respiratory diagnoses may be considered together ("Other chronic obstructive pulmonary disease", "Pneumonia, organism unspecified", "Unspecified acute lower respiratory infection"). These together accounted for 10.6% of all emergency medical admissions in 1997.

Patients with diagnoses in ICD10 chapter XVIII (Symptoms, signs...) were younger and slightly more deprived than those having diseases of the circulatory system, while patients with respiratory disease were still more deprived and older. A striking difference is seen in patients with diagnoses in ICD10 chapter XIX (Injury and poisoning...) who were the youngest group. They were also from the most deprived areas of Glasgow (alongside patients with mental and behavioural disorders due to the use of alcohol). (Table 20).

5.4 EMERGENCY MEDICAL ADMISSION RATES

5.4.1 Patients' age and sex

Patient' emergency medical admission rates more than doubled with every two decades increase in patients' ages (Figure 23). They rose from 15.6 admissions per 1000 CHI population in the age group 20 to 29, reaching 213.2 for patients aged 80 to 89 (Table 21). This statistically highly significant rise then flattened off for the group of patients aged over 90.

Figure 23 also shows that this age related rise in emergency medical admission rates was found for both men and women. However, while men and women had similar overall emergency medical admission rates, men had markedly higher age specific admission rates than women between the ages of 40 and 89 years (Table 21).

5.4.2 Carstairs' deprivation categories

Emergency medical admission rates increased more than twofold with increasing patients' Carstairs' deprivation category (Figure 24). This was statistically highly significant, rising from 32.1 in deprivation category 1 to 73.1 admissions per 1000 population per annum amongst patients from areas in deprivation category 7 (Table 22).

As noted above, Carstairs' DEPCATs have a markedly skewed distribution amongst Glasgow's population (Table 9). I therefore explored the use of deciles of Carstairs' scores, rather than Carstairs' deprivation categories. Figure 25 shows the association between Glasgow's emergency admission rates and socio-economic deprivation measured using these deciles. Figure 25 also shows that doubling of emergency admission rates between the most affluent and deprived postcodes. However, as will be seen, the use of deciles of Carstairs' scores does not lead to improved discrimination within the most deprived DEPCATs. This suggested that there was no benefit to be gained from further analyses using deciles of Carstairs' score. I therefore decided to continue to use the conventional Carstairs' deprivation categories, rather than complicating further analyses with additional degrees of freedom.

5.4.3 Patients' ages, sex and Carstairs' deprivation categories

The rise in emergency medical rates with increasing age and with increasing Carstairs' deprivation category was consistent even when patients' age, sex and deprivation category are considered simultaneously. This is shown by Figure 26 for men and by Figure 27 for women. Table 23 shows the age, sex and deprivation specific emergency medical admission rates. There were 112 of these rates, derived from the product of 8 age bands, 2 sexes and 7 deprivation categories.

I had had some concerns about adjusting simultaneously for as many as 112 specific rates when calculating standardised admission ratios. Therefore, the use of these categories was examined by considering the relationships between the specific rates for these categories. Figure 26 and Figure 27 show that the category specific rates were increasing functions of both age in decades and deprivation categories. The relative smoothness of these relationships confirmed that it was appropriate to continue with calculation of standardised rates, adjusting for patients' ages, sex and deprivation categories using the 112 categories shown in Table 23.

The relationship between crude rates of emergency medical admissions and socio-economic deprivation at the level of individual post code sectors (measured using Carstairs' deprivation score) is shown in Figure 28. Pearson's correlation coefficient ($r=0.63$, $r^2=0.40$) showed that this relationship was statistically highly significant ($p<0.00001$).

To examine the possibility that patients' age and sex might be a confounding factor in the relationship between emergency admission rates and deprivation, standardised emergency medical admission ratios (adjusted for age and sex) were plotted against Carstairs' scores (Figure 29). As shown, this relationship became more significant following the described adjustment ($r=0.71$, $r^2=0.50$, $p<0.00001$).

The relationships between patients' demographic and socio-economic factors and their emergency medical admission rates was further explored using logistic regression. This adjustment technique was used to assess the possibility of relationships between these major variables having confounding effects on emergency medical admissions. Table 24 shows the adjusted logistic regression derived odds ratios risk estimates of the probabilities of emergency medical admissions for patients' age sex and deprivation category.

I also used logistic regression to examine the possible statistical interactions between these variables. While these interactions were statistically significant, their inclusion did not usefully improve the logistic regression model. Logistic regression modelling was also used to calculate odds ratios for individual deprivation categories and age bands. These failed to improve the overall power of the logistic regression by greater than five percent. The use of categorical variables and interaction terms in logistic regression was therefore abandoned.

5.4.4 Postcode sectors

The variation in crude emergency medical admission rates between Glasgow's postcode sectors is shown in Figure 30 (mean annual emergency medical admissions per 1000 population = 52.9, range 5.4 to 113.4).

Adjustment for patients' age and sex using indirect standardisation produces the map shown in Figure 31. Comparison with the map of Glasgow's population deprivation categories (Figure 13) suggests that the most deprived postcode sectors are also those areas with the highest emergency medical admission rates even after adjustment for patients' age and sex. (These form a band running roughly from west to east through the city centre in Figure 13 and Figure 31.)

There was no significant association between postcode sectors' rates of emergency medical admissions and their distances from their nearest hospitals. Examination of Figure 31 confirms the finding that there was no central or peripheral trend in emergency medical admission rates.

The effect at the level of postcode sectors of this additional adjustment for Carstairs' deprivation category is shown in Figure 32 which shows two areas with high emergency medical admission ratios lying to the north and south-west of the city. This compares with the previously noted strip of postcodes having raised emergency admission ratios that ran from east to west in Figure 31.

5.5 SUMMARY

This chapter has tested two broad hypotheses that were based on two of the original study objectives.

The first hypothesis was that:

1. Rates of emergency medical admissions in Glasgow varied with differences in patients' age, sex, socio-economic status and that they varied in different geographical areas of the city.

The above results show that there were substantial variations in emergency medical admission rates with differences in these patient characteristics. There were also substantial variations between different parts of the city of Glasgow. These variations remained present even after adjustment for patients' ages, sex and Carstairs' deprivation categories.

The second hypothesis was that:

2. The principal diagnoses of patients admitted as medical emergencies to Glasgow hospitals changed over time.

This chapter has shown that the numbers of principal diagnoses in all of the major diagnostic categories more than doubled in a fifteen year period. However, "Cardiovascular disease" rose by a much lower proportion than the other categories, while "Symptoms, signs and abnormal clinical and laboratory findings" rose fourfold in this time, becoming the largest group of diagnoses by 1997.

The other major conclusion to be drawn from the above follows from the finding that patients' age, sex and Carstairs' deprivation categories were all shown to have strong independent relationships with emergency admission rates. Therefore, all further comparisons of emergency medical admission rates should take patient's Carstairs' deprivation category into account as well as adjusting for their age and sex.

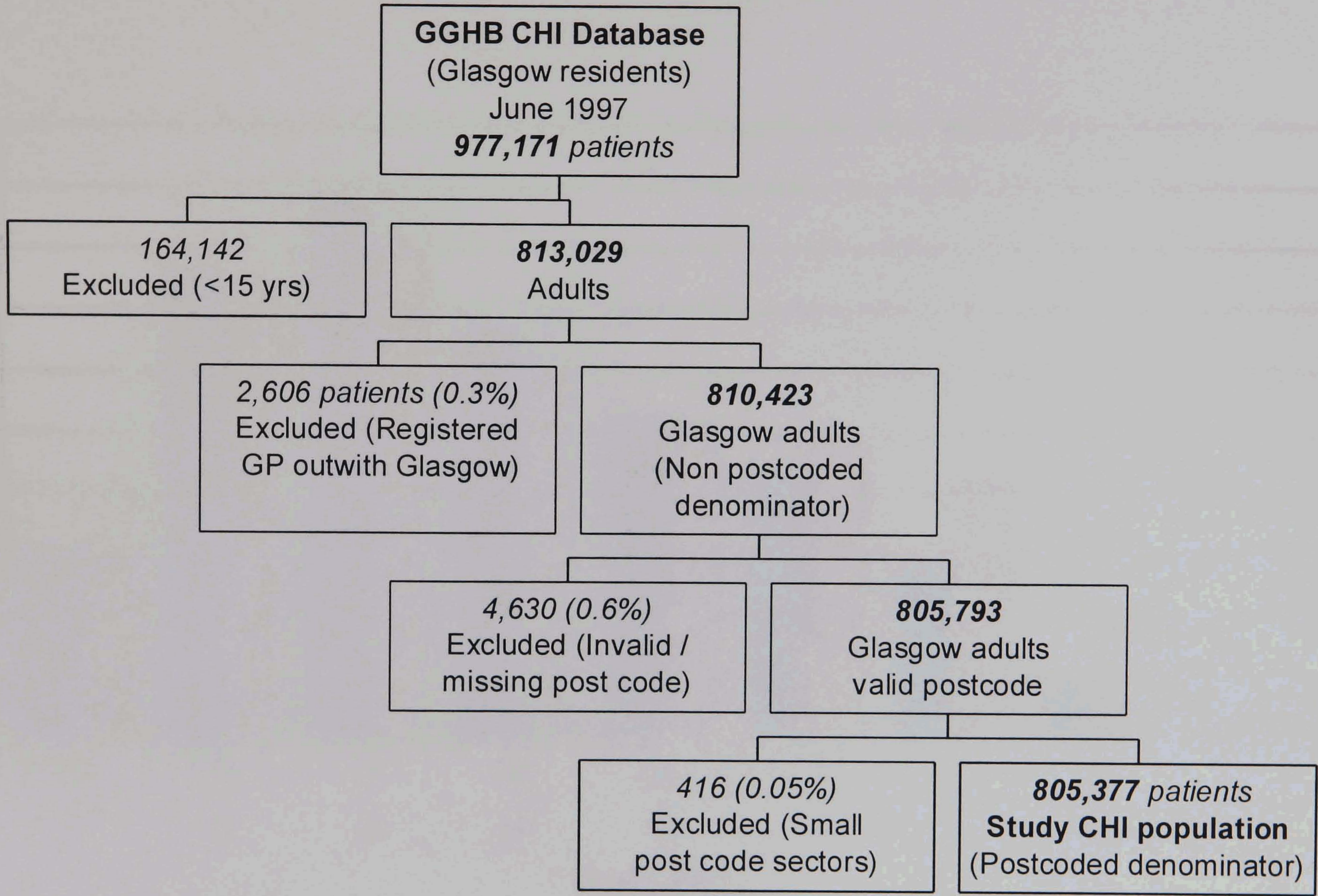

Figure 9 — Numbers on the CHI denominator database

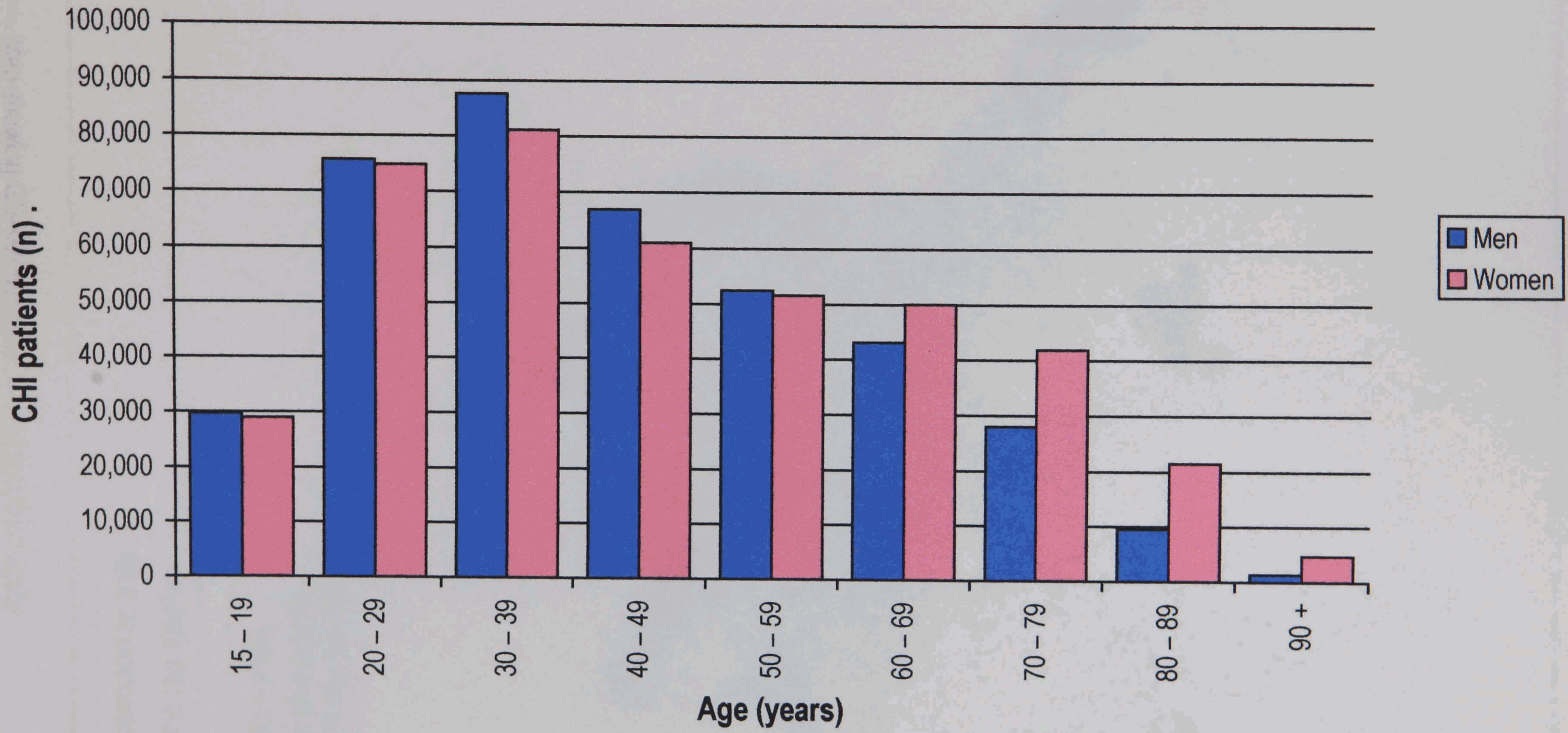

Figure 10 — Age and sex of CHI patients

Original in colour

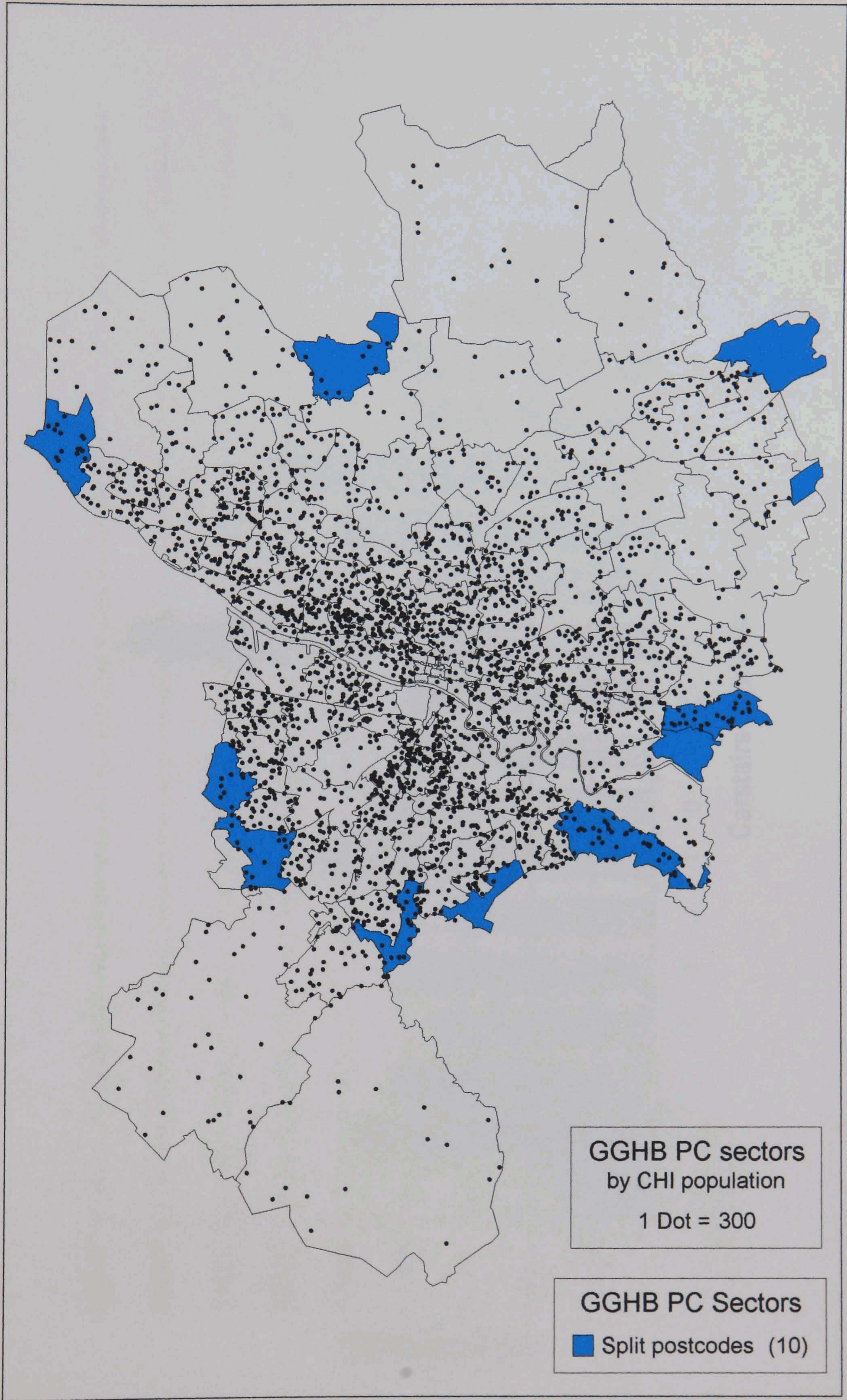

Figure 11 — Map showing GGHB postcodes' CHI population density

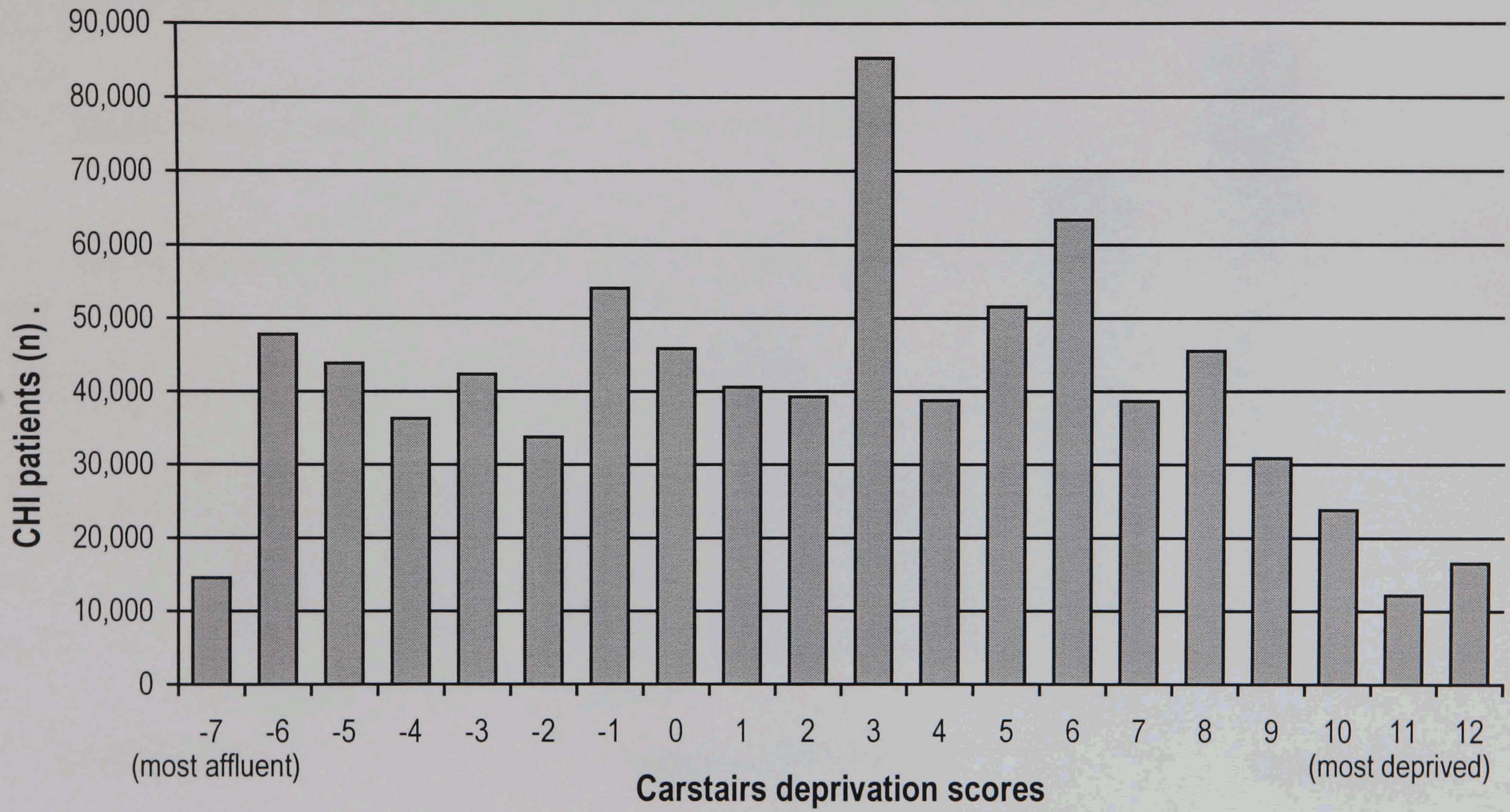

Figure 12 — CHI patients' Carstairs' deprivation scores

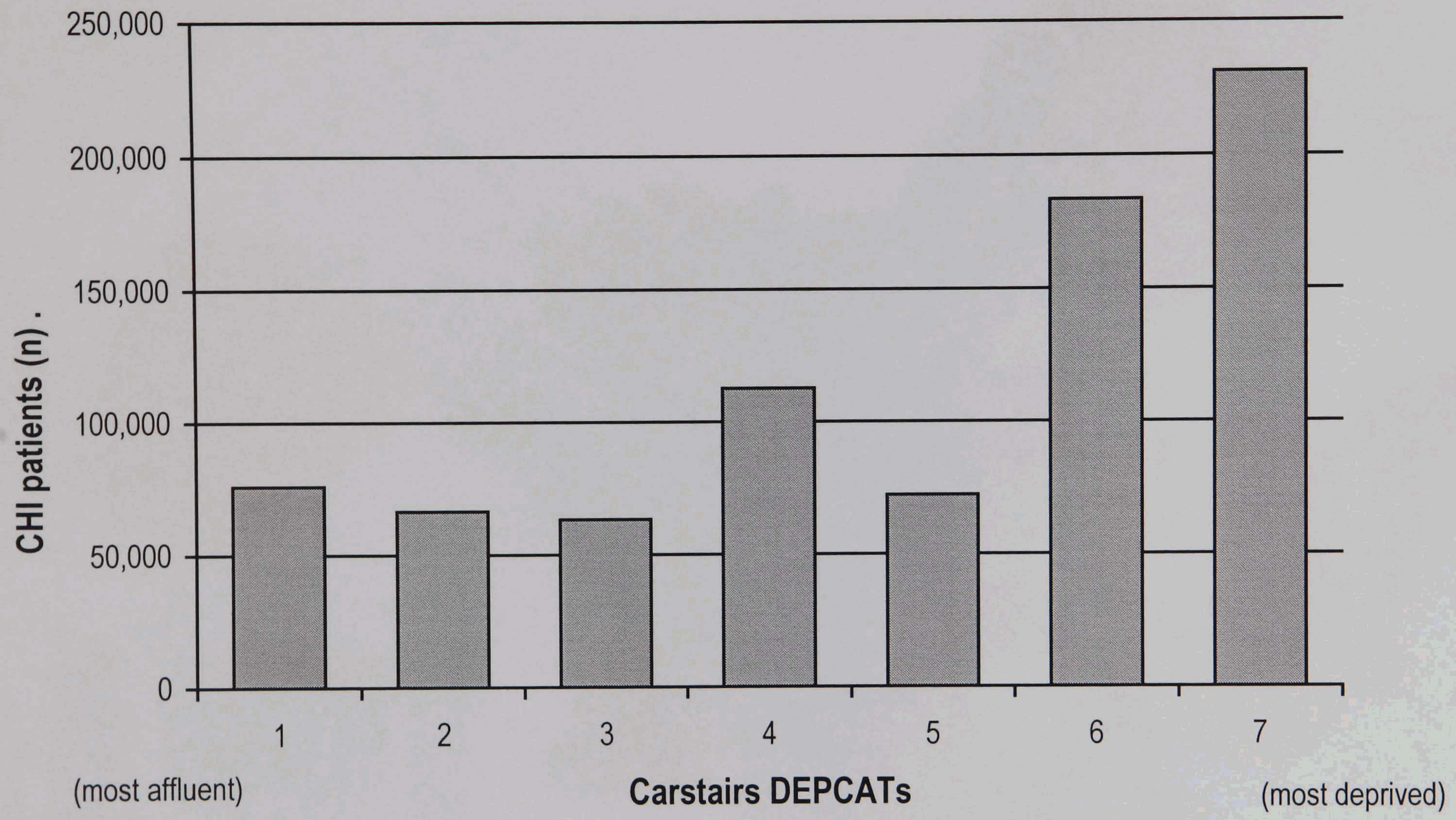

Figure 13 — CHI patients' Carstairs' DEPCATs

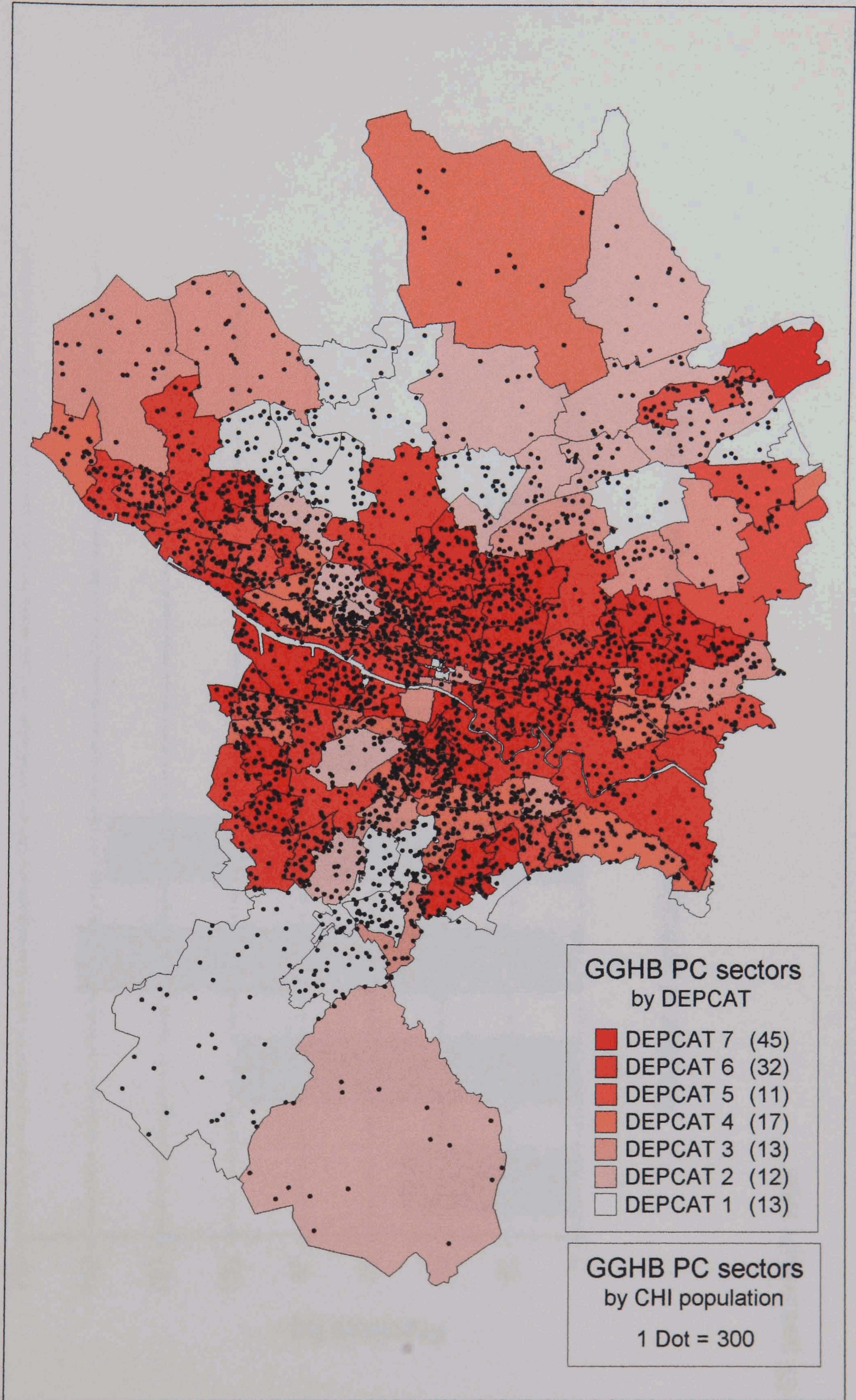

Figure 14 — Map of GGHB's postcodes' DEPCATs and CHI population density

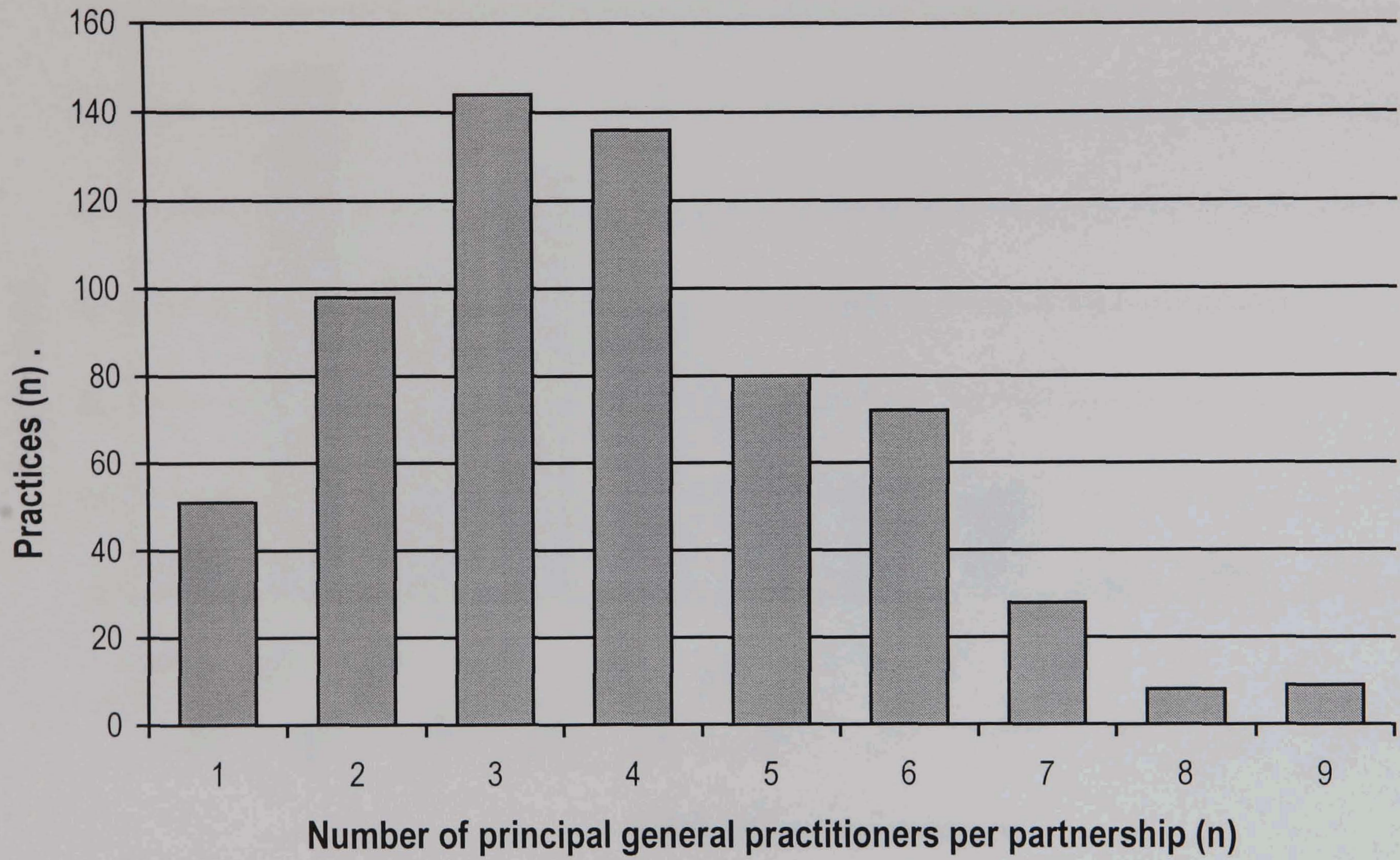

Figure 15 — GP partnerships' sizes

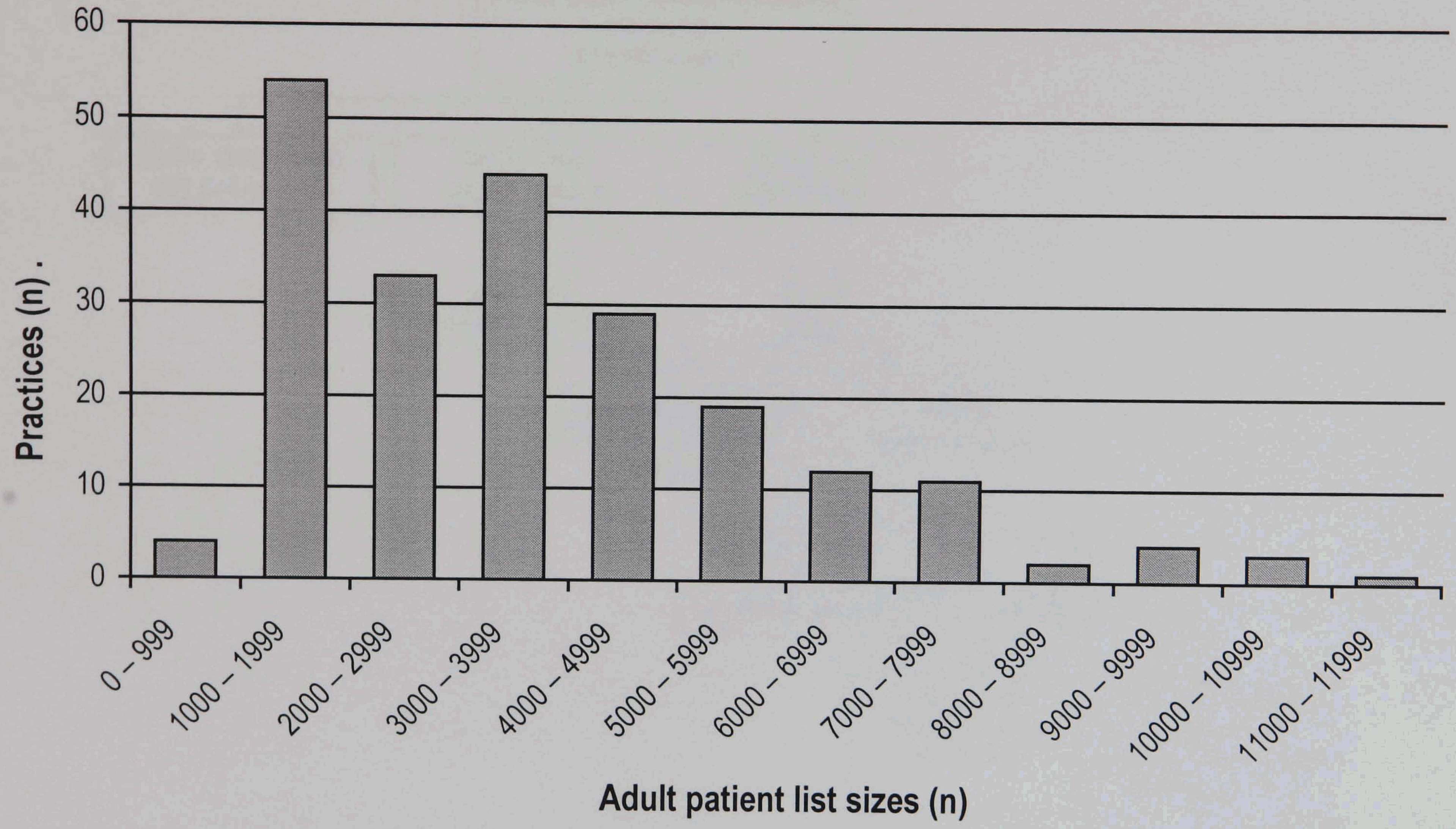

Figure 16 — GP partnerships' patient list sizes

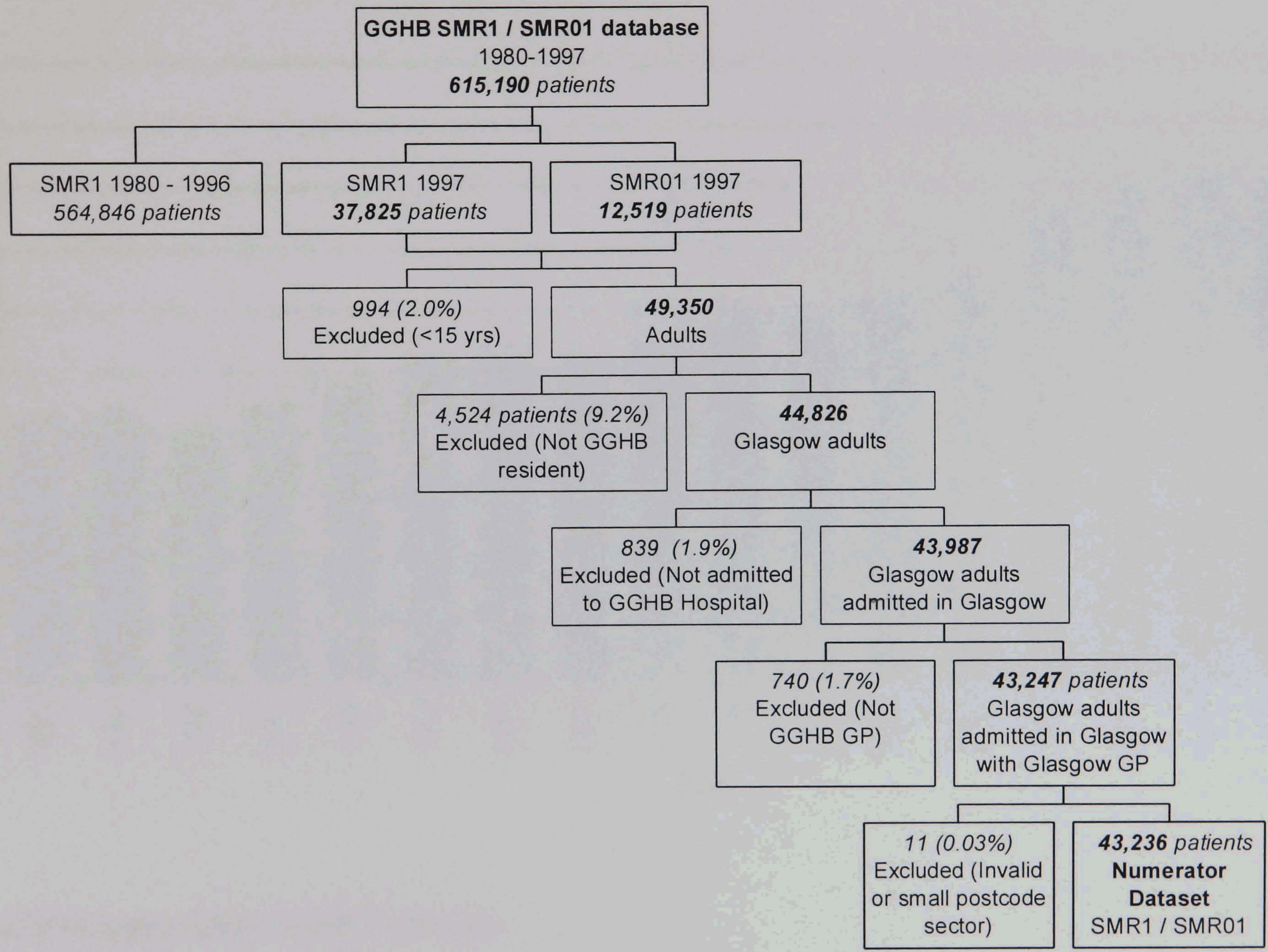

Figure 17 — Numbers of EMAs in the 1997 SMR1 / SMR01 numerator database

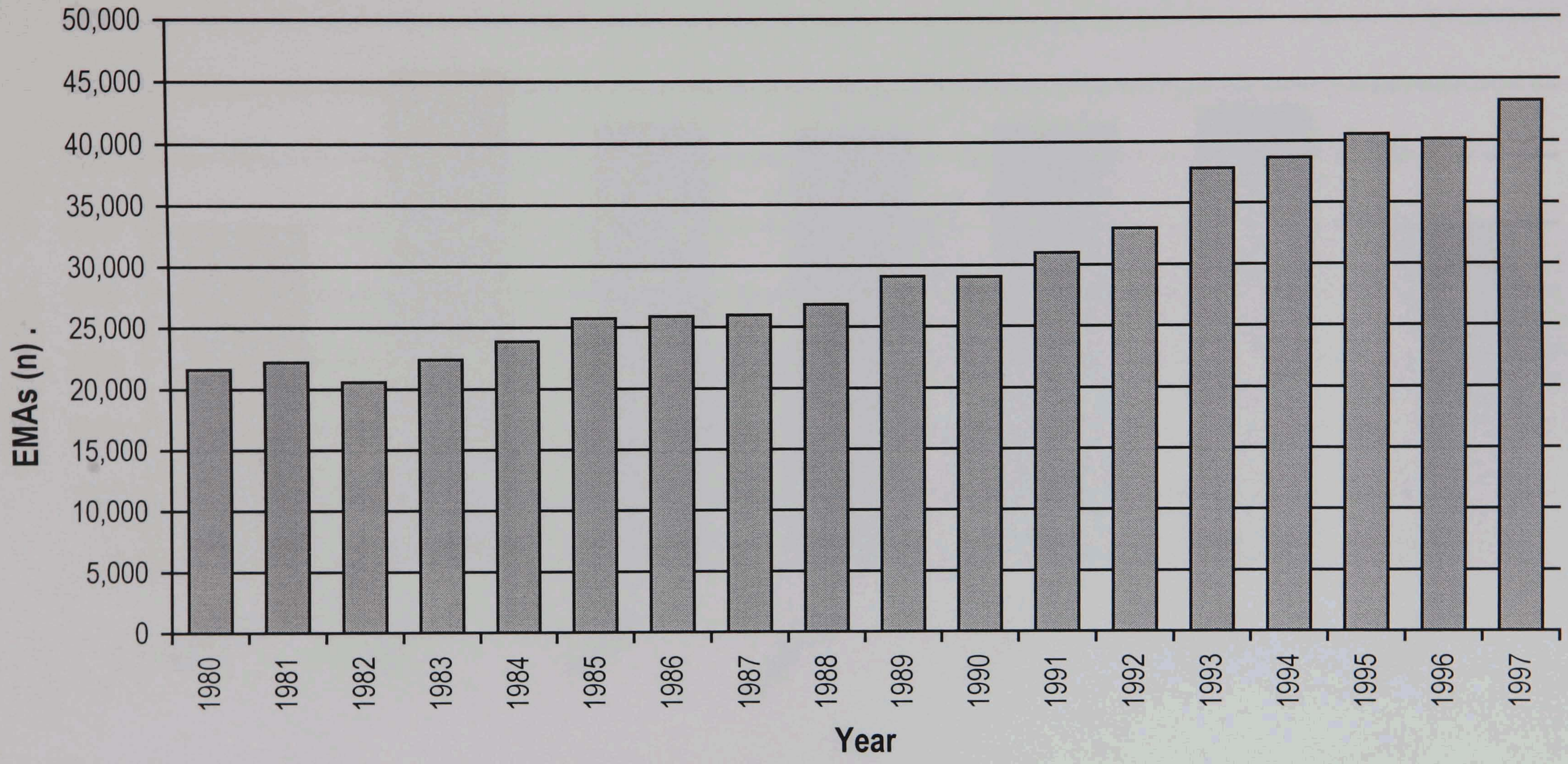

Figure 18 — Numbers of EMAs by year (SMR1 / SMR01 databases)

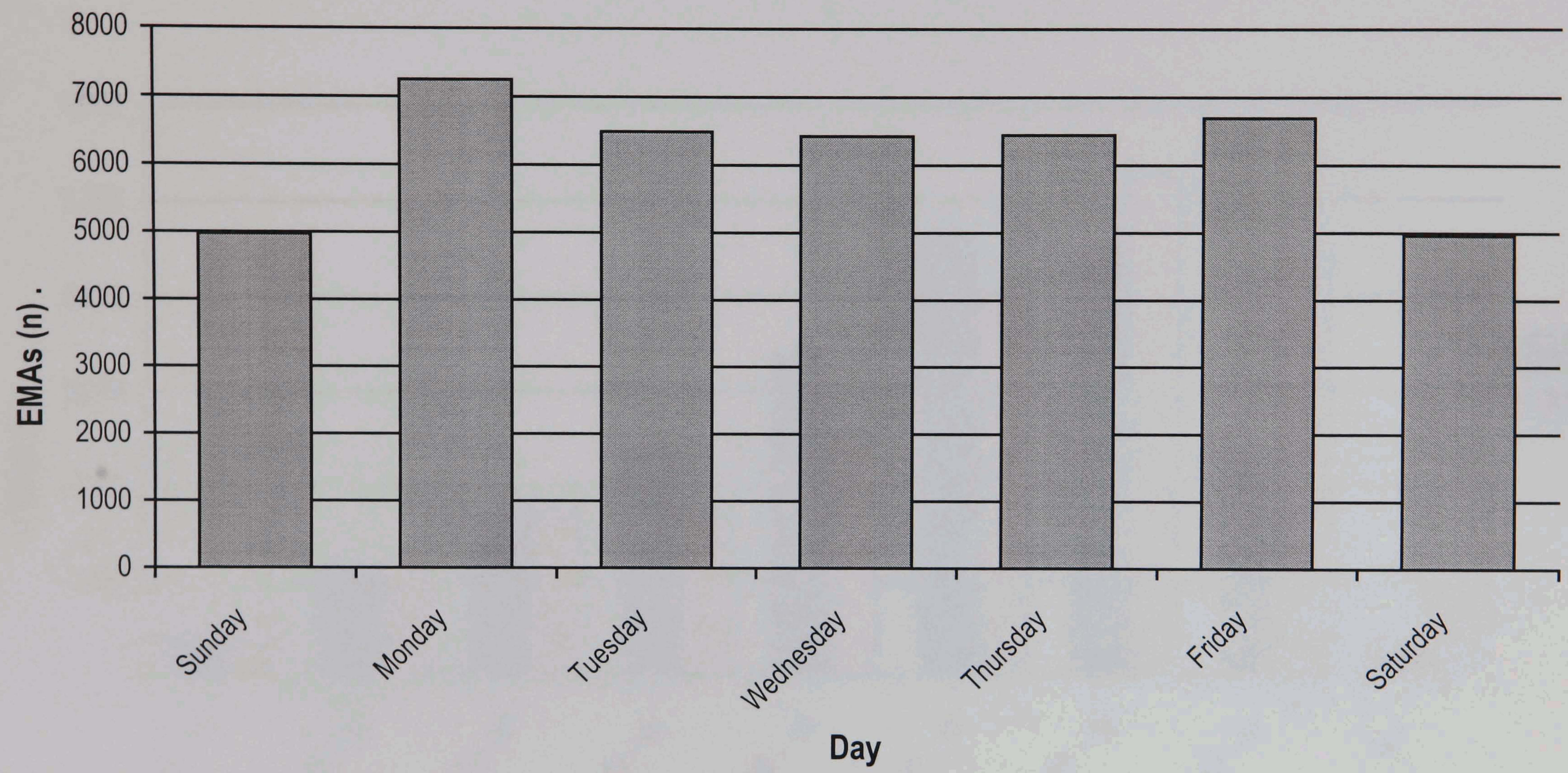

Figure 19 — Numbers of EMAs by day of the week (1997)

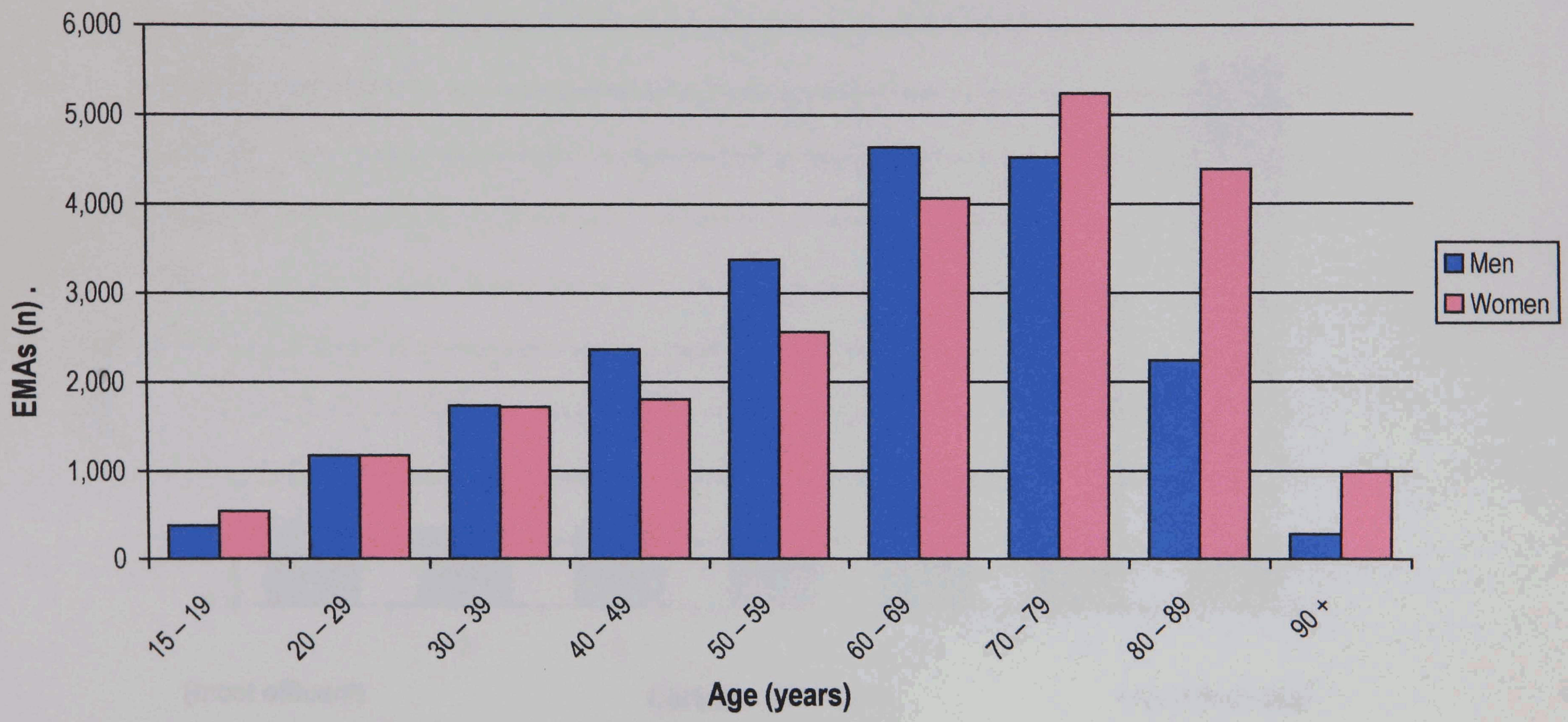

Figure 20 — EMAs' age and sex

Original in colour

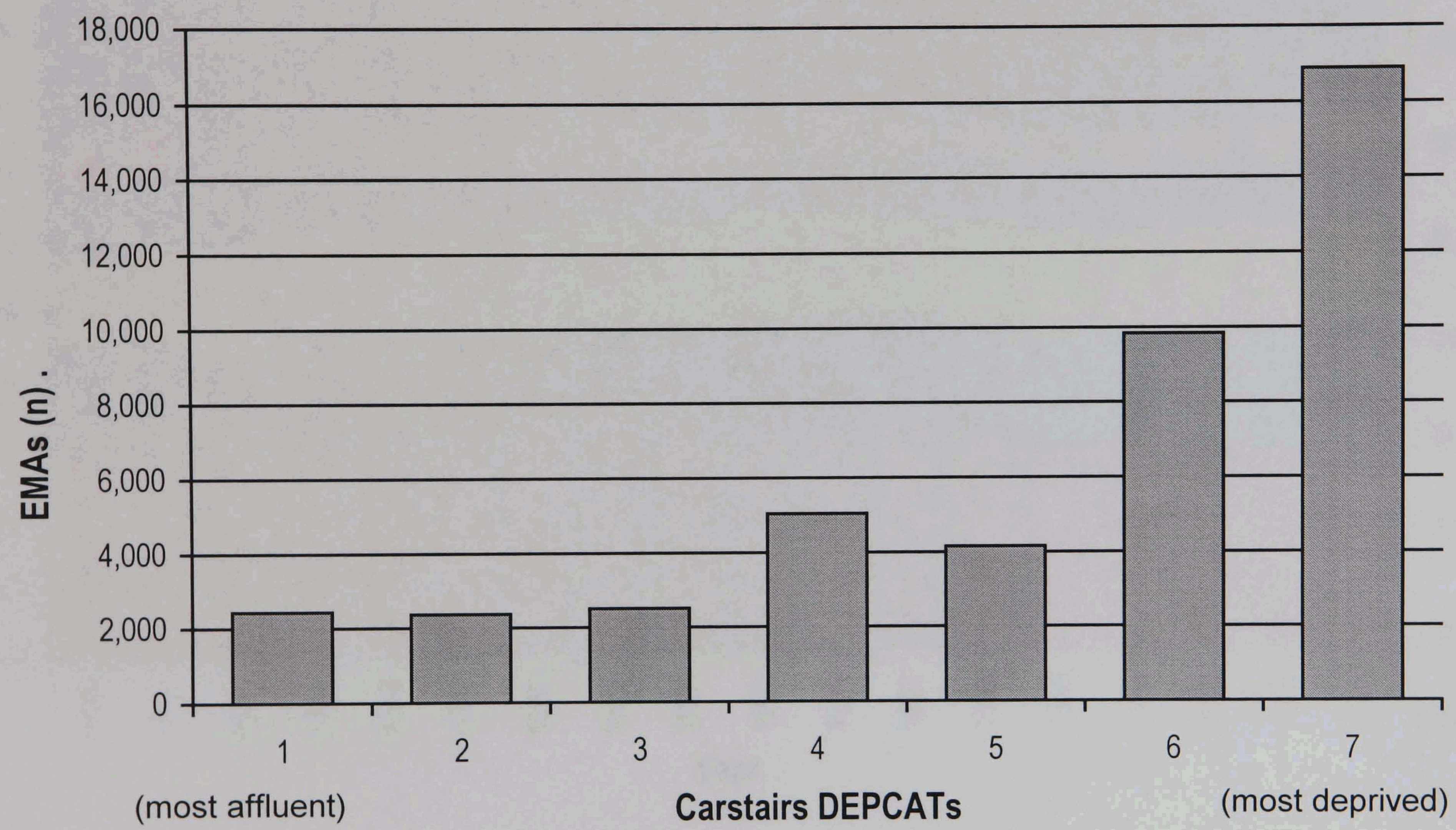

Figure 21 — EMAs' Carstairs' DEPCATs

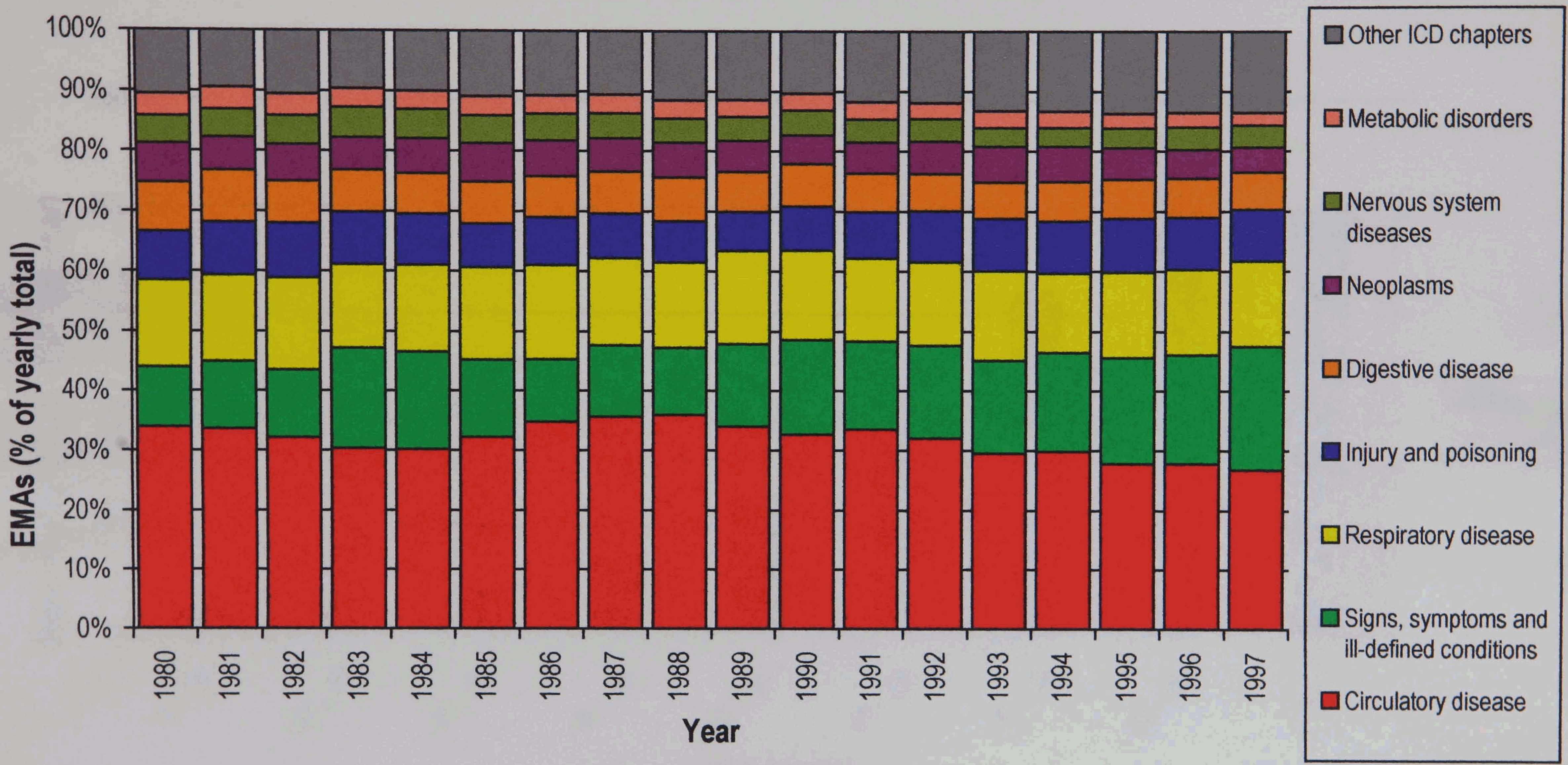

Figure 22 — EMAs' principal ICD chapter diagnoses by year (SMR1 / SMR01)

Original in colour

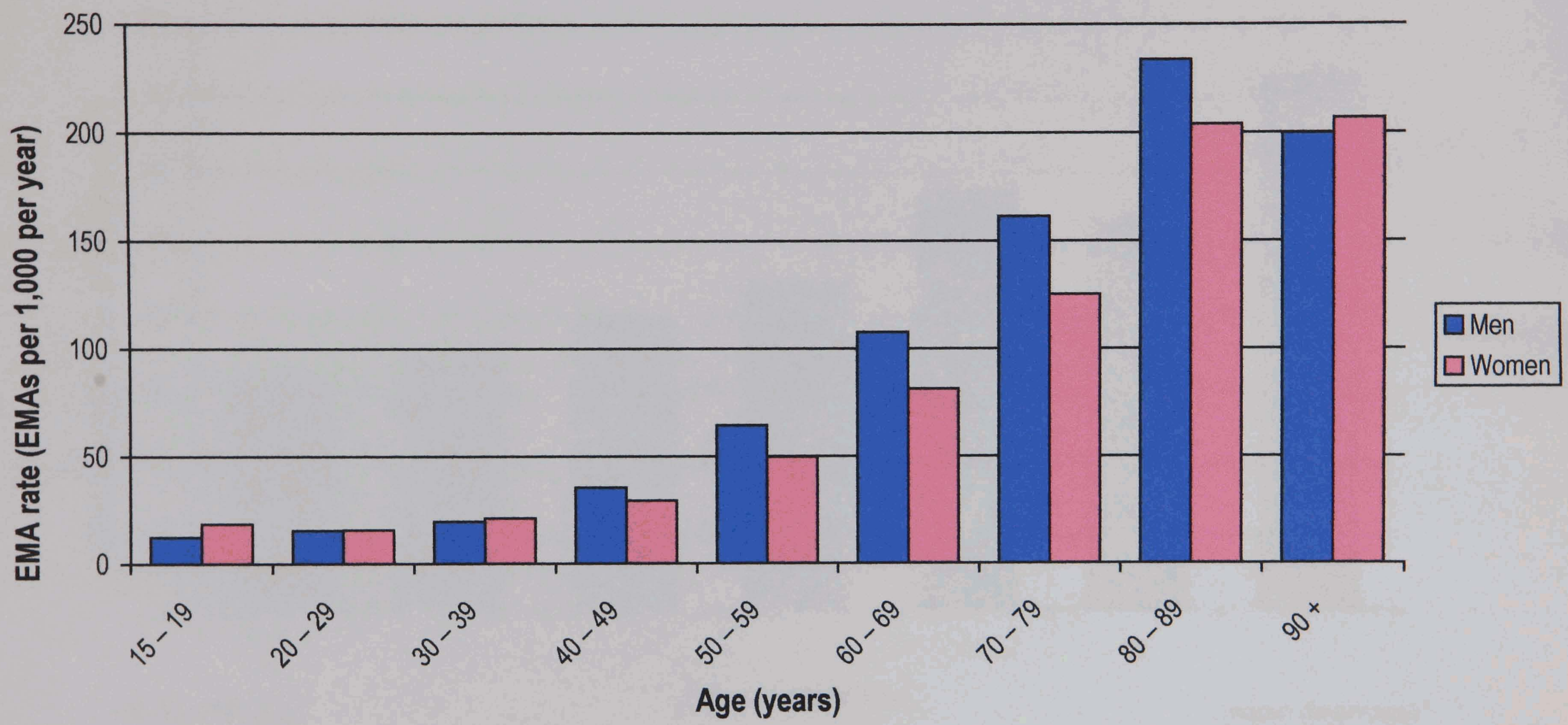

Figure 23 — EMA rates by patients' age and sex

Original in colour

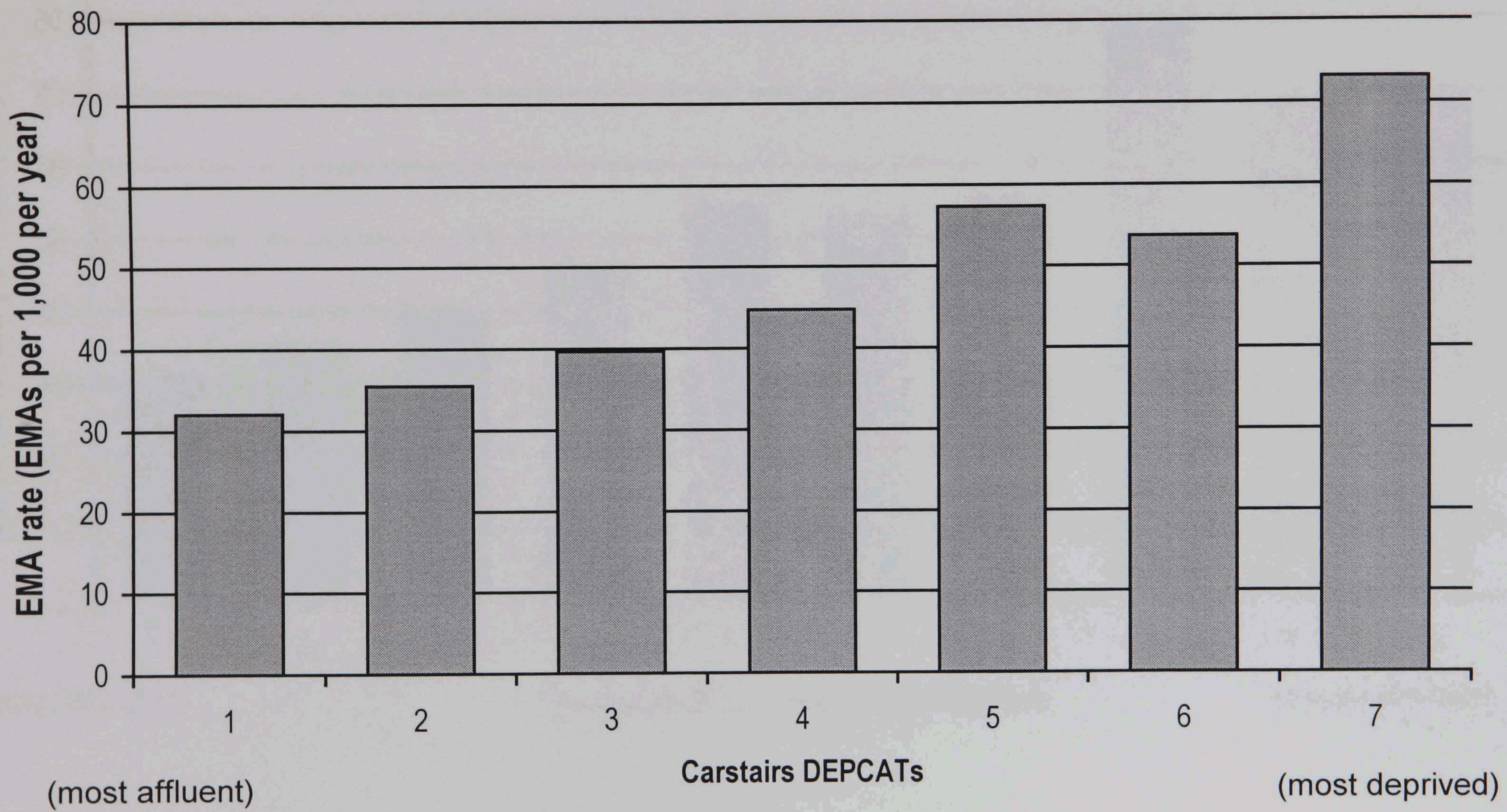

Figure 24 — EMA rates by Carstairs' DEPCATs

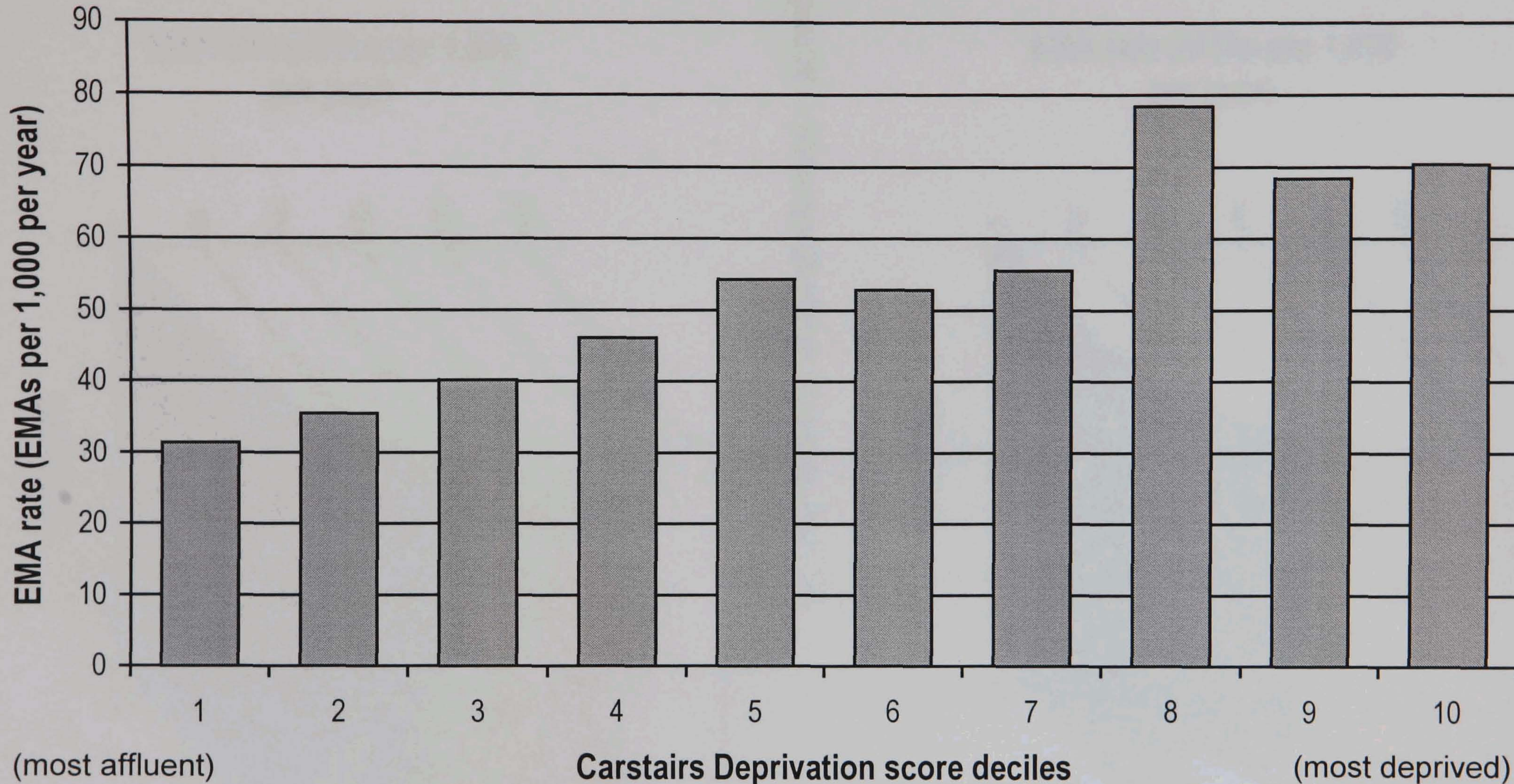

Figure 25 — EMA rates by deciles of Carstairs' score

Figure 26 — Mens' age and DEPCAT specific EMA rates

Figure 27 — Womens' age and DEPCAT specific EMA rates

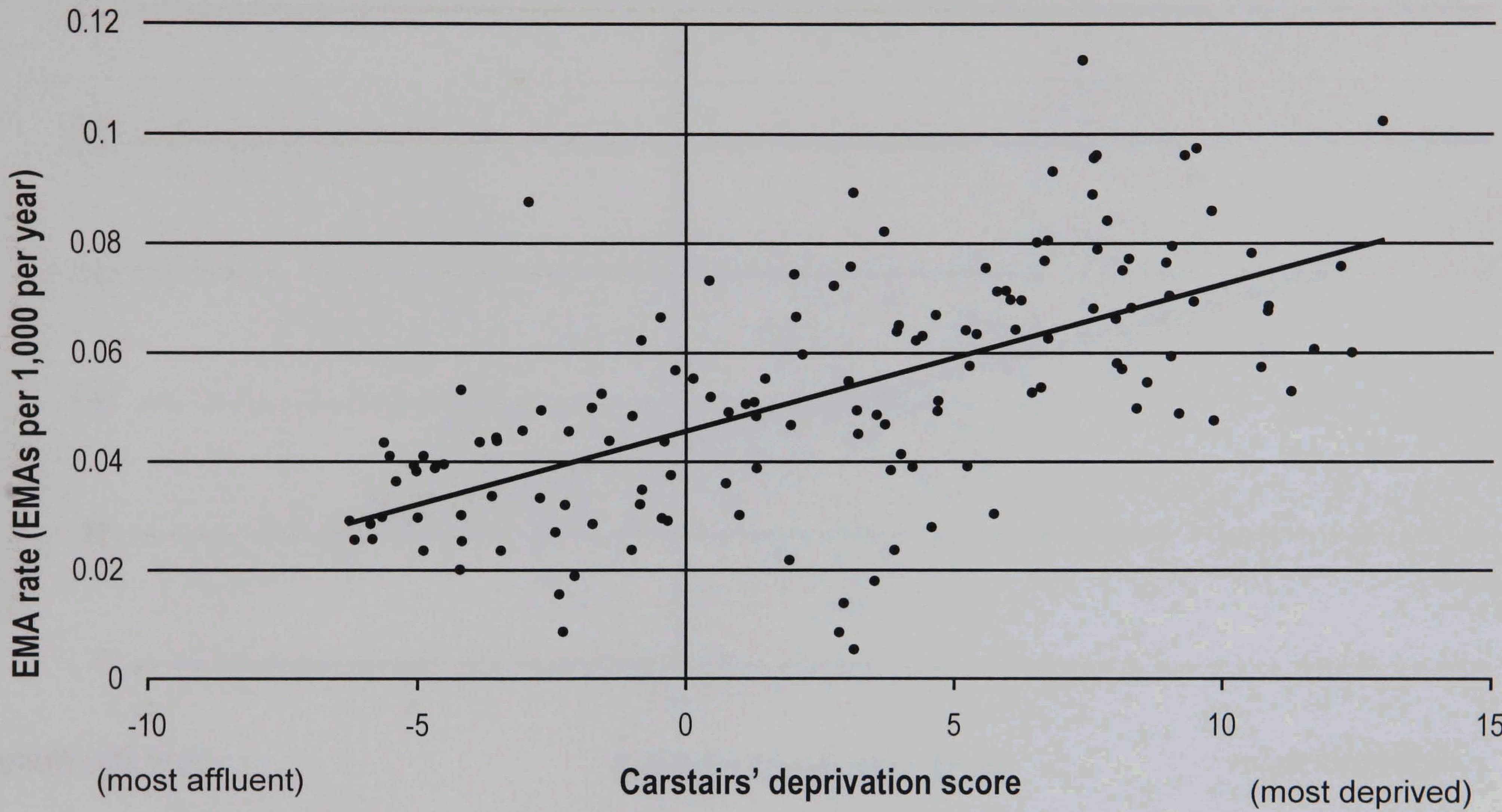

Figure 28 — Carstairs' deprivation scores against postcode sectors' crude EMA rates

(Pearson's correlation: $r=0.63$, $r^2=0.40$, $p<0.00001$, two tailed)

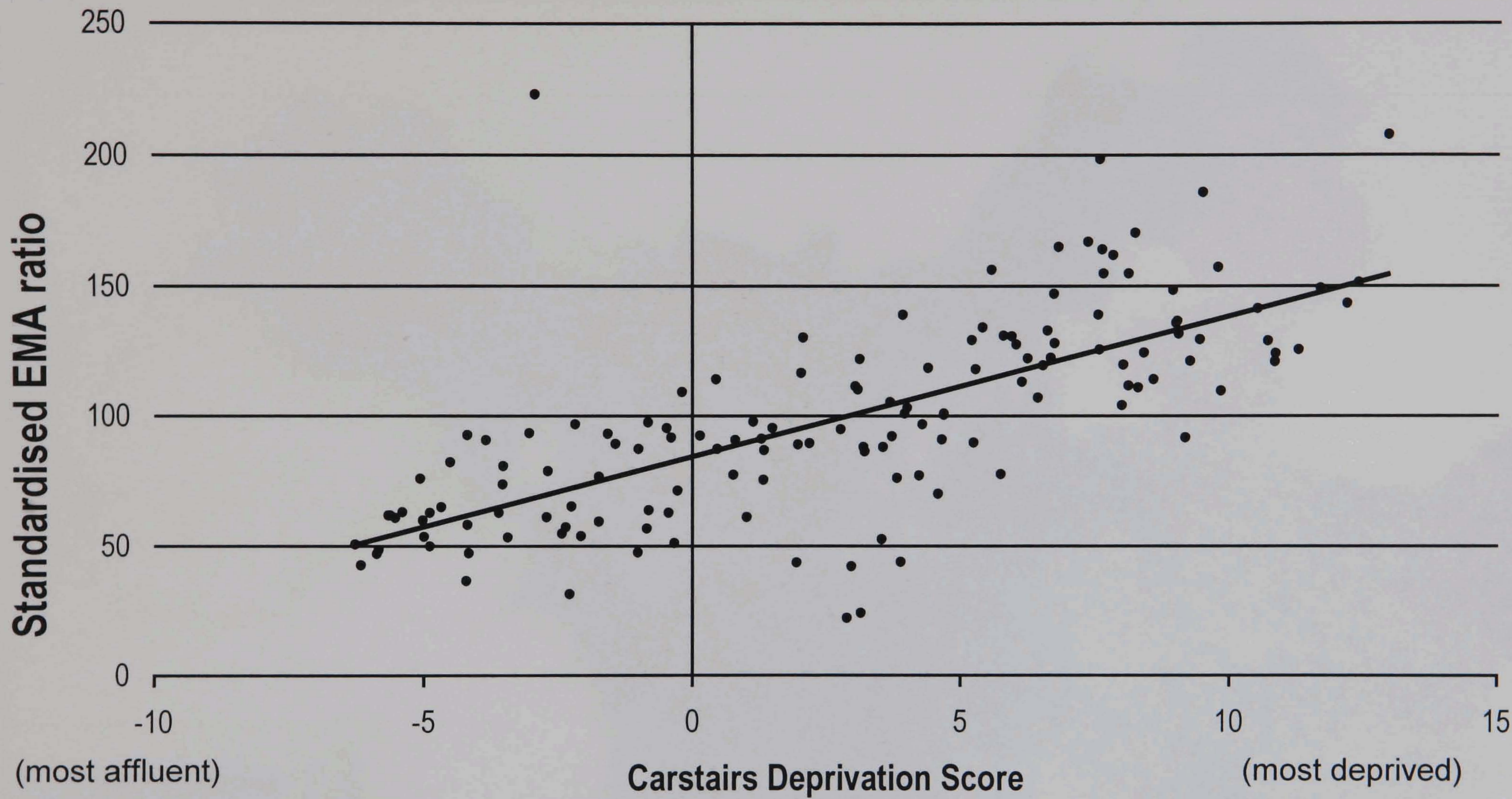

Figure 29 — Carstairs' deprivation scores against postcode sectors' standardised EMA ratios (adjusted for age and sex)

(Pearson's correlation: $r=0.71$, $r^2=0.50$, $p<0.00001$, two tailed)

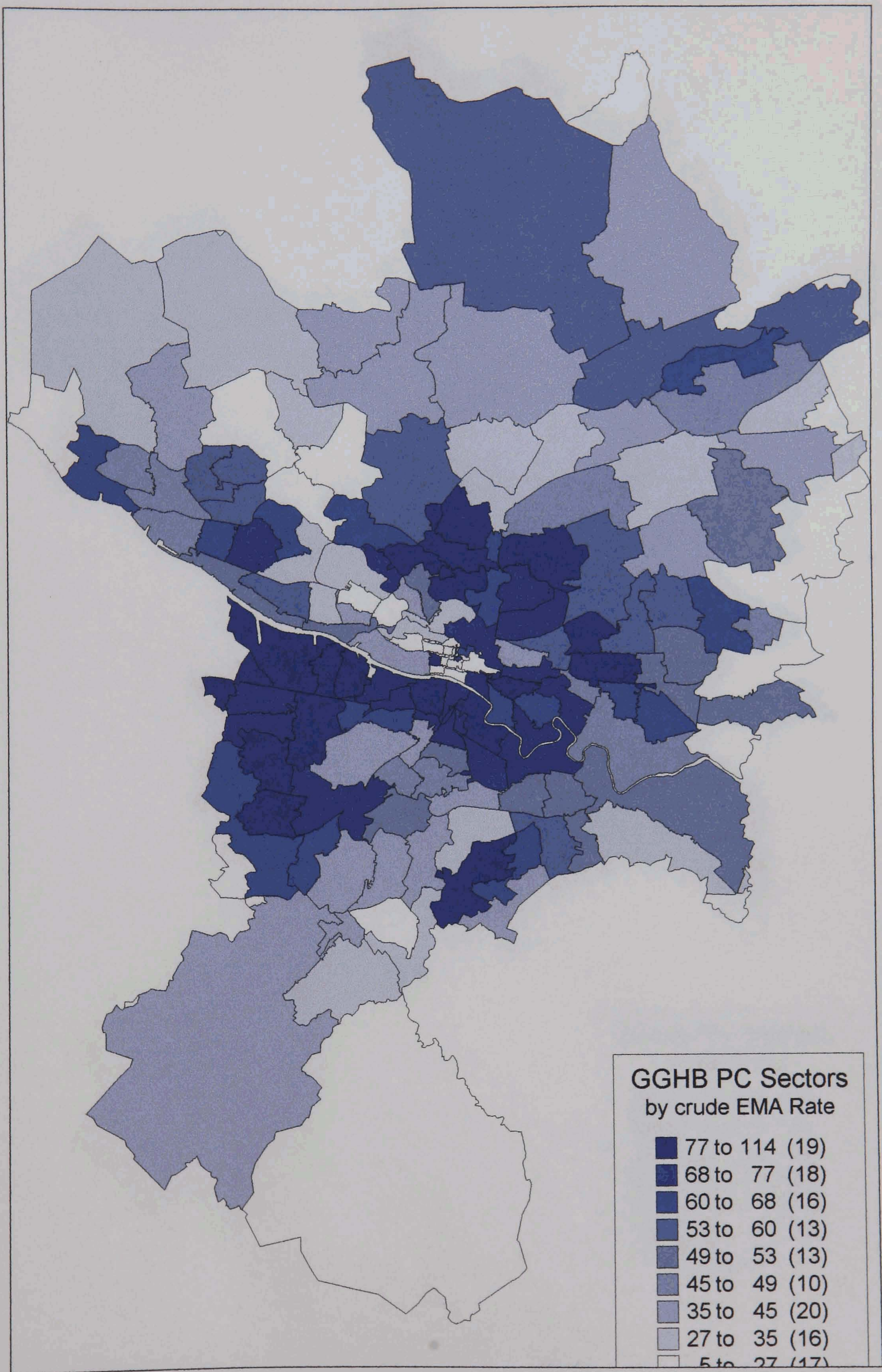

Figure 30 — Glasgow's postcode sectors crude EMA rates

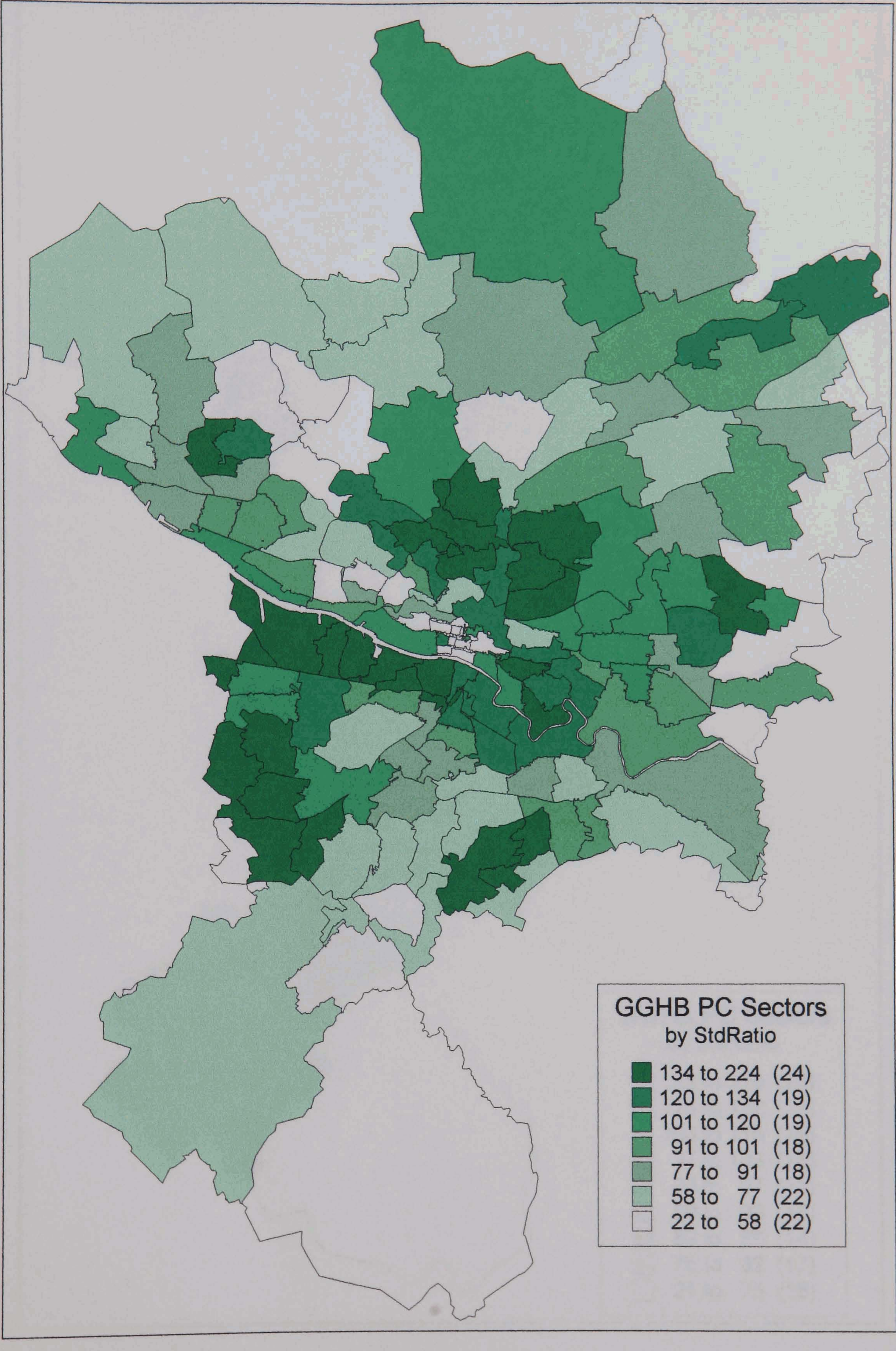

Figure 31 — Glasgow's postcode sectors standardised EMA ratios (age and sex adjusted)

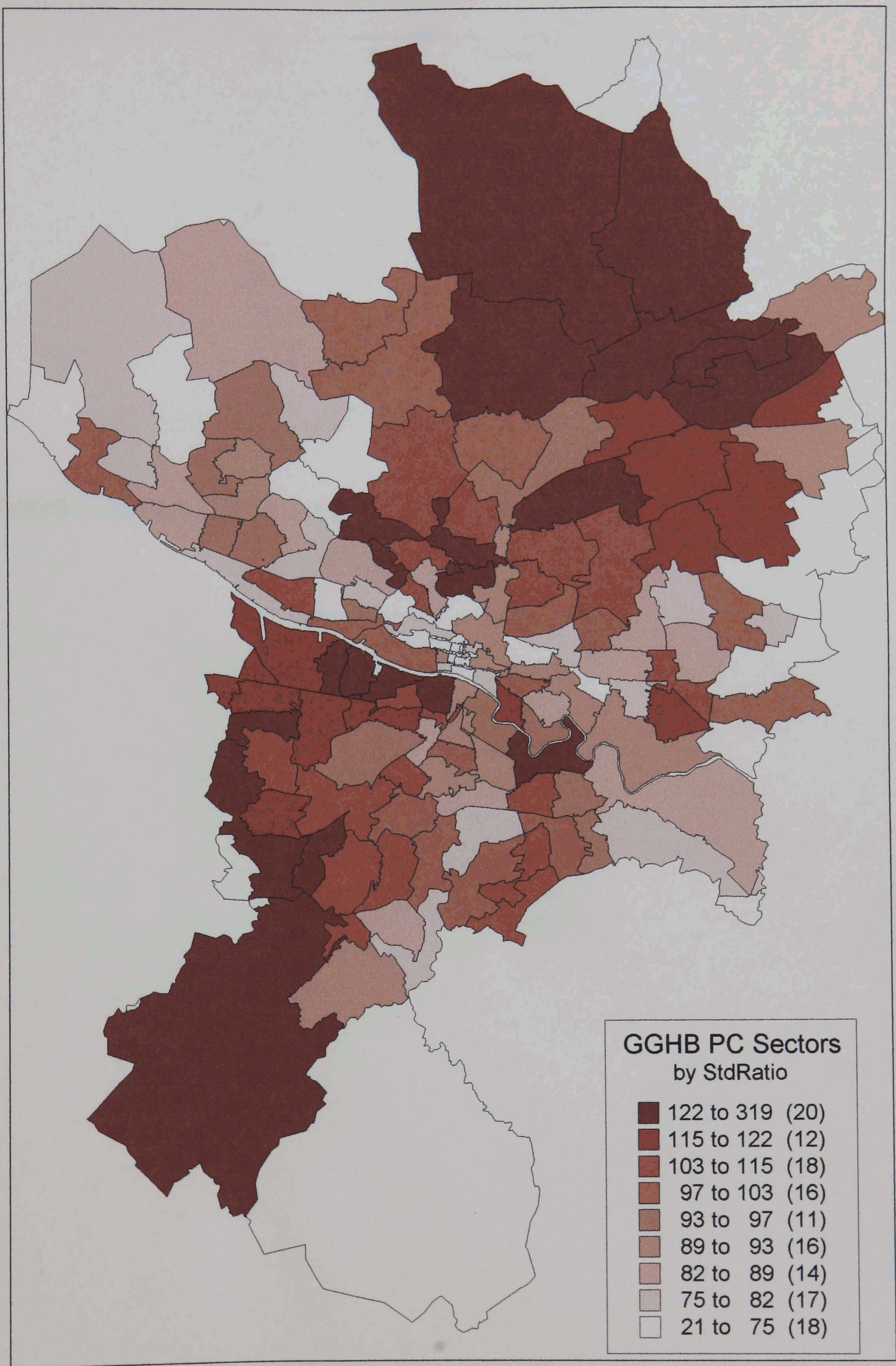

Figure 32 — Glasgow's postcode sectors' standardised EMA ratios (age, sex and DEPCAT adjusted)

Table 8 — Sex and ages of patients on GGHB CHI

Age	Male (n)	Female (n)	Total (n)
15 – 19	29,763	28,966	58,729
20 – 29	75,680	74,862	150,542
30 – 39	87,539	81,146	168,685
40 – 49	66,946	61,004	127,950
50 – 59	52,437	51,642	104,079
60 – 69	43,137	50,063	93,200
70 – 79	28,065	41,858	69,923
80 – 89	9,596	21,505	31,101
90 +	1,412	4,802	6,214
Total	394,575	415,848	810,423

Table 9 — Carstairs' DEPCATs of GGHB CHI patients

DEPCAT	Patients (n)
1	75,992
2	66,538
3	63,303
4	112,820
5	72,284
6	183,378
7	231,062
Unknown	5,046
Total	805,377

Table 10 — Comparison of GGHB 1991 census population with June 1997 CHI

	Census			Chi Excess					
	Male	Female	Total	Male		Female		Total	
Age	n	n	n	n	%	n	%	n	%
15 - 19	28,571	28,101	56,672	1,192	2.0	865	3.7	2,057	2.5
20 - 29	68,675	75,912	144,587	7,005	11.7	-1,050	-4.5	5,955	7.2
30 - 39	61,727	65,423	127,150	25,812	43.3	15,723	67.0	41,535	50.0
40 - 49	51,927	53,529	105,456	15,019	25.2	7,475	31.9	22,494	27.1
50 - 59	47,404	52,454	99,858	5,033	8.4	-812	-3.5	4,221	5.1
60 - 69	43,251	52,791	96,042	-114	-0.2	-2,728	-11.6	-2,842	-3.4
70 - 79	25,011	40,648	65,659	3,054	5.1	1,210	5.2	4,264	5.1
80 +	8,384	23,522	31,906	2,624	4.4	2,785	11.9	5,409	6.5
Total	334,950	392,380	727,330	59,625	-	23,468	-	83,093	-

Table 11 — Comparison of GGHB 1997 population mid year estimate with June 1997 CHI

	Census mid year estimate			Chi Excess					
	Male	Female	Total	Male		Female		Total	
Age	n	n	n	n	%	n	%	n	%
15 - 19	28,243	27,315	55,558	1,520	2.1	1,651	3.2	3,171	2.5
20 - 29	73,424	73,611	147,035	2,256	3.1	1,251	2.4	3,507	2.8
30 - 39	73,760	74,412	148,172	13,779	18.7	6,734	12.9	20,513	16.3
40 - 49	55,289	56,753	112,042	11,657	15.8	4,251	8.1	15,908	12.6
50 - 59	44,788	48,334	93,122	7,649	10.4	3,308	6.3	10,957	8.7
60 - 69	39,440	48,266	87,706	3,697	5.0	1,797	3.4	5,494	4.4
70 - 79	25,161	38,947	64,108	2,904	3.9	2,911	5.6	5,815	4.6
80 +	8,904	23,171	32,075	2,104	2.9	3,136	6.0	5,240	4.2
Total	320,766	363,494	684,260	73,809	-	52,354	-	126,163	-

Table 12 — Comparison of 1991 GGHB census population with June 1997 CHI by DEPCAT

DEPCAT	Census n	CHI n	CHI excess n *	CHI excess Row %	CHI excess Column %
1	68,812	75,992	7,180	10.4	9.2
2	58,481	66,538	8,057	13.8	10.3
3	56,066	63,303	7,237	12.9	9.3
4	104,509	112,820	8,311	8.0	10.6
5	69,364	72,284	2,920	4.2	3.7
6	157,216	183,378	26,162	16.6	33.5
7	212,882	231,062	18,180	8.5	23.3
Total	727,330	805,377	78,047	10.7	100.0

* χ^2 (trend) = 1.71, p = 0.19 with 1 df

Table 13 — GGHB GP partnership sizes

Partners n	GPs n	Partnerships n
1	51	51
2	98	49
3	144	48
4	136	34
5	80	16
6	72	12
7	28	4
8	8	1
9	9	1

Table 14 — GGHB GP Partnership practice list sizes (adults >= 15 years)

List size n patients	Partnerships n
0 – 999	4
1,000 – 1,999	54
2,000 – 2,999	33
3,000 – 3,999	44
4,000 – 4,999	29
5,000 – 5,999	19
6,000 – 6,999	12
7,000 – 7,999	11
8,000 – 8,999	2
9,000 – 9,999	4
10,000 – 10,999	3
11,000 – 11,999	1

Table 15 — Numbers of SMR1 EMA records extracted for each year

Year	Total SMR1 (SMR01) records	Admissions aged < 15 years	Adult admissions: GGHB hospital – not GGHB resident	GGHB resident – not GGHB hospital	GGHB resident and hospital – not GGHB GP	Invalid or missing postcode	GGHB GP, resident and hospital, valid postcode
1980	24,509	474	2,403			20	21,612
1981	25,226	443	2,530			30	22,223
1982	23,599	308	2,661			38	20,592
1983	25,272	313	2,540			27	22,392
1984	26,689	352	2,419			35	23,883
1985	28,840	482	2,546			45	25,767
1986	28,847	592	2,320			44	25,891
1987	28,813	625	2,145			22	26,021
1988	29,867	657	2,315			21	26,874
1989	32,261	628	2,464			40	29,129
1990	33,042	625	2,423	868		63	29,063
1991	35,044	515	2,584	854		84	31,007
1992	38,639	590	2,882	932	1227	33	32,975
1993	44,502	1,161	3,607	914	976	22	37,822
1994	45,578	1,365	3,623	1,068	849	21	38,652
1995	47,733	1,502	3,920	1,003	744	22	40,542
1996	46,385	1,019	3,883	662	691	12	40,118
1997	50,344	994	4,524	839	740	11	43,236
Total	615,190	12,645	51,789	7,140	5,227	591	537,798

* Data for GGHB residents admitted to hospitals outwith the GGHB area were not available before 1990. They are not included in the total records column.

† GP practice was very poorly recorded before 1992 when it became a mandatory SMR1 field.

Table 16 — Percentage of annual EMAs total on each day of the week, by year

Year	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1980	9.6	17.4	15.1	15.0	15.2	16.0	11.6
1981	10.8	16.9	15.0	14.8	15.0	15.3	12.2
1982	10.4	17.1	15.8	15.0	15.1	15.1	11.6
1983	10.7	16.6	15.7	14.6	14.5	15.9	11.9
1984	10.7	16.6	15.4	14.6	15.3	15.7	11.7
1985	10.9	16.6	15.1	14.6	14.8	16.5	11.6
1986	10.7	16.7	14.9	14.7	14.8	16.1	12.1
1987	10.9	16.7	14.7	15.4	14.9	15.4	12.1
1988	11.3	16.7	15.2	15.0	14.7	15.5	11.5
1989	11.1	16.2	15.1	15.0	15.2	15.9	11.5
1990	10.6	16.5	15.2	15.1	15.3	15.8	11.5
1991	10.9	17.0	15.0	14.8	15.3	15.8	11.2
1992	11.0	16.7	15.0	15.1	15.0	15.8	11.4
1993	11.0	16.1	15.3	15.2	15.2	16.0	11.2
1994	10.7	16.7	15.5	14.9	15.0	15.9	11.3
1995	11.2	16.5	15.0	15.1	15.3	15.8	11.0
1996	11.4	16.8	15.1	14.9	14.9	15.8	11.1
1997	11.5	16.8	15.0	14.9	14.9	15.5	11.5

Table 17 — Numbers of EMAs by patients' age and sex

Age group	Male	Female	Total
15 – 19	379	545	924
20 – 29	1,172	1,176	2,348
30 – 39	1,734	1,723	3,457
40 – 49	2,370	1,808	4,178
50 – 59	3,378	2,567	5,945
60 – 69	4,644	4,067	8,711
70 – 79	4,528	5,239	9,767
80 – 89	2,243	4,388	6,631
90 +	282	993	1,275
Total	20,730	22,506	43,236

χ^2 = 1326 with 8 degrees freedom. $P < 0.00005$

χ^2 for linear trend = 482 with 1 degree freedom. $P < 0.00005$

Table 18 — EMAs and patients' DEPCATs

DEPCAT	Number of EMAs
1	2,438
2	2,365
3	2,512
4	5,048
5	4,145
6	9,845
7	16,883
Total	43,236

Table 19 — EMAs principal diagnoses' ICD10 chapter headings

Chapter heading for primary diagnosis coded to ICD10	Chapter	Count	
Diseases of the circulatory system	IX	11,762	27.2
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	XVIII	9,077	21.0
Diseases of the respiratory system	X	6,526	15.1
Injury, poisoning and certain other consequences of external cause	XIX	3,563	8.2
Diseases of the digestive system	XI	2,726	6.3
Neoplasms	II	1,761	4.1
Diseases of the nervous system	VI	1,625	3.8
Diseases of the musculoskeletal system and connective tissue	XIII	1,196	2.8
Mental disorders	V	1,174	2.7
Diseases of the genitourinary system	XIV	1,146	2.7
Endocrine, nutritional and metabolic diseases and immunity disorders	IV	900	2.1
Diseases of the blood and blood-forming organs	III	579	1.3
Infectious and parasitic diseases	I	509	1.2
Diseases of the skin and subcutaneous tissue	XII	492	1.1
Factors influencing health status and contact with the health services	XXI	83	0.19
Diseases of the eye and adnexa	VII	45	0.10
Diseases of the ear and mastoid	VIII	40	0.09
Congenital malformations, deformations and chromosomal abnormalities	XVII	17	0.04
Complications of pregnancy, childbirth, and the puerperium	XV	15	0.03
Total		43,236	

Table 20 — Commonest primary ICD10 diagnoses and chapter headings

ICD10 codes			Chapter				Main code			
Chapter	Main code	Description	n		Carstairs' (mean)	Age (mean yrs)	n		Carstairs' (mean)	Age (mean yrs)
IX		**Diseases of the circulatory system**	**11,762**	**27.2**	**3.4**	**67.**	**8**			
	I20	Angina pectoris					2,327	5.4	4.1	64.3
	I50	Heart failure					1,758	4.1	3.4	74.4
	I21	Acute myocardial infarction					1,694	3.9	3.2	67.6
	I25	Chronic ischaemic heart disease					917	2.1	4.0	65.2
	I48	Atrial fibrillation and flutter					867	2.0	3.0	70.1
	I64	Stroke, not specified as haemorrhage or infarction					766	1.8	3.3	73.9
	I63	Cerebral infarction					744	1.7	2.6	71.5
	I80	Phlebitis and thrombophlebitis					509	1.2	4.6	53.1
		Other chapter IX diagnoses					2,180	5.0		
XVIII		**Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified**	**9,077**	**21.0**	**3.8**	**60.9**				
	R07	Pain in throat and chest					4,171	9.6	4.0	57.3
	R55	Syncope and collapse					1,043	2.4	3.5	68.2
	R26	Abnormalities of gait and mobility					619	1.4	2.6	80.6
	R56	Convulsions, not elsewhere classified					477	1.1	5.2	51.8
	R51	Headache					437	1.0	3.7	42.3
		Other chapter XVIII diagnoses					2,330	5.4		

(continued)

Table 20 (continued) — Commonest primary ICD10 diagnoses and chapter headings

ICD10 codes			Chapter				Main code			
Chapter	Main code	Description	n		Carstairs' (mean)	Age (mean yrs)	N		Carstairs' (mean)	Age (mean yrs)
X		**Diseases of the respiratory system**	**6,526**	**15.1**	**4.1**	**65.3**				
	J44	Other chronic obstructive pulmonary disease					2,432	5.6	4.7	69.9
	J18	Pneumonia, organism unspecified					1,105	2.6	3.8	70.2
	J22	Unspecified acute lower respiratory infection					1,063	2.5	3.5	68.9
	J45	Asthma					672	1.6	3.8	44.6
		Other chapter X diagnoses					1,254	2.9		
XIX		**Injury, poisoning and certain other consequences of external cause**	**3,563**	**8.2**	**4.7**	**41.6**				
	T39	Poison by nonopioid analgesic antipyretic and antirheumatics					1,159	2.7	4.7	32.9
	T43	Poisoning by psychotropic drugs, not elsewhere classified					549	1.3	5.3	34.8
	T42	Poison antiepileptic sed-hypnotic and antiparkinsonism drug					453	1.0	5.3	40.3
		Other chapter XIX diagnoses					1,402	3.2		
XI		**Diseases of the digestive system**	**2,726**	**6.3**	**4.5**	**57.2**				
	K92	Other diseases of digestive system								
		Other chapter XI diagnoses					728	1.7	4.9	53.5

(continued)

Table 20 (continued) — Commonest primary ICD10 diagnoses and chapter headings

ICD10 codes			Chapter				Main code			
Chapter	Main code	Description	N		Carstairs' (mean)	Age (mean yrs)	n		Carstairs' (mean)	Age (mean yrs)
II		**Neoplasms**	**1,761**	**4.1**	**3.3**	**69.6**				
	C34	Malignant neoplasm of bronchus and lung					716	1.7	3.8	69.5
		Other chapter II diagnoses					1,045	2.4		
VI		**Diseases of the nervous system**	**1,625**	**3.8**	**3.9**	**58.3**				
	G40	Epilepsy					638	1.5	4.7	51.6
		Other chapter VI diagnoses					987	2.3		
XIII		**Diseases of the musculoskeletal system and connective tissue**	**1,196**	**2.8**	**3.4**	**61.9**				
V		**Mental disorders**	**1,174**	**2.7**	**4.9**	**57.1**				
	F10	Mental and behavioural disorders due to use of alcohol					753	1.7	5.6	48.1
		Other chapter V diagnoses					421	1.0		
XIV		**Diseases of the Genitourinary System**	**1,146**	**2.7**	**3.2**	**65.1**				
	N39	Other disorders of urinary system					486	1.1	3.3	71.5
		Other chapter XIV diagnoses					660	1.5		
		Other ICD10 chapters	**2,680**	**6.2**						
		Total	**43,236**	**100.0**	**3.8**	**61.8**				

Table 21 — EMA rates by age and sex

Age years	Emergency medical admissions n			CHI Population n			Emergency admission rates (annum^{-1} x1000)		
	Male	Female	Total *	Male	Female	Total *	Male	Female	Both
15 – 19	379	545	924	29,763	28,966	58,729	12.7	18.8	15.7
20 – 29	1,172	1,176	2,348	75,680	74,862	150,542	15.5	15.7	15.6
30 – 39	1,734	1,723	3,457	87,539	81,146	168,685	19.8	21.2	20.5
40 – 49	2,370	1,808	4,178	66,946	61,004	127,950	35.4	29.6	32.7
50 – 59	3,378	2,567	5,945	52,437	51,642	104,079	64.4	49.7	57.1
60 – 69	4,644	4,067	8,711	43,137	50,063	93,200	107.7	81.2	93.5
70 – 79	4,528	5,239	9,767	28,065	41,858	69,923	161.3	125.2	139.7
80 – 89	2,243	4,388	6,631	9,596	21,505	31,101	233.7	204.0	213.2
90 +	282	993	1,275	1,412	4,802	6,214	199.7	206.8	205.2
All ages	20,730	22,506	43,236	394,575	415,848	810,423	52.5	54.1	53.3

* χ^2 = 35,500 with 8 degrees freedom. $P < 0.00001$

χ^2 for linear trend = 30,850 with 1 degree freedom. $P < 0.00001$

Table 22 — EMA rates by Carstairs' DEPCATs

DEPCAT	Admissions* n	CHI Population* n	EMA rates (annum^{-1} x1000)
1	2,438	75,992	32.1
2	2,365	66,538	35.5
3	2,512	63,303	39.7
4	5,048	112,820	44.7
5	4,145	72,284	57.3
6	9,845	183,378	53.7
7	16,883	231,062	73.1
Total	43,236	805,377	53.7

* χ^2 = 2,941 with 6 degrees freedom. $P < 0.00001$

χ^2 for linear trend = 2,608 with 1 degree freedom. $P < 0.00001$

Table 23 — Age, sex and DEPCAT specific emergency medical admission rates

		Men							Women						
Age	**DEPCATs**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15-19		8.4	7.3	8.9	11.2	10.1	13.3	15.8	9.4	13.5	8.1	16.6	13.9	18.6	27.8
20-29		6.3	8.9	9.0	11.4	14.0	14.8	23.9	8.5	9.8	12.6	10.0	15.9	14.8	23.3
30-39		10.6	7.8	7.9	12.7	17.0	19.9	32.4	10.5	12.0	13.2	14.5	21.7	22.3	32.3
40-49		13.8	18.9	22.2	25.3	30.2	34.6	62.4	10.2	15.6	19.0	24.1	27.3	35.1	48.4
50-59		22.4	33.9	40.7	49.9	60.1	65.5	107.2	18.2	30.2	35.5	37.1	44.0	55.9	80.2
60-69		45.5	75.1	78.7	82.2	108.7	114.9	150.7	30.6	54.2	56.5	69.1	82.8	90.5	110.0
70-79		125.8	112.4	136.5	129.2	167.9	158.8	203.3	82.7	95.5	97.5	108.9	120.2	129.4	157.7
80+		199.5	229.5	181.0	202.9	248.5	241.8	227.0	157.5	166.4	207.5	176.0	184.8	186.6	236.7

Table 24 — EMAs adjusted logistic regression odds ratios for admission

Patient parameter	Adjusted odds ratio (95% CI)
Age (per decade age increase)	1.62 (1.61 to 1.63)
DEPCAT (per unit DEPCAT increase)	1.18 (1.17 to 1.19)
Sex (risk for men compared with women)	1.20 (1.18 to 1.23)

CHAPTER 6—

EMERGENCY MEDICAL ADMISSIONS IN GLASGOW – GENERAL PRACTICE AND HOSPITAL VARIATIONS

6.1 INTRODUCTION

The second aim of this study was to use the epidemiological information (presented in the preceding chapter) to investigate variations between the rates of emergency medical admissions of Glasgow's general practices and hospitals. This chapter presents results that address this second aim. To meet this aim, five broad objectives were identified; these were:

- To determine whether Glasgow's general practice partnerships had different rates of emergency medical admissions
- To ascertain the principal patient factors associated with these variations in general practices' emergency medical admission rates
- To investigate whether residual variations in general practices' emergency medical admission rates are related to other available practice data
- To ascertain and describe variations in diagnoses and rates of emergency medical admissions between Glasgow's hospitals. This was necessary for the final objective of the chapter which was:
- To determine whether the variation in general practices' emergency medical admission rates was associated with variations in their hospitals' admission rates.

Addressing hospital-related differences in rates of emergency medical admissions required that I should determine the hospitals' denominator "catchment" populations. This chapter therefore also presents the derivation of these populations.

6.2 GENERAL PRACTICES' EMERGENCY MEDICAL ADMISSION RATES

6.2.1 Crude rates

Glasgow's 216 general practices had a median of 184 emergency medical admissions per practice in 1997 (range 23 to 905). There was a wide variation in crude emergency medical admission rates which ranged from 17.6 to 131 admissions per 1000 CHI patients per annum (median = 53.3). There was a 2.51 fold variation between the crude emergency medical admission rates of the top and bottom deciles (31.3 to 78.6, Figure 33).

6.2.2 Age, sex and deprivation adjusted ratios

The standardised emergency admission ratios for Glasgow's general practices, adjusted for individual patients' age, sex and deprivation category are shown in Figure 34. The range of emergency admission ratios was 50.2 to 225.3. There was a 1.87 fold variation between the top and bottom deciles of standardised emergency medical admission ratios (71.5 to 133.4).

A scattergram that compares practices' crude emergency medical admission ratios with their standardised ratios is shown in Figure 35. This confirms that even after adjusting for patients' age, sex and Carstairs' deprivation category, a substantial variation between practices' emergency medical admission ratios remains. Pearson's correlation coefficient between crude and adjusted rates was 0.692. This yields an R^2 value of 0.479, which implies that adjustment for age, sex and deprivation accounted for 52.1% of the variation in crude emergency medical admission rates between general practices.

A comparison of general practices' standardised emergency admission ratios for 1997 with the preceding year is shown in Figure 36. This shows that there is a highly significant correlation, with an R^2 value of 0.61. This suggests that the differences between general practices' emergency admission ratios are stable rather than being due to random variation.

6.2.3 Greater Glasgow Health Board's localities

In 1994, the Greater Glasgow Health Board allocated each of Glasgow's 216 general practices into one of nineteen localities. These had been intended to be of approximately equal size, to facilitate GP-led commissioning of health services on behalf of GPs' patients. Details of these localities are shown in Table 25. This shows that there were substantial variations in patient numbers between these localities.

The variation between the standardised emergency medical admission rates of general practices in these Greater Glasgow Health Board localities may be seen in Figure 37. Two localities in particular (Kirkintilloch and Govan / Ibrox) had notably high adjusted emergency medical admission ratios (130.4 (95% CI 124.4 to 136.6) and 129.6 (95% CI 125.8 to 133.4) respectively, Table 25). Kirkintilloch is at the northern extreme of Glasgow, while Govan / Ibrox is at the south western edge of the city. The finding of raised emergency medical admission ratios in these localities should be compared with the last chapter's result of elevated adjusted ratios in postcode sectors in the south west and north of Glasgow (Figure 32).

6.2.4 General practice fundholding

By the end of 1996, the majority of Glasgow's general practitioners had joined the National Health Service's general practice fundholding scheme. Altogether, 45 partnerships were in the full fundholding scheme while 55 had commenced community fundholding. A further 18 partnerships were in the preparatory phase before entry to one or other of the programmes (Table 26). Apart from the three practices that had undertaken total purchasing fundholding, the mean deprivation score of practices in the various categories of fundholding were comparable and similar to that of non-fundholding practices.

Table 26 shows that fundholders and non-fundholders had similar crude rates of emergency medical admissions (53.5 versus 52.0 admissions per 1,000 patients per year respectively). However, after adjustment for their patients' ages, sex and Carstairs' categories, patients registered with Glasgow's fundholding practices were significantly more likely to be admitted as emergencies to a hospital (odds ratio = 1.06; 95%CI 1.04 to 1.08; Figure 38). This was confirmed by fundholders' significantly higher standardised emergency medical admission ratios than non-fundholders. (Fundholders = 102.1, 95% CI 100.9 to 103.4, non-fundholders = 97.0, 95% CI 95.5 to 98.4).

Every category of fundholding had higher emergency medical admission ratios than the non-fundholding practices (Table 26). The highest emergency admission ratios were found amongst those practices preparing to be full fundholders and the three practices that were already fundholders which were preparing to be total purchasing fundholders. These had emergency medical admission ratios, adjusted for age, sex and deprivation category of 125.7 (95% CI 112.2 to 140.3) and 117.6 (95% CI 110.2 to 125.3) respectively. The group of practices that had elected not to join the fundholding scheme had the lowest adjusted emergency medical admission ratio at 96.8 (95% CI 95.3 to 98.2).

6.2.5 Other general practice parameters

The standardised emergency medical admission ratios (adjusted for age, sex and Carstairs' deprivation category) of Glasgow's 216 general practices were then correlated with the General practice parameters shown in Text Box 8. The first four of these practice parameters had been derived from the CHI database while the others had been obtained directly from the Greater Glasgow Health Board.

Text Box 8 — Practice parameters used in comparison with standardised admission ratios

The number of general practitioner principals in the practice.
The numbers of patients and of adult patients (aged 15 years and over) in the practice.
The numbers of patients and of adult patients per general practice principal in the practice.
The mean of the distances of residence of every patient from the mid-point of the practice. (Practice mean patient dispersal)
The proportion of women aged 20 to 60 years in the practice who had had a cervical smear in the last three years.
The proportion of eligible babies and children who had received full courses of immunisation against diphtheria, tetanus, pertussis and measles, mumps and rubella (MMR).
The proportions of babies that the practice health visitors had documented as ever having been breast fed.
The proportions of babies that the practice health visitors had documented as having mothers who smoked.

The Pearson's correlation coefficients between these practice parameters and the practices standardised emergency medical admission ratios are shown in Table 27. There were only three statistically significant correlations with emergency admission ratios. These were a negative correlation with proportions of breast fed babies ($p = 0.008$, $R^2 = 0.032$) and a positive association with the proportions of babies with smoking mothers ($p = 0.33$, $R^2 = 0.021$). Lastly, there was a positive correlation between practice mean patient dispersion and practice standardised emergency medical admission ratio ($R = 0.17$, $R^2 = 0.03$, $p = 0.014$). The low values of these three R^2 statistics shows that these correlations, whilst statistically significant, represent weak associations.

The relationships between practices' mean patient dispersals and their standardised emergency medical admission ratios are shown in Figure 39. This weak correlation became statistically non-significant ($p= 0.12$) following the exclusion of the one highlighted outlying practice from the calculation.

Interestingly, there was a highly significant negative correlation between practices' proportions of smoking mothers and their proportions of breast feeding mothers ($R = -0.68$, $R^2 = 0.46$, $p < 0.00001$). This strong association shows that these parameters are interdependent, suggesting that the weak associations they had with emergency admission ratios may be due to a possible confounding effect.

6.2.6 Patterns of diagnoses and general practices

The possible relationships between variations in general practices' standardised emergency admission ratios and different patterns of discharge diagnoses were examined. This exploration used correlations between practices' proportions of common diagnoses and their emergency admission ratios. The four commonest SMR1 diagnostic chapters in 1997 were (see Table 20):

- Diseases of the circulatory system (ICD10 chapter IX, 27.2%)
- Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (ICD10 chapter XVIII, 21.0%)
- Diseases of the respiratory system (ICD10 chapter X, 15.1%)

- Injury, poisoning and other consequences of external cause (ICD10 chapter XIX, 8.2%).

These diagnostic groups accounted for 71.5% of all emergency medical admissions in 1991. The relative sizes of each of these diagnostic groups expressed as the proportion of the total number of discharges for that general practice in 1997 was calculated. These proportions were correlated with the general practices' adjusted standardised emergency medical admission ratio. The results of these correlation calculations are shown in Table 28.

The striking result from Table 28 was the negative correlation between emergency medical admission ratios and "Diseases of the circulatory system" ($R = -0.41$, $R^2 = 0.17$, $p < 0.00001$). This closely matched the positive correlation with "Symptoms, signs and abnormal findings" ($R = 0.37$, $R^2 = 0.14$, $p < 0.00001$). The R^2 values indicate that practices' differences in proportions of these diagnoses were respectively associated with 17% and 14% of the variations in adjusted emergency admission ratios. These practice variations in emergency medical admission ratios and proportions of diagnostic groups are shown together in Figure 40. This suggests that practices with higher rates of emergency medical admission had proportionally "Signs, symptoms ..." and fewer Circulatory system diagnoses.

It will also be noted from Table 28 that while practices' proportions of "Injury, poisoning ..." were positively correlated ($p = 0.002$) with emergency admission ratios, the R^2 value was nevertheless low at 0.042. This implied that only 4.2% of the residual variation in emergency medical admission ratios between practices was associated with differences in proportions of this diagnostic group.

Following the examination of the broad diagnostic groupings, specific diagnoses were considered next. The variations in practices' proportions of the commonest specific diagnoses within the ICD10 chapter groups discussed above were explored using the same method. (Table 20 shows these commonest diagnoses.) The correlation results in Table 29 show strongly negative correlations with both heart failure (I50; $R = -0.29$, $R^2 = 0.08$, $p < 0.00001$) and acute myocardial infarction (I21; $R = -0.28$, $R^2 = 0.08$, $p < 0.00001$). The negative correlations from the ICD10 chapter of circulatory diagnoses are matched by a strongly positive correlation between the proportion of chest pain diagnoses and practices' adjusted emergency medical admissions ratios (R07; $R = 0.46$, $R^2 = 0.21$, $p < 0.00001$). This suggests that as much as 21% of the variation between general practices' adjusted emergency medical admission ratios was associated with differences in practices' proportions of the diagnosis of chest pain. However this does not imply that this relationship is causal. This finding may well be due to an external confounding factor.

6.3 ACUTE HOSPITALS' CATCHMENT AREAS

As noted above, it became apparent that there were two areas of the city that had elevated emergency medical admission ratios, after adjustment for age, sex and socio-economic deprivation. This suggested that there might be some locally acting factors meriting further investigation. These two areas lay to the north and the south west of the city (see Figure 32). They corresponded to two of the Greater Glasgow Health Board's General Practice Localities (Table 25 and Figure 37). It was also noted that these areas corresponded to two of Glasgow's five acute hospitals. Any further investigation of this observation required the definition of local geographical population denominators (or hospital catchment areas). The method of derivation of these catchment areas has previously been described.

6.3.1 Official catchment areas

The Greater Glasgow Health Board had defined catchment areas for the acute hospitals; these are shown in Figure 41. Having previously undertaken acute clinical work as a general practitioner in Glasgow, I knew that these catchment areas were severely flawed. Firstly, because many general practitioners preferred to refer patients acutely to their nearest hospital, rather than using the officially designated acute hospital. Alternatively, general practitioners may have chosen to refer patients to a hospital where they had good relationships with the clinical staff. Lastly, patients often referred themselves to their nearest hospital, without any reference to the "official" catchment areas.

These catchment areas for acute admissions had occasionally been enforced during the 1970s and early 1980s. They had subsequently become disused.

However, they are still used by the Greater Glasgow Health Board for planning and contracting purposes.

6.3.2 Derived catchment areas

An alternative arrangement of assigning postcode sectors to hospital catchment areas was derived using the method previously discussed in Chapter 1. The result of using this method with the CHI denominator database is shown in Figure 42. Comparison of this figure with Figure 41 shows that the derived catchment areas reallocate a substantial part of the south west sector's catchment to the south east sector of the city.

The validity of this new arrangement of catchment areas was tested by comparing it to a map showing which hospital is used by most patients from each postcode sector of the city (Figure 43). It will be seen that this map's arrangement of catchment areas closely approximates the catchment areas derived for this study (Figure 42). Figure 43 is also different to the Greater Glasgow Health Board's "official" catchment areas (Figure 41), confirming that these do not reflect actual emergency admission practice.

The complete set of age, sex, deprivation category and hospital specific admission rates is shown in Table 31. This table potentially has 560 different specific rates (the product of 5 hospitals, 7 deprivation categories, 8 age bands and 2 sexes). However, some cells in the table were empty because not every hospital had a complete range of deprivation categories within its catchment boundaries. Nevertheless, this implied that standardised ratios would be calculated with adjustments for 480 specific rates.

The possibility that 480 adjustment categories may be excessive was examined by consideration of the category specific rates. Table 31 shows that there might have been some fluctuation across the ranges of ages and deprivation categories. In some categories (such as the young), this would have arisen because there the numerators (numbers of admissions) were small – some were as low as two – affecting the precision of the category specific rates. These categories had low admission rates, so they would not materially have affected the final adjusted figures. However the possibility remained that the use of almost 500 categories was inappropriate as it could result in excessive adjustment. This would have been an artefactual reduction of variability arising from instability of the category specific rates because too many categories were used.

An examination of whether the number of adjustment categories being used would affect the results obtained was performed. Initially, a reduced set of specific rates to be used for adjustment was obtained by pooling some of the previous ranges. Five groups of age ranges and three groups of deprivation categories were used in a revised calculation of 150 new specific rates (Table 32). These were used to calculate general practices' standardised admission ratios, which were then compared to another set of ratios that had been calculated using the full 480 specific rates.

The practices standardised ratios calculated using the restricted set of specific rates for adjustment are shown in Figure 45. These should be compared with the ratios obtained using the full set of specific rates for adjustment (Figure 48). A further direct comparison between these two methods of calculating standardised emergency admission ratios is shown in Figure 46. Because the two methods of calculating standardised emergency admission ratios correlated so highly, I decided that it was unlikely that the use of 480 adjustment categories was leading to excessive adjustment. Therefore, subsequent adjustments for age, sex, deprivation category and hospital have used the full set of 480 specific rates.

6.4 POSTCODE SECTORS ADMISSION RATIOS ADJUSTED FOR ADMITTING HOSPITAL

The effects of adjusting post code sectors' standardised emergency medical admission ratios for admitting hospitals (as well as age, sex and Carstairs' deprivation category) are shown in Figure 44. This shows a more even distribution of emergency medical admission ratios across the city (compare with Figure 32). One feature that may be noted is a band of increased admission ratios, south of the river Clyde that runs in a north - south direction. This probably represents an overlap of the catchment areas of the two hospitals south of the Clyde.

6.5 HOSPITALS' ADMISSION RATES

The crude emergency medical admission rates and the adjusted emergency medical admission ratios of Glasgow's five acute hospitals are shown in Table 30. This table contains two sets of results: the first uses denominator populations based on the Greater Glasgow Health Board's "official" catchment areas (based on Figure 41). The second set of results uses the catchment areas derived in this study (based on Figure 42).

Using the Greater Glasgow Health Board catchment population as a denominator base, there are some differences between the hospitals' adjusted emergency medical admission ratios. In particular, the hospital in the south east sector of the city appears relatively busy. However, this finding does not reflect the results of the previous postcode sector based analysis of emergency medical admission ratios which showed greater activity in the north and south west (Figure 32). Furthermore, it did not reflect the findings of analyses based on the Greater Glasgow Health Board's General Practice Localities (Table 25 and Figure 37), which had a similar finding.

The alternative calculations of hospitals' adjusted emergency medical admission ratios used the derived catchment areas denominator as a population base (Table 30). These showed that the north and the south west sectors of the city had the highest standardised emergency medical admission ratios. Similar results, obtained by logistic regression, are shown in Table 35. These findings mirror those of Figure 32, Table 25 and Figure 37. Therefore, for the remainder of this thesis, calculations needing a hospital denominator population will use the derived catchment areas to define this population.

6.5.1 Hospitals' patterns of diagnoses

Table 33 shows the differences in proportions of different ICD10 diagnostic chapters at Glasgow's five acute hospitals. This shows that the hospitals already noted to have the highest adjusted emergency admission ratios, also have the highest proportion of "Symptoms, signs..." (ICD10 chapter XVIII) and the lowest of "Circulatory disease" (ICD10 chapter IX).

Table 34 shows the differences between the proportions of specific ICD10 diagnoses at the five acute hospitals. The Hospitals in the north and south west have slightly lower proportions of diagnoses of myocardial infarction than the other hospitals, and have higher proportions of admissions for pain in the throat and chest. Intriguingly, the hospital in the south east has the highest proportion of admissions for pain in the throat and chest while it also has the lowest proportion of acute admissions for diagnosed chronic ischaemic heart disease. Interpretation of the specific diagnoses was however made more complex by the possibility of differences in coding practice between hospitals.

6.6 GENERAL PRACTICES' ADMISSION RATIOS ADJUSTED FOR ADMITTING HOSPITAL

General practices standardised emergency medical admission ratios adjusted for hospital factors as well as patients' ages, sex and Carstairs' deprivation categories are shown in Figure 47. Following this additional adjustment, the original 2.5 fold variation in general practices' emergency admission rates decreased to a 1.69 fold variation between the top and bottom deciles (range from bottom to top deciles = 78.3 to 132.8).

Figure 48 shows the relationship between practices' crude emergency admission rates and their fully adjusted standardised ratios. The correlation between the crude emergency medical admission rates and the standardised ratios adjusted for all four factors was R = 0.397 ($p < 0.00001$; Table 36). The R^2 value of 0.157 implies that 84.3% of the variation in crude emergency medical admission rates between general practitioners has been accounted for by adjustment for the following four patient factors:

- Age
- Sex
- Carstairs' deprivation category
- The hospital to which they were admitted.

Figure 49 is a re-drafting of Figure 34 that has been colour coded to indicate which hospital admitted most of the patients of each practice. This confirms that the patients of those practices with higher adjusted admission ratios were mostly admitted to the two hospitals that had the highest admission ratios.

6.6.1 Practices' admission ratios and diagnoses

The association between general practices' patterns of diagnoses and their emergency medical admission ratios (shown in Figure 40) requires re-examination using emergency medical admission ratios that have been further adjusted for admitting hospital. Such re-examination is also necessary, following the finding of varying patterns of diagnoses at the different hospitals, as hospitals might be related to differences in general practices' admission ratios (Table 28 and Table 29). The revised graph of general practices' admission ratios and diagnostic groupings is shown in Figure 50. This shows that while significant associations remain between general practices standardised emergency admission ratios and their pattern of diagnoses, these are much lower when admitting hospitals are taken into account. This is confirmed by the fall in the R^2 value for "Symptoms, signs..." from 0.14 to 0.040 after adjustment for admitting hospital.

6.7 SUMMARY

This chapter has tested five hypotheses. These were based on five of the original study objectives.

The first hypothesis tested in this chapter was that:

3. Glasgow's general practice partnerships had different rates of emergency medical admissions.

Figure 33 showed that Glasgow's general practice partnerships did have a substantial variation in crude emergency medical admission rates.

The second hypothesis relevant to this chapter was:

4. Patient factors including age, sex and socio-economic deprivation were associated with variations in general practices' emergency medical admission rates.

Comparison of Figure 35 and Figure 33 show that adjustment for patients' ages, sex and Carstairs' deprivation categories substantially reduced the variation between practices emergency admission rates. This is confirmed by comparison of correlations between adjusted ratios and the crude rates shown in Table 36.

The third hypothesis considered in this chapter was:

5. Variations in Glasgow's general practices' emergency medical admission rates, after adjustment for age, sex and socio-economic deprivation, were associated with other available practice data.

This study did demonstrate a significant association between general practice fundholding and higher standardised emergency medical admission ratios. This study was unable to find and other practice level data that were associated with residual variations in practices' emergency medical admission ratios, after adjustment for patients' ages, sex and socio-economic deprivation.

The fourth hypothesis examined here was:

6. Glasgow's hospitals had both different patterns of diagnoses and varying rates of emergency medical admissions.

Table 35 confirms that Glasgow' hospitals had varying rates of emergency medical admissions, after adjustment for patients' ages, sex and socio-economic factors. Variations in their patterns of diagnoses was shown in Table 33.

The final hypothesis tested in this chapter was:

7. The variation in Glasgow's general practices' emergency medical admission rates was associated with variations in their hospitals' admission rates.

Figure 49 supports this hypothesis. This shows that general practices with higher admission ratios tended to have the majority of their emergency medical admissions admitted to one of the two hospitals with higher adjusted admission ratios.

Taken together, these findings suggest that the major part of the variation between Glasgow's general practices' emergency medical admission rates was the hospital to which their patients were admitted. This leads to the further possibility that differences in activity at the level of general practices may not be related to variations in emergency medical admissions.

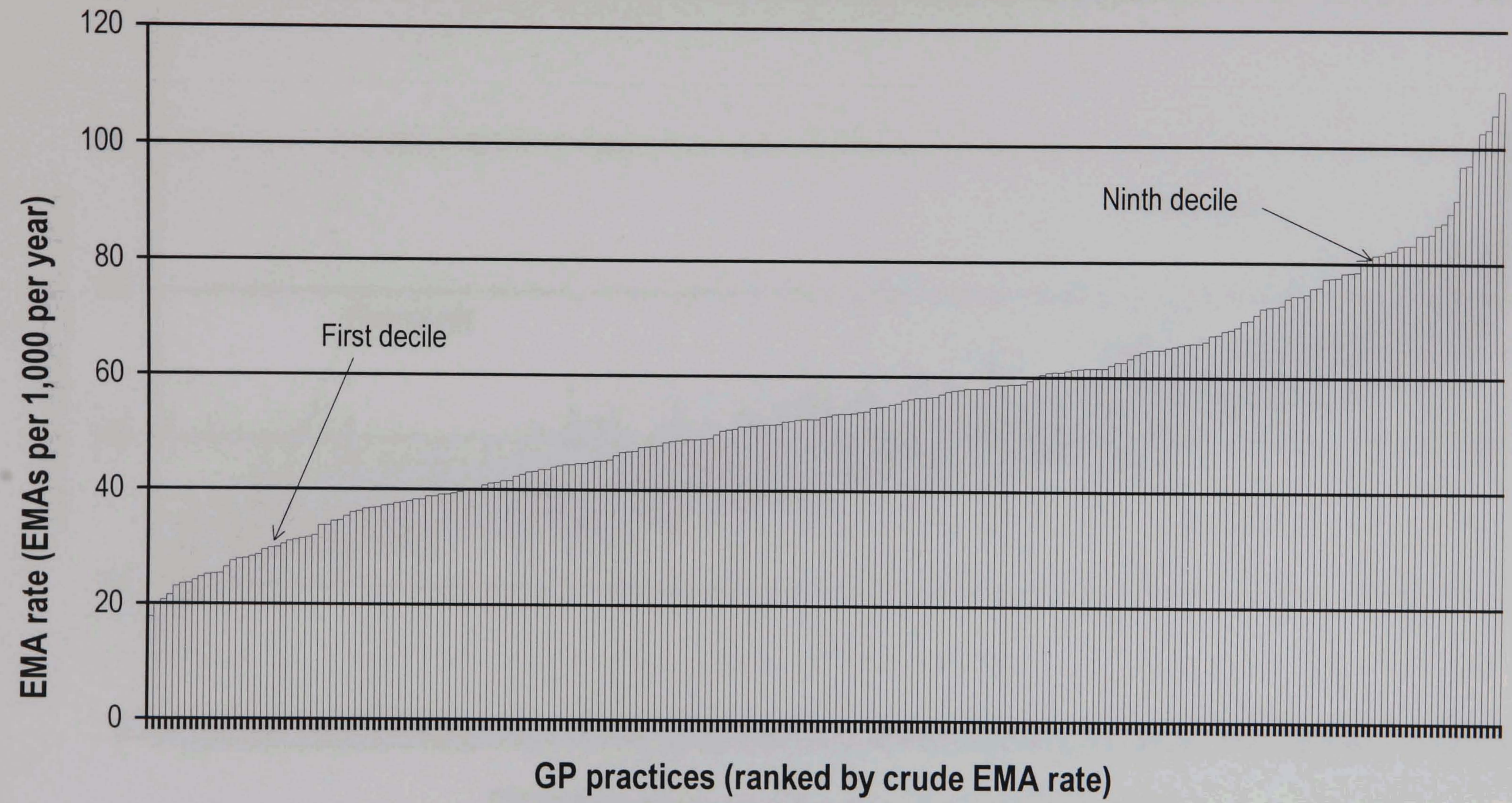

Figure 33 — GP practices' crude EMA rates (ranked)

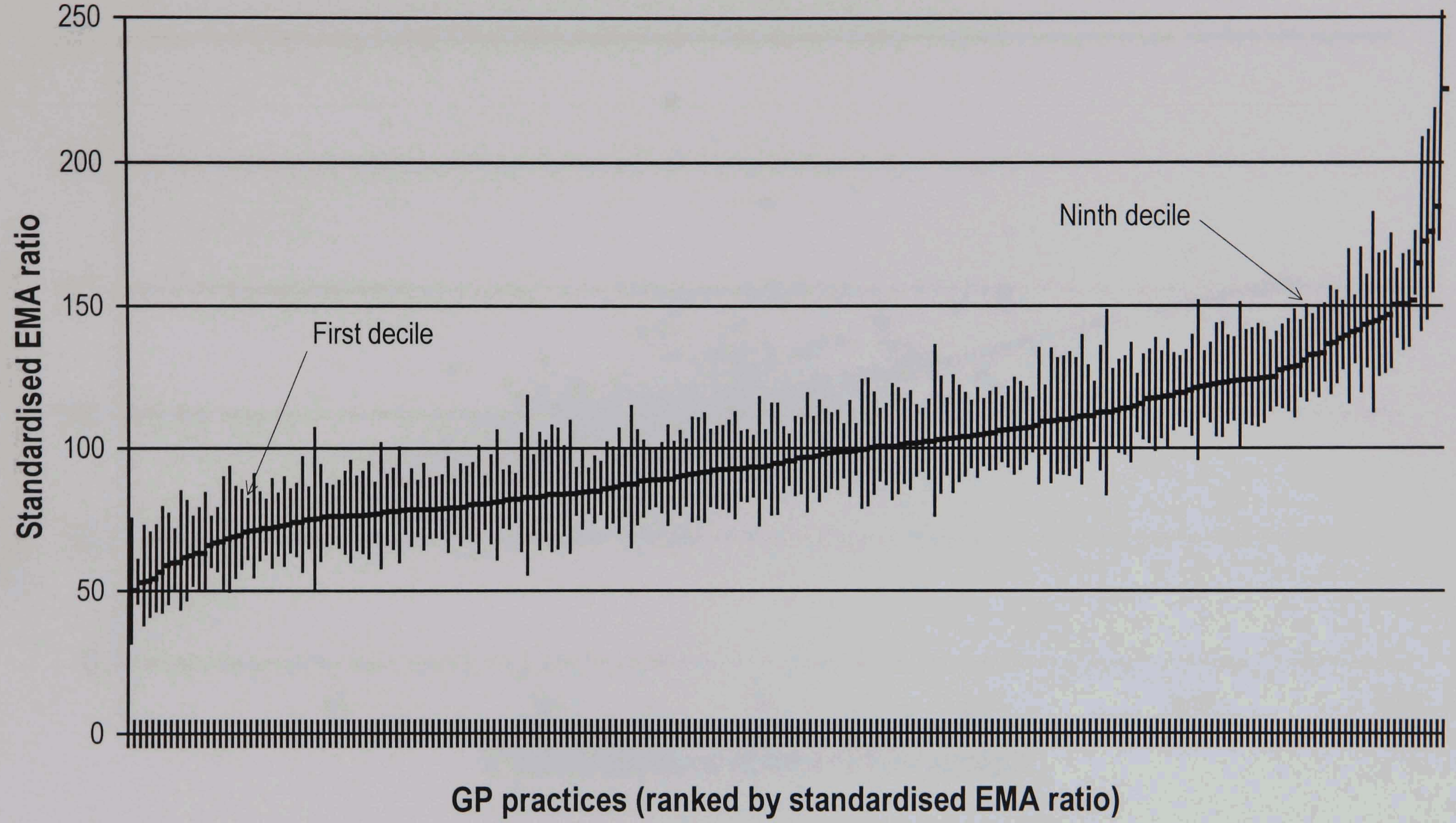

Figure 34 — GP practices' standardised EMA ratios (adjusted for age, sex and DEPCAT; ranked with 95% CIs)

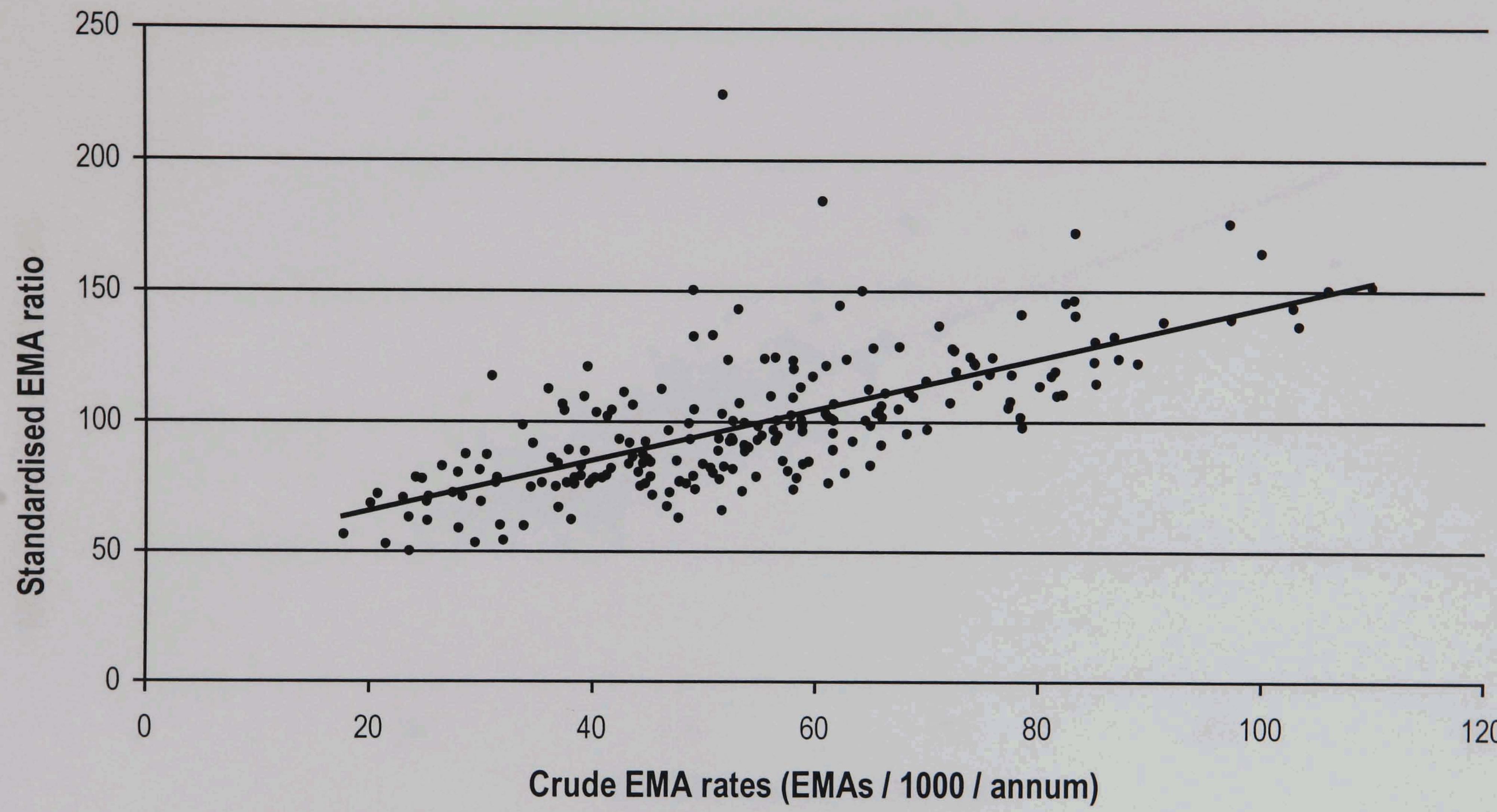

Figure 35 — GP practices' crude EMA rates against standardised EMA ratios (adjusted for age, sex and DEPCAT)

(Pearson's correlation: $r=0.692$, $r^2= 0.479$, $p<0.00001$, two tailed)

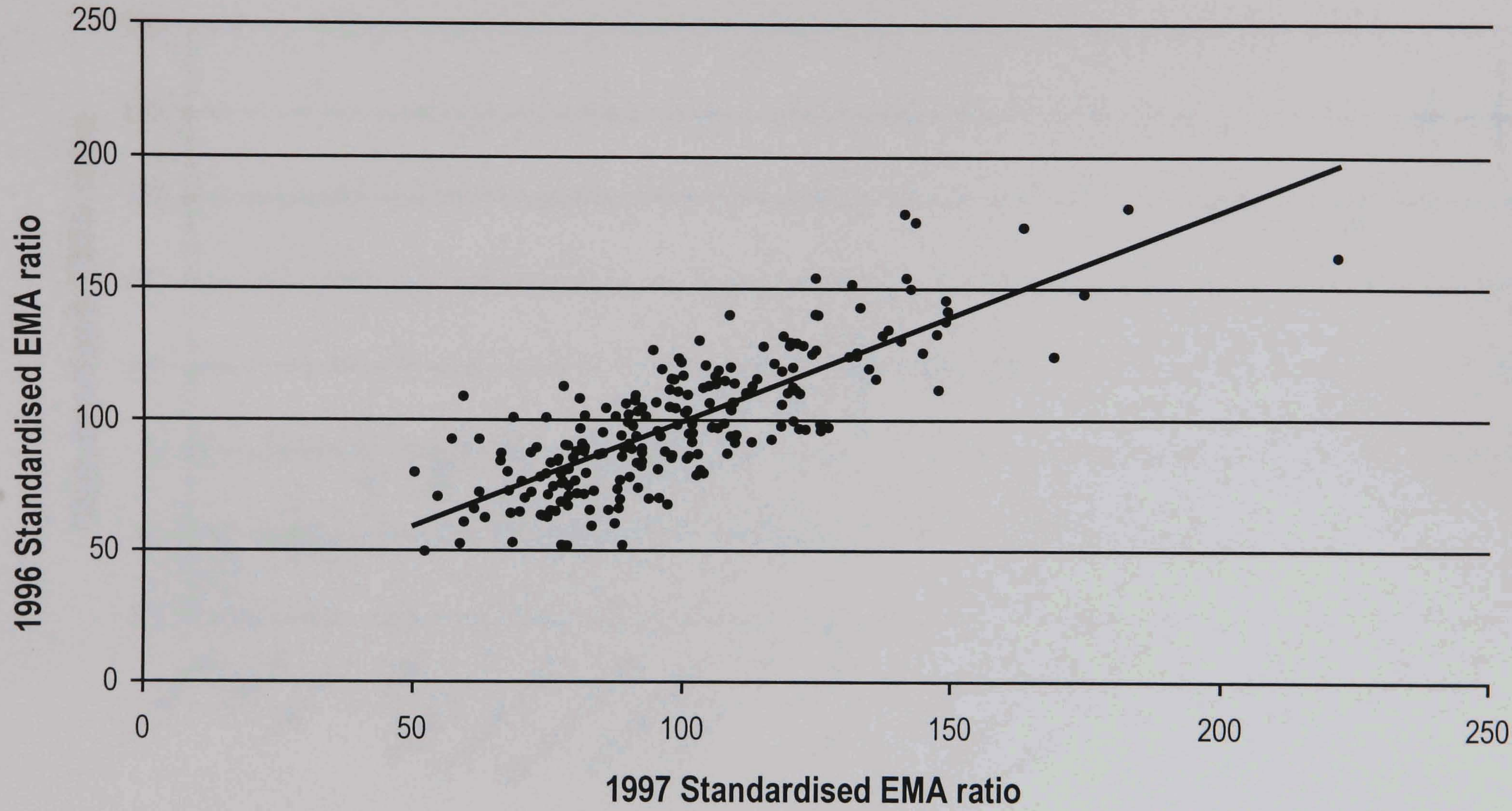

Figure 36 — Comparison of GP practices' 1997 and 1996 adjusted standardised EMA ratios (adjusted for age, sex and DEPCAT)

(Pearson's correlation: $r=0.78$, $r^2 = 0.61$, $p<0.00001$, two tailed)

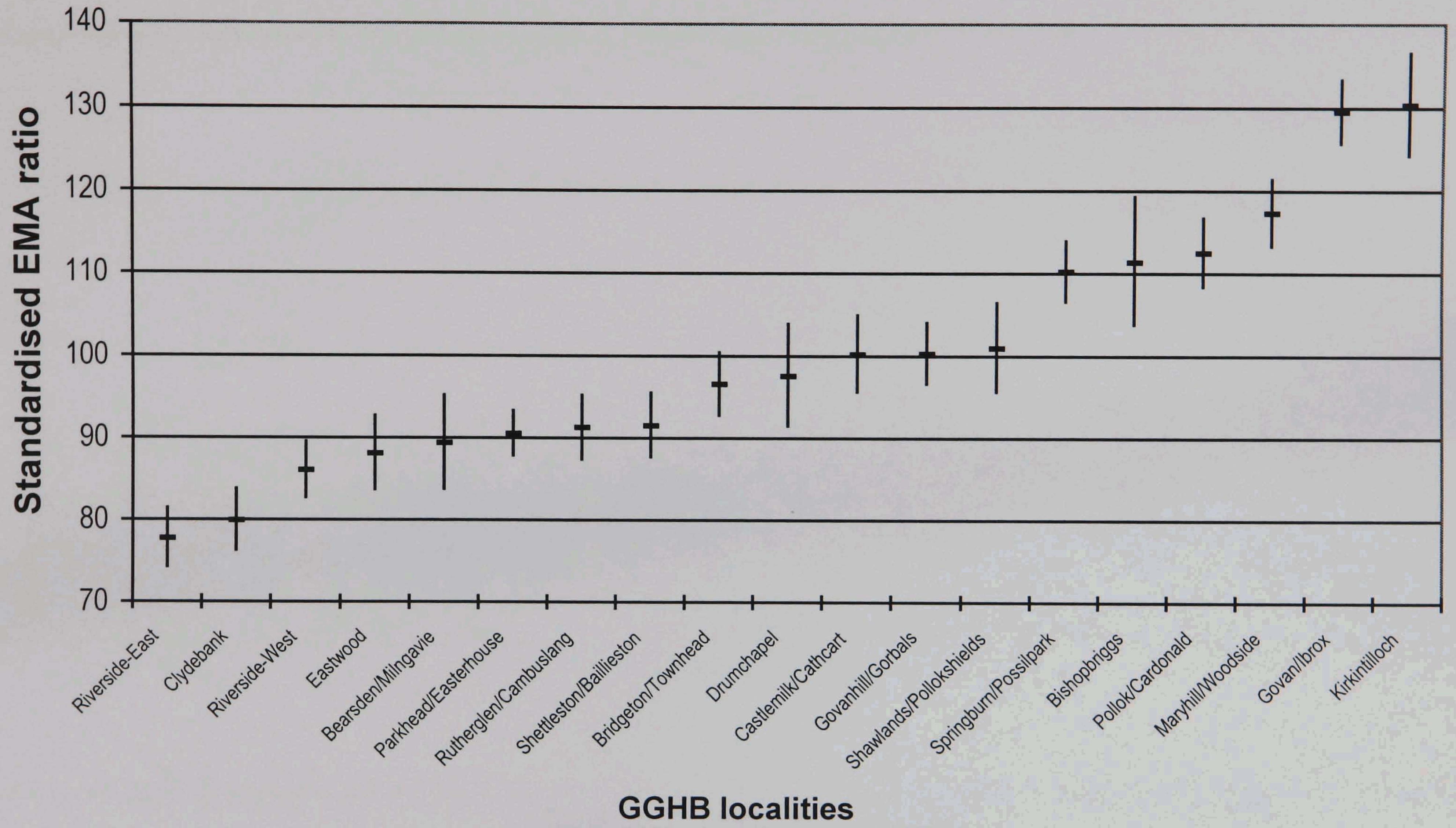

Figure 37 — GGHB localities standardised EMA ratios

(Standardised EMA ratios adjusted for patients' ages, sex and Carstairs' DEPCATs.)

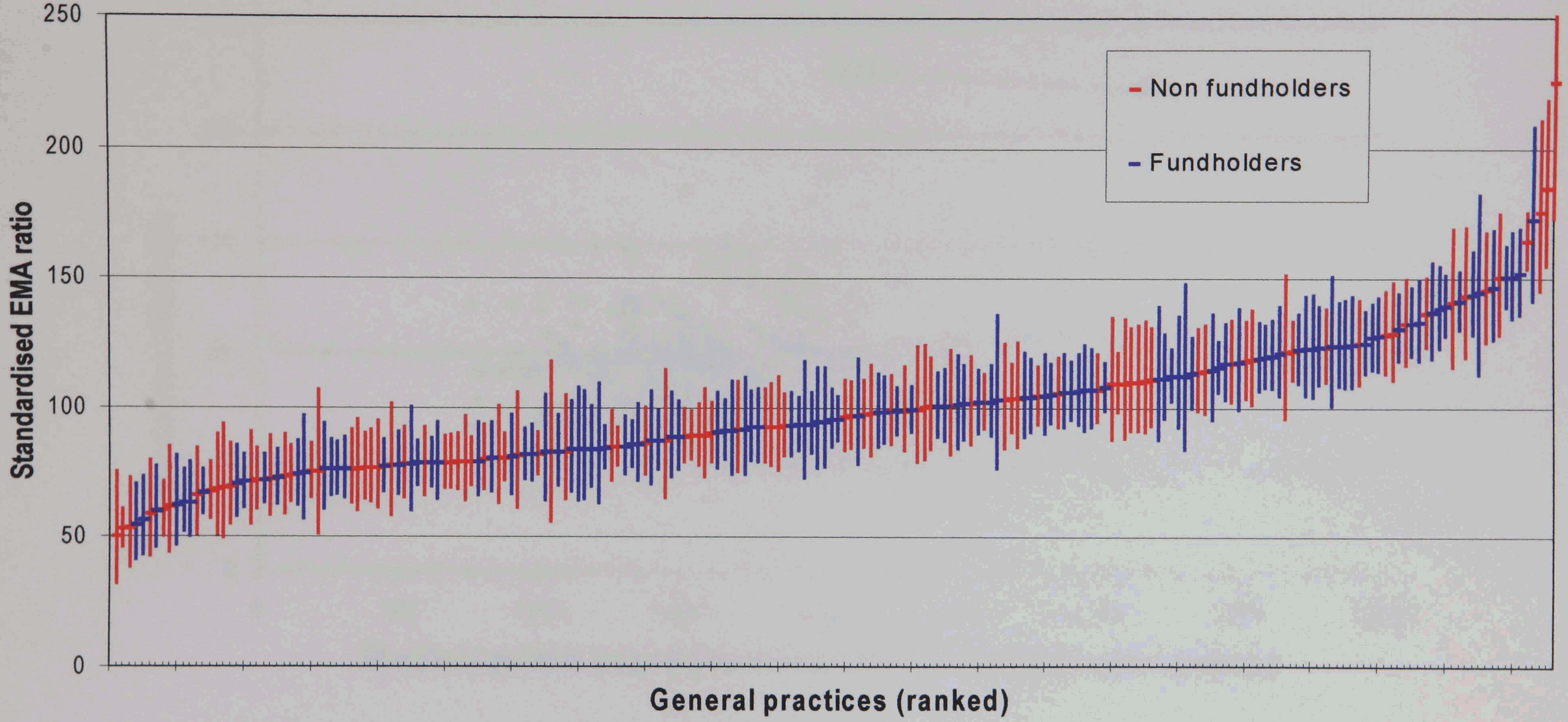

Figure 38 — GP practices' standardised EMA ratios showing fundholding and non-fundholding practices (adjusted for age, sex and DEPCAT; ranked with 95% CIs)

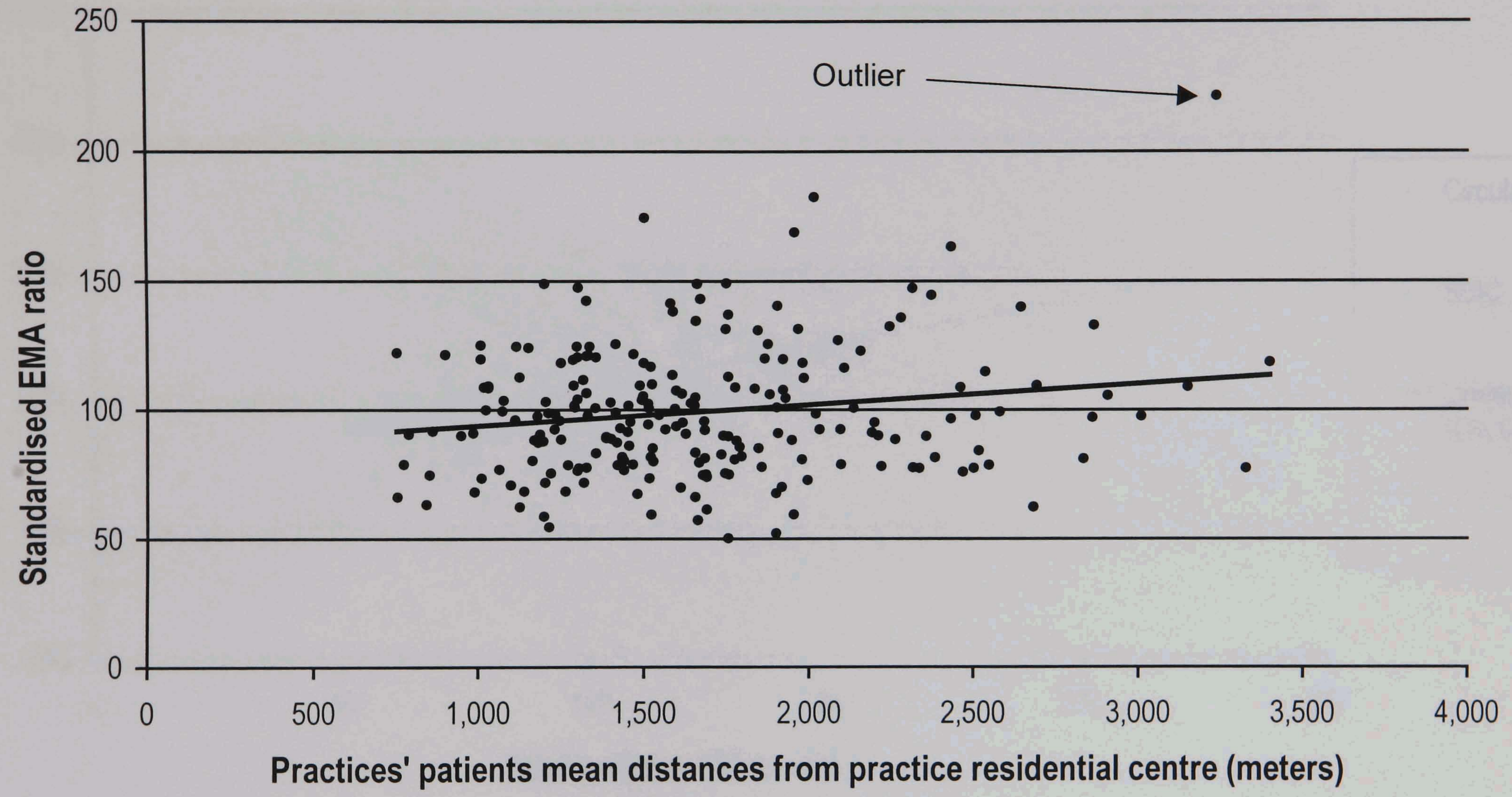

Figure 39 — GP practices' standardised EMA ratios and practices' mean patients dispersions (adjusted for age, sex and DEPCAT)

(Pearson's correlation: $r=0.166$, $r^2=0.027$, $p<0.014$, two tailed)

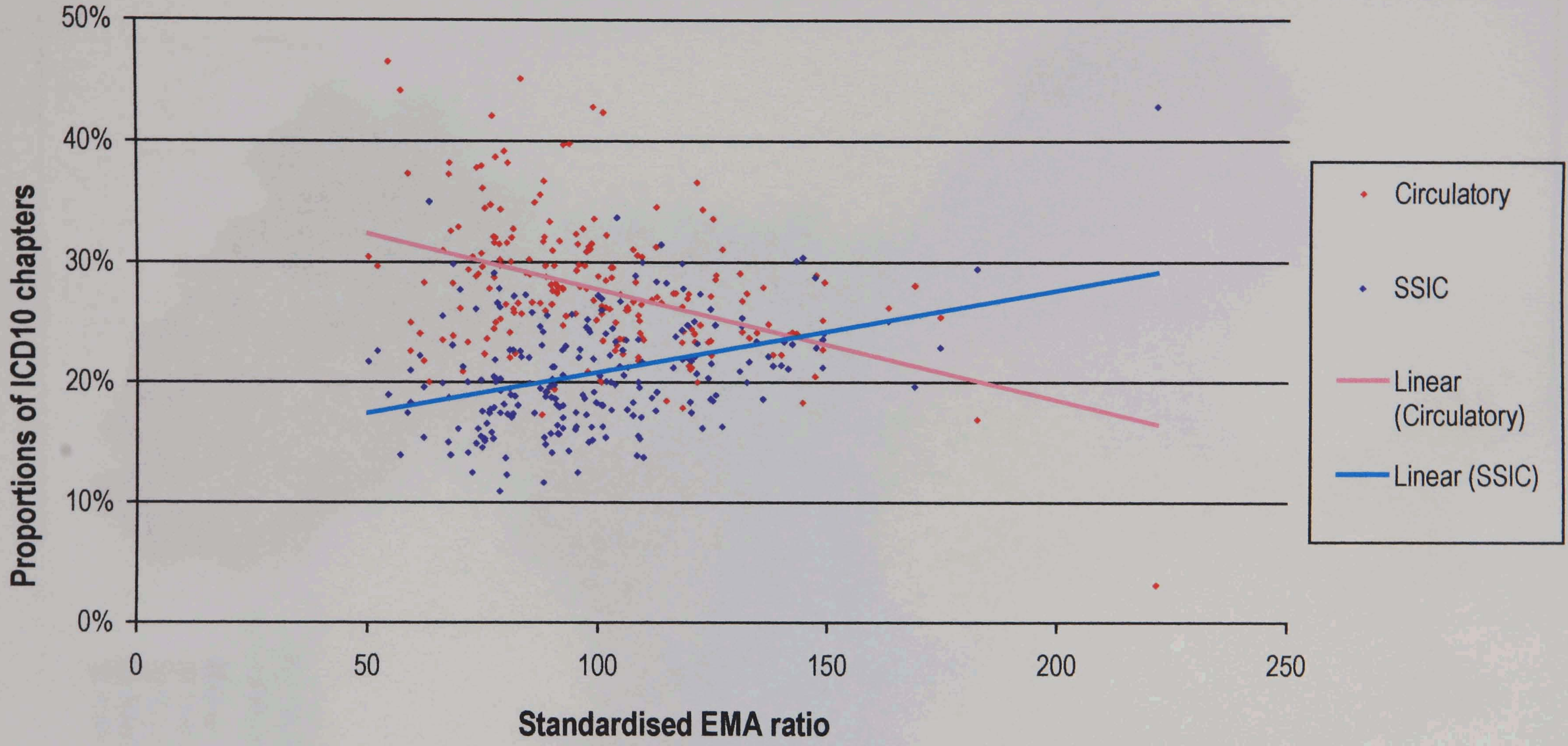

Figure 40 — GP practices' standardised EMA ratios and practices' proportions of ICD10 chapters "Circulatory disease" and "Symptoms, signs..." (adjusted for age, sex and DEPCAT)

(Pearson's correlation (circulatory disease): $R = -0.41$, $R^2 = 0.17$, $p < 0.00001$; (Symptoms, signs...): $R = 0.37$, $R^2 = 0.14$, $p < 0.00001$, two tailed)

Original in colour

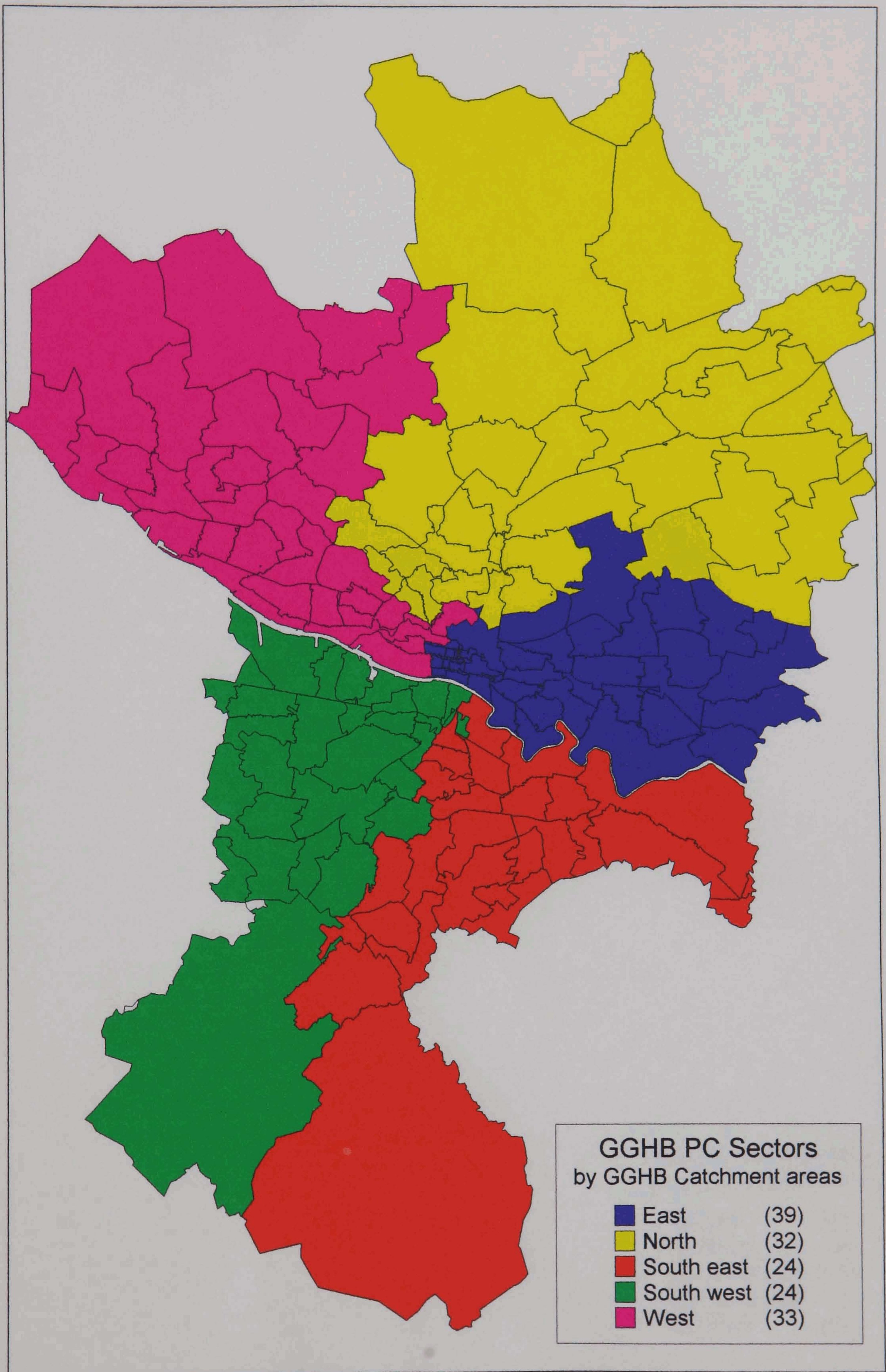

Figure 41 — Map showing GGHB's "official" hospitals' catchment areas

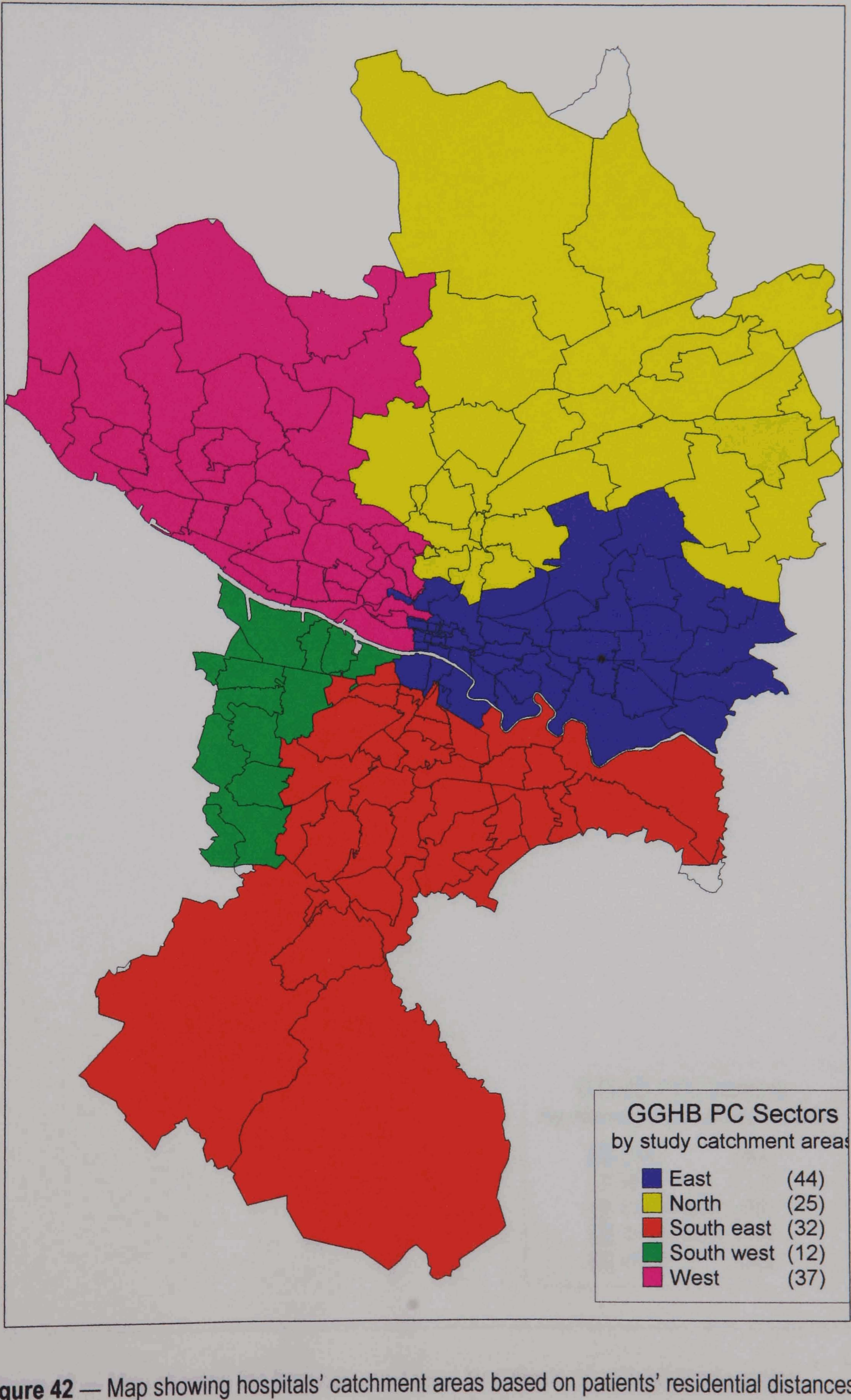

Figure 42 — Map showing hospitals' catchment areas based on patients' residential distances

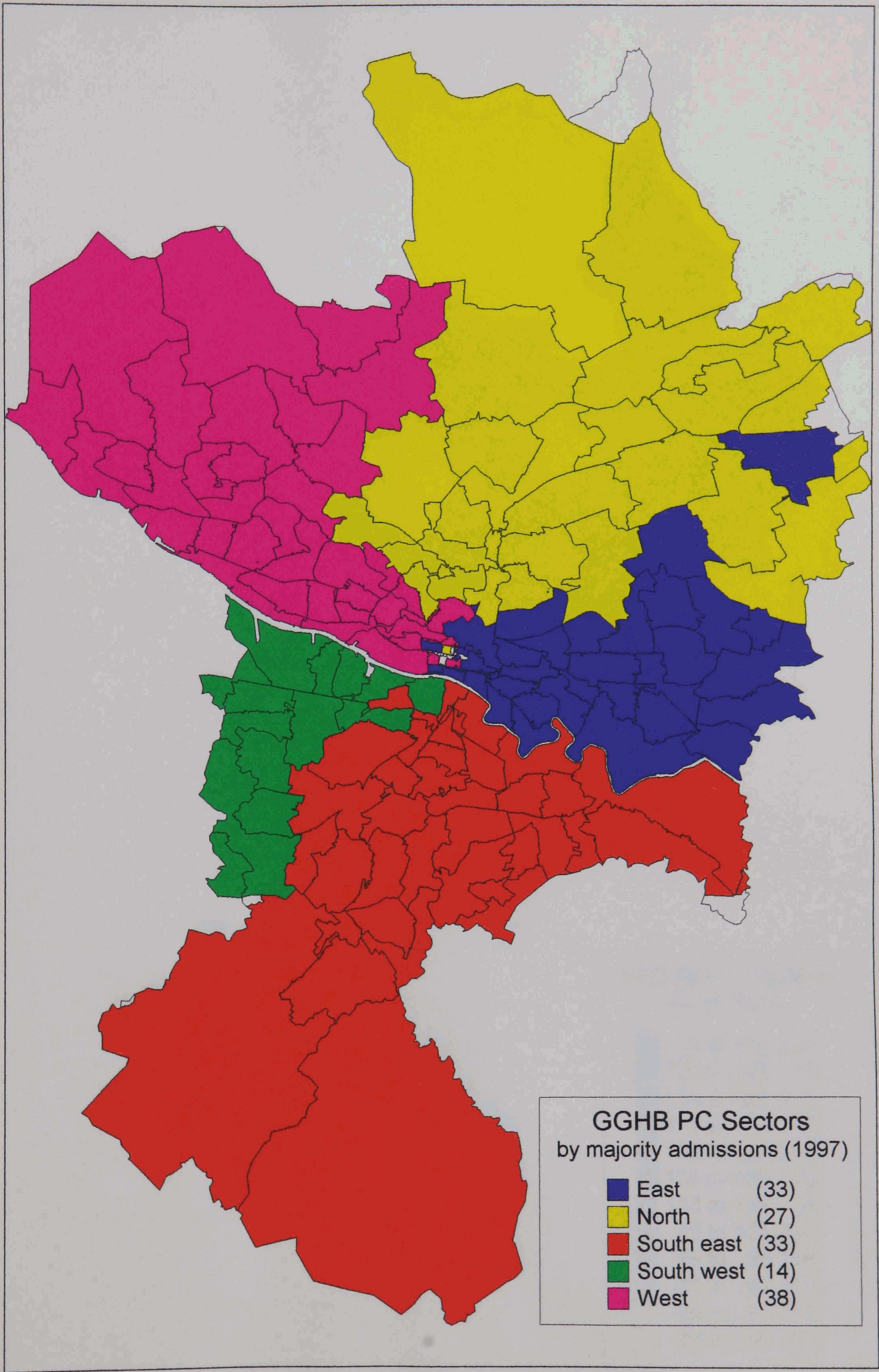

Figure 43 — Map showing the hospitals most used by patients of each postcode sector

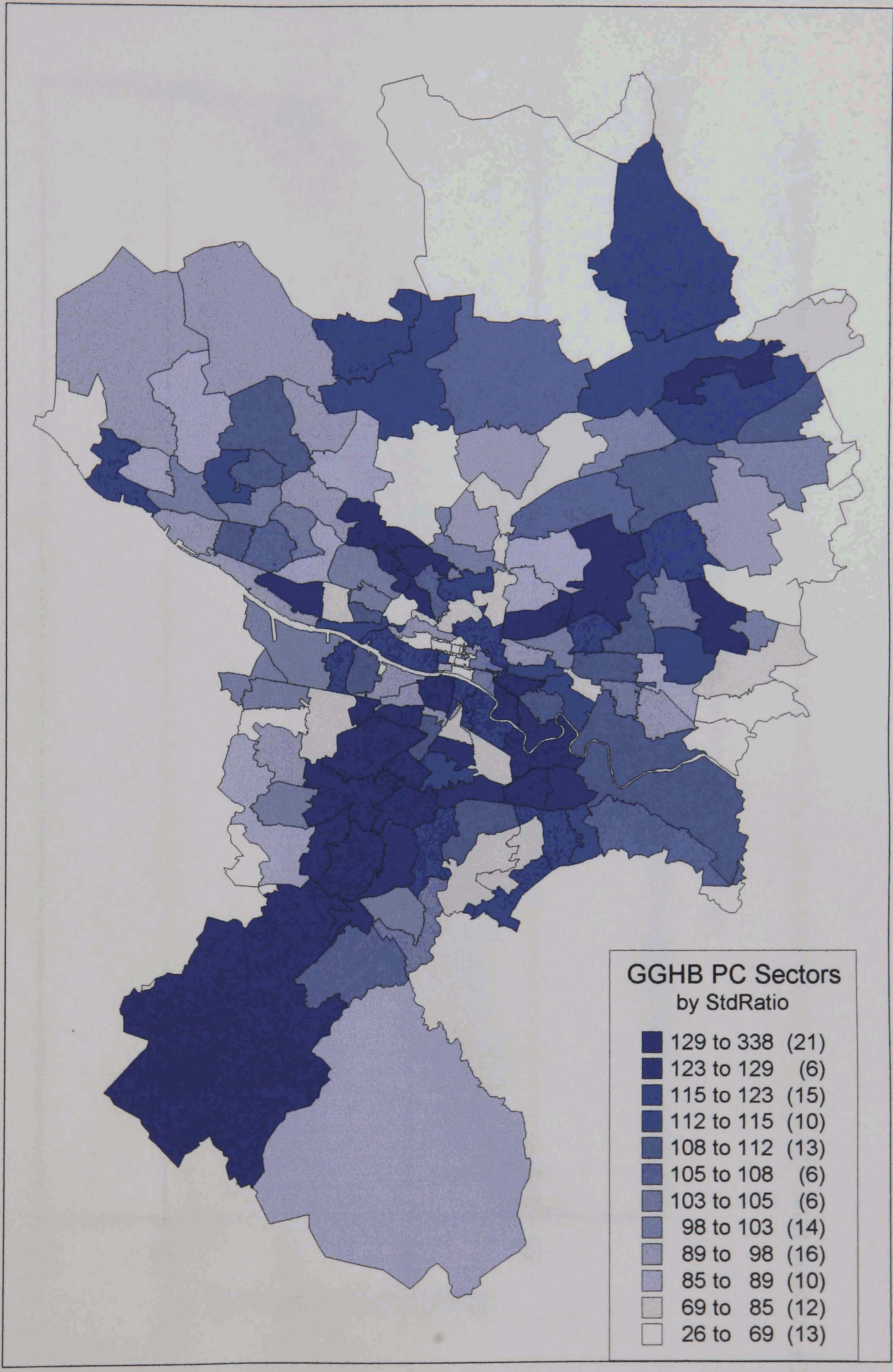

Figure 44 — Postcode sectors' standardised EMA ratios (adjusted for age, sex, DEPCAT and hospital)

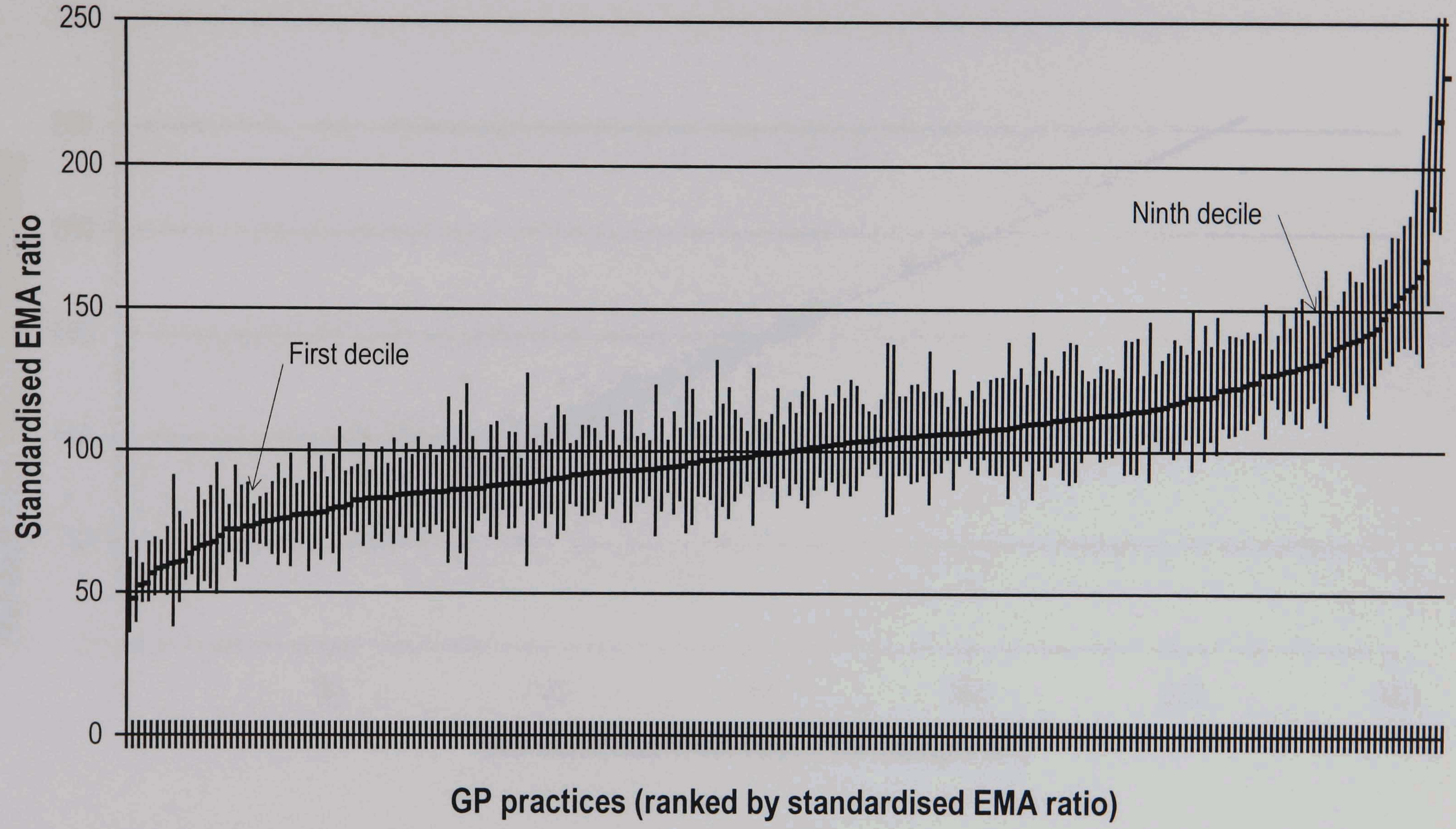

Figure 45 — GP practices' standardised EMA ratios (adjusted for restricted groupings of age, sex, DEPCAT and hospital; ranked with 95% CIs)

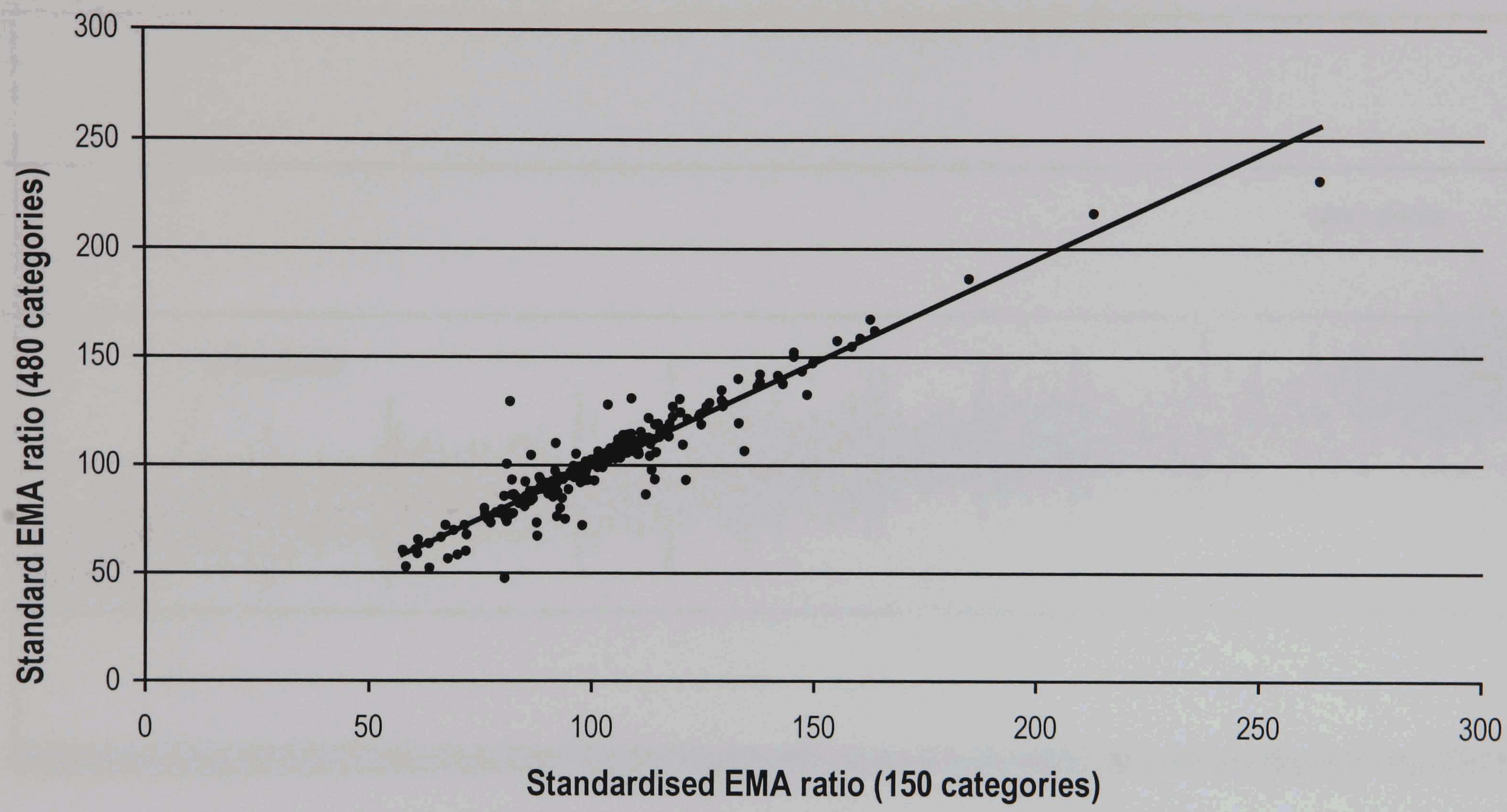

Figure 46 — Comparison of use of all, or restricted groups of adjustment factors for GP practices' standardised EMA ratios (adjusted for sex, DEPCATs, age and hospital)

(Pearson's correlation: r=0.947, r^2= 0.896)

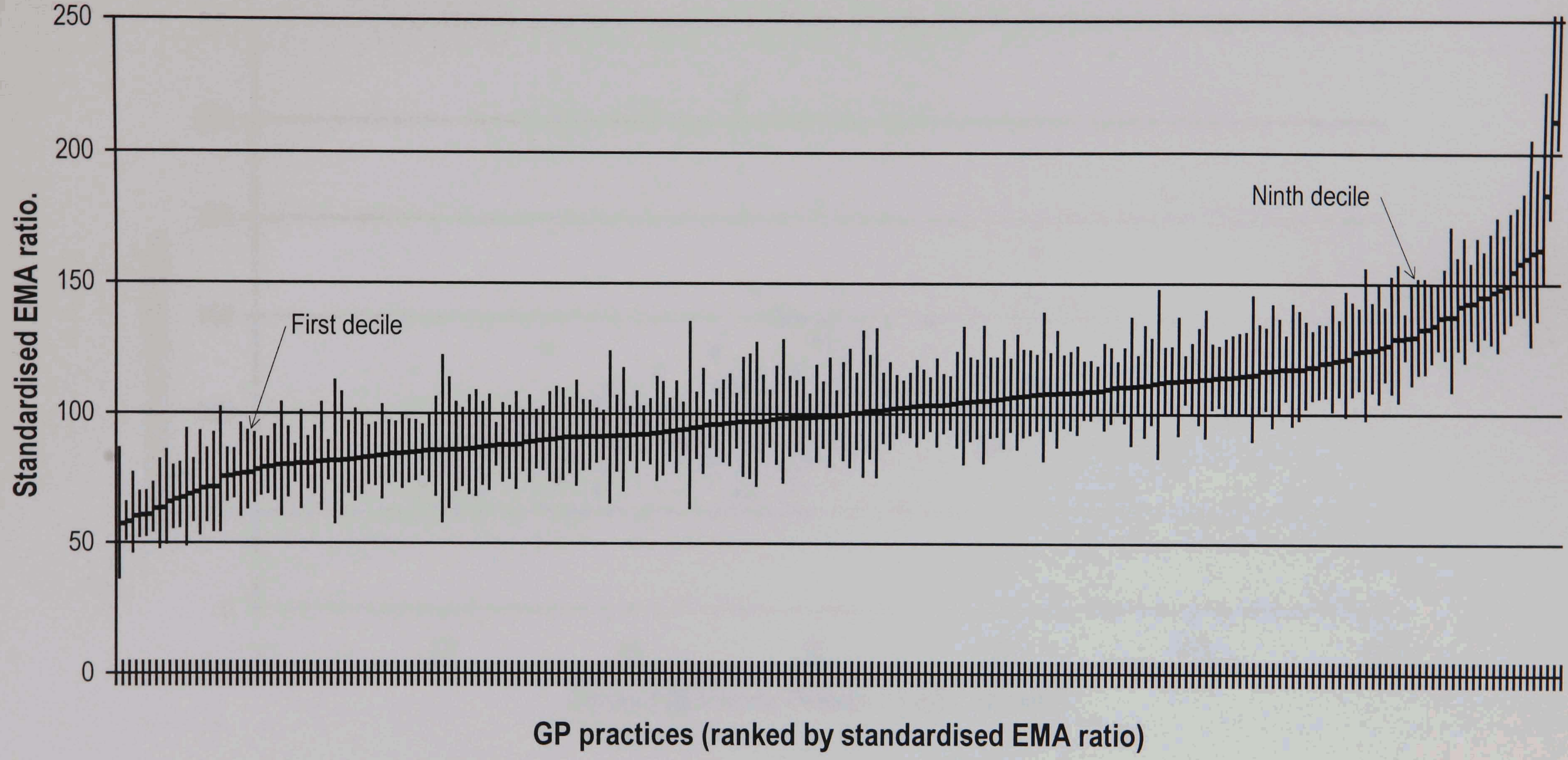

Figure 47 — GP practices' standardised EMA ratios (adjusted for age, sex, DEPCAT and hospital; ranked with 95% CIs)

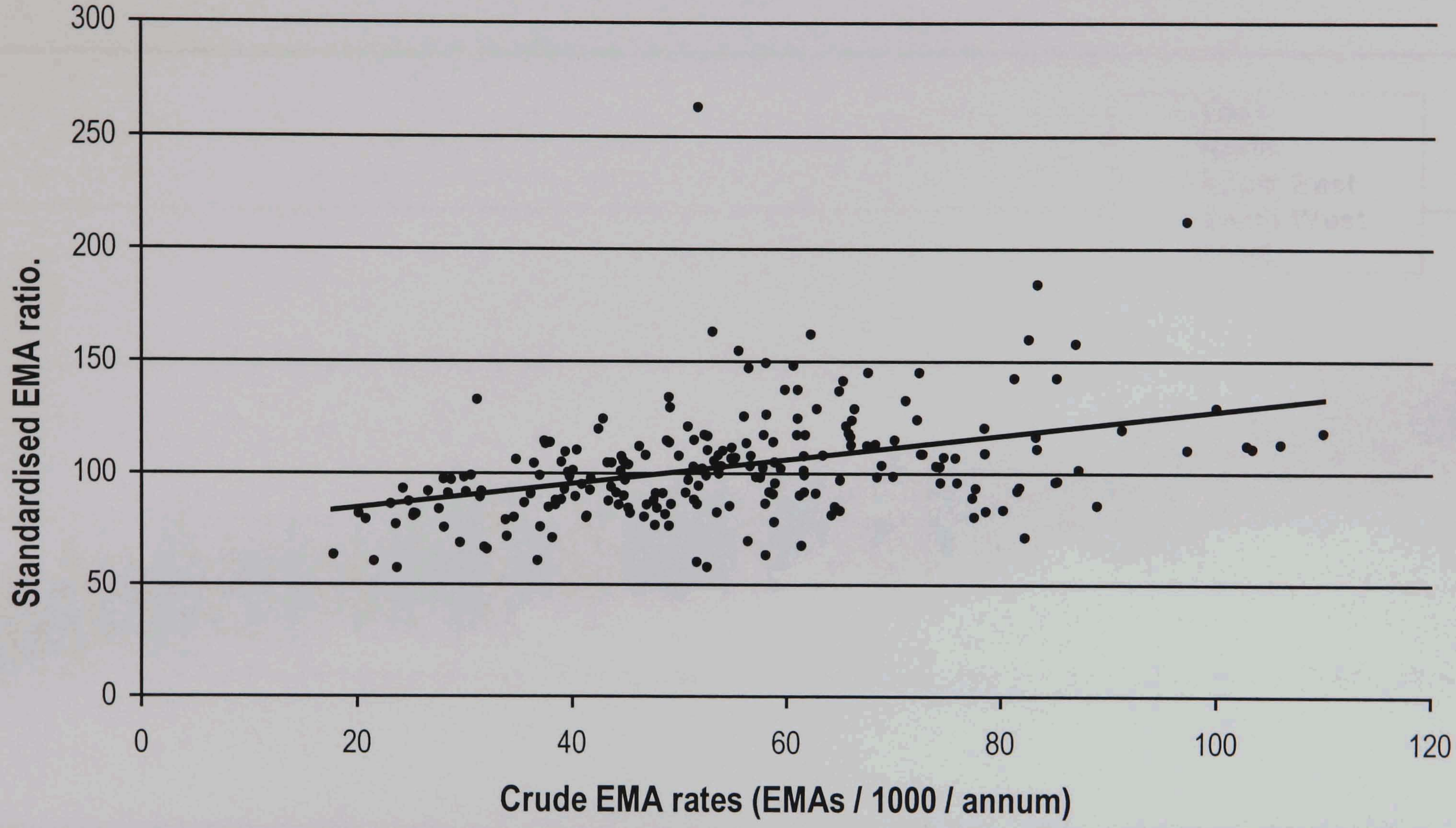

Figure 48 — GP practices' crude EMA rates against standardised EMA ratios (adjusted for age, sex, DEPCAT and hospital)

(Pearson's correlation: $r=0.397$, $r^2= 0.157$, $p<0.00001$, two tailed)

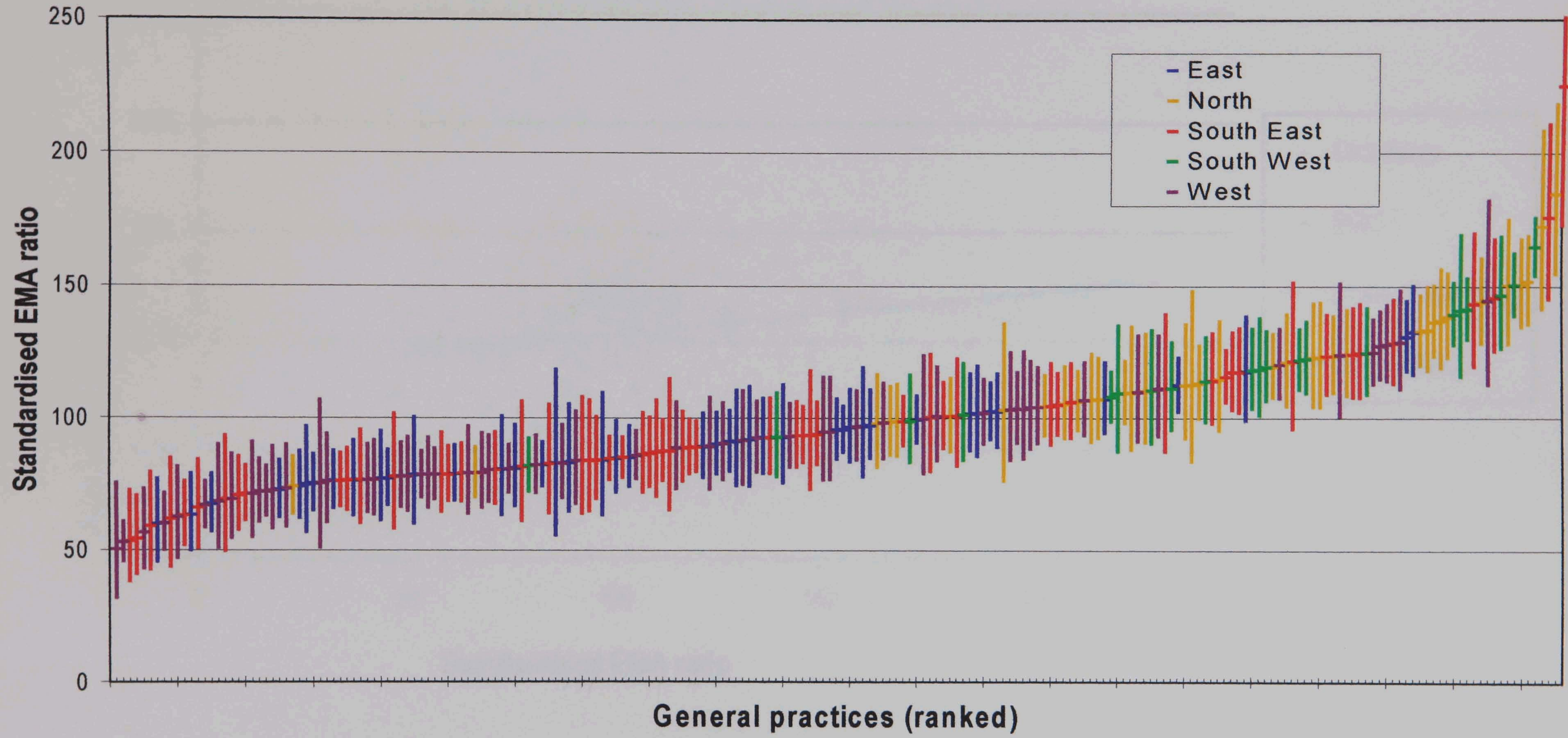

Figure 49 — GP practices' standardised EMA ratios showing practices' usual admitting hospital (adjusted for age, sex and DEPCAT; ranked with 95% CIs)

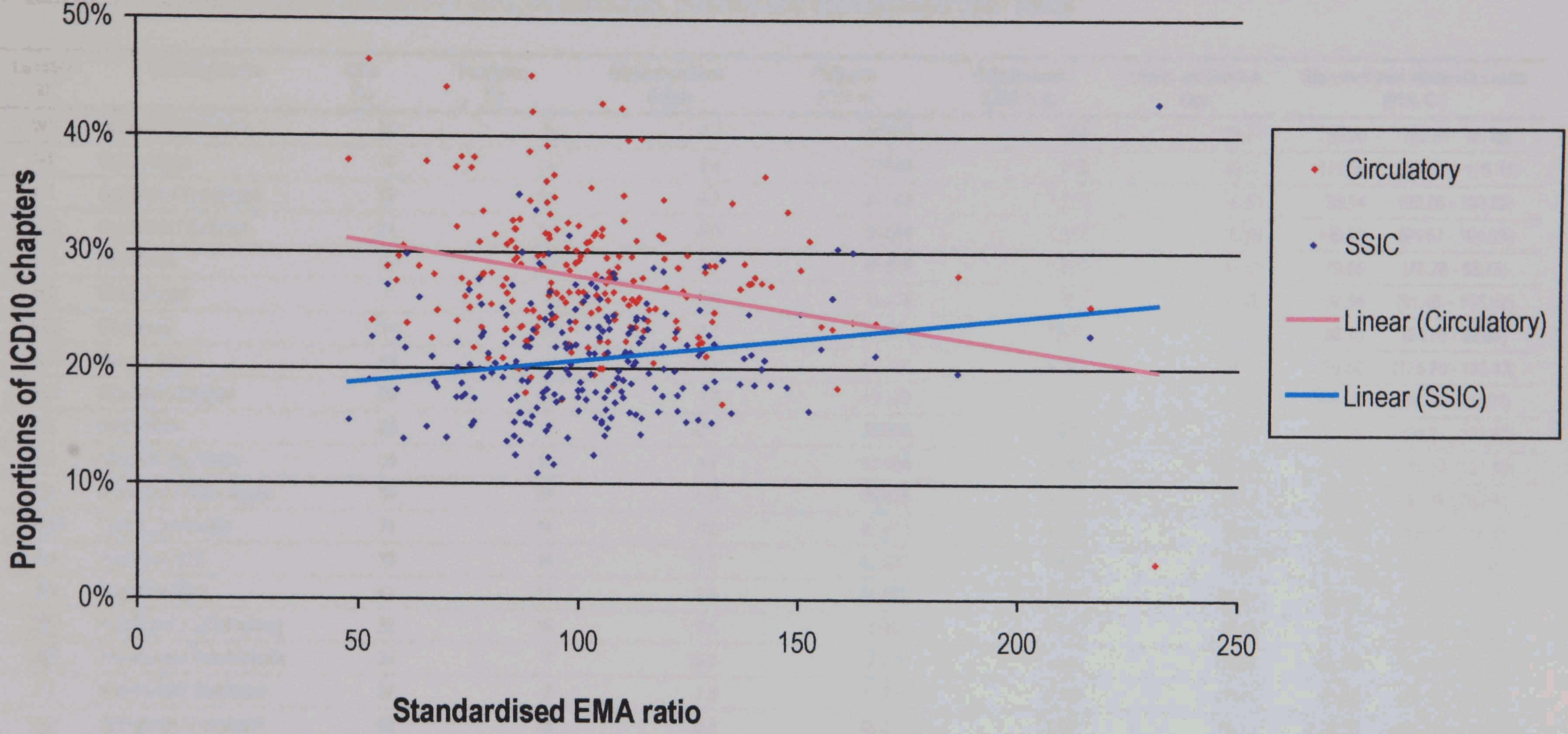

Figure 50 — GP practices' standardised EMA ratios and practices' proportions of ICD10 chapters "Circulatory disease" and "Symptoms, signs..." (adjusted for age, sex, DEPCAT and hospital)

(Pearson's correlation (circulatory disease): $R = -0.278$, $R^2 = 0.077$, $p < 0.00001$, two tailed) (Pearson's correlation (Symptoms, signs...): $R = 0.201$, $R^2 = 0.040$, $p < 0.003$, two tailed)

Original in colour

Table 25 — GGHB GP localities showing numbers of GPs, partnerships, patients and standardised EMA ratios

Locality ID	Locality Name	GPs (n)	Practices (n)	Mean Carstairs' score	Patients (CHI, n)	Admissions (SMR1, n)	Crude admission rate	Standardised admission ratio (95% CI)	
W1	Bearsden / Milngavie	24	6	-4.7	30,595	966	31.57	89.36	(83.81 - 95.18)
N1	Bishopbriggs	15	4	-2.3	20,018	810	40.46	111.36	(103.83 - 119.31)
E1	Bridgeton / Townhead	27	16	6.5	38,315	2,513	65.59	96.54	(92.80 - 100.39)
SE4	Castlemilk / Cathcart	24	12	2.8	36,048	1,819	50.46	100.22	(95.67 - 104.93)
W3	Clydebank	34	10	2.0	41,879	1,778	42.46	79.95	(76.28 - 83.76)
W2	Drumchapel	16	6	6.0	16,558	957	57.80	97.54	(91.46 – 103.92)
SE3	Eastwood	35	11	-4.1	45,875	1,501	32.72	88.10	(83.70 - 92.68)
SW1	Govan / Ibrox	48	11	5.1	53,310	4,443	83.34	129.56	(125.78 - 133.43)
SE1	Govanhill / Gorbals	39	11	4.3	49,389	2,861	57.93	100.28	(96.64 - 104.02)
N2	Kirkintilloch	28	7	-2.1	36,086	1,760	48.77	130.39	(124.37 - 136.63)
N3	Maryhill / Woodside	38	13	4.7	51,994	3,242	62.35	117.38	(113.38 - 121.49)
E3	Parkhead / Easterhouse	54	21	6.9	75,626	4,320	57.12	90.53	(87.86 - 93.28)
SW2	Pollok / Cardonald	34	14	3.8	42,833	2,863	66.84	112.55	(108.46 - 116.75)
W5	Riverside-East	33	14	1.7	59,633	1,826	30.62	77.75	(74.22 - 81.40)
W4	Riverside-West	41	17	1.8	48,878	2,462	50.37	86.04	(82.68 - 89.51)
SE2	Rutherglen / Cambuslang	32	12	1.5	45,287	2,112	46.64	91.23	(87.38 - 95.20)
SE5	Shawlands / Pollokshields	24	7	-0.5	27,840	1,361	48.89	100.94	(95.64 - 106.45)
E2	Shettleston / Baillieston	37	9	1.8	44,727	2,144	47.94	91.52	(87.69 - 95.48)
N4	Springburn / Possilpark	43	15	6.8	45,532	3,467	76.14	110.27	(106.63 - 114.00)
	Total	626	216		810,423	43,205	53.31		

(Standardised EMA ratios adjusted for patients' ages, sex and Carstairs' DEPCATs.)

Table 26 — GGHB GP fundholder statuses showing numbers of GPs, partnerships, patients and standardised EMA ratios and odds ratios

Fundholder type	**GPs** (n)	**Practices** (n)	**Patients** (n)	**Carstairs' score** (mean)	**Admissions** (n)	**Crude admission rate** (admissions/1,000/year)	**Standardised admission ratio**	(95% CI)	**Odds Ratios**	
Non fundholders	245	98	323,796	2.73	16,822	52.0	97.0	(95.5 - 98.4)	1	(reference)
All fundholders	381	118	481,581	2.45	25,749	53.5	102.1	(100.9 - 103.4)	1.04	(1.02 – 1.06)
Preparatory community fundholders	43	17	51,574	3.08	2,988	57.9	105.1	(101.4 - 109.0)	1.11	(1.07 – 1.16)
Community fundholders	186	55	235,724	2.92	12,617	53.5	101.2	(99.5 - 103.0)	1.04	(1.01 – 1.06)
Preparatory full fundholders	4	1	4,363	2.71	315	72.2	128.1	(114.4 - 143.1)	1.30	(1.15 – 1.46)
Full fundholders	132	42	168,623	2.21	8,879	52.7	100.1	(98.0 - 102.2)	1.05	(1.02 – 1.07)
Full fundholders - preparatory total purchasing	16	3	21,297	-2.49	950	44.6	119.3	(111.9 - 127.2)	1.29	(1.21 – 1.39)
Total	626	216	805,377	2.56	42,571	52.9				

(Standardised emergency medical admission ratios and odds ratios adjusted for patients' ages, sex and Carstairs' deprivation categories.)

Table 27 — Correlations between selected practice parameters and standardised EMA ratios

Practice parameter	Pearson's correlations		
	(r)	R^2	p value
General practitioners	0.061	0.004	0.369
Total number of patients	0.031	0.001	0.651
Total number of adults (≥ 15 years)	0.008	0.000	0.909
Patients per General practitioner	0.014	0.000	0.843
Adults (≥ 15 years) per General practitioner	-0.056	0.003	0.415
Practice mean patient dispersal*	0.166*	0.027*	0.014*
Proportion of women aged 20 – 60 with recent cervical cytology	0.065	0.004	0.343
Proportion of children immunised against diptheria	-0.048	0.002	0.484
Proportion of children immunised against measles, mumps, rubella	-0.019	0.000	0.776
Proportion of children immunised against pertussis	-0.067	0.005	0.326
Proportion of babies breast fed	-0.180	0.032	0.008
Proportion of babies with smoking mothers	0.145	0.021	0.033

(Standardised EMA ratios adjusted for patients' ages, sex and Carstairs' DEPCATs.)

* Correlation before exclusion of one outlying practice, shown in Figure 39. After exclusion of this practice, R = 0.166, R^2 = 0.027, p= 0.12

Table 28 — Correlations between GP practices' proportions of ICD10 chapters and standardised EMA ratios

ICD10 diagnosis chapter	Pearson's correlations		
	(r)	R^2	P value
Diseases of the circulatory system	-0.413	0.170	< 0.00001
Symptoms, signs and abnormal findings	0.369	0.136	< 0.00001
Diseases of the respiratory system	0.109	0.012	0.1100
Injury, poisoning and consequences of external cause	0.205	0.042	0.0025
Other ICD10 chapters	-0.114	0.013	0.0944

(Standardised EMA ratios adjusted for patients' ages, sex and Carstairs' DEPCATs.)

Table 29 — Correlations between GP practices' proportions of ICD10 diagnoses and standardised EMA ratios

ICD10 diagnosis	Pearson's correlations (r)	r^2	P value
Angina pectoris (I20)	0.057	0.003	0.4054
Heart failure (I50)	-0.288	0.083	< 0.00001
Acute myocardial infarction (I21)	-0.281	0.079	< 0.00001
Chronic ischaemic heart disease (I25)	-0.068	0.005	0.3175
Pain in throat and chest (R07)	0.458	0.210	< 0.00001
Syncope and collapse (R55)	0.054	0.003	0.4320

(Standardised EMA ratios adjusted for patients' ages, sex and Carstairs' DEPCATs.)

Table 30 — Hospital EMA rates and adjusted ratios (using GGHB and derived hospital populations)

Catchment area basis	Crude EMA rate annum^{-1} x1000	Standardised EMA ratio	(95% CI)
Hospital sector			
Greater Glasgow Health Board's catchment areas			
West	46.94	99.50	(97.52 - 101.52)
North	51.93	101.32	(99.11 - 103.57)
East	62.56	98.67	(96.64 - 100.73)
South east	57.29	116.26	(113.87 - 118.69)
South west	48.01	85.26	(83.29 - 87.27)
Study derived catchment areas			
West	41.95	87.31	(85.57 - 89.08)
North	66.68	129.54	(126.72 - 132.42)
East	55.25	88.13	(86.32 - 89.97)
South east	41.14	86.79	(85.00 - 88.60)
South west	92.61	142.90	(139.59 - 146.27)

(Standardised EMA ratios adjusted for patients' ages, sex and Carstairs' DEPCATs.)

Table 31 — Age, sex, DEPCAT and hospital catchment area specific EMA rates

		East hospital													
		Men							Women						
Age	**DEPCATs**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15-19		-	-	4.0	13.3	10.2	9.2	12.9	-	-	4.0	5.8	25.8	13.9	15.9
20-29		-	-	6.8	12.5	30.7	12.4	17.8	-	-	7.2	8.0	30.4	13.8	19.0
30-39		-	-	4.6	15.3	21.9	14.2	24.8	-	-	9.2	18.6	27.1	16.5	23.5
40-49		-	-	26.6	47.1	60.1	27.3	49.0	-	-	15.4	56.1	34.3	25.4	34.8
50-59		-	-	56.6	64.9	69.4	54.7	79.6	-	-	32.9	49.1	54.8	40.8	63.2
60-69		-	-	72.0	125.0	220.6	110.7	123.5	-	-	60.5	91.4	172.7	79.1	92.4
70-79		-	-	124.3	164.6	215.8	133.2	151.3	-	-	119.0	134.6	190.9	107.9	132.2
80+		-	-	192.0	208.3	440.0	212.8	174.6	-	-	261.5	206.9	354.8	160.9	201.1

		North hospital													
		Men							Women						
Age	**DEPCATs**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15-19		8.3	5.9	13.6	7.7	9.4	24.5	27.6	13.1	13.1	7.0	14.3	15.6	36.7	42.7
20-29		4.2	10.8	11.4	25.3	12.5	66.9	34.0	17.2	15.9	16.5	22.6	15.1	47.4	27.5
30-39		15.4	10.0	9.7	27.6	15.3	45.8	37.1	14.6	14.6	15.2	65.9	14.6	49.2	41.2
40-49		8.4	23.5	18.6	43.5	39.6	106.5	65.1	9.4	21.0	27.5	41.3	20.5	64.9	63.9
50-59		24.1	39.5	42.7	105.3	55.2	139.0	133.6	21.4	34.0	43.6	45.0	34.8	124.7	97.8
60-69		45.4	91.8	79.4	142.0	95.0	348.0	186.1	46.5	61.5	85.5	165.7	64.0	283.7	131.1
70-79		168.3	122.7	174.7	193.2	147.6	539.3	235.8	81.6	121.2	144.4	208.6	140.6	428.1	195.7
80+		137.5	279.4	330.6	409.8	250.0	921.9	277.0	173.1	204.8	340.4	468.8	158.2	902.3	261.8

(continued)

Table 31 (continued) — Age, sex, DEPCAT and hospital catchment area specific EMA rates

		West hospital													
		Men							Women						
Age	**DEPCATs**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15-19		4.0	8.5	3.4	5.6	14.9	13.4	8.0	8.1	11.3	10.2	18.6	9.8	18.8	24.2
20-29		5.0	5.5	8.9	7.1	14.1	9.8	19.4	6.9	6.6	9.5	8.0	18.7	11.2	17.6
30-39		5.8	5.6	11.0	10.7	21.7	15.4	34.1	8.0	8.0	17.0	13.0	27.2	22.7	31.1
40-49		15.0	9.3	15.7	17.1	21.3	33.0	50.0	10.9	13.3	21.0	21.9	24.2	35.0	41.1
50-59		21.8	23.7	25.8	49.2	64.3	59.9	85.9	14.0	20.6	35.6	35.9	44.8	51.5	64.2
60-69		34.9	54.8	76.9	87.5	103.1	97.8	133.7	25.5	50.9	50.8	59.8	68.1	81.3	91.2
70-79		99.4	78.6	129.0	129.8	159.1	127.6	207.3	82.0	87.1	91.5	103.2	101.3	114.3	140.7
80+		194.0	231.0	166.7	190.5	205.6	222.6	115.8	173.0	156.6	201.9	145.7	161.7	136.6	146.7

		South west hospital													
		Men							Women						
Age	**DEPCATs**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15-19		-	-	-	20.2	5.5	24.7	15.4	-	-	-	26.3	11.4	23.7	34.1
20-29		-	-	-	32.8	8.0	25.3	24.9	-	-	-	17.0	19.0	29.4	24.5
30-39		-	-	-	34.6	10.1	34.6	38.5	-	-	-	18.3	27.8	26.2	39.5
40-49		-	-	-	58.3	39.1	43.3	82.3	-	-	-	42.2	30.3	57.5	59.5
50-59		-	-	-	127.1	77.2	91.9	133.1	-	-	-	94.5	52.3	90.2	102.5
60-69		-	-	-	109.9	111.5	175.4	158.7	-	-	-	104.3	104.3	144.6	119.3
70-79		-	-	-	260.6	213.9	243.8	245.2	-	-	-	230.2	172.0	203.9	191.5
80+		-	-	-	503.5	285.7	365.1	294.1	-	-	-	402.3	238.8	334.5	358.8

(continued)

Table 31 (continued) — Age, sex, DEPCAT and hospital catchment area specific EMA rates

		South east hospital													
		Men							Women						
Age	DEPCATs	1	2	3	4	5	6	7	1	2	3	4	5	6	7
15-19		8.2	7.1	11.8	13.0	8.8	9.4	16.2	8.0	17.7	7.6	16.6	12.7	17.0	38.3
20-29		6.3	6.4	9.0	11.3	11.2	17.1	34.7	7.1	3.0	15.7	10.9	9.7	13.5	37.8
30-39		8.0	5.8	6.0	10.0	15.7	22.1	40.5	8.9	8.4	12.8	10.9	18.6	19.8	37.1
40-49		12.5	15.6	19.9	21.5	16.7	28.7	88.2	8.6	4.4	12.2	15.3	31.1	27.3	60.4
50-59		18.4	26.1	33.1	30.3	47.2	58.6	144.7	16.5	24.7	27.7	25.0	41.7	46.8	86.8
60-69		49.6	39.1	75.7	53.6	79.5	87.1	190.3	25.5	31.1	36.4	55.3	70.4	57.2	133.0
70-79		117.9	91.6	120.2	86.9	152.7	141.3	274.9	71.2	48.6	66.7	72.9	87.7	90.4	153.0
80+		182.9	121.8	132.7	134.6	258.4	158.0	328.0	134.1	89.0	144.9	124.2	156.7	139.8	224.9

Table 32 — Age, sex, DEPCAT and hospital catchment area specific EMA rates (reduced categories)

			Men					Women				
Hospital	DEPCATs	Age	15-39	40-59	60-69	70-79	80+	15-39	40-59	60-69	70-79	80+
East	1-4		12.0	53.1	114.8	169.0	211.1	11.7	41.0	83.9	136.7	237.7
	5-6		14.5	43.7	131.8	147.6	234.1	16.9	34.9	96.5	120.6	185.4
	7		20.2	63.0	123.5	151.3	174.6	20.4	48.3	92.4	132.2	201.1
North	1-4		10.9	30.1	82.0	147.2	284.2	16.5	27.8	69.9	126.3	255.6
	5-6		24.7	71.0	169.0	264.2	494.3	24.7	48.3	131.8	235.8	388.4
	7		34.5	97.2	186.1	235.8	277.0	36.0	81.3	131.1	195.7	261.8
West	1-4		7.2	22.0	62.8	110.5	198.6	9.9	20.7	46.8	92.8	158.7
	5-6		13.4	43.9	99.2	137.7	217.1	17.2	40.7	77.5	110.0	144.3
	7		23.4	65.0	133.7	207.3	115.8	24.0	50.8	91.2	140.7	146.7
Soputh west	1-4		42.8	127.0	161.4	372.7	723.4	29.3	95.9	149.6	305.7	539.5
	5-6		23.6	61.3	153.8	233.6	334.7	25.6	60.7	129.7	191.6	298.9
	7		29.3	105.5	158.7	245.2	294.1	32.8	79.4	119.3	191.5	358.8
South east	1-4		8.9	21.2	54.7	104.3	147.8	10.4	16.1	38.9	68.3	126.9
	5-6		16.8	37.8	84.6	145.2	194.5	16.0	36.1	62.0	89.4	145.4
	7		34.4	112.2	190.3	274.9	328.0	37.6	72.2	133.0	153.0	224.9

Table 33 — Percentages of major ICD10 chapters by hospital

ICD10 diagnosis chapter	Greater Glasgow Health Board Hospitals				
	West	North	East	South east	South west
Diseases of the circulatory system	30.5	23.9	29.7	26.4	25.0
Symptoms, signs and abnormal findings	18.3	24.8	16.6	23.8	22.4
Diseases of the respiratory system	16.5	15.0	15.7	14.3	14.2
Injury, poisoning and consequences of external cause	8.4	8.5	7.4	9.2	8.0
Other ICD10 chapters	26.3	27.8	30.7	26.4	30.5

Table 34 — Percentages of major ICD10 diagnoses by hospital

ICD10 diagnosis	Greater Glasgow Health Board Hospitals				
	West	North	East	South east	South west
Angina pectoris (I20)	5.7	6.4	6.4	4.6	4.1
Heart failure (I50)	3.8	3.1	4.8	4.3	4.0
Acute myocardial infarction (I21)	4.7	3.5	3.6	4.4	3.4
Chronic ischaemic heart disease (I25)	2.7	1.3	3.6	0.5	2.5
Pain in throat and chest (R07)	8.9	10.7	6.8	12.0	11.0
Syncope and collapse (R55)	2.2	3.0	1.5	3.0	2.6

Table 35 — EMA odds ratios with hospitals included in the logistic regression model

Patient parameter	Adjusted odds ratio (95% CI)
Age (per decade age increase)	1.63 (1.62 to 1.63)
DEPCAT (per unit DEPCAT increase)	1.16 (1.15 to 1.17)
Sex (risk for men compared with women)	1.21 (1.18 to 1.23)
East hospital	1.08 (1.04 to 1.11)
North hospital	1.65 (1.59 to 1.71)
West hospital	0.99 (0.96 to 1.02)
South west hospital	1.83 (1.76 to 1.90)
South east hospital (reference)	1.00

Table 36 — Correlations between practice crude EMA rates and standardised EMA ratios, adjusted for varying combinations of factors.

	Adjustment factors						
Number of adjustments	**Age**	**Sex**	**DEPCAT**	**Hospital**	**R**	**R^2**	**$(1-R^2)$**
1 Factor							
	X				0.918	0.843	0.157
		X			1.000	1.000	0.000
			X		0.836	0.700	0.300
				X	0.720	0.518	0.482
2 Factors							
	X	X			0.919	0.845	0.155
	X		X		0.690	0.476	0.524
	X			X	0.624	0.389	0.611
		X	X		0.837	0.700	0.300
		X		X	0.720	0.518	0.482
			X	X	0.510	0.260	0.740
3 Factors							
	X	X	X		0.692	0.479	0.521
	X	X		X	0.624	0.390	0.610
	X		X	X	0.396	0.157	0.843
		X	X	X	0.510	0.261	0.739
4 Factors							
	X	X	X	X	0.397	0.157	0.843

(Adjusted for 7 DEPCATs, 5 hospital catchment areas, 8 age groups and 2 sexes.)

CHAPTER 7 —

DISCUSSION

7.1 STUDY METHODS – POTENTIAL LIMITATIONS

In this section, I shall discuss the problems I encountered during this study along with the strengths and weaknesses of the methods I used to address these problems. It is important to consider the potential limitations of the study's methods and main data sources before discussing the findings of the study itself.

7.1.1 Datasets

This is the only study of which I am aware that has used anonymous linkage of two large routinely collected datasets to investigate variations in patterns of emergency medical admissions. The two major datasets used in the study (CHI and SMR1) have both been used in Glasgow for many years. However, their linkage at the level of general practices only become possible from 1991, when general practitioners codes were recorded in the SMR1. General practitioner codes were previously an optional field and so this field was seldom completed. It only recently became possible to link CHI and SMR1 using a personal computer as relational database software for personal computers was previously not able to cope with such large datasets. In addition, the increased power of personal computers made it much easier to create links between such large datasets.

It would have been possible to have done this study in any of the smaller Scottish health boards. However, basing this study in Glasgow, the largest of the Scottish health boards, enabled me to use the biggest sets of numerator data (hospital admissions) and denominator data (health board residents) in Scotland. Analyses of such large numbers of patients' records from these datasets should have improved the robustness of the study conclusions.

Limitations of CHI data

The ideal population denominator for this study would have been a census. It was not possible to use the most recent census for three reasons. Firstly, the last census was conducted in 1991, while the admissions data used in this study were taken from 1997. A significant change in the population of Glasgow might be expected over a six-year period. Secondly, while the population census contains a very large number of items of detailed information about the residents of small areas, it does not record the general practices with which the residents of an area are registered. Thirdly, publicly available census data are only available in aggregate form: the details of individual residents (patients) are concealed by this aggregation. This study relied on having individual patients' demographic and residential details as well as information about the general practitioner with which they were registered. Even if data from a recent census containing the relevant general practice data was available, this study could not have used this information because of the aggregation of personal details in census data.

The only dataset in existence that contained this information was CHI. Therefore, short of commissioning the creation of a special population survey, CHI was the only population denominator dataset that could be used for this study.

The CHI dataset was created primarily so that general practitioners could be paid for providing general medical services for the National Health Service patients on their practice lists. CHI is therefore an administrative database rather than a population census. Levels of registration of patients with general practitioners and CHI recording of these registrations are generally very high for two reasons. Firstly, patients cannot receive medical care from a general practitioner under the National Health Service without first being registered on CHI. Secondly, because general practitioners are only paid a capitation fee for those patients who are registered on CHI, they have a financial incentive to ensure complete registration of their patients. The Greater Glasgow Health Board CHI database should therefore have a similar number of patients to the number of residents in the Greater Glasgow Health Board area at the census. A comparison of the data in Greater Glasgow Health Board's CHI with appropriate data from the 1991 census was therefore undertaken to ascertain how well CHI matched the census.

The 1991 census recorded that the Greater Glasgow Health Board had a population of 727,330 residents aged over 15 years in 1991. This was 10.3% less than the 810,423 patients of the same age who were on the CHI database at the mid-point of 1997. Examining this difference by age and sex showed (Table 10) that most of this discrepancy between the two datasets arose from an excess of both men and women aged from 30 to 49 years. There were reasonably similar numbers in other age groups. There may be three plausible explanations for this difference:

- Glasgow's demography could have changed between 1991 and 1997
- CHI could have over-represented these specific age ranges
- The 1991 census could have under-enumerated residents of these ages.

The 1991 census was noteworthy in that it was taken at the height of Scottish protests against the recently introduced Community Charge (also known as the "Poll Tax"). A substantial number of mostly younger economically active people attempted to evade poll tax registration. When the census was undertaken, many people who had been evading poll tax registration avoided completion of census documents, as they did not believe that census data would remain confidential. They feared that the 1991 census would be used to identify poll tax defaulters, following which they would be pursued for arrears of tax.

CHI inflation is also a well-recognised phenomenon. (Personal communication, Janet Mair, 1997.) It arises by two major mechanisms. Firstly, CHI inflation may arise because of delays in removing patients from CHI when they have died or emigrated. While these patients remain on CHI, their registered general practitioners will continue to receive payments for providing General Medical Services for them. (These patients are therefore locally known as "ghosts".)

Secondly, it may happen because patients' registrations with general practitioners are often more rapid than their de-registrations with their previous general practitioners. The general practice registrations of patients changing their general practitioners (for whatever reason) are rapidly processed by general practitioners so that their patient capitation numbers (and income based on these numbers) are maintained. Scottish health boards process these data reasonably promptly. For patients changing general practitioners within an individual health board's area, this re-registration is simply a matter of amending the CHI registration data. However, when patients change to general practitioners in different health board areas, the health board to which they have moved will notify the health board from which they came to remove the patient from their CHI database. Until this has happened, such a patient will be registered on two CHI databases. The effects of such delays in de-registration due to patient migration are worsened when the delays are greater. When a patient migrates outwith the Scottish National Health Service (to an English region for example), these delays often increase substantially. (Personal communication, Janet Mair, 1997.) All three of the reasons listed on page 260 probably contributed to the differences between CHI and the 1991 census. The population will undoubtedly have changed between 1991 and 1997, although the differences shown in Table 10 would have required a marked change in the population composition to have affected an relatively narrow range of ages. Neither of the major causes of CHI inflation is likely to have differentially affected these age groups. Delays in de-registration following patients' deaths would affect mainly the elderly. The other causes of CHI inflation would require very large numbers of migrants specifically in this age range within and outwith Scotland.

The last mechanism suggested on page 260 is the most likely. This suggests that political factors led to a substantial under-enumeration of Glasgow residents aged 30 to 49 years in the 1991 population census. Interestingly, Table 12 shows that this under enumeration may been slightly worse for Glasgow's most deprived residents. 56.8% of the excess in CHI arose in residents of areas in Carstairs' deprivation categories 6 and 7, but they comprised 51.4% of Glasgow's population.

Patients aged 30 to 49 comprised only 17.6% of all emergency medical admissions in 1997 (Table 17). Therefore, even if they were over-represented in the CHI database, because they had had relatively few emergency medical admission events, the effects on the study findings of their possible over representation would be minimised. (The 74.7% of admissions for patients aged over 50 years would have a greater effect on the findings of the study.)

Further examination of CHI was undertaken using the 1997 census population estimate for the Greater Glasgow Health Board area. These estimates are interpolations between censuses. They take many other sources of data including birth and deaths notifications as well as electoral rolls into account. Although they do not have the quality or accuracy of census data, they are useful for planning purposes. Table 11 shows an even greater discrepancy between CHI and the 1997 census estimate (15.5% using the 1997 estimate rather than having been 10.3% using the 1991 census). The substantial differences between the two datasets for the age groups 30 to 49 have been substantially reduced, suggesting that the 1997 census mid year estimates had been adjusted for possible shortfalls in the 1991 census. The inter-census population estimates do not contain the detailed postcode level personal data that would be required for calculating deprivation statistics. It was therefore not possible to compare the 1997 estimate with the deprivation details of CHI.

Because of the possibility that there may be some inflation of patients on the Greater Glasgow Health Board's CHI database, it is important to be aware of the effects of such inflation when in interpreting results based on these data.

Limitations of SMR1 data

The SMR1 and SMR01 datasets are the national datasets containing (effectively) a census of all acute hospital admissions (with the exceptions noted on page 130). Their accuracy and completeness are dependent on the provision of appropriate data by health boards and accredited trust hospitals. Before the 1990 introduction of the "internal market" [163] in which contracting played such a major part, there was little motivation for providers to ensure that their data were complete. Following the introduction of the "internal market", contract negotiations were liked to the performance of provider trust hospitals, whether these were block contracts, cost and volume or cost per case contracts. Provider hospitals were therefore motivated to improve their data accuracy and completeness because their revenues depended on the amount of clinical activity they could show they had performed.

A further factor that has acted to improve the quality of SMR1 / SMR01 data has been the regular audits undertaken by the Information and Statistics Division of providers' data. The Information and Statistics

Division has introduced a program of accreditation of trust hospitals which are now able to provide their own activity data directly to the Information and Statistics Division in Edinburgh.[228, 231] (Previously, hospitals' data had been passed via the health boards.) The accreditation process now includes checks on the standards of accuracy and completeness of provider-supplied data, thus reducing possible variations in diagnostic coding between hospitals. These controls on the quality of SMR1 data have been shown to be effective.[250]

Despite these controls on data quality,[228, 231] variations in local clinical practices may have affected comparisons between acute hospitals within the Greater Glasgow Health Board's hospitals may have different admitting policies for different clinical conditions. For example, acute upper gastrointestinal haemorrhage was initially treated as a medical problem at three of Glasgow's acute hospitals. At another hospital, it was either a medical or a surgical condition, depending on severity. At the remaining hospital, it is always a surgical problem. As a result, these hospitals have large differences in the numbers of emergency medical admissions for upper gastrointestinal haemorrhage.[251] However, I do not know of any other similar administrative or clinical confounding factors that might affect the more common diagnoses leading to emergency medical admissions to hospitals in this city.

The introduction of the new COPPISH hospital admission dataset[232] (SMR01) during 1996/7 should not have affected the case definition of emergency medical admissions used in this study. The major changes introduced under the COPPISH project included the additions of new data fields and new record types. Because the COPPISH SMR01 data was designed to be mapped backwards onto the SMR1 dataset, designing the study to use the (old-style) SMR1 data fields implied that these data would be easily derived from the new database. Such a process would not have been possible if features specific to the newer COPPISH SMR01 database had been necessary for this study. [232]

The SMR1 / SMR01 databases therefore represent the best sources of data on emergency medical admissions, containing as they do, a census of all emergency medical admissions to all Glasgow hospitals.

A further limitation of the use of SMR1/SMR01 data arises from the completed consultant episode basis of data recording these used. Ideally, I would have wished to analyse patients' durations of in-patient stay in Glasgow's hospitals. For those patients whose admissions comprised more than one consultant episode of care, I could only access their first episode, that at which they were admitted. Using the linked dataset [44] would have addressed this shortcoming in the SMR1 data. However, at the time that this study was being conducted, SMR1 dataset linkage of 1996 and 1997 data was not available. This was because the introduction of the COPPISH datasets had introduced problems with the linkage of data. (Personal communication, James Boyd, 1998.)

7.1.2 Dataset management problems

The large volumes of data in the CHI and SMR1 datasets created substantial difficulties for the study. The initial downloaded CHI dataset had 977,171 patients' records while the initial SMR1/SMR01 extract had 615,190 records. These datasets were far too large to be managed in a spreadsheet. (Microsoft Excel [234] can only handle a maximum of 65,536 rows of data.) Therefore, both the CHI and SMR1 datasets had to be stored using a computer database package. It was also not possible, due to the size of the datasets, to perform the dataset linkages within the database and then to perform the analyses using a spreadsheet. For that reason, all analyses of these datasets had to also be conducted within the computer database.

The calculation of standardised emergency medical admission ratios, adjusted patients' age, sex, deprivation and admitting hospitals each of Glasgow's 216 general practices could have been undertaken using a spreadsheet. The database would have been used to produce initial counts of the patients in the relevant numerator and denominator categories before exporting these counts to the spreadsheet. Initial experimentation showed that this use of a spreadsheet was impractical. The spreadsheet could have handled the matrix operations for the 216 general practices, each with more than 100 specific rates requiring adjustment. The manual manipulation required to produce so many standardised ratios would have been highly labour intensive. This introduced a high likelihood of errors resulting from the need for data matching of the large number of intermediate results (more than 20,000).

I recognised that an automated solution that calculated standardised ratios was needed. The database package was therefore used to calculate adjusted standardised emergency admission ratios for general practices. This required a re-analysis of the method of calculating these ratios, so that the algorithm could be translated into a series of linked SQL queries. The SQL program described in the methods section above was written in response to the need for an efficient, simple and reliable method of calculating standardised ratios for these very large datasets (Appendix 1, Text Box 14). Further analysis showed that the method could be expressed as a generalised set of linked SQL queries. With little extra effort, standardised admission rates could be calculated not only for general practices, but also for hospitals, postcode sectors or for any other coded grouping. Moreover, it became possible to use any number of coded adjustment categories when calculating standardised ratios. Finally, it was possible to modify the SQL code, so that 95% confidence intervals were automatically generated for the standardised ratios. I am not aware of anyone having previously used a SQL database package to calculate standardised ratios in this way.

A further problem arose from the size of the datasets. Attempts to use a statistics package (SPSS [242]) to calculate adjusted odds ratios for emergency medical admissions for individual general practices were unsuccessful. SPSS was able to deal with the large numbers of records in denominator and numerator datasets when creating tables and performing other analyses. However, it appeared that the logistic regression module within SPSS was unable to deal with the large number of categories needed when calculating odds ratios for 216 practices while dealing with the required large number of data records. Attempts to use sampling to reduce the sizes of the datasets proved unreliable. When these analyses were repeated following resampling, the odds ratios for individual general practices proved to be unstable. This appeared to be due to the reduction in the numbers of numerator events for each practice. This confirmed that the only reliable means of calculating adjusted odds ratios for individual general practices would be to use the population data. The logistic regression module of SPSS had already failed to analyse these population data, so there was no option other than calculation of standardised ratios. The calculation of indirectly standardised emergency admission ratios also addressed the problem of possible interactions between age, sex and deprivation category.

7.1.3 Statistical methods

As discussed, the choice of statistical techniques was limited by the large sizes of the two main datasets used for this study. Ideally, a model building approach based on the use of logistic regression or of multilevel modelling would have been used. Despite the installation of additional computer memory and using a fast computer processor, attempts at running overnight logistic regression analyses at the levels of both patient factors and general practices were abandoned because they failed to run to completion.

Use of correlation

Analyses at the level of differences between general practices required that adjusted practice emergency medical admission ratios were used. While these ratios were derived from patient level data, further analyses of these ratios at the level of general practices might have introduced some problems. The principal problem was that this process obscured the size of individual general practices. Correlation analyses which compared practices' adjusted emergency medical admission ratios with other practice parameters (such as practice immunisation rates), finding that these were not related to emergency admission rates, may have had different conclusions had practices' sizes been accounted for.

A further problem with correlation analyses arises in the interpretation of the correlation coefficients (R and R^2) in successively applying more adjustment levels in calculating standardised emergency medical admission ratios. Consideration of the amounts by which R^2 values were reduced, lead to conclusions about the relative proportions contributed to the adjustments by the different factors included in the adjustments. It might be tempting to analyse components analysis using R^2 (or $1-R^2$)

values in the same way that components of χ^2 are often analysed. This was empirically examined by correlating crude and adjusted emergency medical admission rates of all possible permutations of the four adjustment factors used in this study. The results of this are shown in Table 36. Examination of this table suggests that the components of R^2 calculations may not be additive. However, interactions between adjustment terms may account for this. Moreover, comparison of the magnitudes of individual R^2 results remains valid.

Multiple adjustments

A potential analytic problem arises in the calculation of indirectly standardised emergency medical admission ratios. The application of multiple adjustments for age, sex, deprivation categories and hospital catchment areas results in a large reduction of the number of degrees of freedom of the results of individual general practices. Adjustment for the first three of these variables resulted in the calculation of 112 category specific rates.

Further examination of whether the number of adjustment categories being used was possibly excessive was performed by comparison of general practices standardised emergency admission rates derived using pooled ranges. Five groups of age ranges and three groups of deprivation categories were used in this revised calculation of standardised results, resulting in the reduction of the previous 480 categories to give 150 new categories. These standardised rates are shown in Table 32. The results of standardisation for age, sex, deprivation category and hospital catchment using these grouped categories showed that despite the reduction to 150 standardising categories, practices standardised emergency medical admission ratios remained stable (Figure 46).

Because the two methods of calculating standardised emergency admission ratios correlated so highly, I decided that it was unlikely that the use of 480 adjustment categories was leading to excessive adjustment. Therefore, the use of a full set of 480 specific rates for adjustment was felt to be appropriate when considering age, sex, deprivation category and hospital together.

7.1.4 Use of Carstairs' deprivation measures

Carstairs' scores and deprivation categories were used in this study as the proxy measure of the relative extent of material deprivation amongst Glasgow's residents. The Carstairs' measures were readily available and easily assigned to patients' postcodes.

Carstairs' deprivation scores and the deprivation categories derived from the Carstairs' score have already been reviewed and discussed in Chapter 3 (Literature review) and Chapter 4 (Methods) above. Many studies have found these measures to be robustly associated with variations in health status. [57 - 62]

As discussed, findings based on the use of Carstairs' scores may suffer from ecological bias. This follows from the observation that not all people living in deprived areas are themselves deprived (the "ecological fallacy"). While the use of individual measures of economic status would be preferable in order to avoid this bias, [63] this would have required the collection of a completely new set of data for individual Glasgow residents. Other studies have shown while Carstairs' scores may have some limitations, they remain useful measures of individuals' socio-economic circumstances. [64, 65] As discussed above, greater heterogeneity exists in rural areas. In urban areas such as Glasgow, poorer people do tend to live together. This makes it possible to use area based deprivation measures, such as Carstairs' scores, as a proxy marker for individual disadvantage in urban areas.

A specific potential problem with using Carstairs' deprivation categories in the Greater Glasgow Health Board area arises from the fact that 30.1% of Glasgow's population live in the single most disadvantaged deprivation category (7). In addition, 51.4% live in the most deprived two categories. The use of deprivation categories may therefore not have sufficient discrimination to reflect important socio-economic variations within these two most deprived population groups in Glasgow.

To address this potential limitation, the analysis of emergency medical admission rates by deprivation category was replicated using a new set of deprivation categories based on deciles of the Greater Glasgow Health Board population's Carstairs' deprivation scores. This analysis (Figure 25) showed that the use of these deciles did not improve discrimination within the most deprived groups (compare with Figure 24). Indeed, Figure 25 suggests that the lowest three deciles (7, 8 and 9) have similar emergency medical admission rates, while the next three deciles (5, 6 and 7) form a separate group on their own. These two groupings of deciles of deprivation score correspond broadly to deprivation categories 7 and 6 respectively. Because of the failure of deciles of deprivation score to improve discrimination, it was decided that deprivation categories should continue to be used as the proxy marker of material disadvantage in subsequent analyses.

7.1.5 Hospital catchment areas

Three different schemes of hospital catchment areas could have been used in this study.

Firstly, there were the official hospital catchment areas defined by the Greater Glasgow Health Board. These were administratively convenient but were also known not to reflect the reality of referral and admission practice. These official catchment areas were therefore rejected.

Secondly, catchment areas could have been defined by using the existing patient referral patterns. Thus postcodes would be allocated to the catchment area of the hospital that admitted the majority of their patients. This too was rejected, because it entailed using the numerator to define the denominator for calculation of rates.

Lastly, catchment areas could have been defined by allocating patients to their closest hospital. This computationally intensive calculation of distance based catchment areas required modification for geographical boundaries such as the river Clyde. It resulted in a scheme of catchment areas which closely approximated the patient referral patterns scheme as may be seen by comparing Figure 42 with Figure 43. It was used in this study because it closely matched the reality of admission patterns while being based on an *a priori* calculation. The validity of this scheme was supported by the higher emergency medical admission ratios of two practice localities which matched the higher emergency medical admission ratios of the two hospitals. This validity was further supported by the postcode sector based map of emergency medical admission ratios which showed the highest rates in the north and south west of Glasgow (Figure

32). This corresponded with the catchment areas of the two hospitals with the highest admission ratios.

Any of these catchment schemes could be criticised for being somewhat arbitrary. They do however represent the best proxy measure that could be derived within this study. (The criticism of the arbitrariness of any catchment area arrangement could only be avoided if there was a centrally defined and rigidly enforced system of hospital admission areas. Given human mobility, no scheme of catchment areas will be perfect.)

7.2 EPIDEMIOLOGICAL FINDINGS

Emergency medical admissions are quite common events in Glasgow. With around 43,000 such admissions annually in an adult population of more than 800,000, most Glasgow residents are likely to know of at least one emergency medical admission every year.

At the time this study was conducted, I was not aware of any other large scale study examining variations in general practitioners' emergency medical admission rates through the use of patient level data. A report of a study using this approach to consider supply side factors has recently been published. [75] and a patient level study of general practice factors has very recently been published. [78] The principal benefit of using patient level data was that it became possible to examine emergency medical admissions at the level of general practices, using an epidemiological approach to consider potential associations with socio-economic and demographic factors.

This section discusses this study's findings relating to the epidemiology of emergency medical admissions in the Greater Glasgow Health Board area. I have used the conventional epidemiological approach of "time, person and place", with a final sub-section for discussion of patients' diagnoses.

7.2.1 Time factors

The long-term trend of rising emergency admissions seen elsewhere was also found in this study: Glasgow's emergency medical admissions doubled between 1980 and 1997 (Figure 18 and Table 15). This is consistent with all reports (except one very recent one [48]) that has considered the long term trends in emergency admissions. [4, 5, 6, 7, 21, 49] As noted in the introduction to this thesis, this rise in emergency admissions to hospitals causes major concerns for British society. The substantial resource implications of this rise has implications for funding of the National Health Service. Similar rises have been seen in health care systems in other countries. While many reasons have been suggested for the long term rise in emergency hospital admissions, none has yet been proven to be actually causing the increase. Indeed, it may be that no cause of the rise will ever be proven.

The other time related factor considered in this study was the variation in numbers of emergency medical admissions through the week (Figure 19 and Table 16). The pattern of a peak in the number of emergency admissions on Mondays, with a weekend trough bottoming out on Sundays has been found in other studies.[52] Although these results were not adjusted for public holidays, because the largest number of British public holidays falls on Monday, the peak in admissions found on Mondays would probably be even larger had such adjustment been made.

Hospitals also have been shown to have their highest numbers of elective admissions on Mondays.[52] The coincidence of the peaks of elective and emergency admissions (over which hospitals may have much less control) does have resource implications for hospitals. Their staff will be busiest on Mondays, when there will also be the greatest pressure on their beds.

7.2.2 Person factors

Patients' age

This study's finding of rising emergency medical admission rates for both men and women with increasing age (increasing by approximately 60% per decade; Table 21 and Figure 23) is consistent with previous studies.[4, 5, 21, 45, 73, 74, 75, 77, 90, 91, 92] This rise should be expected as older people have more frequent illnesses with more complications and hence a greater need for medical care. In addition, they may have less community social support.[4, 45] All of these factors will result in increased numbers of admissions to hospitals amongst the elderly.

The plateau in emergency medical admission rates amongst patients aged over 90 years was probably an artefact. This would be due to expansion of the denominator due to CHI inflation, which is greatest amongst very old patients. To minimise the effects of this artefact on this study's results, all adjusted admission ratio calculations used a top age band containing all patients aged 80 years and above. This was also appropriate because of the very small numbers of patients aged 90 years and above.

Patients' sex

In 1997, men and women had almost exactly the same crude emergency medical admission rates (Table 21). However, apart from the group aged over 90 years, men had higher consistently higher age specific emergency medical admission rates than women at all adult ages. This disparity increased with age (Figure 23). This result is consistent with the observation that men have a shorter life span and greater mortality rates. They may be likely to have more admissions than correspondingly aged women, who will in general be healthier. This would lead one to predict higher adjusted admission rates for men.

At the time that this study was commenced, no reports of an association between patients' sex and variations in emergency hospital admission rates were found. Two recent studies have reported this association between male sex and increased emergency admissions. One of these was restricted to emergency admissions to geriatric medicine,[77] while the other was an incidental finding of an analysis of the effects of supply side variations.[75]

7.2.3 Place factors

Socio-economic deprivation

Individuals' socio-economic deprivation was measured using Carstairs' deprivation categories. This is an area-based proxy measure and therefore deprivation has been considered as a place factor rather than a person factor. (Patients' Carstairs' deprivation categories are derived from where they live rather than from their individual material circumstances.) The potential for ecological bias when using area based measures has been discussed above.

This study showed that in Glasgow, people from more deprived areas of the city were more likely to be admitted to hospital as medical emergencies (Figure 24 and Table 22). This association with greater socio-economic deprivation is to be expected as many adverse health outcomes, which may necessitate emergency hospitalisation, have been shown to be associated with socio-economic deprivation.[57 - 62, 67, 79]

Despite the fact that extrapolation from these (and other) other studies might lead one to predict this relationship, only four studies appear to have examined this possible association. The first study that reported this association did not use patient level data, but used instead general practices' mean Townsend scores and showed that practices with more deprived patients had higher emergency medical admission rates.[73, 74] The remaining studies were published after this project was commenced. Round used patient level data to show the same association.[75] A recent study in Nottingham using patient level data has reported increasing geriatric emergency admissions amongst the more deprived elderly.[77] The very recent study from Reid *et al*[78] had similar findings of an association between deprivation and admission rates.

It is not possible to compare directly the magnitude of the effect of deprivation found in this study with the other ones for two major reasons. Firstly, the other studies used different deprivation measures. Secondly, the populations were themselves different. In all of the other studies, English rather than Scottish data were used. This implies that the study populations were less deprived. Moreover, one study was of emergency admissions of elderly patients only.

Patients' distance from hospital

In this study, distances between patients' homes and their nearest hospitals was not associated with variations in emergency medical admission rates in Glasgow (Figure 30). This remained true after adjustment for age, sex and deprivation categories as shown in Figure 32.

The findings of other studies that have investigated this potential factor have been contradictory. One study has reported that the distances between patients' homes and their admitting hospitals was inversely associated with emergency admission rates. [73, 74] Another study has however reported that patients living further away were more likely to be admitted to hospital. [75] These studies had both used adjustments for patients' age, sex and deprivation characteristics. In addition, both of these were undertaken in areas with substantial rural populations. The negative finding of this study may result from the fact that the city of Glasgow has smaller distances, with no large, sparsely populated rural districts. It does concur with the very recent study from Reid *et al.* [78]

7.2.4 Diagnoses

The changing pattern of diagnoses giving rise to emergency medical admissions shown in Figure 22 suggests that while all diagnoses have been rising, the non-pathological diagnoses included in the group "Symptoms, signs ..." have been increasing fastest. The rapid rise in these diagnoses was also noted by Kendrick.[4] Edwards and Haycock[14] suggested (see page 111 above) that the National Health Service would experience increased number of 'less serious' admissions that could be amenable to outpatient management. Their prediction is consistent with the findings of this thesis. This suggests that the introduction of outpatient pre-admission assessment facilities, such as chest pain clinics, would be most useful for diagnoses in the "Symptoms, signs..." grouping (ICD10 chapter XVIII). Chest pain clinics[199] would also be valuable, because the 18.9% of all emergency medical admissions present with clinical problems that would be managed in these clinics. (Chest pain accounted for 9.6% of admissions, with angina at 5.4% and acute myocardial infarction at 3.9%, Table 20).

7.3 GENERAL PRACTICE AND HOSPITAL FINDINGS

In this section, I shall discuss the findings of this study in relation to the second objective. This study was designed as an investigation of variations between general practices. However, the study's results have suggested that there was a close relationship between the emergency medical admission rates of general practices and those of Glasgow's hospitals.

I shall initially discuss variations between general practices. This is followed by a short sub-section on hospital variations. The section concludes with a brief discussion of the relationship between hospitals' and general practices' variations in rates of emergency medical admissions.

7.3.1 General practices

The wide variation (2.51 fold) in the crude emergency medical admission rates of Glasgow's general practices was an important finding of this study (Figure 33). These crude rates must be adjusted before it is possible to make any meaningful interpretation of variations in emergency medical admission rates. This study has already showed that patients' ages, sex and Carstairs' deprivation categories were all associated with variations in rates of emergency medical admission. In the absence of adjustment for these factors, the variations between general practices could simply be due to differences in the relevant characteristics of the patients who comprise the practices' lists. Because this study had used anonymous patient level data, linked at the level of general practices, it was possible to make the necessary adjustments.

Following adjustment for patients' age, sex and deprivation status using the method of indirect standardisation, a substantial (1.85 fold) difference in emergency medical admission ratios between top and bottom deciles of practices remained (Figure 34). This residual variation was intriguing and unexpected. It was very close to the 1.69 fold variation in adjusted ratios recently found by Reid *et al.* [78]

Figure 35 shows clearly that there is a substantial relationship between crude and standardised emergency medical admission rates which suggests that suggesting strongly that there are other causes of variation in practice rates. The R^2 value of 0.479 implies that about 52% of the variation in practices' crude emergency medical admission rates was accounted for by adjustment for their patients' ages, sex and Carstairs' deprivation categories. The remaining 48% requires further explanation. If there were no relationship between the crude and the standardised rates, this would imply that the remaining variation between practices' emergency medical admission rates was truly random and that the standardisation process had adjusted for all of the variations.

In order to investigate whether these variations in outcome measures were associated with differences in the nature of practitioners' clinical practices, associations between these adjusted standardised rates and practice outcome indicators were sought. Unfortunately, no outcome indicators directly relating to general practice activity are routinely collected. While practices' standardised mortality ratios may appear to be an attractive outcome indicator for general practices, these are derived from area based data rather than being based on the deaths of patients of individual practices. They are therefore not outcome measures for individual general practices. (They do however have a place in the planning of primary care services.)

The significant association between general practice fundholding and higher adjusted emergency medical admission rates is an important finding. This contradicts the recent report of Reid *et al* who found an inverse association between practices' emergency medical admission rates and their fundholding status. [78] Other, much smaller, studies have found either no association between fundholding and emergency medical admissions [76, 100, 166] or a negative association [167] or a positive association. [168] This study is the first large scale study to provide evidence supporting Keeley's suggestion that because fundholding practices are not charged for urgent admissions, investigations and some elective hospital work may be referred as emergency admissions. The resulting savings for practice funds would be an incentive to increase emergency referrals amongst fundholders. [165]

The relationship of general practice fundholding with variations in emergency medical admission rates was complex (Table 26). Non-fundholding general practices had lower rates of emergency medical admissions than all of the varieties of fundholders. It is more difficult to test the effects of the fundholding scheme on non-fundholding practices however. It is probably not worthwhile attempting to interpret the effects of different varieties of fundholding on emergency medical admissions seen in Table 26.

A limited range of proxy outcome data for individual general practices was available. This study failed to find any meaningful relationships between practices' adjusted standardised emergency medical admission ratios and any of these proxies (Table 27). This suggested that the residual variations in emergency medical admission ratios, after adjustment, was probably due to factors extrinsic to the general practices. Reid *et al* had similar findings and conclusions in their paper which was published while the final draft of this thesis was being written. [78]

As many as 51% of emergency hospital admissions have referred themselves to hospital. [21, 38, 74, 90, 100, 108, 109] Unlike elective admissions to hospitals, self referred admissions to hospitals are not directly under the control of general practices.[8, 125] Since hospitals must have their own internal gatekeepers for emergency admissions, it is unlikely that the variation between practices was due to differences in patients' self-referrals.

Since 1996, the Glasgow Emergency Medical Service (GEMS) has provided out of hours cover for almost all of Glasgow's general practitioners.[87] This may have reduced the variations between Glasgow's general practices, because it introduced a common pathway for all practices' emergency referrals to hospitals at nights and weekends.

Two of the Greater Glasgow Health Board's general practitioner localities showed elevated adjusted rates of emergency medical admissions (Figure 37, Table 25). These elevated practice based rates were consistent with the raised postcode sector based rates that had already been noted in the north and south-west of Glasgow (Figure 32). This merited further investigation, as it appeared that there might be an association with the local hospitals.

The differences in patterns of diagnoses of chest pain and acute myocardial infarction seen in Figure 40 are interesting. Chest pain was the commonest medical reason for emergency admission to hospital in 1997. General practices with higher adjusted emergency medical admission ratios appeared to have had substantially higher proportions of (myocardial infarction negative) chest pain than those with low ratios. The R^2 values do suggest that between 14% and 17% of the variation in emergency medical admission ratios may have been associated with differences in patients' discharge diagnoses. (Circulatory disease R2 = 0.17, "Symptoms, signs..." R2 = 0.14). That, however, does not imply that general practitioners were making different proportions of referrals. Confounding factors such as patients' self-referrals or hospital-mediated effects might also have explained this observation.

7.3.2 Hospitals

It would seem reasonable to expect that Glasgow's five hospitals would have had broadly comparable adjusted emergency medical admission ratios. Therefore, the finding (Table 35) that two hospitals had substantially higher emergency admission ratios than the other hospitals was unexpected. This finding was based on the use of catchment area boundaries that were derived especially for this study. However, this finding is probably an accurate reflection of reality as it is supported by two independent observations, neither of which depends on the derived catchment areas. Figure 37 and Table 25 show that the Greater Glasgow Health Board general practitioner localities that are central to these hospitals' catchment areas had the highest admission ratios. Figure 32 which uses a postcode sector based denominator shows that the north and south west of Glasgow had the highest emergency medical admission ratios. The disparity between the results based on the Greater Glasgow Health Board's "official" catchment areas and those derived for this study suggests that, for emergency medical admissions at least, the "official" catchment areas should be abandoned.

The variations in diagnostic groupings of the patients of Glasgow's hospitals (Table 33) suggest that the hospitals with the highest emergency medical admission ratios also had the highest proportions of diagnoses of "Symptoms, signs..." compared with cardiovascular disease. This was consistent with Edwards and Haycock's [14] predictions of the effects of increased supply side generated activity (page 111).

7.3.3 General practices and hospitals

Differences between hospitals' admission ratios were shown to be responsible for a large part of the residual differences between general practices' emergency medical admission ratios. This was shown firstly by the reduction of differences in general practices emergency admission rates, following additional adjustments for admitting hospitals (Figure 47, Figure 48). The R^2 value of 0.157 suggests that almost 85% (Table 36) of the variation between the crude emergency medical admission rates was accounted for by differences in practices' patients' ages, sex, Carstairs' deprivation categories and their admitting hospitals. This compares with 52% that was accounted for without adjustment for hospitals (Table 36). Figure 49 confirms that the patients of practices with high adjusted emergency medical admission ratios tended to be admitted to hospitals which had the highest ratios. These findings suggest very strongly that differences between hospitals account for a substantial part of the differences between practices' emergency medical admission rates. These hospital differences may relate to clinical variations, or to differences in diagnostic and coding practices. Nevertheless, they require further investigation.

Figure 50 showed that the relationship between diagnoses and adjusted admission ratios was much less following adjustment for admitting hospitals (compare with Figure 40). The R^2 values for circulatory disease fell from 0.17 to 0.077 and for "Symptoms, signs..." from 0.14 to 0.040 following adjustment for admitting hospitals. This fall confirms that the differences between practices' diagnostic patterns was highly dependent on differences between hospitals.

All of these findings suggest very strongly that for emergency medical admissions, it is hospitals that act as the gatekeepers rather than general practitioners. Hospitals are responsible for their emergency medical admission rates. Hospitals are also responsible for deciding whether or not patients with Edwards and Haycock's "less serious" diagnoses should be admitted. [16] Although these differences arise within hospitals, they will be reflected in differences between general practices admission patterns.

That general practices' variations in emergency admission rates may originate outwith their practices, should be borne in mind when considering Donald Acheson's comment: "The variation is, to put it mildly, hard to explain – certainly on morbidity" [grounds]. [18]

Despite the passage of 14 years since Acheson made his comment, and despite evidence of ideal referral rates, The Scottish Office recently announced that Scottish General practitioners would soon be facing examination of their emergency referral rates. [252] This study would suggest that hospitals, rather than general practitioners, should be targeted in examination of emergency medical rate admission variations.

This study has raised fundamental questions about the value of using general practitioners emergency medical admission rates as a marker for the quality of their clinical practices. While admission rates are readily accessible from routine data, they do not appear to represent valid quality indicators for general practice. [253] No research has been published suggesting what practices' ideal emergency admission rates should be. Apart from this study's finding of the perverse incentive provided by fundholding, there is little evidence from this study or elsewhere suggesting that general practices can affect their emergency admission rates. However, this study has found that a substantial influence on general practitioners' emergency medical admission rates lies outwith their practices, in hospitals. Because of this, emergency medical admission rates should not be used as measures of practice quality.

CHAPTER 8—

CONCLUSIONS

8.1 CONCLUSIONS OF THIS STUDY

This study had two aims. These were:

1. To investigate the epidemiology of emergency medical admissions in Glasgow
2. To explore variations in Glasgow's general practices' and hospitals' emergency medical admission rates.

In identifying and describing variations in Glasgow's emergency medical admission rates in terms of time, person and place factors, this study successfully achieved its first aim. The finding of a strong association between emergency medical admission rates and socio-economic deprivation, while predictable, had not been previously reported when the study was commenced. Increased age specific emergency medical admission rates for men had also not been reported before this study was conducted. While this was a new observation, it was consistent with the known pattern of population mortality.

Variations in rates of emergency medical admission between general practices and hospitals were investigated. Glasgow's general practices and hospitals had differing rates of emergency medical admissions, even after adjustment for their patients' characteristics. A small association with fundholding status was the only general practice parameter which was associated with variation in emergency medical admission rates. This finding had been predicted [165] but has not previously been reported. The discovery that variations between general practices in Glasgow could be largely explained by differences between their local admitting hospitals' rates of emergency medical admissions was unexpected. Together, these findings confirm the success of this study, achieving its second aim.

A further success of this study was that it showed that it is possible to establish complex linkages between two large databases that were originally established for entirely different purposes. Without this linkage, this study could not have made any of the important discoveries reported here. Similar large dataset linkages may be used in the future for health needs assessment to inform the planning of health care delivery.

The study also showed that the rise in emergency medical admissions has not been an artefact, but has been genuine. The finding that the patterns of patients' diagnoses leading to their admissions had changed over time is unlikely to have arisen from major changes in patterns of illness. However, it could be explained by the introduction of specific new health care interventions (treatments and diagnostic procedures) into the National Health Service. If this is the case, we should expect the numbers of emergency medical admissions to continue to rise in response to further medical developments.

The finding of wide variations in emergency admission rates with patients' age, sex and deprivation characteristics shows that any analysis of such rates for general practitioners must be adjusted to account for these patient factors. Several health authorities have recently used such crude rates for various purposes. In the absence of such standardisation, these crude rates are at best meaningless. However, potentially misleading conclusions could be drawn from differences between practices' crude rates and ill informed planning decisions made on this basis. The use of such crude admission rates in the development of quality standards in general practice might further disadvantage health care providers in deprived areas, further diminishing health care provision for socially excluded and elderly patients.

This study showed that in Glasgow, supply side factors arising in general practices' admitting hospitals appeared to be responsible for a substantial part of the variation in practices' rates of emergency medical admissions. Clearly, practices will have very little ability to effect change in their local hospitals' admission practices.

This study did not find a clear association between general practices' emergency medical admission rates and markers of practice activity or quality. Taken together, these findings provide evidence supporting the conclusion that admission rates (even if adjusted for practice patient populations) should not be used as indicators of practice quality or activity levels. This conclusion may be expected. As discussed in the literature review, there is still no wide consensus about the mechanisms that have caused the rise in emergency admissions. The use of emergency admission rates as a quality marker when little is understood about the patterns of such admissions must be untenable.

Two explanations for the recent use of emergency medical admissions in health service planning are possible. Firstly, they are relatively readily accessible using modern computer databases. Secondly, emergency admissions are, by their nature, costly for the health service. Their recent use suggests that there may have been a degree of confusion between the cost of delivering health care and its quality. Emergency medical admissions should not be used as a measure of practice quality until a clear link between emergency medical admission rates and improved health care outcomes has been established.

The literature review conducted for this study indicated that there was a surprising lack of reported research in the area of emergency hospital admissions. Indeed, identification of relevant literature using the established bibliographic medical databases required the development of a complex search strategy. This showed that it was possible to identify much of this scanty literature, despite the poor indexing of articles in dealing with emergency admissions. The observation that there were fewer peer-reviewed research reports than articles containing opinion and grey literature suggests that work in this area might not be appealing for potential researchers. Alternatively, publishers may be disinclined towards submissions relevant to the rise in emergency admissions. At the conclusion of the current study, it is clear that there remains a dearth of published research investigations of causes of the rise in emergency admissions. In addition, hospitals' coping strategies for dealing with increased demand for admissions require proper evaluations to be reported in the public domain.

There remains a need for further studies in the field of emergency medical admissions. As Wears put it about American healthcare resources, "we owe it to our patients to ensure that their need for [healthcare] service is expressed...in a manner that best meets those needs. The only way in which we are likely to discover new methods and techniques in estimating the need for emergency medical services is to encourage more investigators to risk failure by further work in this area." [254]

This study design did not allow examination of the underlying causes of the proven rise in rates of emergency medical admissions. It is important nevertheless to obtain an understanding, however imperfect, of some of the factors associated with emergency medical admissions. In meeting its aims, this study has added to the body of knowledge about emergency medical admissions. Despite the large and growing numbers of emergency medical admissions, there has been, until recently, very little published research in this area. This study has contributed to the epidemiological knowledge of factors relating to emergency medical admissions.

8.2 RECOMMENDATIONS

8.2.1 Dissemination of results

As noted in the preface of this thesis, several publications and presentations of the new epidemiological findings of this study have already been made. Publication on the Internet is planned. The results of this study will also be presented to senior staff of the Greater Glasgow Health Board.

Because of the lack of published evidence about emergency medical admissions, the findings of this study should be further disseminated. Three specific areas require to be more widely aired. The results suggesting that hospitals are responsible for a large part of the variation between general practices should be published in a peer reviewed journal as they are new findings. The finding of a modest association between general practice fundholding and increased emergency medical admission rates needs to be made widely known. Lastly, a summary of the literature review should also be submitted for publication as no review of the epidemiological literature of emergency medical admissions has been published.

8.2.2 Further research

This study could be repeated on a Scotland-wide basis. Complexities would arise from the differences between the CHI databases of different health boards. In the 1980's it was proposed that a national Scottish CHI (covering all general practices in Scotland) should be established. If this "super-CHI" had been implemented, such a national study would be comparatively simple. In April 1999, the CHIs of the all of the Scottish health boards were transferred from health boards to the Common Services

Agency. It remains to be seen whether this agency will combine all of these CHIs into one single database, which would again make a such a national study possible.

The benefits of such an extended national Scottish study would include:

- The potential to examine factors relating to the differences between urban and rural patients
- With increased numbers of less deprived patients, a broader view on the effects of socio-economic deprivation might be obtained
- The effects of variations in out of hours care patterns in different parts of Scotland could be examined
- With the greater distances involved, distance factors may be considered.
- The special problems of remote and island communities could be studied
- The findings might be able to be generalised, with caution, to other geographical areas.

Potential problems with such an extended study would include increased difficulties of data handling, possible greater heterogeneity of hospitals' management of patients and data, and probable difficulties with the definitions of hospital catchment areas in other cities and rural areas.

A second avenue would be to use other datasets for epidemiological research on emergency medical admissions. Had the linked dataset [44] been available for 1997 admissions, it would have been possible to have undertaken several further analyses in this study. These could have included readmissions to hospital, patients' survival following emergency medical admission including patients' deaths in the community following discharge from hospital. It was also not possible to use earlier years' linked SMR1 data to calculate emergency medical admission rates, as no earlier archived CHI datasets could be located.

The SMR1 dataset does not contain the time of day at which a patient was admitted to hospital. Analyses of times of the day might may have been interesting, as a means of distinguishing between patients referred by their own general practitioners and those referred by a deputising doctor or one based in a general practitioner co-operative. Another useful SMR1 data field would have been an indicator of the source of referral of patients: whether they had referred themselves or been sent to hospital by their general practitioners or a deputy. While some individual hospital trusts' patient administration computer systems do have optional fields for recording these data items, these datasets were not available for linkage in this study. Moreover, my personal experience in other studies [251, 255] has been that the quality of these data items is poor, probably because they are not standard SMR1 data fields and therefore not subject to audit of data quality.

A third direction for further research would be to further investigate the noted inter-hospital variations in diagnoses. In this study, chest pain and myocardial infarction were discovered to be significant. Other diagnoses may be shown to be important in subsequent studies. Further studies could consider whether these differences were due to different:

- Hospital admission policies including the implementation and use of outpatient rapid investigation clinics
- Clinical management approaches following patients' admissions
- Differences in diagnostic procedures
- Coding practices in different hospitals.

A study of this nature would require the identification of such differences – probably by the use of routine data. This would be followed by special (probably qualitative) studies within the individual hospitals to identify the sources of variation. A major objective of such projects would be to determine whether these differences were artefactual or real. If real, would changes within the hospitals affect their emergency medical admission rates? What would be the costs of such changes?

The fourth avenue for further study could be the use of multi-level modelling of variations in emergency medical admission rates. This could aim to establish the relative extent of the effects of factors operating at different levels. Considerable technical problems arising from the large size of the datasets would have to be addressed.

A fifth area needing research is more formal evaluations of interventions within hospitals to cope with peaks in demand for emergency medical admissions. This need has been highlighted by the literature review of this thesis. A particular need is for formal evaluations of emergency assessment (pre-admission) outpatient clinics, as these have the potential to best manage the rise in admission of more minor diagnoses, such as those in the group of "Symptoms, signs...". Chest pain clinics in particular should be formally evaluated, as they would provide a paradigm for the extension of rapid assessment clinics for the management of other clinical presentations.

A final focus for further research in the area of emergency medical admissions would be to investigate the supply-side effects of variations in the supply of hospitals' resources, especially beds, on admission rates. Such an investigation would ideally be based on a controlled supply side intervention. Clearly, this could not be a blinded study. In addition, given the sensitivity of the public, politicians and the media to resource issues in the National Health Service, a planned intervention may not be possible. "Natural experiments" where for example, a service becomes unavailable for reasons not related to research, could be opportunistically studied and provide useful information.

APPENDICES

APPENDIX 1 —
COMPUTER PROGRAMS

Text Box 9 — WordBasic code for restructuring downloaded Ovid records

```
Public Sub ovidfixup2()


Rem bracket every reference item with manual page breaks
WordBasic.EditReplace Find:="^p^p<", Replace:="^m<",
   ReplaceAll:=1, Wrap:=1,
WordBasic.EditReplace Find:="^p<", Replace:="^m<",
   ReplaceAll:=1, Wrap:=1
WordBasic.EditReplace Find:="^p^p", Replace:="^m",
   ReplaceAll:=1, Wrap:=1


Rem this loop "brackets" the headers
Rem flag all ovid paragraph headers with * and ***:***
WordBasic.StartOfDocument
WordBasic.EditFind Find:="^p^$", Wrap:=0
While WordBasic.EditFindFound()
    Rem at start of line put in a *
    Selection.HomeKey Unit:=wdLine
    Selection.MoveDown Unit:=wdLine, Count:=1
    Selection.TypeText Text:="*"
    Rem at end of line, insert "***:***"
    Selection.EndKey Unit:=wdLine
    Selection.TypeText Text:="***:***"
    Rem go to next line
    Selection.MoveDown Unit:=wdLine, Count:=1
    Rem and finish the loop
    WordBasic.EditFind Find:="^p^$",  Wrap:=0
    Selection.HomeKey Unit:=wdLine
Wend


Rem change all line ends with two spaces to single spaces -
   collapsing paragraphs correctly
Selection.HomeKey Unit:=wdStory
WordBasic.EditReplace Find:="^p  ", Replace:=" ",
   ReplaceAll:=1, Wrap:=1


Rem change all paragraphs to tabs (make tabbed records)
WordBasic.EditReplace Find:="^p", Replace:="^t",  ReplaceAll:=1,
   Wrap:=0
Rem change page breaks to para ends - finish making tabbed
   records
```

```
WordBasic.EditReplace Find:="^m", Replace:="^p",  ReplaceAll:=1,
   Wrap:=0


Rem delete blank lines
WordBasic.EditReplace Find:="^p^t^p", Replace:="^p",
   ReplaceAll:=1, Wrap:=0
WordBasic.EditReplace Find:="^p^p", Replace:="^p",
   ReplaceAll:=1, Wrap:=0


Rem this loop numbers the individual fields of each paragraph
WordBasic.StartOfDocument
WordBasic.EditFind Find:="<",  Wrap:=0
While WordBasic.EditFindFound()
    Rem at start of line, delete <
    WordBasic.StartOfLine
    WordBasic.EditClear
    Rem find > & move back to before it
    WordBasic.EditFind Find:=">",  Wrap:=2
    WordBasic.CharLeft 1
    Rem secelt to start of line & copy it. This is the ovid ref
   number
    WordBasic.StartOfLine 1
    WordBasic.EditCopy
    Rem restore the opening <
    WordBasic.CharLeft 1
    WordBasic.EditUndo
    Rem now select the record and put this number from the
   clipbaord into all tabbed fields of the current record
    WordBasic.ParaDown 1, 1
    WordBasic.EditReplace Find:="^t", Replace:="^t*^cKW*",
   ReplaceAll:=1, Wrap:=0
    Rem next para
    WordBasic.ParaDown 1
    Rem and finish the loop
    WordBasic.EditFind Find:="<",  Wrap:=0
    WordBasic.StartOfLine
Wend


Rem the next loop replaces all full stops in authors sections
   with commas
WordBasic.StartOfDocument
WordBasic.EditReplace Find:="^t*", Replace:="^p",
   ReplaceAll:=1, Wrap:=2
WordBasic.StartOfDocument
```

```
WordBasic.EditFind Find:="Authors***:***", MatchCase:=1, Wrap:=0
While WordBasic.EditFindFound()
    WordBasic.StartOfLine
    WordBasic.ParaDown 1, 1
    WordBasic.EditReplace Find:=". ", Replace:=", ",
   ReplaceAll:=1, Wrap:=0
    WordBasic.ParaDown 1
    WordBasic.EditFind Find:="Authors***:***", MatchCase:=1,
   Wrap:=0
Wend


WordBasic.StartOfDocument
WordBasic.EditReplace Find:="KW**", Replace:="^t", MatchCase:=1,
   ReplaceAll:=1, Wrap:=2
WordBasic.EditReplace Find:="***:*** ", Replace:="^t",
   MatchCase:=1, ReplaceAll:=1, Wrap:=2


Rem this loop deletes all opening <nnn> paras
WordBasic.StartOfDocument
WordBasic.EditFind Find:=">^p", MatchCase:=1, Wrap:=0
While WordBasic.EditFindFound()
    WordBasic.StartOfLine
    WordBasic.EndOfLine 1
    WordBasic.EditClear
    WordBasic.EditFind Find:=">^p", MatchCase:=1, Wrap:=0
Wend
WordBasic.StartOfDocument
WordBasic.EditReplace Find:="  ", Replace:=" ", MatchCase:=1,
   ReplaceAll:=1, Wrap:=2
WordBasic.EditReplace Find:="  ", Replace:=" ", MatchCase:=1,
   ReplaceAll:=1, Wrap:=2
WordBasic.EditReplace Find:=" ^p", Replace:="^p", MatchCase:=1,
   ReplaceAll:=1, Wrap:=2
WordBasic.EditReplace Find:=".^p", Replace:="^p", MatchCase:=1,
   ReplaceAll:=1, Wrap:=2
WordBasic.EditReplace Find:=",^p", Replace:="^p", MatchCase:=1,
   ReplaceAll:=1, Wrap:=2


End Sub
```

Text Box 10 — SAS script used for extracting CHI data.

```
data _NULL_;
    set chidata.allchi;
    where gpref is not missing;
    keep postcode dob centbrth sex gpref ptncd;
    file 'chiextr.dat';
    put postcode dob centbrth sex gpref ptncd;

run;
```

Text Box 11 — Sample SAS script used for extracting 1997 SMR01 (COPPISH) data.

```
data _NULL_;

    set lib1.smr1cop;
    where admtype between '30' and '39'
        and disdate between '01apr97'd and '31dec97'd
        and spec in ('A1', 'A2', 'A8', 'A9', 'AG', 'AR', 'AQ',
   'AA',
                     'AC', 'C3', 'AB', 'J4', 'H1' );
    keep hbres hosp dob age sex postcode gpprac admtype admdate
      disdate cat spec dg1 dg2 dg3 dg4 dg5 dg6 areasp admsrce;

    file 's01y97.asc';
    put hosp      1-5           hbres     6
        dob       7-14          sex       15
        postcode 16-22          gpprac    23-27
        admtype  28-29          admdate   DDMMYY6.
        disdate  DDMMYY6.       cat       42
        spec     43-45          dg1       46-51
        dg2      52-57          dg3       58-63
        dg4      64-69          dg5       70-75
        dg6      76-81          areasp    82-83
        admsrce  84-85          age       86-89 ;

run;
```

Text Box 12 — Sample SAS script used for extracting 1997 SMR1 data.

```
data _NULL_;

* this extracts SMR1 records for all patients treated in the
   Greater
* Glasgow Health Board in 1997

    set lib1.smr1cur;
    where tadm ge '4'
       and disdate between '01jan97'd and '31mar97'd
       and spec in ('16', '17', '18', '21', '24', '25', '28',
   '32',
                    '36', '41', '48', '50', '62', '33', 'IT',
   'CU');
    keep hbres hosp dob age sex postcode gpprac tadm admdate
   disdate
         cat spec dg1 dg2 dg3 dg4 dg5 dg6 areasp adtf;

    file 's1y97.asc';
    put hosp     1-5             hbres    6
        dob      7-14            sex      15
        postcode 16-22           gpprac   23-27
        tadm     28              admdate  DDMMYY6.
        disdate  DDMMYY6.        cat      41
        spec     42-43           dg1      44-49
        dg2      50-55           dg3      56-61
        dg4      62-67           dg5      68-73
        dg6      74-79           areasp   80-81
        adtf     82              age      83-85 ;

run;
```

Text Box 13 — Access Basic programme used to calculate distances

```
Function funDistanceSQ(X1, X2, Y1, Y2 As Variant) As Variant
' this function returns the square of the distance between
   points (X1, Y1) and (X2, Y2)
' It is used by function funDistance to calculate a Pythagoras'
   theorem distance


Dim dX, dY As Double


    If VarType(X1) < 2 Or VarType(X1) > 5 _
    Or VarType(X2) < 2 Or VarType(X2) > 5 _
    Or VarType(Y1) < 2 Or VarType(Y1) > 5 _
    Or VarType(Y2) < 2 Or VarType(Y2) > 5 Then
        funDistanceSQ = Null
        Exit Function
    End If

    dX = X1 - X2
    dY = Y1 - Y2
    funDistanceSQ = (dX * dX) + (dY * dY)
End Function



Function funDistance(X1, X2, Y1, Y2 As Variant) As Variant
' this function returns the distance between points (X1, Y1) and
   (X2, Y2)
' calculated by Pythagoras theorem

    Dim Dsq As Variant

    Dsq = funDistanceSQ(X1, X2, Y1, Y2)

    If VarType(X1) >= 2 And VarType(X1) <= 5 Then
        funDistance = Sqr(Dsq)
    Else
        funDistance = Null
    End If

End Function
```

Text Box 14 — SQL code for calculating standardised ratios and confidence intervals

```
qry1InputNumeratorEvents:

SELECT tblHospCodes.Hospital AS ClusterVar,
   [tblSMR1ExportSexAgeDEPCATPCHospPracCounts]![SexAgeDEPCAT]
   AS StandardisingVar,
   Sum(tblSMR1ExportSexAgeDEPCATPCHospPracCounts.CountOfSex) AS
   CountEvents

FROM tblHospCodes INNER JOIN
   (tblSMR1ExportSexAgeDEPCATPCHospPracCounts INNER JOIN
   tblCatchments ON
   tblSMR1ExportSexAgeDEPCATPCHospPracCounts.PCODE =
   tblCatchments.GGHBPC) ON tblHospCodes.HospNo =
   tblSMR1ExportSexAgeDEPCATPCHospPracCounts.HospNo

GROUP BY tblHospCodes.Hospital,
   [tblSMR1ExportSexAgeDEPCATPCHospPracCounts]![SexAgeDEPCAT];


qry2InputDenominatorPop

SELECT tblHospCodes.Hospital AS ClusterVar,
   tblCHIExportSexAgeDEPCATPCPracCounts.SexAgeDEPCAT AS
   StandardisingVar,
   Sum(tblCHIExportSexAgeDEPCATPCPracCounts.CountPatients) AS
   CountPop

FROM (tblCHIExportSexAgeDEPCATPCPracCounts INNER JOIN
   tblCatchments ON tblCHIExportSexAgeDEPCATPCPracCounts.PCODE
   = tblCatchments.GGHBPC) INNER JOIN tblHospCodes ON
   tblCatchments.GGHBCatch = tblHospCodes.HospNo

GROUP BY tblHospCodes.Hospital,
   tblCHIExportSexAgeDEPCATPCPracCounts.SexAgeDEPCAT;


qry3CountActualEvents

SELECT qry1InputNumeratorEvents.ClusterVar,
   Sum(qry1InputNumeratorEvents.CountEvents) AS ActualEvents

FROM qry1InputNumeratorEvents

GROUP BY qry1InputNumeratorEvents.ClusterVar;


qry3aCountDenominatorPopulation

SELECT qry2InputDenominatorPop.ClusterVar,
   Sum(qry2InputDenominatorPop.CountPop) AS ActualPop

FROM qry2InputDenominatorPop

GROUP BY qry2InputDenominatorPop.ClusterVar;


qry4CountStandardEvents

SELECT qry1InputNumeratorEvents.StandardisingVar,
   Sum(qry1InputNumeratorEvents.CountEvents) AS Events

FROM qry1InputNumeratorEvents

GROUP BY qry1InputNumeratorEvents.StandardisingVar;
```

```
qry5CountStandardPop

SELECT qry2InputDenominatorPop.StandardisingVar,
    Sum(qry2InputDenominatorPop.CountPop) AS Pop

FROM qry2InputDenominatorPop

GROUP BY qry2InputDenominatorPop.StandardisingVar;


qry6CalcSpecificRates

SELECT qry4CountStandardEvents.StandardisingVar, [events]/[pop]
    AS SpecificRate

FROM qry4CountStandardEvents INNER JOIN qry5CountStandardPop ON
    qry4CountStandardEvents.StandardisingVar =
    qry5CountStandardPop.StandardisingVar;


qry7CalcExpectedEvents

SELECT qry2InputDenominatorPop.ClusterVar,
    Sum([countpop]*[SpecificRate]) AS ExpectedEvents

FROM qry6CalcSpecificRates INNER JOIN qry2InputDenominatorPop ON
    qry6CalcSpecificRates.StandardisingVar =
    qry2InputDenominatorPop.StandardisingVar

GROUP BY qry2InputDenominatorPop.ClusterVar;


qry8CalcRatesStandardRatios

SELECT qry7CalcExpectedEvents.ClusterVar,
    [qry3CountActualEvents]![ActualEvents]/[qry3aCountDenominato
    rPopulation]![ActualPop] AS CrudeRate,
    100*[Upper]/[ExpectedEvents] AS StdRatio95pcUCI,
    100*[Lower]/[ExpectedEvents] AS StdRatio95pcLCI,
    100*[ActualEvents]/[ExpectedEvents] AS StdRatio

FROM qry3aCountDenominatorPopulation INNER JOIN
    ((qry7CalcExpectedEvents INNER JOIN qry3CountActualEvents ON
    qry7CalcExpectedEvents.ClusterVar =
    qry3CountActualEvents.ClusterVar) LEFT JOIN
    tblPoisson95PCCIvalues ON qry3CountActualEvents.ActualEvents
    = tblPoisson95PCCIvalues.ActualCount) ON
    qry3aCountDenominatorPopulation.ClusterVar =
    qry3CountActualEvents.ClusterVar;
```

APPENDIX 2 —
THE SMR1 AND SMR01 DATASETS

The following pages contain Figure 51, Figure 52 and Figure 53. These show replicas of the SMR1 and SMR01 data collection forms reproduced in a reduced format and indicate the relevant fields captured and held in these datasets.

Scotland - Inpatient and Day Case Records Summary Sheet **SMR1 Medical In Confidence**

Hospital ____________________

Time of admission/transfer ____________ Ward (WARD) 157-159

Previously attended this hospital? YES/NO

If YES state year

Address (ADDR) 160-219

Tel. no. Postcode

Religion

Next of kin (Relationship) ____________

Name ____________

Address ____________

Tel. no. ____________ Postcode ____________

Family Doctor

Name ____________

Address ____________

Tel. no. ____________ Postcode ____________

Provisional Diagnosis on Admission

Hospital Code (HOSP) 1-5

Hospital Case Reference No. (CRN) 6-15

Surname (SN) 16-35

First Forename (FN1) 36-50

Second Forename (FN2) 51-65

Maiden Name (MN)

Alternative Case Reference No. (ACRN)

Age .... Date of Birth (DOB)

Sex (SEX) 104 Marital State (MRST) 105

Postcode (PC)

GP Practice Code (GPPC)

GP GMC Number (GPC)

Admitted/transferred from (ADTF) 125 Type of Admission (TADM) 126

Date placed on Waiting List (DWL)

Date of Admission (DOA)

Date of Discharge (DOD)

Time of Discharge ____________ Discharge Code (DISC) 145

Category of Patient (CAT) 146 Type of Facility (TOF) 147

Specialty (SPEC)

Consultant Surname (CONS) 152-171

Consultant Initials 172-173 Consultant Code (CONC) 174-180

To be completed by doctor on discharge of patient

(1) Main Condition (DG1) (DG1C) 1-66

(2) Other Conditions (DG2) (DG2C) 67-132

(3) (DG3) (DG3C) 133-198

(4) (DG4) (DG4C) 1-66

(5) (DG5) (DG5C) 67-132

(6) (DG6) (DG6C) 133-198

(1) Main Operation (OP1) (OP1C) 1-68

(2) Other Operations (OP2) (OP2C) 69-136

(3) (OP3) (OP3C) 137-204

(4) (OP4) (OP4C) 1-68

Date of Main Operation (DOP1) → Date of Main Operation (DOP1) 69-74

ERROR REPORT COMMENT: Data items specified in boxes below are correct (COM)

Enter field abbreviations 75-134

Additional notes: ____________

Contract No. (CTN) 135-150

Local use (LUSE) 151-156

National use (NUSE) 157-162

Figure 51 — Sample SMR1 data collection form (page 1)

Key to Coded Items

Full Instructions for completing this form are contained in the SMR1 Manual

Sex (Sex)

1 Male
2 Female
8 Other or NK

Marital State (MRST)

1 Never Married - Single
2 Married - (Includes Separated)
3 Widowed
8 Other - (Includes Divorced)
9 NK

Admitted/Transferred From (ADTF)

1 Home (Usual Address)
2 Other NHS Hospital (Inpatient, Short Stay or Day Bed Facilities only)
3 Other Unit In This Hospital (Inpatient Facilities or Day Bed Units only)
8 Other

Type of Admission (TADM)

0 Deferred Admission
1 Waiting List/Diary/Booked
2 Repeat Admissions
3 Transfer

4 Emergency - Deliberate Self-inflicted Injury or Poisoning
5 Emergency - Road Traffic Accident
6 Emergency - Home Accident (*includes* Accidental Poisoning in the home)
7 Emergency - Other Injury (*includes* Accidental Poisoning *other than* in the home)
8 Emergency - Other (*excludes* Accidental Poisoning)

Discharge Code (DISC)

0 'Irregular' - eg Self Discharge
1 Home
2 Convalescent Hospital or Home
3 Other Hospital
4 Local Authority Care
5 Transfer to other specialty in same hospital
6 Died (PM)
7 Died (No PM)
8 Other

Category of Patient (CAT)

1 Amenity
2 Paying
3 NHS
4 Overseas Visitor - Liable to pay for treatment
5 Overseas Visitor - Not liable to pay - reciprocal arrangements
7 Special Arrangements

Type of Facility (TOF)

1 Inpatient Admission
4 Day Case Remaining Overnight in Inpatient Facilities
5 Five Day Ward
6 Day Bed Unit
7 Day Case Inpatient Facilities
8 Day Case Other

Specialty (SPEC)

Read detailed instructions in manual

01 General Surgery
02 Orthopaedic Surgery
03 ENT Surgery
04 Ophthalmology
05 Urology

06 Neurosurgery
07 Cardiothoracic Surgery
08 Plastic Surgery (*includes* Burns)
11 Orthodontics and Paediatric Dentistry
12 Oral Surgery and Oral Medicine
13 Restorative Dentistry
16 General Medicine
17 Cardiology
18 Metabolic Disease
19 Neurology
21 Gastroenterology

22 Poisons Unit
23 Dermatology
24 Nephrology
25 Rheumatology
26 Rehabilitation Medicine

28 Respiratory Medicine (*includes* Respiratory TB)
31 Communicable Diseases
32 Genito-Urinary Medicine
33 Diagnostic Radiology
34 Radiotherapy (consultative)

36 Homoeopathy
37 Medical Oncology
38 Spinal Paralysis
39 Surgical Paediatrics
40 Medical Paediatrics

41 Pain Control (Anaesthetist)
42 Gynaecology
46 Special/Intensive Care Baby Unit
48 Intensive Therapy Unit
49 Accident & Emergency

50 Geriatric Assessment
51 Geriatric Long Stay
52 Young Chronic Sick
62 Haematology
73 GP (other than Obstetrics)

76 Acute Mixed
98 Other Acute

Revised 1.1.93

Figure 52 — Sample SMR1 data collection form (page 2)

Sample Form (SMR01)

SPECIMEN - *for illustrative purposes only*

isd **Information & Statistics Division**
National Health Service in Scotland

Medical in confidence

Copplsh SMR 01

Inpatient/Day Case Record

I/A/D/C

Patient Identification

Hospital:

Health Records System ID

Patient Identifier

Copplsh SMR Episode Record Key

Surname

First Forename

Second Forename

Previous Surname

Date of Birth

Sex (Gender)

Marital Status

Central Index (CI)/CHI Number)

NHS Number

Alternative Case Ref. No.

Patient's Address

Postcode

Ethnic Group

GP Practice Code

GMC Number of Referring GP/ GDP/ Consultant

Episode Management

Spell/ Care Package ID

Location/ Hospital

Admission Date

Specialty/ Discipline

Significant Facility

Clinical Facility Start

Consultant/HCP Resp. for Care

Management of Patient

Patient Category

Waiting List Guarantee Exception Code

Waiting List Date

Admission Type

Admission Reason

Admission/ Transfer From

Admission/ Transfer From -Location

GP Referral Letter Number

Waiting List Type

Contract Identifier: Provider, Purchaser, Contract Serial Number, Contract Service No., Iso Resource Grp, Invoice Number, Invoice Line

Contract Charge

General Clinical

Main Condition/ Principal Diagnosis/ Problem Managed - ICD10

Other Condition/ Comorbidity/ Complication - ICD10-2

Other Condition/ Comorbidity/ Complication - ICD10-3

Other Condition/ Comorbidity/ Complication - ICD10-4

Other Condition/ Comorbidity/ Complication - ICD10-5

Other Condition/ Comorbidity/ Complication - ICD10-6

Discharge Data

Ready for Discharge Date

Clinical Facility End

Discharge Date

Discharge Type

Discharge Transfer to

Discharge/Transfer to - Location

Main Operation/ Procedure

Other Operation/Procedure 2

(OPP3)

(OPP4)

Date Main Operation

Clinician Responsible

Date (OPP2)

Clinician Responsible(2)

Date (OPP3)

Clinician Responsible(3)

Date (OPP4)

Clinician Responsible(4)

Chronic Sick/Disabled

Clinical Problem of Spell/Care Package

Lifestyle Risk Factors 1 2

Outcome Measures 1 2

Dependency/Severity Measures 1 2

Figure 53 — Sample SMR01 data collection form

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