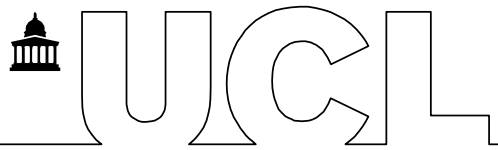

Is access to and use of Exercise Referral Schemes equitable?

An examination of socioeconomic differences in referral to and use of Exercise Referral Schemes in London

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Declaration

I, Sarah Lucy Sowden, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

Exercise Referral Schemes (ERSs) are a widespread multi-agency intervention in which patients are referred to a programme of supervised sessions of subsidised exercise at a local leisure centre. National guidance states that schemes should employ strategies to engage people from disadvantaged groups. While people from such groups are known to attend primary care more frequently than those from more advantaged socioeconomic groups, research suggests that they are less likely to use preventive and specialist health services. This thesis aims to evaluate whether access to and use of ERSs is equitable through an examination of socioeconomic differences in referral, uptake and completion of the service.

Firstly, the thesis presents a case study of key research, policy and practice events concerning the development of ERSs. Secondly, the thesis details findings of a scoping review undertaken across all ERSs in Greater London to identify schemes with suitable routine data collection to participate in the equity analysis.

Thirdly, the thesis presents a cross-sectional analysis of 7985 patients referred by general practices to ERSs operating in six PCTs between April 2004 - March 2006. The main outcome measures were i) risk ratios for referral by general practice deprivation quintile ii) odds ratios for uptake of ERSs and iii) odds ratios for completion of ERSs by patient deprivation quintile. Fourthly, an exploration of the added value of using a geodemographic segmentation tool to enhance understanding of socioeconomic inequalities in service utilisation at small-area level is described.

This research found that general practices within deprived areas were more likely to refer patients to ERSs than their counterparts in more advantaged areas. There was no evidence of an association between socioeconomic circumstance and likelihood of either taking up or completing the scheme. The implications of this research for policy, practice and future research are discussed.

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I am grateful to Lawrence Raisanen, Andy Pringle and a senior member of the NICE Public Health team for background information which contributed to the critical review of Exercise Referral development. The research presented in three of the thesis chapters has been published. Comments made by both journal reviewers and colleagues, namely Mark Petticrew, Sue Atkinson and Mai Stafford, on these elements have helped to shape the thesis.

It has been an absolute pleasure to work with Jessica Sheringham on the ACORN research. I am indebted to David Harris at CACI for providing the ACORN data and details of the methods used to construct ACORN.

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Publications

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Chapter 1

Introduction

Chapter 1. Introduction

1.1 Introduction

Exercise referral schemes (ERSs) are one of the most widely established primary care physical activity interventions in England[15]. ERSs are a multi-agency intervention in which patients are referred by their GP or other health professional to a subsidised programme of supervised sessions of exercise. Equity of access to healthcare has been a central tenet of the UK National Health Service since its inception[16]. National guidance emphasises the importance of ensuring that ERSs are delivered equitably and explicitly states that schemes should employ strategies to target and engage people from socially disadvantaged groups[17]. Although people from deprived socioeconomic groups attend primary care more frequently than those from more advantaged socioeconomic groups[18], (which accords with their greater need for care), they are less likely to use preventive[19] and specialist[20-22] health services. This observation, that those in most need of healthcare are often the least well served in terms of receipt of such care, has been termed the 'inverse care law'[23].

The benefits of physical activity, for the primary and secondary prevention of a range of clinical conditions[24], underpin the eligibility criteria for ERSs[17]. There is higher eligibility for ERSs among more deprived socioeconomic groups because these groups suffer from more of the conditions[25] for which Exercise Referral is indicated and are less likely to engage in leisure-time physical activity[24;26] than those from more advantaged socioeconomic groups. Despite higher eligibility for the service, known barriers to participating in physical activity such as lack of money, access to transport, and the availability of leisure facilities[26;27] are socioeconomically patterned[28;29].

In 1994, when ERSs were in their infancy, concerns were raised about their value and possible inequitable impact. Iliffe et al. wrote that:

"as with many other initiatives promoting health, there is a danger that effort and resources may be misspent in promoting exercise to those who would have taken it up anyway, the 'worried well.' This group is likely to be younger and already more fit and active than average"([30] p.282).

Hillsdon et al. supported this concern, speculating that leisure centre based schemes are unlikely to recruit and retain sectors of society who would have most to gain from adopting an active lifestyle[31]. Chinn et al. argued that differential uptake across population sub-groups of physical activity interventions in favour of the more socioeconomically advantaged could contribute to widening health inequalities[32]. Recent guidance by the National Institute for Health and Clinical Excellence (NICE)[33], published over a decade after the establishment of the first ERSs[34], confirmed that evidence on the impact of ERSs on health inequalities was still unavailable[33;35].

1.2 Aim of thesis

This thesis examines the influence of socioeconomic circumstance on referral to and use of Exercise Referral Schemes (ERSs). This informs an assessment of whether access to and use of ERSs is equitable across socioeconomic groups.

1.3 Objectives

Primary objective:

1. To examine the association of socioeconomic circumstances with three stages of the ERS pathway; GP referral, uptake and completion of the scheme.

Subsidiary objectives:

2. To critically examine the development of ERSs, documenting key policy, practice and research events.
3. To understand ERS provision across Greater London and to identify schemes eligible for inclusion in the research.
4. To assess the validity and value of using a geodemographic segmentation tool to enhance understanding of socioeconomic inequalities in service utilisation at small-area level.

1.4 Thesis overview

Background: Chapters 2 - 3

Chapter 2 introduces ERSs and critically examines their development. The rationale for physical activity promotion including the health benefits of physical activity and the current low prevalence of activity across the English population is outlined. The English Government's commitments to increasing physical activity participation and the evolution of ERSs are then described. Finally, the implications of Government policy on the ability to evaluate ERSs is discussed.

Chapter 3 discusses the meanings of equity, need and socioeconomic circumstance. It presents the rationale for examining the socioeconomic equity of access to and use of ERSs. The chapter outlines the aim, objectives and research hypotheses and concludes with a discussion of potential mechanisms through which socioeconomic inequities in ERS access and use may arise. Appendix B describes the techniques I used to retrieve literature to inform the background sections of this research.

Preparatory work: Chapters 4 - 5

Chapter 4 presents the findings of the scoping review of ERSs across Greater London undertaken to identify schemes eligible for inclusion in the equity research.

Chapter 5 outlines the methods for this research. It includes the stages carried out before the equity research could commence including; obtaining data, standardising and reformatting information from different ERSs, linking multiple data sources and deriving a measure of eligibility for Exercise Referral which was then applied to the local populations in the study.

Research findings: Chapters 6 - 8

Chapter 6 describes the characteristics of the study areas and the patients referred to ERSs within the research sample. These are compared to England and other ERSs reported in the literature to assess the likely generalisability of the research findings. The chapter also compares the socioeconomic characteristics of patients referred to ERSs with those of the local populations from which they are drawn. This provides an insight into the equality of service provision.

Results addressing the primary research objective are presented in Chapter 7, namely the association between socioeconomic circumstance and, respectively, referral,

uptake and completion of ERSs. The limitation of using an area-based measure of deprivation discussed in Chapter 7 provides the rationale for the research presented in Chapter 8.

Chapter 8 describes a methodological investigation undertaken to assess the validity and value of using a commercial geodemographic segmentation tool (ACORN) to enhance understanding of socioeconomic inequalities in service utilisation at small-area level.

Explanation and Implications: Chapter 9

The final chapter provides an assessment of whether the findings of this research suggest that ERS access and use is equitable across socioeconomic groups and an explanation of the research findings. The implications for future policy, practice and research are discussed.

Chapter 2

The development of Exercise Referral Schemes

Chapter 2. The development of Exercise Referral Schemes

2.1 Health benefits of physical activity

In 2004 the Chief Medical Officer published a review of evidence on the relationship between physical activity and health[24]. Epidemiological studies have established that living a sedentary lifestyle increases the incidence of at least 17 medical conditions[36]. There is evidence for the benefits of physical activity for the primary prevention of chronic conditions such as: Depression and anxiety with improvements in mood[37]; Cardiovascular disease (CVD)[38;39] with improvements in blood pressure[40] and cardiorespiratory fitness[41]; Type 2 diabetes mellitus[42]; Osteoporosis in postmenopausal women[43]; and Colon cancer[44].

Furthermore, numerous systematic reviews have reported the benefits of exercise for the secondary prevention of illness in individuals with existing conditions including[45]: Coronary Heart Disease (CHD)[46;47]; Cardiac failure[48]; Chronic fatigue syndrome[49]; Fibromyalgia[50]; Intermittent claudication[51]; Diabetes mellitus[52;53]; Obesity[38;54]; Osteoarthritis[55;56]; Osteoporosis in postmenopausal women[43]; Multiple sclerosis[57]; Lower back pain[58]; Peripheral neuropathy[59]; Depression (short-term symptom reduction)[60]; Chronic Obstructive Pulmonary Disease[61]; and Asthma (improvements in cardiopulmonary fitness)[62].

Participating in physical activity has also been shown to: Improve smoking cessation success[63]; Reduce falls and falls related injuries in older adults[64]; Impact beneficially on cognitive function in middle and old age[65], delaying onset of dementia and Alzheimer disease[66;67]; and contribute to the maintenance of physical functioning in old age[68;69].

Overall, people who are physically active have a 20-40% reduced risk of premature death compared to those who are not[24]. Allender et al.[70] reported that in 2003-04 physical inactivity was responsible for 3.1% of all morbidity and mortality in the UK[70].

Recommended levels of physical activity

In recognition of the health benefits of physical activity, and in line with the US Centre for Disease Control together with the American College of Sports Medicine, the British Government recommends[24;71] that all adults should achieve 30 minutes a day of moderate intensity physical activity on five or more days of the week. The activity can

be a lifestyle activity (for example, climbing stairs, walking or cycling) or structured exercise and can occur in one session or in several shorter bouts of activity of 10 minutes or more. The recommended level of physical activity is only partially based on empirical evidence, as there is still an incomplete understanding of the specific frequency, intensity and duration of physical activity, and the related volume of energy expenditure that is effective in achieving specific biological or clinical outcomes[72-74].

2.2 Prevalence of physical activity

Physical activity levels in England are low, with just over a third of men and a quarter of women achieving the Government recommended levels[24;75]. The current low prevalence of physical activity across the population has been attributed to multiple aspects of modern day life. Less routine travel is undertaken on foot or by bicycle; data from the National Travel Survey shows that the distance people walk and cycle has declined significantly over the last 3 decades[76;77]. The average distance walked, per person per year, has fallen from 255 miles in 1975 to 201 miles in 2006 and bicycle mileage has fallen across this period from 51 to 39 miles per person per year[77]. Other elements of modern day life which create a more sedentary population include: fewer manual jobs requiring physical exertion[78], and a reduction in the physically active elements of housework and other necessary activities with the advent of labour saving mechanical and electronic devices[24].

The Health Survey for England reports a small increase in physical activity levels between 1997 and 2004[77;78] although changes in the way physical activity has been measured over time means that reporting on temporal trends with any certainty is problematic[78].

Although people from more deprived socioeconomic circumstances are more likely to be employed in manual jobs requiring physical activity[44], they have the lowest levels of leisure-time physical activity[24;26;79-85]. The Sports Equity Index, developed by Sport England, provides an analysis of the relative propensity of different groups within the population to take part in leisure-time physical activity[79]. The definition of participation used is “having taken part in sports or physical activity on at least one occasion in the last 4 weeks excluding walking.” Those from semi-routine and routine occupations and those who had never worked or were long-term unemployed were shown to be 31% less likely to participate in leisure-time physical activity, compared to the average (all adults)[79]. Those from professional and higher managerial positions were 25% more likely to take part in sport[79].

Results from the Health Survey for England and the National Fitness Survey show that deprived people are twice as likely to be sedentary than the most socioeconomically advantaged[44]. The Chief Medical Officer's report also documents that in both men and women and in all age groups, low educational attainment predicts higher levels of inactivity[24]. In terms of overall physical activity participation, a life course analysis of British women aged 60-79 years found that those women from poorer socioeconomic circumstances in childhood and adulthood, and those living in more deprived areas spent fewer hours per week in moderate or vigorous activity[86]. A cross sectional survey of deprived areas of England (areas in receipt of New Deal for Communities regeneration funding) reported that people living in these areas were less likely than the population as a whole to meet the recommended levels of physical activity; only 13% of residents were exercising for 20 minutes five times a week (a shorter length of time than the 30 minute recommendation)[87].

2.3 Measurement of physical activity

Difficulties in measuring physical activity accurately mean that estimates are unlikely to be exact. Ways of measuring physical activity include observation, diaries, questionnaires, interviews, recording of physiologic response to activity, and monitoring devices such as pedometers and accelerometers[88]. Most commonly, (and for the references cited above), physical activity participation is self-reported retrospectively using questionnaires. This form of data collection has the advantages of being relatively low cost and easy to administer. However, the validity and reliability of self-reported physical activity participation is questionable[73;75;89;90]. Social desirability bias can occur leading to inflated reports of activity levels, with research suggesting overestimation of activity intensity occurs particularly by less fit individuals and sedentary adults[91]. The failure of self-report to reflect actual activity levels may also be explained by recall bias[89]. Individuals are generally better at recalling more structured high-intensity activity than short bursts of activity as part of everyday life (for example walking up stairs or carrying shopping home from the supermarket)[92].

Problems also arise in comparing prevalence estimates between studies for two reasons. Firstly, researchers measure different constructs in different studies, and the measures used are not always clearly articulated (for example habitual versus total physical activity, leisure-time versus all forms of activity). Secondly, estimating whether individuals fulfil recommended levels of activity necessarily involves a synthesis of responses to a range of questions about physical activity frequency, intensity, duration and mode. Question wording differs across surveys and few directly measure '30

minutes of moderate exercise five times a week.' Therefore, in combining answers to generate summary estimates, a series of assumptions are required. These assumptions are not consistent across studies hindering the direct comparability of estimates of physical activity prevalence.

However, objective measures of activity such as pedometers and accelerometer are not problem-free either. Whilst these are beneficial for monitoring low intensity activity which may be more difficult to recall through self-report, they pose logistical and practical problems. It is inconvenient to wear these devices for several days or weeks in order to monitor habitual activity levels and the devices can breakdown. There is evidence that measuring physical activity (by either a device or a questionnaire) can influence activity behaviour[93;94]. Finally, simple devices such as pedometers and accelerometers have been reported to underestimate walking and to overestimate jogging activity, and to fail to detect arm movements and resistance exercise[73].

In summary, the problems of measuring physical activity participation mean that reported figures should be viewed more as a guide than as an exact quantification of the true prevalence of physical activity across the population. Nevertheless, the consistency of findings on the low prevalence of exercise[44], particularly amongst those most in need of accessing the benefits of physical activity, cannot be dismissed.

2.4 Physical activity policies and interventions

Morris argues that the high prevalence of inactivity in the population and the relative increased risk for CHD which is consequent upon this inactivity (and which is similar in magnitude to the risk from smoking, high levels of cholesterol or hypertension) makes physical activity promotion the 'best buy' in public health[36;95]. The high financial cost of inactivity in the UK is reflected through the direct and indirect costs of treating associated diseases, estimated at £8.2 billion per year in 2002, with an additional £2.5 billion spent on the treatment of obesity[24;96]. A more recent 2007 analysis revised the figure to £1.06 billion[70], although this lower estimate did not account for indirect costs (for example, losses in production) or several of the conditions (angina pectoris, osteoarthritis and hypertension) included in the earlier estimate[70].

Recognition of the economic consequences of the ill-health burden associated with inactivity has led to worldwide developments to improve health and reduce health inequalities by tackling sedentary lifestyles[97]. Ambitious targets for raising participation in physical activity across the population have been set in England[98]. The 2002

Government strategy on sport and physical activity 'Game Plan'[96] aimed to increase participation levels across the population so that by 2020, 70% of the population will be meeting the 30 minutes of moderate exercise five times a week recommendation[98;99].

To achieve these targets, numerous national and local government physical activity policies have been drawn up. There are an array of policies to promote physical activity both within and outside the health sector. Reference to physical activity appear in the following policy documents from the Department of Health (DH):

- The Public Health White Paper 'Choosing Health'[100], which is supported by a Physical Activity Delivery Plan[101]. Physical activity is one of the six priorities identified in the White Paper.
- The National Service Framework for Coronary Heart Disease (CHD) requires primary care organisations to include advice on physical activity as part of a systematic treatment regime for patients with CHD and diabetes, and also for patients at high-risk of developing these conditions[102].
- The National Service Framework for Older People, Standard 8 aims to promote independent living and healthy, active life for older people. It states that in partnership, the NHS with local authorities should ensure that older people have fair access to programmes and advice about physical activity[103].
- The National Service Framework for Diabetes. This requires primary care to develop, implement and monitor strategies to reduce the risk of developing Type 2 diabetes in the population, which includes action on promoting activity[104].
- The NHS Plan. This includes a commitment to develop local plans to tackle obesity and physical inactivity[105].

Multi-agency action on physical activity is encouraged[77;98;100]. The Department for Transport[106], Department of Culture, Media and Sport[107], Department for Environment, Food and Rural Affairs[108] and Sport England[109;110] have all produced strategies and policy commitments which feature physical activity promotion. The London 2012 Olympics provides further impetus to the campaign to raise awareness and participation in sport and exercise[111;112]. Physical activity promotion is central to a number of 2007 government performance targets[77] including:

- Public Service Agreement 21 (to increase the uptake of cultural and sporting opportunities by adults and young people aged 16 and above). Lead Department: Communities and Local Government[113].
- Public Service Agreement 22 (to deliver a successful Olympic Games in 2012 and a sustainable legacy). Lead Department: Culture, Media and Sport[114].

- Public Service Agreement 27 (to lead the global effort to avoid dangerous climate change). This includes a target to reduce UK net CO2 emissions by 26–32% by 2020. Measures to achieve this include encouraging more people to cycle and walk. Lead Department: Environment, Foods and Rural Affairs[115].

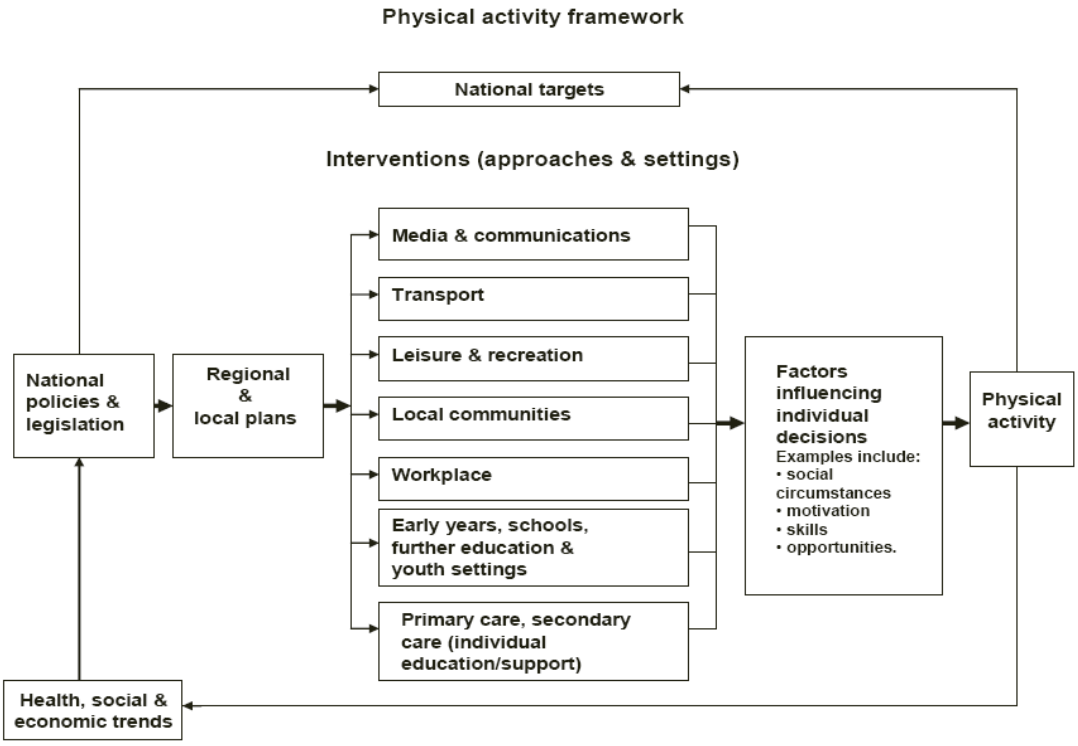
The multidisciplinary action required to address sedentary lifestyles within the population presents considerable challenges. Although commitments to physical activity promotion appear across Government, no single Department of cross-Departmental agency has taken overall responsibility for strategic direction of this agenda or is held accountable for the achievement of an overarching target. As a result it has been argued that the physical activity promotion agenda has suffered from being 'everyone's but no ones responsibility'([98]pg.115).

Physical activity interventions

Challenges aside, numerous interventions to promote physical activity have been adopted. NICE has provided a framework for considering action on physical activity, which NICE themselves have used when developing recommendations[77] (Figure 2.1). This framework appears to stem from a socio-ecological theoretical orientation in that it acknowledges the multiple determinants of physical activity participation operating at macro (national, community) and micro (individual) levels[116]. Dzewaltowski[117] and Sallis and Owen[118] were among the first to discuss the need for an ecological approach to physical activity research and promotion[119].

The types of intervention used to support national and local policies range from macro-level interventions to create a physical environment conductive to activity (for example, traffic-calming measures, cycle lanes, improvements to public open spaces, street lighting to deter crime and encourage walking[77]) through to micro-level action targeted at changing individuals' attitudes and behaviours.

Figure 2.1 Physical activity framework from the National Institute for Health and Clinical Excellence[77]



One important domain for action is primary and secondary healthcare services (Figure 2.1) [77;92]. In recent years the Government has placed considerable emphasis on the importance of preventive services and health promotion[16;100;120;121] for the long term sustainability of the NHS. However, health services researchers and public health practitioners have expressed concern that in reality, given funding shortfalls, PCTs deviate from this commitment, diverting money earmarked for lifestyle interventions to acute services[122].

Nevertheless, Owen, amongst others, has identified general practitioners and practice nurses as important agents for encouraging lifestyle change in primary care[33;123]. This is because advice given by general practitioners is influential on patients[124], and also because general practitioners have the potential to reach a large proportion of the local community, because they see the majority of their practice population over several years[125]. Around 95% of the population will see a medical practitioner within any three-year period, yet only around one in four of these people is likely to be physically active on a regular basis[17].

Physical activity promotion action undertaken by healthcare professionals (predominantly general practitioners and practice nurses in primary care[17]) includes; providing advice to patients on being more active[126], offering specific counseling services or referral to health trainers[100], recommending facilities or services such as local walking programmes, and issuing pedometers to encourage walking[17;33]. One of the most established primary care interventions for promoting physical activity is the Exercise Referral Scheme (ERS).

2.5 Exercise Referral Schemes

Exercise Referral Schemes (ERSs) (also known as 'exercise on prescription' or 'physical activity referral schemes') are a multi-agency intervention involving local Primary Care Trusts (PCTs), local councils and often voluntary and private leisure service providers. Sedentary patients with existing health problems (for example, diabetes, asthma, back pain, depression, osteoarthritis) or risk factors for future ill-health (for example, those who are overweight/obese or have other risk factors for CVD) are referred by general practitioners and other healthcare professionals to a programme of subsidised exercise at a local leisure centre.

I will now chart the influence of Government policy and research evidence on the evolution of ERSs. I discuss the impact of policies on the ability to evaluate the effectiveness of ERSs for improving health and reducing health inequalities. The implications of these findings are discussed and ways forward are suggested. This research is published in the Journal of Epidemiology and Community Health[127].

2.6 Running along parallel lines: how political reality impedes the evaluation of public health interventions

2.6.1 Introduction

Soon after coming into office New Labour introduced a commitment[128] that government policy must be evidence based, properly evaluated and based on best practice[129]. Here-in lies a problem: whilst there is good evidence of the health benefits of leading an active lifestyle[24] (Section 2.1), there is limited evidence for the effectiveness of many physical activity initiatives (Section 2.4) in terms of their ability to improve health and reduce inequalities[33;130-133]. This gap between describing the problem and evaluating the effectiveness of proposed solutions is not unique to this public health issue. A recent review found that only 4% of public health research in the UK focused

on interventions rather than simply documenting problems and that just 10% of the intervention research measured outcomes[134].

The methodological difficulties and practical constraints to conducting good quality evaluations of public health and social initiatives have been well documented[135-137]. Another reason why so little high quality evidence for the effectiveness of such initiatives exists is the overriding influence of the political imperative[134]. The failure of Government to fulfill their own remit on evidence-based policy making across the raft of NHS reforms introduced from the year 2000[105] and the rationale for the selective use of evidence in policy-making[128] has been extensively discussed[138]. Factors include; the need to address pragmatic considerations such as cost and time constraints, the influences of pre-existing beliefs and underlying values, and political timeliness[139-141]. These constraints are not unique to England: in the United States and Canada explicit attempts have been made to incorporate evidence into policy by establishing independent national bodies to provide summaries of the scientific evidence on health promotion[142]. However these have had variable impact because for example, funding for evidence-based policies is not always forthcoming[142].

Whilst the limited impact of evidence on policy has been examined in depth, the impact of policy on the ability to gather evidence has attracted less attention. Here using the case study of ERSs, I demonstrate how the evolution of policy in public health can impede the evaluation of the effectiveness of public health interventions. My analysis of the development of ERSs shows that a series of policy decisions evolved in parallel with, and with little reference to, the development of evidence. The impact of a single key policy decision has been previously noted with respect to the “Sure Start” programme. The Government chose to establish Sure Start as a universal area-based intervention for all young families living in designated areas[134;143]. This was against the recommendation of research advisers who advocated random allocation of communities to the programme to allow systematic evaluation of outcomes[143].

2.6.2 Method

I retrieved peer reviewed articles, national policy documents, reports, press releases and guidance relating to ERS research, policy and practice development in England from 1994 – January 2008 in order to establish an interpretative account of events. I adhered to a comprehensive literature search strategy to minimise the likelihood of selection bias. This comprised:

- Searches of electronic databases including Medline and Web of Science.

- Searches of websites for grey literature (for example, DH, NICE)
- Retrieval and cross-checking of references cited in published articles and reports.
- Follow-up of citations recommended by researchers and experts in the field.

In addition:

- I used direct and referenced quotes to avoid the potential for inaccurate paraphrasing or de-contextualisation.
- I discussed initial interpretations with experts in the field, and where necessary, clarified issues with authors of the peer reviewed and grey literature examined.

2.6.3 Results

Policy impeding evidence – the chronology of events

Table 2.1 outlines the chronology of key research, policy and practice events concerning ERSs in England.

Table 2.1 Chronology of key research, policy and practice events concerning ERSs in England

Date	Research on effectiveness	Government policy	Expansion of exercise referral schemes
1992			72 leisure-centre managed schemes identified[34]
1994	**Editorial**[30] "Any future prescription for exercise programmes should be carefully evaluated; the results will help in the design of a definitive multi-centre trial. Unevaluated initiatives may be of no more value than prescribing coloured water. While we await the results of careful evaluation, primary health care teams should look closely before they leap into prescribing exercise. There may be many far more effective ways from them to use their resources to increase the fitness of their practice populations." pg. 495		52 more leisure-centre managed schemes planned for 1994[34]
1996	**Systematic review**[31] of physical activity promotion strategies. Included 11 trials, none of which were undertaken in the UK. Small number of trials limited strength of conclusions. Called for more research.		Over 200 primary-care based physical activity promotion schemes running[144]
1997	**Cross sectional survey**[145] of physical activity promotion in primary care in England: "The design of evaluation packages was unsophisticated. With the exception of one example, these evaluations did not involve randomisation or control groups….It became clear that schemes are inadequately resourced to conduct long-term rigorous evaluation." pg. 368 "Randomised controlled trials accompanied by process-oriented research methods are needed for the comparison of the long-term effectiveness of different types of physical activity intervention in primary health care, and their effectiveness for different patient groups." pg. 369		
1998	First UK **RCT** of exercise referral published[146] **Health Education Authority review**[144] "In contrast to the large number of UK schemes, evidence relating to effectiveness is sparse, and this is a matter of some concern at a time of scarce primary care resources and within a climate of evidence-based medicine." pg. 12 **Commentary**[147] "The (GP Referral) schemes are characterised by their lack of formal		

	evaluation, making conclusions about effectiveness impossible."		
1999	**RCT of methods to promote physical activity in primary care**[148] "Primary healthcare teams…should reconsider the use of scarce resources to fund "exercise prescription" schemes… Further research is needed to develop interventions that promote long term adherence to exercise in addition to adoption of exercise and to identify less costly ways of delivering these. There is a need to base policy on evidence, and not simply on fashion and the apparent popularity of current schemes." pg. 832	**DH – White Paper 'Saving Lives: Our Healthier Nation'**[149] "To help support enthusiasm for physical activity and for better health, we will publish a sports strategy later this year…it will build on many existing initiatives: Exercise on prescription where family doctors refer patients for physical activity courses as a cost-effective alternative to prescribing long-term medication." Section 3.6	
2000		**DH press release on ERSs**[150] "The Government is keen to extend the number of schemes in operation. We want to encourage more GPs and health professionals to encourage patients to be active and will be publishing new guidelines to encourage GPs, local authorities and health authorities to set up schemes and ensure that they are effective."	
2001		**DH - National Quality Assurance Framework for Exercise Referral**[17] Aimed to raise standards and improve quality of local schemes.	
2005	**Health Development Agency** review[130] "In the UK 'exercise referral schemes' are increasingly common yet remain under-evaluated. Much time, effort and resources are being invested in such programmes and therefore it is imperative that their effectiveness is evaluated through rigorous studies" pg. 22 **Critique**[97] "This endorsement by government (the NQAF) has probably been a major factor in the rapid increase in the number of ERSs currently being implemented across the UK. It is of further concern that this proliferation has not been underpinned by a solid evidence base for their effectiveness." pg. 1395	**DH - White Paper 'Choosing Health'**[100] Announced the production of specific guidelines for children's exercise referral. pg. 142. Specified exercise referral as one of the treatment programmes for obesity. pg.143. Announced the development of a patient activity questionnaire to assess patients' need for interventions such as exercise referral. pg. 145. **DH – Action plan 'Choosing Activity: A Physical Activity Action Plan'**[101] "Many primary care professionals are already involved in schemes to refer patients to facilities such as leisure centres or gyms for supervised exercise programmes. In 2001, the Department of Health (DH) published a National Quality Assurance Framework to improve the quality of existing referral schemes and help the development of new ones." pg. 6	89% of primary care organisations in England running an exercise referral programme[151] Review of Greater London found that 97% of areas have an ERS (Chapter 4)

Jan-06	**NICE rapid review of effectiveness**[35] Concluded that exercise referral schemes had positive effects on physical activity levels in the short term (6-12 weeks), but were ineffective at increasing physical activity over a longer period (12 weeks). "There is insufficient evidence in any of the four RCTs examined to make any conclusions or recommendations about the effects of exercise referral on health inequalities." pg. 4	**DH - White Paper 'Our Health, Our Care, Our Say'**[16] "A range of different 'prescription' schemes, such as exercise-on-prescription projects, have been established or piloted in a number of areas and have often been very successful. We would like to see increasing uptake of well-being prescriptions by PCTs and their local partners, aimed at promoting good health and independence and ensuring people have easy access to a wide range of services, facilities and activities" pg. 51
Mar-06	**NICE guidance**[33] "PHIAC (Public Health Interventions Advisory Committee) determined that there was insufficient evidence to recommend the use of exercise referral schemes to promote physical activity, other than as part of research studies where their effectiveness can be evaluated. Recommendation Five: Practitioners, policy makers and commissioners should only endorse exercise referral schemes to promote physical activity that are part of a properly designed and controlled research study to determine effectiveness." pg. 6	
May-06	**NICE guidance implementation advice**[152] "Before withdrawing funding, it is important to consider the implications for the work of other partners, so that good partnership arrangements are not damaged for the future." pg. 9 **NICE guidance costing report**[153] "A small sample of PCTs provided cost details and it was found that the average investment per scheme is £100,000 This is potentially a significant investment for something that has a thin evidence base… …A further factor is the multi-sector and joint working arrangements that are in place. PCTs that withdraw support for joint schemes with local authority partners could expose the local authority to financial problems. It should also be noted that exercise schemes may be set up for other reasons than to increase physical activity, such as cardiac rehabilitation." pg. 16	
Dec-06	**LEAP evaluation summary report**[154], (full report April 2007[155]): Included five exercise referral schemes. "The sample of completers represented as little as 10% of the overall participant numbers…..therefore there is potential self selection bias." pg. 4 "Small sample sizes…….not all participants provided data on demographic profile…….. there was no attempt to control for any covariates." pg. 5	**DH press release** announcing package of measures to combat physical inactivity[156] "The (LEAP) pilots demonstrated that physical activity interventions are cost-effective and can save the NHS money in the long-term by reducing ill-health. LEAP has also shown that it is possible to engage a broad range of people, and to increase physical activity levels. Data collected found:

	"Some sites experienced difficulties in developing the evaluation inside the required time frame". pg. 115 "Data was not collected systematically where physical activity leaders were not motivated, or did not see data collection as 'their job." pg. 119 "Data (were) collected …. by those delivering the interventions that have a vested interest in the success of the intervention." pg. 120	Exercise referral schemes: Resulted in almost 70 per cent of those who were sedentary or lightly active to achieve or exceed recommended levels of physical activity. This was effective for adults and older adults." pg. 1 The 70% quoted is based on a sample of 460 people who participated in exercise referral pilots and provided both baseline and post-intervention physical activity measurements (see [155] pg. 51)
March-07	**HTA Exercise Evaluation single centre RCT (EXERT)**[131] Comparison of the effectiveness and cost effectiveness of two structured exercise referral programmes (a leisure centre based exercise programme and an instructor led walking programme) with an advice only group. Exercise referral programme was not more effective than advice only. Advice only was the most cost effective intervention.	**DH Best Practice Guidance**[157] "The Department of Health urges commissioners, practitioners and policy makers to continue to provide high quality exercise referral schemes for their local population where these address: (a) the medical management of conditions e.g. type 2 diabetes, obesity and osteoporosis. (b) Approaches specific to preventing or improving individual health conditions (e.g. falls preventions), which fall outside the overarching advice to achieve 30 minutes moderate activity on at least 5 days a week. Schemes should be commissioned and managed in accordance with the National Quality Assurance Framework for exercise referral in England. Exercise referral schemes solely for the purpose of promoting physical activity (i.e. where there is no underlying medical condition or risk) should only be commissioned or endorsed by commissioners, practitioners and policy makers when they are part of a properly designed and controlled research study to determine their effectiveness." pg. 1-2
Dec-07	**Systematic review of effectiveness of ERS**[158] "Exercise referral schemes have a small effect on increasing physical activity in sedentary people, but it is not certain that this small benefit is an efficient use of resources." pg. 985	
Jan-08		**First speech by Prime Minster Gordon Brown on the NHS**[159] "We will increase the availability of physical activity prescriptions on the NHS."

ERSs were introduced in England in the early 1990s and rapidly expanded within a few years[30;34;144;145]. In 1994 Iliffe and colleagues published the first editorial on exercise referral to raise concern about the opportunity costs of funding an unevaluated public health initiative[30]. However, rapid expansion continued unabated and was encouraged by a Department of Health (DH) press release in 2000 which expressed the Government's keenness to extend the number of schemes in operation[150]. The press release paid lip service to the need to ensure effectiveness, but this stipulation was overshadowed by the headline message that exercise referral was a good thing, that should be expanded. Indeed, a year earlier in the White Paper 'Saving Lives: Our Healthier Nation'[149] the Government appeared to assert that the effectiveness of ERSs was already established; referring to exercise prescription as a 'cost-effective' intervention (although evidence to support this claim was not supplied and the claim was inconsistent with an RCT published in the BMJ in the same year[148]). In 2001, DH published the National Quality Assurance Framework for Exercise Referral (NQAF), which emphasised the importance of evaluation[17;97]. However the awareness, skills and expertise required to ensure that ERSs were able to build in evaluation mechanisms were rarely cultivated within local schemes and the NQAF failed to achieve consistency and comparability of audit and evaluation mechanisms across the country[97;160] (see also Chapter 4). Researchers[97;130;144;145] warned that the policy to promote ERSs was not underpinned by good evidence of effectiveness, but the proliferation of schemes continued[151]. The prominence of ERSs was boosted further by their inclusion in the White Paper 'Choosing Health'[100].

The next White Paper 'Our Health, Our Care, Our Say', published in 2006[16] continued the mantra of expansion and, inexplicably, justified the policy in terms of the 'success' (not defined) of existing schemes. These public assertions of 'success' were published despite the fact that a DH co-funded evaluation of Local Exercise Action Pilots (LEAP) (which included five ERSs)[154] and a NHS Research and Development Health Technology Assessment (HTA) funded single centre randomised controlled trial (RCT)[131] had not yet reported their findings. In 2005 DH had also commissioned the Public Health Interventions Advisory Committee arm of the National Institute for Health and Clinical Excellence (NICE) to survey the evidence and to make recommendations about the use of ERSs. NICE found the evidence for the effectiveness of ERSs to be inconclusive, with the more robust studies suggesting short term benefits from ERSs in terms of increases in physical activity which then diminish to non-significant levels of improvement over the longer term (a finding which was supported in a subsequent systematic review[158]). NICE published their evidence review[35], which led them to

conclude that there was insufficient evidence to recommend ERSs for the promotion of physical activity (unless they were part of a trial to determine effectiveness), in the same month that DH was trumpeting the success of exercise prescription in 'Our Health, Our Care, Our Say'[16].

The NICE guidance caused deep anxiety amongst schemes and the implementation advice published by NICE in 2006 acknowledged their concerns[152]. This resulted in confusing guidance. On the one hand, NICE recognised the contribution that schemes were making to multi-agency working and warned commissioners to consider the implications for good partnership arrangements before withdrawing funding, whilst at the same time, they recommended that commissioners should only endorse "schemes to promote physical activity if they are part of a properly designed and controlled research study to determine effectiveness"([152] pg.8). A year later, the DH Best Practice Guidance clarified the situation by stating that the requirement to be part of a controlled study applied only for those schemes existing solely for the purpose of promoting physical activity in people with no underlying condition or risk factors. All other schemes could continue as before, in accordance with the NQAF[157]. As it is extremely unlikely that any schemes exist solely for healthy people, this statement from the DH allowed schemes to effectively ignore the (DH commissioned) NICE guidance. At the beginning of 2008 the government was still committing NHS resources to further increasing the availability of exercise on prescription[159], despite the conclusions of the most recent ERS systematic review that: "Exercise-referral schemes have a small effect on increasing physical activity in sedentary people, but it is not certain that this small benefit is an efficient use of resources." ([158] pg. 985).

2.6.4 Discussion

Implications

Evaluation of the effectiveness of ERSs in England in terms of improvements in health and reductions in heath inequalities is now an unrealistic aim for several reasons:

Firstly, ERSs have been widely established across England. A recent national survey reported that in 89% of primary care organisations in England had an exercise referral programme[151]. Although the response rate to this survey was just 62%, the survey I carried out as part of the scoping phase for this research (see Chapter 4) of schemes across Greater London found that 30 out of 31 primary care trusts (PCTs) had an ERS running or in development. If this coverage is reflected across the country, then identifying areas which have not established schemes will be difficult. It could be

argued that within PCTs there are general practices who do not participate in the scheme due to clinical uncertainty about effectiveness or to capacity constraints of existing programmes. Such general practices may be willing to be randomised to a controlled evaluation of effectiveness. However the extensive and well publicised presence of these schemes could hamper recruitment to a randomised study. Contamination could also occur because patients who are not randomised to exercise referral by the GP can be referred via other routes (for example, by physiotherapists).

Secondly, even if suitable sites for conducting a controlled evaluation of effectiveness were identified, funding for such a study is likely to be hard to come by. The DH has already contributed to the £2.6M LEAP evaluation[154] and the HTA funded a single site RCT[131] (referred to above). The HTA trial found that referral to an ERS added no additional benefit to simply providing advice on physical activity. The LEAP evaluation suffered from serious methodological difficulties which cast doubt on the value of its conclusions (Table 2.1)[154;155]. Even so, the notion that more DH funding will be forthcoming is unlikely. In the past the Medical Research Council (MRC) has funded applied public health research, however the division of responsibilities between the National Institute for Health Research (NIHR) and MRC implemented as a result of the Cooksey review[161] means that, from now on, such research will be funded by NIHR only. NIHR is the new health research agency of the DH. PCTs and LAs are unlikely to fund evaluations of their schemes in the face of funding shortfalls and the diversion of money earmarked for lifestyle interventions to acute services[122].

Thirdly, even if sites for evaluation were identified and research funding was found, the results are unlikely to have an impact on the provision of existing schemes. Dismantling schemes would have profound effects which go beyond simply saving the costs of an ineffective intervention because hard won and effective partnerships between PCTs and Local Authorities would be damaged[152]. Modifying existing schemes would also be difficult, akin to “unravelling and reknitting a cardigan while we continue to wear it” as described by Muir Gray with respect to the similar situation facing some screening programmes([162] pg. 358).

Fourthly, as discussed in detail in Chapter 3, analysis of referral to and use of exercise referral by disadvantaged groups is required to examine the success of schemes at reaching those most in need, a frequently cited objective of local ERSs to improve health inequalities[17](Chapter 3). However a comprehensive analysis of equity across schemes is not possible because guidance on the collection of sociodemographic data

using standard definitions has never been issued. The result is that, data collection is incomplete and inconsistent across schemes[160](Chapter 4).

If the experiences of ERSs are ignored, then mistakes could be made again with other public health interventions. There are already signs that this could happen with another initiative. The Health Trainer Scheme was launched in the 2005 White Paper 'Choosing Health'[100]. This involves recruiting people from the local community or from health promotion programmes in the public and voluntary sectors to help individuals develop and maintain healthy lifestyles. Initially targeted at the most disadvantaged areas, in 2007 the DH allocated funding to all PCTs to allow them to establish schemes despite the fact that the results of a DH commissioned preliminary audit of activity in this area was not available until November 2007 and a synthesis of local evaluations not available until Spring 2008 (personal communication with DH-commissioned evaluation team at UCL). The DH are planning to fund a comprehensive evaluation of the clinical and cost effectiveness of health trainers, but once again, their commitment to universal provision precludes the ability to undertake an evaluation using a randomised controlled design.

Converging parallel lines

On the one hand, the DH has shown a continued commitment to accumulating and appraising research evidence by funding a succession of relevant evaluations. In parallel to this stream of enquiry, DH has promoted the expansion of an intervention without sufficient reference to the evidence it commissioned. In doing so the ability to accrue meaningful evidence to support policy making has been undermined. This situation has probably occurred for the well known reasons outlined in the policy literature[139;141]. These include the pressure to achieve outcomes within short time scales, to satisfy the public and health professionals, to be seen to take action and to appease powerful lobbies[139]. In the context of ERSs, policy makers were faced with the unenviable situation of having insufficient evidence of effectiveness of interventions to tackle sedentary lifestyles, coupled with an imperative to be seen to be taking action to tackle major and increasing problems such as obesity. It is not therefore surprising that some policy analysts are resigned to the inevitability of the illusory nature of evidence based policy making[163]. However, other policy makers have shown that it is feasible to bring the parallel tracks of evidence and policymaking into closer convergence[164;165].

For this to occur, a shift towards an 'evaluation culture' is required[140]. This is not an unrealistic recommendation. The World Bank now stipulate that they will only fund

projects which have appropriate evaluation and monitoring built in[165]. A range and combination of quantitative and qualitative research methodologies are likely to required[135;166]. Where randomisation is not possible or appropriate, the next best research method should be used. But it should not be assumed that randomisation is never possible on the basis that the public will not accept being denied a plausible intervention on a random basis while it is being evaluated amongst their neighbours. Important lessons about working effectively with communities can be learnt from the Welsh Assembly Government's Primary School Free Breakfast Initiative[164]. Rather than being implemented in all schools immediately, this has taken a pilot approach including a cluster randomised trial of the intervention[167;168].

With respect to exercise referral, the Welsh Assembly Government have also funded a national development and evaluation of ERSs, which employs a randomised design and which includes the requirement for all included ERSs to adhere to national guidance on data collection[45]. This convergence of implementation with evaluation allows the development of nationally agreed standardised minimum datasets containing socio-demographic data, process and even validated outcome measures. These can be established at the outset and enable high-quality monitoring and evaluation of schemes in routine service delivery.

There are signs that the Department of Health in England is following this lead and ensuring adequate evaluation is built into programme development. For example, Family Nurse Partnerships (an initiative formulated around an evidence-based programme in the US[169]) has been piloted in a number of sites across England since April 2007 and has recently tendered for an RCT[170] to evaluate programme effectiveness.

To avoid perpetuating the current situation in which political decisions prevent the accumulation of evidence about effectiveness, researchers need to become adept at "managing the political terrain"[171]. This is a resource intensive and long term task which researchers cannot do alone. To be effective, collaborations are required with established and successful advocacy groups (such as the National Heart Forum) and with stakeholders[172]. A political analysis of stakeholder interests is therefore a key primary task. Working together, stakeholders can ensure that public awareness is maintained and that systematic approaches are employed to getting and keeping the evaluation issue on the policy agenda.

Plausible and well meaning public health interventions may not work; they could produce harmful effects or widen health inequalities. The political argument for controlled roll outs of public health interventions must now be won.

Chapter 3

Equity in healthcare

Chapter 3. Equity in healthcare

3.1 Introduction

One of the founding principles of the English National Health Service (NHS) was[173]:

"To ensure that everybody in the country, irrespective of means, age, sex, or occupation, shall have equal opportunity to benefit from the best and most up to date medical and allied services available."

Underpinning this statement is the notion of equitable healthcare; services provided on the basis of clinical need rather than ability to pay. 60 years after the inception of the NHS, the commitment to providing equitable healthcare remains[159]:

"We celebrate the 60th anniversary of the National Health Service which is not just a great institution but a great, unique and very British expression of an ideal - that healthcare is not a privilege to be purchased but a moral right secured for all."

January 2008 speech by Gordon Brown, British Prime Minister.

Despite unswerving commitment to equity as a fundamental principle of the NHS, there is much less consensus around the definition of equity[174] and whether this is actually achieved in practice[175;176]. The chapter begins with a discussion of the meanings of equity, need and socioeconomic circumstance. The rationale for examining equity with respect to ERSs is then provided. The chapter outlines the aim, objectives and research hypotheses and concludes with a discussion of potential mechanisms through which socioeconomic inequities in ERS access and use may arise.

3.2 Defining equity

Firstly it is necessary to distinguish inequity from inequality. These terms are often used synonymously in the healthcare literature. Inequality refers to the unequal distribution of healthcare. Inequity refers to unequal distribution that is deemed to be unfair[177-182]. In the context of the NHS, which was established on collectivist principles, inequalities are deemed unfair (inequitable) if healthcare varies according to non-clinical factors such as socioeconomic circumstance, gender, age or ethnic group[183-185].

Mooney has outlined that healthcare equity can refer to[186]:

1. Equality of expenditure per capita
2. Equality of inputs (resources, for example staff/equipment) per capita
3. Equality of input for equal need
4. Equality of access for equal need
5. Equality of utilisation for equal need
6. Equality of marginal met need
7. Equality of health

The NHS does not tend to rely on equality of expenditure or inputs per capita (definitions 1 and 2) because these definitions do not encompass any notion of need. It is important to take account of need for healthcare when considering equity of services because this varies across the population[186] (see Section 3.3). Similarly, definition 6, 'equality of marginal met need' is rarely employed and not appropriate to consider in the context of this ERS research because it refers to global resource allocation across competing healthcare services and priorities.

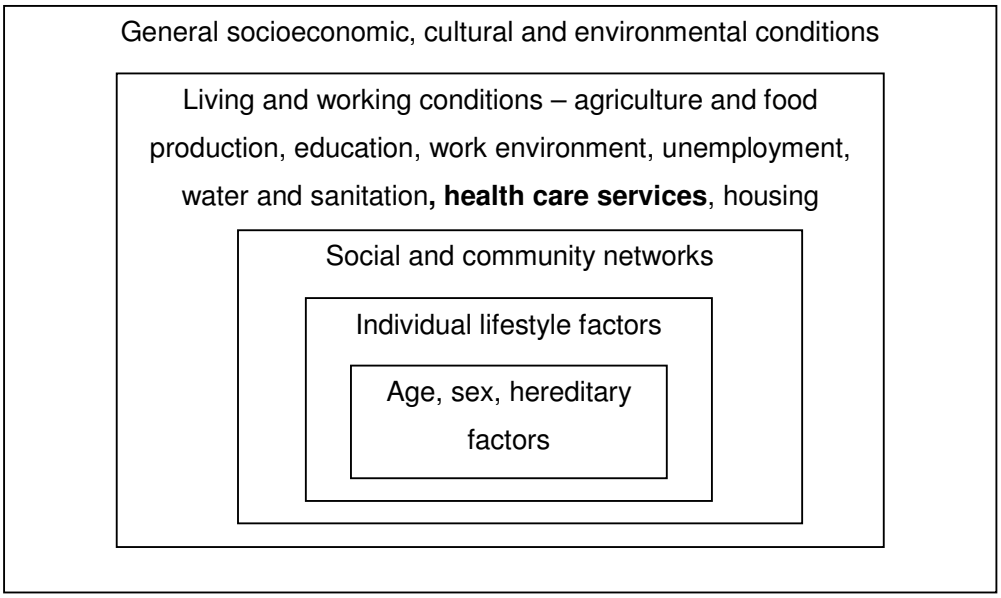
Instead, equity in the NHS is often described in terms of equality of inputs, access or utilisation for equal need (i.e. irrespective of non-need factors such as socioeconomic circumstance)[173;176] (definitions 3-5). 'Equality of access' (definition 4) and 'Equality of utilisation' (definition 5) both recognise the interplay of supply and demand factors and that barriers (direct and opportunity costs) to healthcare should be taken into account when considering the delivery of an equitable service[187]. Dimensions of the concept of 'access' include the availability, accessibility, accommodation, affordability and acceptability of healthcare services[188].

The English Government is committed to redressing the unfair inequalities in health found across socioeconomic groups in the population (deprived groups having poorer health than more socioeconomically advantaged groups)[173;184;189-191]. Therefore recently, the NHS has adopted 'equality of health' (definition 7) as an aspirational definition of equity to reflect this wider agenda around 'tackling health inequalities'[184]. It is recognised that healthcare is one of a multitude of determinants of health and health inequalities (others include biological, environmental and social factors[192-198], see Figure 3.1). Under this definition the aim of an equitable healthcare service is to contribute to redressing the underlying inequalities in health between groups within the population, to ultimately secure similar health outcomes regardless, for example, of socioeconomic circumstance[173;199].

The former Health Development Agency (now incorporated into NICE) articulates this aim([200]pg.6):

"The purpose is for health and other services to help narrow health inequalities by taking positive decisions on investment, service planning, commissioning and delivery that narrow inequalities."

Figure 3.1 Dahlgren and Whitehead's 1991 model illustrating the multiple determinants of health[201]



Vertical equity refers to providing greater healthcare to those with a greater level of need, to an extent which is judged to be fair[202;203]. Mooney articulates vertical equity in terms of the greater proportion of those from disadvantaged population groups who have disease at any given level of disease severity requiring effective treatment[204;205]. Mooney argues that positive discrimination in resource and healthcare allocation in favour of disadvantaged groups should be in place in order to work towards achieving vertical equity[204-206]:

"if, as is normally the case, ill health is not randomly distributed across different groups in society, might that society not want to give preference, on vertical equity grounds, for health gains to those groups in that society who are on average in poor health?"[207] pg.102

However, achieving 'equality of health' through healthcare is an aspirational aim rather than a realistic equity objective. This is because it assumes that equality of health can be attained through healthcare interventions alone, and as Figure 3.1 demonstrates this is not the case[201]. Indeed, two thirds of indicators chosen to monitor progress in tackling health inequalities fall outside the Department of Health's remit and the traditional realm of healthcare[173;189] illustrating how non-health care inputs are required to achieve 'equality of health.'

Furthermore, the idea of positive discrimination implied by such a definition concerns some equity commentators who believe that denying opportunities to certain groups which are offered to others is inconsistent with the fundamental principle of equity. As Chang explains:

"It is of utmost importance for equity to mean that all individuals be provided with 'equal' opportunities to actualise their health potential regardless of whether the differential between groups are narrowed or not…It would be totally inappropriate, then, to try to enhance the opportunities for better health for only certain groups at the expense of others, by misinterpreting the idea of 'bringing health differentials down to the lowest level possible.'"[208] pg. 489

Therefore, I decided that this research would be guided, first and foremost, by the two more conventional and less contentious definitions of horizontal healthcare equity. These are 'equal access for equal clinical need' (definition 3) and 'equal use for equal clinical need' (definition 4). In this research 'access' to Exercise Referral was defined in terms of 'referral' to the service by a healthcare professional. However, the Government's aspirational goal of achieving 'equality of health' was also taken into consideration when assessing the extent to which the findings of this research reflected equitable healthcare access and use (Chapter 9).

Raine explains that for a comprehensive assessment of equity, use must be measured at each level of clinical need[209;210]. For example, patients with severe disease should be more likely to receive an effective intervention compared with patients with a milder form of the disease, regardless of socioeconomic circumstance and other non-need variables such as age, gender or ethnicity[210;211]. It is only possible to examine vertical equity in these terms for conditions where higher and lower levels of clinical need can be explicitly defined (for example, the need for cardiac interventions[210]). In the case of Exercise Referral, there is not yet good evidence for different levels of need for the

intervention owing to the limited evidence of ERS effectiveness (Chapter 2). Therefore, this research only examined horizontal equity (equal access/use for equal need).

3.3 Defining need

In order to make a judgement about equity, 'need' for ERSs must be defined[202]. Following Culyer, public health practitioners, policy makers, planners and health services researchers conventionally define normative need for healthcare in terms of a person's 'capacity to benefit' from healthcare[178;195;212-214] and hence need for healthcare can only be present if an effective healthcare intervention exists[215]. This definition of need for healthcare was adopted in this research.

As explained above, determining 'need' for ERSs is currently problematic because the limited evidence about ERS effectiveness means that it is not possible to establish whether, for example, patients from different socioeconomic groups or people referred for different clinical reasons have different 'abilities to benefit' from ERSs. Therefore in this research, eligibility for ERS was used instead as a crude proxy for 'need' for ERSs, every person who met the eligibility criteria for ERSs was classified as having a 'need' for Exercise Referral (Chapter 5, Section 5.6). All ERSs work to strict protocols outlining eligibility criteria for entry onto the programme (Chapter 4). In order to be eligible for the service patients must be inactive and have one of a range of clinical conditions (Chapter 2, Section 2.5).

3.4 Defining socioeconomic circumstance

Throughout the thesis I use the term socioeconomic circumstance. According to Krieger, socioeconomic position refers to[216] pg.697:

"both resource-based and prestige-based measures, as linked to both childhood and adult social class position. Resource-based measures refer to material and social resources and assets, including income, wealth, and educational credentials; terms used to describe inadequate resources include 'poverty' and 'deprivation.' Prestige-based measures refer to individuals' rank or status in a social hierarchy, typically evaluated with reference to people's access to and consumption of goods, service, and knowledge, as linked to their occupational prestige, income and education level."

In addition to individual (compositional) factors which are stressed in this definition of socioeconomic position, the contribution of context characteristics (the environment in which a person lives, for example housing density, crime or pollution levels in a

neighbourhood) to the concept of socioeconomic experience has also been acknowledged[217-221]. In the current research the term socioeconomic circumstance is used in preference to socioeconomic position to explicitly encompass both compositional and contextual dimensions of the socioeconomic construct. In this research I also use the terms 'deprived' or 'deprivation' to refer to people who are from one extreme of the socioeconomic spectrum and 'advantaged' to refer to those who are at the other. Shaw et al. ([9]pg. 5) defines 'deprivation' as follows:

"'Deprivation' (often used in conjunction or interchangeably with the term 'disadvantage') is a term that refers to a variety of conditions experienced by people who lack certain resources in relation to others in the community, thereby making them 'deprived' compared to others in the population…These conditions may be material, such as dietary intake, home environment, housing and clothing. Alternatively, they might be social conditions, referring to the right of employment, community integration, recreation, education and so on."

3.5 Measuring socioeconomic circumstance

Given the multi-dimensional components of socioeconomic circumstance it is unsurprising that it can be measured in many different ways[217;222]. A major distinction is whether socioeconomic circumstance is measured at an individual or an area level.

There are many individual-based measures used to represent aspects of a persons' socioeconomic circumstance and often these are used in combination[9]. These include a person's income, employment, education, housing status, wealth and number/type of assets (such as car, cooker, central heating).

Alternatively, socioeconomic circumstance can be measured at an area-level. Area measures are commonly produced from individual or small area data which are aggregated[217]. Data sources include the decennial census, government administrative databases and surveys[9;223]. Often area-based measures are produced in the form of deprivation indices. These bring together a number of data sources into a single value or index that can be used for comparative analysis between areas[9] by ranking areas, and then dividing these ranks into quintiles or deciles of deprivation which are relative to one another.

In common with other research examining the association of patients' socioeconomic circumstance and health service use, this research was constrained to using an area-

level indicator of socioeconomic circumstance (Chapter 4). The area measure serves as a proxy for the socioeconomic circumstance of an individual in the absence of this information[217]. Commonly used area deprivation measures include the Carstairs Index, Townsend Index and the Index of Multiple Deprivation[9]. The Index of Multiple Deprivation (IMD) 2004[12] was chosen for this research. The IMD 2004 is a composite area-based measure which includes indicators of deprivation within the following seven domains (the percentages show the weights attributed to each domain[9;12]):

- Income (22.5%)
- Employment (22.5%)
- Health and disability (13.5%)
- Education, skills and training (13.5%)
- Barriers to housing and services (9.3%)
- Living environment (9.3%)
- Crime (9.3%)

IMD 2004 data and guidance on the methodology used to derive the index is available from the Department for Communities and Local Government[224]. The variables used to construct the domains are listed in Appendix C. The statistical methods used to produce the index involved standardising and transforming the data within each of the domains to ensure they all had a common distribution. The domains were then combined with appropriate weightings to create the final index. The weights reflect both the robustness of the domain[9] and the relative importance afforded to the domain in terms of its contribution to the concept of multiple deprivation (decided through consultation and reviewing published literature on the subject)[12]. The IMD 2004 has been constructed at the smallest practicable spatial scale for which data are available. This is the lower layer super output area (LSOA) which covers approximately 1500 people[225]. Each LSOA in England has been assigned an overall IMD 2004 score and also a rank (1=most deprived LSOA in England, 32,482=least deprived LSOA in England).

A major limitation with using area-based measures as a proxy for individual level socioeconomic circumstance is the potential for misclassification[217]. Misclassifying an individual's socioeconomic circumstance on the basis of their area of residence (for example, labeling an individual as deprived because they live in an area which is classified overall as deprived, but in fact they themselves are socioeconomically advantaged) is referred to as the problem of ecological fallacy[226-228].

Choice of area-based deprivation measure

Other measures that I considered were the Townsend deprivation index and the Carstairs deprivation index[229]. Townsend and Carstairs are very similar indices, both using census variables on overcrowding, unemployment and car ownership to measure relative material deprivation across the population[9]. They differ in that Carstairs includes the proportion of all people in private households with an economically active head of household in social class IV or V whereas Townsend includes the proportion of private household that are not owner-occupied[9]. Both of these indices are produced at a smaller area level than IMD 2004 (output area as opposed to super output area, see Chapter 8, Figure 8.1). This has a potential advantage in terms of capturing socioeconomic heterogeneity at small area level and minimising the problem of ecological fallacy (see Chapter 8). Despite the small-area advantage of Carstairs/Townsend, I decided instead to use IMD 2004 for the following reasons.

Firstly, Carstairs and Townsend rely solely on data from the decennial census. In contrast, IMD 2004 is a more holistic and comprehensive measure of deprivation, using data from a range of sources including the decennial census, government administrative databases detailing income and disability benefit claimants, hospital episodes statistics, educational attainment records, Home Office crime statistics and air quality monitoring records[12]. Indices based solely on census information can only be updated every 10 years. In contrast, by including data from a range of sources, the IMD 2004 is a more up-to-date measure of deprivation (data from 2001, 2002 and 2003, see appendix C). The IMD has been updated every three years and since carrying out this research a new 2007 version has been released. The IMD 2007 updates the data used in IMD 2004, but to enable direct comparison to 2004 it retains broadly the same methodology, domains and indicators[11].

Secondly, the IMD 2004 is a widely used indicator of deprivation in the England[230] and has been used before in studies of ERSs[231;232]. Use of this measure therefore enabled direct comparison of this research population to other populations covered in previous ERS studies (see Chapter 6).

Thirdly, the reliance of the Carstairs and Townsend indices on car ownership is problematic. Cars are thought to be more of a necessity in rural areas, which has led some to argue that this variable is a better indicator of urban rather than rural deprivation[233]. Furthermore, the strength of any relationship between car ownership and deprivation is likely to have declined over time, and the number of cars owned

rather than owning one at all may be a better contemporary socioeconomic discriminator[9]. Using IMD 2004, which does not include car ownership, avoids this contentious issue.

Finally, the 2001 census changed the way the number of rooms were counted, which affects the overcrowding element of the Townsend and Carstairs indicators[9]. In light of these changes, there is ongoing debate as to the validity and consistency of calculating Townsend and Carstairs measures based on 2001 census data[9]. Whereas Townsend and Carstairs were originally based on older censuses and then updated with the 2001 release, the IMD 2004 was created and tailored specifically to the data available in the 2001 census and data from other sources. The fact that IMD 2004 draws from a range of sources, unlike Townsend and Carstairs, means that any issues with the stability or measurement of one particular variable will not have such a major impact on the overall validity of the measurement.

One of the criticisms levelled at the IMD is the problem of 'mathematical coupling.' Because IMD 2004 is a composite measure of deprivation, there are some aspects of certain domains that overlap with other variables included in the analysis (for example, distance from general practice/person's home to nearest participating leisure centre may overlap with the 'barriers to housing and services domain'). Previously, this 'mathematical coupling' has been identified as a potential problem when applying the IMD 2004 to the analysis of health service access and use[234]. However, analysis of health data both including and excluding the potential problematic domains of the IMD 2004 found no significant difference in the relationship between key health variables from the census and deprivation[234]. Excluding domains from the analysis introduces further problems, as it requires individual researchers to decide the redistribution of weights in the remaining domains, and therefore hinders comparison across studies using IMD. For these reasons I chose to use the IMD 2004 in is original format, with all domains included, in this research.

3.6 Rationale for examining equity of ERSs

3.6.1 ERS policy focus on ensuring an equitable service

Need for Exercise Referral, and physical activity promotion interventions more generally, will be higher in more compared with less deprived socioeconomic groups. This is because deprived groups suffer more from the conditions[25;235] for which Exercise Referral is indicated and are less likely to engage in leisure-time physical

activity[24;26;79;123] than those living in less deprived circumstances. Despite greater need, known barriers to participating in physical activity such as lack of money, access to transport[28;29] and the availability of leisure facilities[26;27] are socioeconomically patterned (see section 3.8).

In view of this, ensuring access to services for those in greatest need features prominently in physical activity promotion policy. In 2006 NICE highlighted the requirement to pay attention to the needs of disadvantaged communities when developing services to promote physical activity[33]. The physical activity strategy 'Game Plan'[96] announced a package of measures to assist disadvantaged adults. This package included measures such as opening up school facilities for community use and subsidising leisure opportunities to overcome cost barriers. The Physical Activity Action Plan accompanying the Choosing Health White paper made specific reference to targeting disadvantaged groups in physical activity promotion[101].

The National Quality Assurance Framework for Exercise Referral[17] emphasises the importance of ensuring that ERSs are delivered equitably and explicitly states that schemes should employ strategies to engage people from disadvantaged groups:

Guideline 1
"Schemes should provide for adults (16+) and should address issues of the individual's health need as well as the health needs of the local community. They should also address equity and social exclusion."[17] p.18

Guideline 6
"Some patients may meet the normal criteria for referral but may be reluctant to enter an exercise referral scheme for a number of socioeconomic reasons. Additional strategies should be devised to encourage uptake of a referral (for example, reduced costs for unemployed, transport or extra support for elderly and isolated groups)." [17] p.19

Extracts from the documentation of several London-based ERSs reflect this national guidance:

"The main aim of Fitness for Life is to encourage, educate and provide opportunities for Barnet residents to participate in physical activity, particularly disadvantaged groups, in order to improve the health and quality of life of the local community."

Barnet Exercise Referral Scheme annual report 2005

The ERS aims: "To heighten the profile of physical activity in communities who are currently excluded from current provision."

Lewisham GP Exercise Referral handbook 2005

Potential benefits to stakeholders of the ERS include: "Meeting public health targets within 'Health Improvement and Modernisation Programme,' National Service Frameworks and health inequalities."

Newham Exercise Referral Scheme interim referee manual 2004

3.6.2 Research examining the equity of healthcare

Although equity is a fundamental principle of the NHS and a key consideration for ERSs, there is large body of evidence demonstrating that, whilst fairer than many health systems across the world, the British NHS nevertheless harbours systematic and persistent healthcare inequities[19;22;236-240]. Reviews by Goddard and Smith[19;241] and Dixon et al.[176] have summarised this research. The Goddard and Smith[19] review included literature from the 1990s, and the latest research cited in the Dixon et al.[176] review was published in 2004.

People from deprived socioeconomic groups attend primary care more frequently than those from more advantaged socioeconomic groups[18;19;236;242]. This can be explained in part by the greater need for care in deprived groups, given that they suffer from more morbidity. In studies which attempted to control for need across socioeconomic groups the higher consultation rates in deprived groups have remained[19;236]. This suggests either that there was a pro-deprivation gradient in consultation behaviour or that need was inadequately defined and accounted for in these studies[241].

Although more likely to attend primary care, people from deprived groups have been reported to be less likely to use a number of preventive and specialist health

services[19;21;22;176;236;238;243;243;244]. This observation, that those in most need of health care are often the least well served in terms of receipt of such care , has been termed the 'inverse care law'[23]. Childhood immunisation, breast cancer and cervical cancer screening uptake rates have been previously reported to be lower for those living in deprived compared to advantaged socioeconomic circumstances[19;176;241].

Inequities favouring the socioeconomically advantaged over the more deprived have also been reported for flu immunisation and cholesterol screening when differential need for these services across the population had been taken into account[243]. Being from a more deprived socioeconomic group has also been shown in the past to be associated with poorer attendance at health checks[19], diabetes clinics and diabetes reviews[176], which may in part be due to poorer provision of services in deprived areas[176].

However, there is some evidence pointing to more equitable preventive health service access and use in recent years. For example, several studies have reported that smoking cessation services have been largely successful at reaching smokers from socioeconomically deprived backgrounds[245-248]. A study conducted across general practices in Rotheram, England, found that those practices in the most deprived areas did not appear to provide a lower quality of CHD care[249].

With respect to cervical screening and MMR immunisation, an analysis at health authority level showed that, although screening coverage was consistently higher in advantaged socioeconomic areas from 1991-1999, the actual inequity in screening coverage between deprived and more advantaged areas declined over this period[250;251]. In the case of MMR immunisation however, this did not represent 'progress' in tackling inequities given the decrease in inequity was achieved, not by improvements in deprived areas, but instead through declines in coverage (following the 1997 vaccine scare) that were initially more pronounced in advantaged areas[252].

The Quality and Outcomes Framework (a financial incentive scheme that renumerates general practices in the UK for their performance against a set of quality indicators) was one of a raft of initiatives introduced by the incoming Labour government of 1997 to tackle healthcare inequity[184;236;253]. Other initiatives included the National Service Frameworks[102-104] and the establishment of the National Institute for Health and Clinical Excellence (NICE). A longitudinal study of the impact of the Quality and Outcomes Framework recently published demonstrated that this framework was making a

substantial contribution to the reduction in inequalities in the delivery of clinical care related to area deprivation[230]. However, this finding must be treated with caution as an alternative explanation is the increase in exception reporting over the study period. This may have indicated inappropriate exclusion of difficult patients, and this phenomenon may have been more likely in the initially poorly performing (hence deprived) practices[230]. This limitation however is unlikely to explain the improvements in full and so, as the authors claim, this renumeration scheme introduced by the Government may indeed be an example of an equitable public-health intervention[230].

3.6.3 Lack of previous ERS research examining equity

In view of the equivocal evidence with respect to the equity of preventive and primary care services more generally, there is a lack of previous research which has examined the socioeconomic circumstance of people accessing and using ERSs which would enable a judgement as to the likely equity of ERSs.

A 2005 systematic review of attendance at ERSs identified extremely limited published information about the characteristics of patients who take up and complete ERSs[254]. Only 1 of the 9 studies included in the review reported whether socioeconomic characteristics were associated with likelihood of use of the ERS, an RCT conducted in Hailsham in East Sussex[146;254]. Subsequent to this review, two observational studies, one in rural Somerset[232], one in an urban area of North-west England[231] have specifically investigated factors associated with the likelihood of attendance and adherence to ERSs. There has been one further study in South Islington (an inner city area of North London) not included in the 2003 review[29] which did not look explicitly at socioeconomic circumstance and use of ERSs but instead examined barriers to adherence to Exercise Referral. One of the barriers studied was 'lacking money to exercise.' Lacking money to exercise may be an indicator of material deprivation, which is one dimension of socioeconomic circumstance (see Section 3.4).

None of these previous studies have investigated factors associated with likelihood of referral (i.e. access) to ERSs. All of these studies are limited to analyses of single ERSs, they have methodological weaknesses, and they have produced conflicting results.

The study in North-West England found that overall patient deprivation status had no influence on the likelihood of attending the first ERS appointment[231]. In contrast,

deprived patients in Somerset were found to be less likely to take up their initial ERS appointment[232].

Both the Hailsham RCT[146] and the study of the scheme in rural Somerset[232] found that deprived patients were just as likely to complete the scheme as their more socioeconomically advantaged counterparts. In contrast, the London study found patients who cited lack of money as a barrier to exercise had one quarter the odds of completing the ERS programme than those who did not perceive lack of money as a barrier[29].

The Hailsham RCT was conducted in the 1990s[146] so may not be applicable to schemes running today. Furthermore, because of its experimental nature it might not accurately reflect equity of schemes running as part of routine service delivery. For example, recruitment was systematic (medical records of patients registered at general practices were screened for eligibility by the research team and eligible patients sent an invitation to participate in the research through the post) whereas referral to ERSs in a routine service context is carried out opportunistically[17]. The primary objective of the RCT was to determine effectiveness of the ERS, and only passing reference was made to the fact that adherence to the intervention was not related to employment status, occupational type, educational level or housing tenure (owner occupied, renter)[146]. No data was provided to substantiate this claim.

The cross-sectional survey of barriers to adherence to ERS was small and conduced over a decade ago (1995-1996) in an inner city population[29]. Therefore, it may not apply to other populations within England or current ERS practice. It did not set out to examine the association between socioeconomic circumstance and scheme access and use, and although I have surmised that 'lack of money to exercise' maybe a proxy for socioeconomic circumstance this may not be the case.

The two observational studies[231;232] potentially offer the greatest insight of any research to date into the association between socioeconomic circumstance and use of ERSs because both were undertaken on schemes running as part of routine service delivery and were conducted relatively recently. However, there were limitations to both studies. Firstly, neither examined equity across the whole scheme pathway; the North-west England study only examined likelihood of taking up the intervention[231], and the Somerset study examined likelihood of both taking up and completing the intervention but not of being referred in the first instance[232]. Secondly, although both of these

studies controlled for the potentially important confounding effects of age and sex (the Somerset study also adjusted for rurality), there were other possible confounders not considered. For example, ethnicity, reason for referral or training status of the referring general practice (see Chapter 5, Section 5.9.2.1). This means there may be residual confounding in the relationships reported in these studies. Thirdly, neither study considered the clustering of referred patients within general practices. Patients within a general practice are likely to be more similar to each other than to patients from different general practices given that they share the same local environment and the same provision of primary care services, and as such referred patients are clustered within general practices. Neither of these previous studies undertook multi-level analysis to account for this and so the reported relationships might be inaccurate. Finally, both of the studies were carried out on single ERSs so the potential to generalise from these contexts to other ERSs is relatively limited.

Given the scarcity of research, its methodological weaknesses and the equivocality of existing knowledge in this area, the relationship between socioeconomic circumstance and access and use of ERSs was identified as an area requiring research. The importance of examining the equity of ERSs was reinforced by previous concern in this regard. In 1994, when ERSs were in their infancy, Iliffe et al. highlighted the potential problem of the inequitable impact of this intervention:

"as with many other initiatives promoting health, there is a danger that effort and resources may be misspent in promoting exercise to those who would have taken it up anyway, the 'worried well.' This group is likely to be younger and already more fit and active than average."[30] p.282

Hillsdon et al. have supported this concern, speculating that leisure centre based schemes may be unlikely to recruit and retain sectors of society who would have most to gain from adopting an active lifestyle[31].

3.7 Aim, objectives and hypotheses

The overarching aim of this research was to examine the influence of socioeconomic circumstance on referral to and use of ERSs. There were three objectives:

(i) To examine the association between the socioeconomic circumstance of the area within which a general practice was located and the likelihood of referring patients to ERSs.

(ii) To examine the association between patients' socioeconomic circumstance and the likelihood of attending the initial ERS appointment (uptake of the service).

(iii) To examine the association between patients' socioeconomic circumstance and the likelihood of attending the final ERS appointment (completing the service).

The analysis to address objective (i) was carried out at the level of the general practice, rather than the individual patient (see Chapter 5 for explanation).

The research hypotheses were as follows:

Referral

General practices in more deprived localities will be less likely to refer eligible patients to ERSs than those situated in more socioeconomically advantaged localities.

Uptake

Patient's living in more deprived localities will be less likely to take up ERSs than those living in more socioeconomically advantaged localities.

Completion

Patient's living in more deprived localities will be less likely to complete ERSs than those living in more socioeconomically advantaged localities.

3.8 Explanations to support hypotheses

I have formulated the research hypotheses based on the premise that the inverse care law may be operating with respect to access to and use of ERSs. I will now discuss evidence which suggests possible mechanisms through which deprived socioeconomic circumstance may translate into lower access and use of ERSs. This discussion provides the theoretical underpinning for the hypotheses outlined above. In doing so, I will be drawing on two areas of interrelated literature. Firstly, research examining differences in health behaviour (specifically physical activity participation) across socioeconomic groups. Secondly, literature examining differences in health service

access and use across socioeconomic groups. There is considerable overlap in the underlying mechansisms proposed in both sets of literature, and so they will be discussed in tandem.

Figure 3.2 outlines the conceptual framework proposed by Kilbourne[255] and colleagues to understand inequities in health and healthcare from a health services research perspective. It is informed by a socio-ecological approach[80], which acknowledges the interaction of individual, psychological, social, physical, political and environmental influences on service use[255]. A socio-ecological approach is also adopted to understand factors determining participation in physical activity and physical activity interventions[80;119;256]. The progression of a patient through an ERS can be represented in a diagram which draws on Kilbourne's[255] framework to illustrate where inequities may occur with respect to access and use of ERSs (Figure 3.3).

Figure 3.2 Kilbourne et al.[255] model showing key potential determinants of health and health care disparities from a health service research perspective

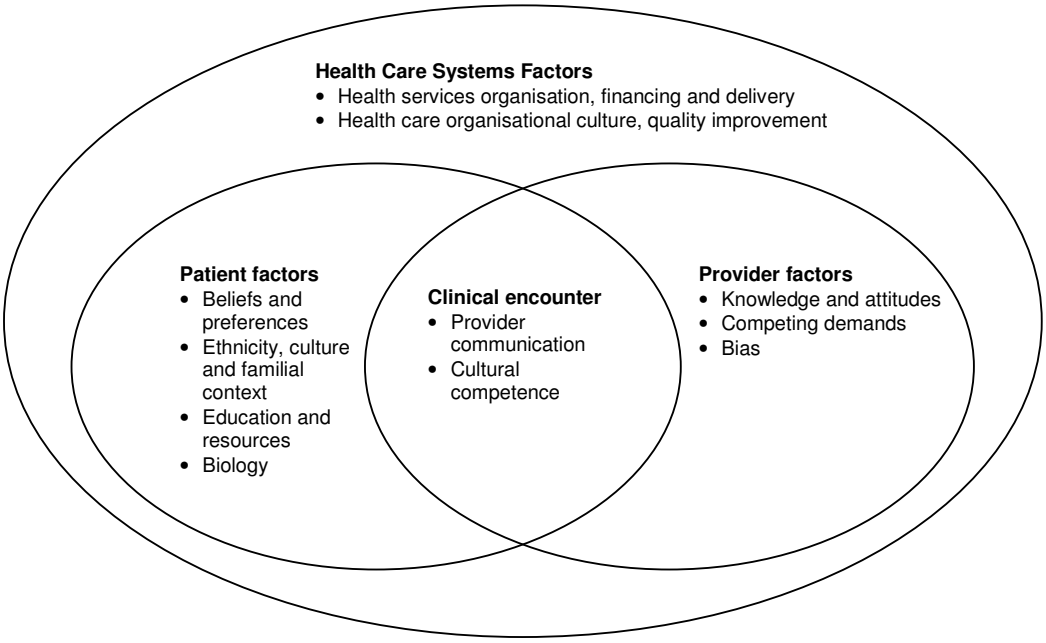
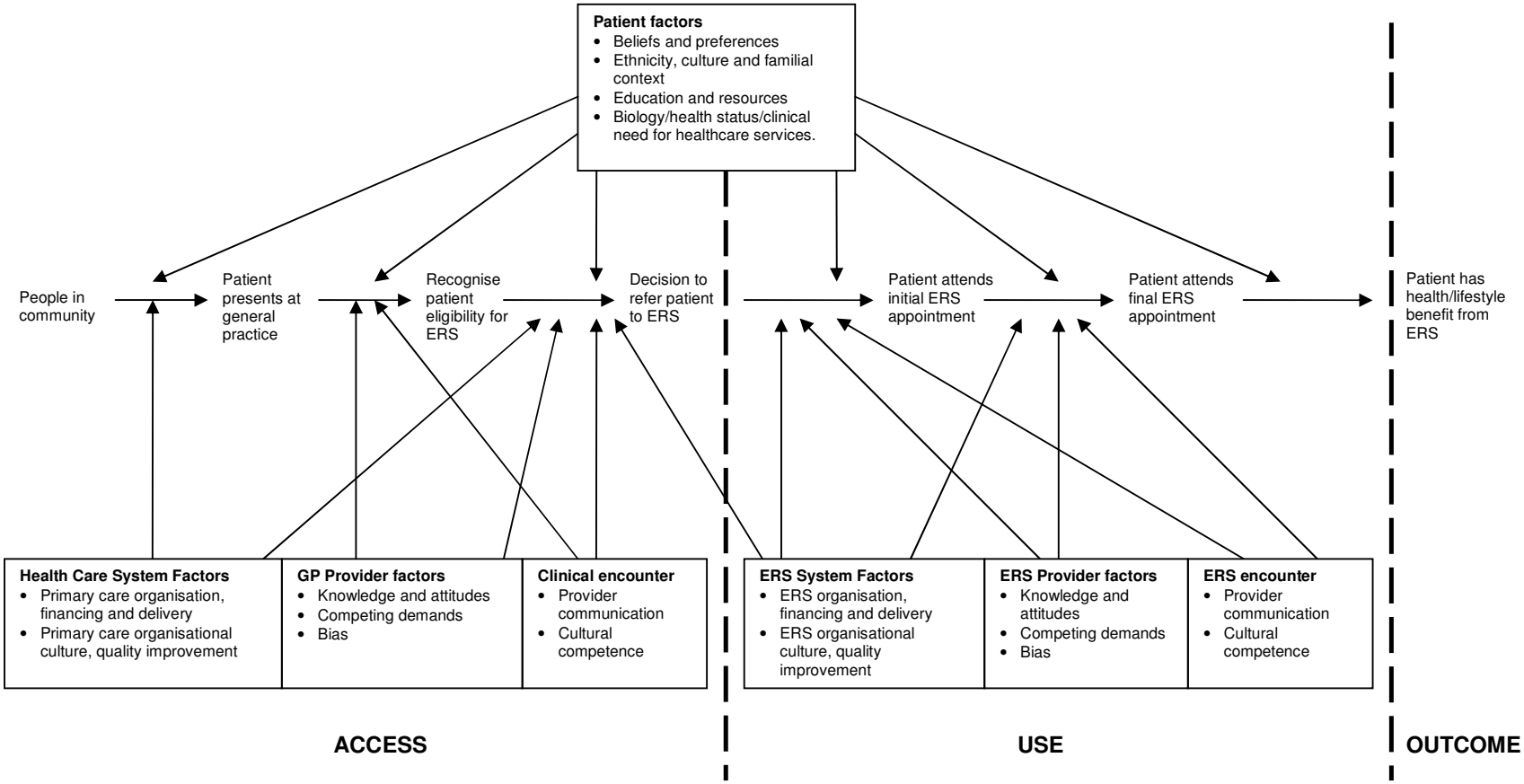


Figure 3.3 Model outlining interplay of patient, provider, encounter and system factors determining access, use and outcome from ERSs



I will describe patient, provider, encounter and system factors and how these may interact and influence access and use of ERSs differently according to the socioeconomic circumstance of patients.

Patient factors

There are several ways in which the deprived socioeconomic circumstance of patients may result in lower access and use of ERSs.

Firstly, perceived physical health and physical competence are known determinants of adherence to exercise programmes[29], and so poor health may act as a barrier to participating in physical activity[257]. Given that patients from deprived socioeconomic groups suffer from more ill-health overall[81], there is greater likelihood of ill-health acting as a barrier to engaging with a preventative health service and attending a physical activity intervention for patients in these groups compared to more advantaged socioeconomic groups[257;258].

Secondly, income may influence an individual's ability to obtain the social and material resources necessary to lead an active lifestyle[80] and engage with physical activity interventions[29] such as ERSs. Barriers to participating in physical activity[28;29;29;258-260]and attending healthcare services[261] such as lack of money or access to transport are socioeconomically patterned.

Thirdly, educational attainment may influence the likelihood of patients accessing and using interventions such as ERS. This influence may be mediated through differences in problem-solving and coping capability arising from education experience, which in turn may impact on self-efficacy for physical activity[80;84;262]. Those with higher levels of education may have greater exposure to health promoting messages which will influence beliefs about the importance of physical activity which in turn will generate a greater propensity to pursue, understand, internalise and act upon these health messages, resulting in higher self-efficacy for physical activity[80;84;262] and ability to overcome barriers to participating in physical activity[263]. Those in lower socioeconomic groups are thought to place less value on their health and health related behaviour, perceive a lower level of control over their health and health behviours[84], exhibit more fatalistic attitudes[261;264] and short-termism[265;266]. As a result, those from more deprived socioeconomic circumstances are less likely to engage with the healthcare system for preventive interventions[19] and to adopt healthy lifestyle behaviours.

Fourthly, individuals are likely to share a similar hierarchy of values and norms as those in their social network[267;268], and as such individuals with higher levels of education are likely to get more support and encouragement to live an active lifestyle than those with lower levels of education where exercising is not the norm or necessarily a priority in life[80]. Individuals with lower education have been shown to have lower social capital[81;269]. Receiving social reinforcement and support have been shown to be important determinants of accessing primary care services[261] and adhering to exercise programmes[29].

An alternative mechanism through which higher educated patients will be more likely to adopt healthy behaviours is that because they are likely to have a better understanding of the benefits of physical activity they may seek to live in activity-friendly environments[80] (and due to greater income are likely to be able to materially afford to live in such areas).

There are aspects of socioeconomic circumstance operating on a neighbourhood level, which may independently affect participation in physical activity[80;119]. The physical characteristics of the neighbourhood environment[82], access to recreational facilities and social capital in terms of the cultural and social norms of the neighbourhood, and perceived safety, trust, connections and reciprocity reported in the area[80;265] may all influence participation in physical activity. Although there is research to suggest access to urban green space is not associated with population levels of recreational physical activity[270], other aspects of living environment have been found to be important determinants of exercise patterns[82]. In the Netherlands, neighbourhood characteristics (for example, physical design) have been shown to contribute to neighbourhood socioeconomic inequalities in physical activity[82]. Living in an area with options to engage in physical activity located nearby is likely to be important[26;271-273].

In general, more deprived areas have been demonstrated to have more limited access to environments conducive to leading an active lifestyle[26;98;265]. For example, Hillsdon et al.[26] demonstrated that the availability of physical activity facilities declines with increasing level of deprivation such that areas in most need of facilities to assist people to live active lifestyles have fewer resources.

Another aspect of living environment is actual or perceived safety of an area[274]. Perceived safety of walking during the day was positively reported to be associated with walking for women in an English study[273]. Worries about personal safety and the

lack of anyone to walk with were the most commonly reported barriers to neighbourhood walking in a prospective survey of older people attending walking schemes throughout England and Scotland[275]. A large cross-sectional study conducted in North West England reported that people who felt safe in their neighbourhood were more likely to be physically active, although no association was found with actual experience of violence or crime[276]. As safety concerns, fear of crime and actual incidence of certain crimes are reportedly higher in more deprived areas[12], actual or perceived safety of an area may pose a greater barrier to physical activity participation for those living in deprived rather than more advantaged socioeconomic circumstances.

These interrelated explanations of the ways in which dimensions of socioeconomic circumstance (income, education, neighbourhood) can influence both access and use of health services as well as the propensity to live an active lifestyle can be brought together to support the hypotheses for ERSs outlined in section 3.8. Wealthier individuals are more likely than those on low income to be able to overcome material barriers to exercise such as not being able to pay for transport to get to the ERS venue or tariff to participate in the exercise session[28], not having money to buy appropriate equipment or clothing to exercise in[277], not being able to afford alternative childcare arrangements or flexible working hours to free-up time to visit a general practice[261] or to participate in the exercise sessions once referred. It is plausible that the higher value placed on the health benefits of physical activity and being better informed about routes to access services[261] may mean those from better educated groups will be more aware of the ERS intervention (knowledge about available facilities has been previously reported as an important determinant of participation in an ERS[29]). As a result patients from more highly-educated groups maybe more likely to bring up the idea of referral to Exercise Referral within a consultation, or reinforce any suggestion of referral made by a Health Care Professional (HCP).

Once referred to ERSs, the greater self-efficacy of patients with higher educational levels coupled with the increased likelihood of living in an environment conducive to exercising with leisure services located nearby, as well as being surrounded by a supportive social network of friends and family who encourage participation, may mean those with higher educational levels will have a greater propensity to take up the ERS intervention and have more success at adhering to the programme. Factors identified previously as reasons for non-adherence to ERSs including lack of self-efficacy[278] and poor body image, finding time, transport, interruptions of routine by illness, poor social

support and feeling uncomfortable in the gym environment[146;279-283] may be socioeconomically patterned across the population, with those from deprived groups more likely to experience these negative factors.

Provider factors

See Tai et al. acknowledge that both the referring health care professional (HCP) and the ERS personnel may influence the likelihood of patients accessing and using ERSs, but that isolating and measuring the influence of providers is difficult and could not be explored in their study based on a small sample[29]. Previous research indicates there are many factors influencing health care professionals' (HCPs) referral behaviour[284-286], and consideration of a patient's clinical 'need' for a service is only one factor. These factors are outlined in Figure 3.4.

Figure 3.4 Factors influencing health care professionals' referral behaviour[287-291]

- **HCP factors** – personality, knowledge and interests, relationships with patients[292;293] and colleagues, tolerance of uncertainty, beliefs about intervention effectiveness.
- **Clinical factors** – type of condition, history of the condition, seriousness of condition, co-morbidities, previous clinical management.
- **Service factors** – waiting lists, practice organization, proximity to the service, workload, consultation time, resources available.
- **Patient-specific factors** – socio-demographic background of the patient[292;294;295], patient preference for referral/prescription[296;297], and patient personality.

Barriers for health professionals in promoting physical activity, and in some cases specifically referral to ERSs[298] include:

- **HCP factors**
  - Legal concerns over responsibility for the exercising patient[298;299]
  - View that primary care is not a suitable forum for promoting lifestyle modification[299]
  - Lack of priority given to physical activity versus other lifestyle areas such as smoking and healthy eating[124;298]
  - Frustration over limited referral criteria[300]
  - If the health professional is sedentary themselves[301]
  - Knowledge gaps and lack of training in physical activity promotion[302]
- **Structural factors**
  - Lack of time[298;303-305]
  - Lack of incentives[301]
  - Lack of feedback about patients referred[298]
  - Concern over additional costs involved in providing the service[299]
  - Insufficient educational materials[304]
- **Patient-specific factors**
  - Feeling that patients would not act on the advice given[298]
  - Feeling it is not worth trying to change an individual's behaviour[305]
  - Preference of patients for drug treatment[304]

HCPs views on the types of patients who are more or less likely to 'act on the advice given'[298] may vary on socioeconomic grounds. This is because, despite reports of

egalitarian philosophies held by many health professionals'[306], research suggests that patient socio-demographic characteristics such as ethnicity, gender, age, sexual orientation and socioeconomic circumstance often influence provider beliefs, attitudes and actions towards patients[19;295;307-310]. Research suggests these stereotyped beliefs are more likely to occur when a HCP is time pressured, suffering from fatigue and information overload[307].

General practitioners are the main referrers to ERSs. Some general practitioners have noted the difficulty in engaging patients from deprived circumstances in preventive healthcare, sighting financial restrictions, limited knowledge, short-term outlook of patients, lack of motivation and lack of 'stability' as reasons for this:

"People from this patient group are more focused on the present. They come to the practice when they have an acute problem, but you need a lot of persuasive qualities to make them come for the monitoring of chronic conditions or for prevention."[311] pg. 180

General practitioner's beliefs about the negative attitudes towards preventative services held by patients from deprived backgrounds may alter their attitudes and actions. This may result in general practitioners being less likely to refer patients from deprived backgrounds to ERSs. As well as reservations held by doctors about the self-efficacy and commitment of those from more deprived groups to undertake preventive interventions, there is also evidence that the assessment of clinical eligibility made by doctors may also be influenced by the socioeconomic circumstance of patients[261]. Given the higher likelihood of co-morbidities, later presentation, and more serious illness reported for deprived patients, patients who are socioeconomically deprived may be judged to be poorer candidates for an intervention than more socioeconomically advantaged patients[261]. Hence, it is plausible that HCPs interpretation or application of the eligibility criteria for Exercise Referral may alter depending on the socioeconomic circumstance of the patient. On the other hand, given the greater need for ERSs within deprived groups and awareness of ERS policy focus on ensuring an equitable service, general practitioners may be more inclined to refer patients from disadvantaged groups.

Once referred, patients will encounter ERS staff at leisure centres and in some cases community exercise venues. Satisfaction with ERS has been largely attributed to the professional, supportive, encouraging, and friendly service provided by the staff[279].

It is plausible to suggest that, just as patient socio-demographic characteristics such as ethnicity, gender, age, sexual orientation and socioeconomic circumstance influence HCPs' beliefs, attitudes and actions toward patients, the same maybe true in respect of the beliefs, attitudes and actions of ERS personnel. However this is no more than speculation as this has not been subject to evaluation.

The clinical / ERS encounter

More highly educated patients may have a greater ability to communicate effectively with HCPs[261;312] and advocate for their health needs[22], and as a consequence may be better able to present a persuasive case for referral to an ERS than patients with less education. Deprived patients often report negative experiences and lower expectations from HCPs than those from more advantaged backgrounds[261]. This has been explained in part due to a poor degree of social alignment between the patient and the HCP and the lack of knowledge sharing and adequate information provided by the HCP[261;264]. When there is cultural and social incongruence between patient and health professionals, consultations can have less satisfactory outcomes[264;313] with the social distance between patient and doctors discouraging verbal assertiveness from patients[314]. Patients' interpersonal and language skills, in particular the ability to articulate health concerns and interact in a healthcare consultation setting, may mediate access to care[261]. Previous research suggests doctors' perceptions of patient pressure to access a service is an important determinant of HCP referral behaviour[297;315;316]. Therefore, being able to present a persuasive case for referral to ERS maybe important.

It is plausible to speculate that there may also be differences in the effectiveness of communication between ERS participants and ERS staff according to the socioeconomic circumstance of patients. These differences may in turn result in differences across socioeconomic groups in the likelihood of patients taking up or adhering to the ERS programme. Once again this is speculation because this has not been researched.

System factors

The organisation, financing and delivery of primary care[261;317] and ERS services are both likely to impact on referral, uptake and use of ERS. Factors such as waiting lists, workload, proximity of a service are all taken into account by health professionals when making referral decisions[287-290] and they are also important in determining patient consultation and use of services (location of service, cost of service, timing of service)[261]. In line with the inverse care law, it is known that practices serving deprived

communities tend to have heavier workloads[318;319] and limited resources[23]. It is theoretically plausible that access to ERSs maybe worse for those living in deprived communities where the general practice is faced with a heavy caseload and limited resources. Quality of service is reportedly higher in training practices[320;321] and as such training practices might have a greater propensity to engage in interventions such as ERSs. Training practices are more commonly represented in less deprived areas[320;322].

Services that use appointment systems rely on patients having access to phone/email/stable postal address and require people to present themselves at particular places at pre-specified times, all of which may be less likely for patients in extremely deprived circumstances[261]. ERS service factors including inconvenient operating hours for working people, congested facilities, insufficient staff, intimidating gym environment or equipment, narrow range of activities and limited opportunities for social interaction have been previously reported in qualitative studies as reasons for non-attendance at ERSs[146;279-283]. If ERS sessions are run at restricted times following inflexible formats with limited support, they may differentially disadvantage patients from more deprived socioeconomic groups who face greater material and psychosocial barriers to participation than patients from more advantaged backgrounds.

3.9 Study design

An observational study design was required to examine the association between socioeconomic circumstance and ERS access and use. I planned to use information collected routinely by ERSs to conduct cross-sectional analysis of patients referred and using the service over a given time period. I undertook a scoping review across the sample frame for this research (Greater London) in order to assess the breadth and comparability of routine data collected by ERSs. This was in order to determine which schemes could provide adequate historical routine data on patients referred to ERSs to be included in this research. Chapter 4 describes this scoping review.

Chapter 4

Scoping review of Exercise Referral Schemes across Greater London

Chapter 4. Scoping review of Exercise Referral Schemes across Greater London

4.1 Introduction

This chapter turns the focus of investigation to Greater London, the sampling frame for this current research. I undertook a scoping review to understand the provision of ERSs across Greater London. The objectives of this review were:

- To establish which PCTs were running ERSs in Greater London.
- To understand service design and delivery of schemes running in Greater London.
- To describe the data collection and routine monitoring undertaken by ERSs.
- To identify schemes with suitable routine data collection to participate in the equity analysis.

It is reasonable to expect that schemes may be broadly similar in terms of design and delivery, due in part to the National Quality Assurance Framework (NQAF) for Exercise Referral[17]. Schemes may also be broadly similar due to the sharing of practice between areas, which occurs at conferences (for example the Wright foundation conferences for Exercise Referral Specialists[323]) or through public health networks or grey literature exchanges. However, it is also reasonable to conjecture that schemes may differ substantially in their detail. This is because the NQAF states that it is not:

"a stand-alone blueprint, "prescription" or business plan for how exercise referral schemes must be commissioned, structured or managed. It is guidance for best practice based on principles that can be applied flexibly to meet local needs."[17] pg. 9

Flexibility is a common feature of many centrally driven health promotion schemes, such as the Health Trainer initiative which was introduced in the 'Choosing Health' White paper[100]. A further example is the early years intervention 'Sure Start,' and indeed the observation by Rutter might equally be applied to ERSs:

"Sure Start Local Programmes (SSLPs) do not have a prescribed curriculum, it being left up to each area to decide for itself what it wished to do…The unavoidable consequence is that SSLPs are highly varied. This would create research problems in any circumstances because of the difficulty in making any kind of comparison across areas."[143] pg.135

In view of the possible high variability in data collection across ERSs due to the lack of a national minimum dataset for ERSs (see Chapter 2), this scoping review formed a necessary initial phase of this research project in order to identify schemes with suitable routine data to be included in the equity analysis.

4.2 Methods

The scoping review of ERSs was carried out October 2005 – March 2006 across all 31 PCTs in Greater London. Initially, I identified ERS coordinators/managers either by contacting a relevant department (for example, local authority Sport and Recreation Department, local authority Culture and Community Department, PCT Public Health Department) or by searching Google (www.google.co.uk) for information about ERSs running in London. I then arranged telephone and face-to-face interviews. I asked ERS coordinators/managers about the design and structure of the scheme, inclusion criteria for patients, and the type of health professionals who can refer to the scheme. I paid particular attention to understanding any monitoring processes in place and finding out what routine electronic information was collected about participants. The topics covered in these interviews are set out in Table 4.1.

Table 4.1 Topics covered in interviews with ERS managers/coordinators

What is the nature of the exercise referral scheme? (i.e. description of scheme, duration of programme, type of activities offered, what happens to patients after they finish the programme?)
What are the reasons for referral and inclusion/exclusion criteria for the scheme?
Who is able to refer onto the scheme? (e.g. general practitioner, practice nurse, physiotherapist, cardiac team)
What is the cost to the participant?
How many participants do you have approximately per month/quarter/year?
How long has the scheme been running?
Which leisure/community venues participate in the scheme?
How is the scheme funded?
Do you have written documentation associated with the scheme I could look at? (e.g. protocol, handbook for referrers)
What information (personal, health, lifestyle) is collected about participants? • At referral • At initial assessment • At mid-point • At end
How is this information collected? (i.e. data collection tool used - paper referral forms, questionnaire)
Of the information collected, what is recorded on an electronic database?
What electronic database software is used?
Anything else about the ERS you would like to tell me about?

I summarised the information provided in these interviews and compared the ERSs running across Greater London. I also compared the design and delivery of the Greater London schemes with previous reports of ERSs in the literature. I then

grouped ERSs together according to the comprehensiveness of information collected, i.e. whether the ERSs electronically recorded:

a) no useful information (least comprehensive)
b) information from point of uptake of ERS by patients
c) information from point of referral to ERS (most comprehensive)

I calculated the average Index of Multiple Deprivation (IMD) 2004 rank (see Chapter 3, Section 3.5 for an explanation of IMD 2004) for each PCT covered by the schemes in these three groups to establish whether there was any relationship between the overall deprivation status of areas and the comprehensiveness of data collection undertaken by the ERSs.

4.3 Review findings

The scoping review uncovered that ERSs were virtually universal across London, with 30 out of 31 (97%) PCTs in Greater London running or developing an ERS (Figure 4.1). This demonstrates the extent to which ERSs have become a widely adopted physical activity promotion intervention (see Chapter 2). One of the strengths of this review was its 100% response rate. I achieved the high response rate by identifying key named contacts across a range of settings (health, council and private leisure centres) and engaging with them actively though telephone conversations, rather than through use of postal questionnaires (a technique which has been employed previously in reviews of ERSs and which has resulted in lower response rates[45;324]). During these initial conversations background information on ERS service design and delivery was gathered. On the basis of these conversations, I ruled out 16 schemes as not having suitable data collection for inclusion in the study. I met with ERS managers in the 15 remaining schemes, to ascertain exact details of data collection to determine eligibility.

All schemes fitted a broad definition of ERSs; patients referred to a series of exercise sessions at a local exercise facility. All of the schemes subsidised the cost of participation for patients. However, there were differences between schemes in the source and level of funding, the inclusion criteria for referral, the types of activity sessions offered, the duration of the ERS programme, the number of sessions to attend per week, the tariff paid by participants, and the type of health professionals who could refer patients to the programme (Table 4.2).

Table 4.2 ERS design and delivery across Greater London

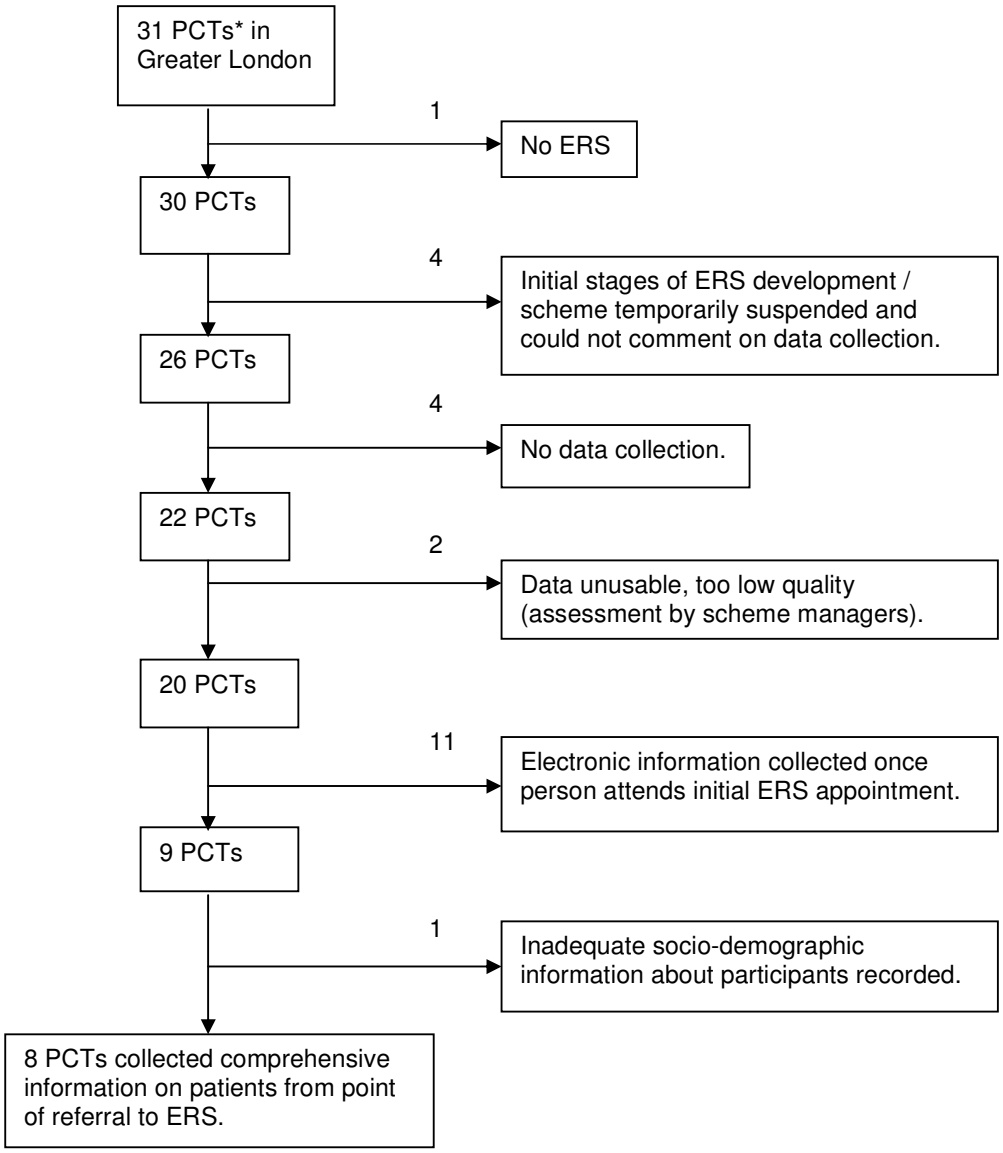
Characteristic		Examples of schemes with characteristic
Inclusion criteria for participants	Some schemes classify participants into risk groups (low, medium, high)	o, r
	Some include cardiac patients	a
	Some include being 'old' and sedentary as a sufficient referral criteria	c
	Some include a psychological component. Patient must be ready to 'take action' rather than be in the pre-contemplation or contemplation phase of behaviour change.	b, g
Type of activity offered	All offer gym based sessions	
	All run sessions during the day in off-peak leisure time	
	All offer tailor-made exercise referral classes	
	Some offer swimming/aqua aerobics	f, h
	Some offer community walks	n, q
	Some provide additional supervision at sessions open to gym members who are not referred through an ERS.	g, t
	Some offer women only classes	b, n
Referring health professionals	All general practitioners and practice nurses	
	Additional referring health professionals in some areas include;	
	• members of the cardiac care team,	a, i
	• diabetic clinic staff,	b
	• physiotherapists,	f, x
	• health trainers,	c
	• mental health workers,	c
	• psychiatric nurses,	c
	• occupational therapists,	c
	• community dieticians,	g
	• back pain clinic staff.	d
Level and source of funding	No formal funding arrangements –	s, w
	to £300,000 per year depending on scheme.	c
	Either funding embedded in mainstream PCT, local authority and private leisure services funding,	d, e
	or, rely on short-term grant funding from various sources including:	
	• Neighbourhood Renewal Fund,	j
	• New Deal for Communities,	p
	• Community chest,	m
	• Single Regeneration Budget,	u
	• Partnership for Older Peoples Projects funding.	c
	Exercise referral coordinators employed:	
	• within local authorities,	e, f
	• within PCT,	o
	• within private leisure company.	g
Tariff paid by participants to take part in scheme	Between £0 –	c
	to £2.90 per session depending on scheme.	y
	Some offer concessionary rates to unemployed / retired.	k, l
Duration of exercise programme	Programme lasts 6 weeks –	a
	to 9 months depending on the scheme attended.	g
	Frequency of exercise sessions for patient between 0 –	g
	3 sessions per week depending on scheme attended	c
	(longer duration programmes require less frequent attendance).	
Exit strategies and continued support	Some offer discounted gym membership upon completion of exercise referral programme.	k, o
	Some have a final appointment to signpost to other physical activity opportunities in the local area	a, b

a = Newham, b = Tower Hamlets, c = Camden, d = Croydon, e = Lewisham, f = Lambeth, g = Bromley, h = Hackney, i = Waltham Forest, j = Barking and Dagenham, k = Islington, l = Barnet, m = Enfield, n = Westminster, o = Kensington and Chelsea, p = Hammersmith and Fulham, q = Ealing, r = Hillingdon, s = Harrow, t = Bexley, u = Greenwich, v = Southwark, w = Kingston upon Thames, x = Sutton and Merton, y = Wandsworth

Figure 4.1 summarises the data collection undertaken by ERSs in Greater London. One area did not have an ERS and a further four were in the early stages of development or had been suspended so the manager could not comment on data collection. Out of the remaining 26 areas with established schemes, four did not collect electronic data and two collected data of such poor quality and reliability that the ERS managers considered the information unusable. Only 9 schemes collected electronic

information about patients from the point of referral as opposed to from the point of initial attendance at the first ERS appointment.

Figure 4.1 Data collection for Exercise Referral Schemes in Greater London



*PCTs are coterminous with Local Authorities. ERSs are a joint venue between both organisations.

Despite the emphasis in the NQAF[17] of ensuring socioeconomic deprivation does not serve as a barrier to ERS participation (Chapter 3), no schemes collected individual-level socioeconomic data (for example, a patient's education, employment status, income or living circumstances) which would enable this goal to be monitored. Socio-demographic variables such as gender and age were collected by most schemes. However, ethnicity was not always recorded and different schemes used different ethnicity groupings.

Some schemes did not monitor outcomes from the programme. For those that did, there were differences in the outcomes monitored between schemes (for example, physical activity status, biomedical endpoints, psychological wellbeing, general self-reported health). A few schemes used validated measures of outcome, such as the Short Form12 - a health survey[325] and the Dartmouth COOP - a survey of patient functioning[326]. These differences appeared to reflect in part a lack of clarity surrounding the aims, objectives and expected outcome from ERSs.

As explained in Chapter 2, a likely explanation for this variability in routine data collection is that although the NQAF emphasised the importance of evaluation[17;97] it failed to provide a clear structure for evaluation (for example providing a national minimum dataset). This failure, along with funding constraints or potential lack of priority given to ERS within overall health improvement agendas, may explain why in some cases the awareness, skills and expertise required to develop comprehensive routine data collection were not demonstrated by local schemes[127].

Table 4.3 shows that on average, schemes located in more deprived PCT areas tended to have more comprehensive electronic data recording.

Table 4.3 The relationship between area deprivation and the comprehensiveness of electronic data recording undertaken by ERSs

Electronic data collection by ERSs		Number (%) of schemes N=26	Average IMD 2004 Rank* of local authorities** (rank 1 = most deprived)
1)	Schemes with no/unusable data	6 (23)	201.57
2)	Schemes with information recorded from point of uptake of intervention	11 (42)	82.50
3)	Schemes with information recorded from point of referral to intervention	9 (35)	74.27

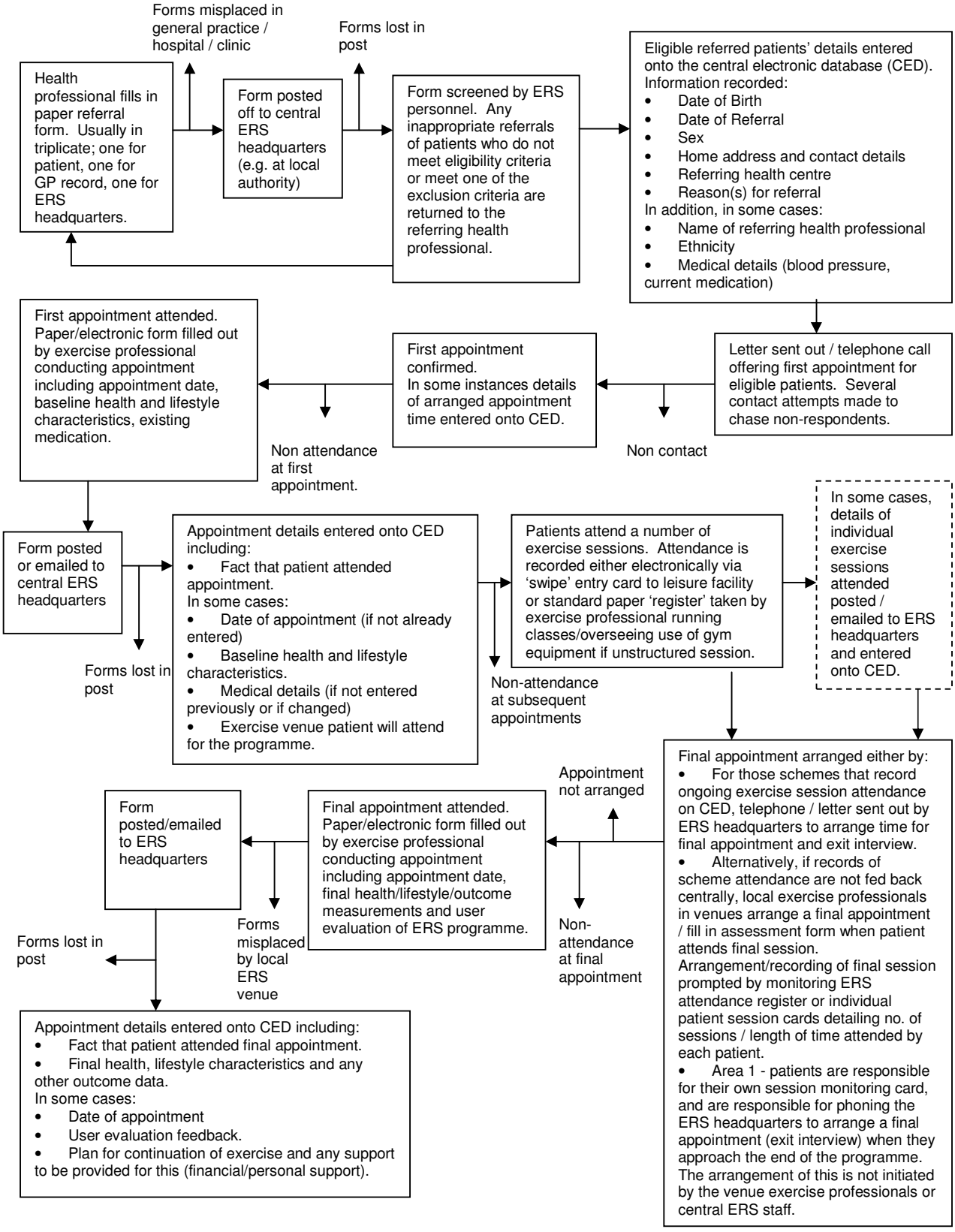
*Each LA rank was derived by averaging the ranks of all SOAs within that LA. The ranks of all LAs in each group were then averaged. **PCTs are coterminous with Local Authorities. ERSs are a joint venue between both organisations.

An overview of the data collection process for the 8 schemes which collected comprehensive information about patients from point of referral is provided in Figure 4.2.

The data flows were largely paper-based through referral forms, questionnaires and registers, the information from these was then transferred manually to an electronic medium. There were several points in the system where there was the potential for information loss (for example, forms may go missing in the post or be misplaced at the health centres or local ERS venues).

Lack of funding and of ERS personnel expertise may explain why data flows through the ERS system were found to rely heavily on paper forms and on posting information between organisations. Some areas did have a degree of electronic data capture, for example one area used the electronic ‘swipe card’ required to gain access to a leisure facility to register attendance by participants, but this was exceptional.

Figure 4.2 Overview of patient flow through ERS system and data collection carried out at each point



Descriptions of the London ERSs that had comprehensive electronic data on patients from point of referral are provided in Tables 4.4 - 4.10. Seven of the eight areas with comprehensive electronic data on patients from point of referral are described because Area 8 declined the invitation to participate in further stages of this research.

Table 4.4 Characteristics of the ERS running in Area 1

Scheme started	2001
Approximate no. of people referred per year	1200
Cost to participant	£5.50 to join scheme, £2.50-£2.75 per session for 20 weeks, then £3.00-£3.80 following this.
Funding for the scheme (i.e. total amount, breakdown PCT/council/private, grant or mainstream)	Funding from PCT CHD budget, around £50,000 per year.
Types of health professional who refer onto the scheme	General Practitioners Practice nurses Dieticians Back pain clinic staff Mental health health-professionals
Personal data collected and recorded electronically	Date of Birth Ethnicity Home address including postcode Gender Employment address
Health/lifestyle/behavioural data collected and recorded electronically	BMI Smoking status PA readiness questionnaire (PARQ)
Other information collected and recorded electronically	Screening date and attended yes/no Initial appointment date and venue Final appointment attendance Reason(s) for referral Referring health professional General practice of referred patient Previous referrals Whether provided with weight loss advice, details of weight management or smoking cessation services
Database software used for electronic data	Microsoft access
Outline of programme (how people are referred, what scheme entails, duration of programme, type of activities offered)	1. GP (or other health professional, majority GP) completes referral form, copy faxed/posted to central office. 2. Patient to ring office to arrange an appointment. If haven't heard from them, letter sent by central office about booking an appointment. 3. Initial one-to-one screening appointment, 45 minutes. 4. Attends 20 supervised sessions
Inclusion criteria (who is eligible to join the programme)	Sedentary and one of the following: Arthritis Back pain Depression / anxiety Hyperlipidaemia Hypertension (Systolic mmHg >140<180, Diastolic mmHg >90<110) Multiple Sclerosis Obesity/overweight: BMI>25 Osteoporosis Peripheral vascular disease Respiratory problems Type I diabetes Type II diabetes Stable Angina
Exclusion criteria (who cannot join the programme)	Already active Blood pressure (systolic mmHg >180, Diastolic mmHg >110) People with previous history of heart disease undertake separate referral process and are screened by cardiac rehabilitation coordinator

	before admission onto the scheme. Unstable conditions.
No. and type of participating ERS venues	8 venues in total: 4 leisure centres and 4 community venues.

Table 4.5 Characteristics of the ERS running in Area 2

Scheme started	1995
Approximate no. of people referred per year	1400
Cost to participant	£2.75 per session
Funding for the scheme (i.e. total amount, breakdown PCT/council/private, grant/ mainstream)	£187,248 in total per year; £28,369 PCT funded, £158,879 funded by a charitable leisure trust set up to manage local authority leisure services in the area.
Types of health professional who refer onto the scheme	General Practitioners Practice Nurses Physiotherapists Hospital Departments Community Dieticians
Personal data collected and recorded electronically	Date of Birth Home address including postcode Gender
Health/lifestyle/behavioural data collected and recorded electronically	None are recorded electronically. Lifestyles details recorded on referral form include: Smoker, Sedentary, Excess alcohol. Clinical measures in referral form include: BP, HR, BMI Details of previous activity undertaken.
Other information collected and recorded electronically	Reason(s) for referral Referring health professional (name, address, postcode) Medication Past medical history Blood pressure, Heart Rate, BMI Attendance on the scheme; take up initial appointment, 10th check, 20th check, 30th check.
Database software used for electronic data	Microsoft Access
Outline of programme (how people are referred, what scheme entails, duration of programme, type of activities offered)	1. GP (or other health professional) completes referral from (triplicate copy) for patient meeting inclusion criteria 2. Patient rings up to make an appointment for initial assessment at venue of their choice. 3. ½ hour free Initial appointment. Check that details on referral form are accurate. Check blood pressure, BMI (if applicable for patients condition), resting HR. 4. Second visit - 1 hour induction about how to use equipment. Patient given programme and attendance card. 5. 30 sessions in total to be completed within 9 month period. 6. Update checks to monitor BP, resting HR, waist circumference, weight (if applicable) at 10th session, 20th session and then final 30th session. 7. After 30th session either free membership for following year (sports centre) or offered membership (leisure centre).
Inclusion criteria (who is eligible to join the programme)	Inactive **and:** Arthritis Asthma/respiratory problems Back pain Depression, anxiety and stress Diabetes Hypertension Multiple Sclerosis Overweight/obesity Osteoporosis Peripheral vascular disease Raised cholesterol
Exclusion criteria (who cannot join the programme)	Under 16 years. Pre-contemplation

	Uncontrolled diabetes Progressive back pain Disability (mental or physical) preventing independent transition between machines Disability (mental or physical) preventing compliance with prescribed exercise programme Patients with established Coronary Heart Disease (identified on GP CHD register) Referrals from Private practice.
No. and type of participating ERS venues	10 in total: 8 leisure centres, 1 gymnastic centre, 1 community venue.

Table 4.6 Characteristics of the ERS running in Area 3

Scheme start year	1994
Approximate no. of people referred per year	800
Cost to participant	Lower risk: £10 per month, three months, £30 paid up front. Medium/high risk: £1.75 concession, £2.25 non-concessions per session
Funding for the scheme (i.e. total amount, breakdown PCT/council/private, grant or mainstream)	£252,000 in total per year; £138,000 PCT mainstream, £114,000 council mainstream.
Types of health professional who refer onto the scheme	General practitioner Practice nurse Hospital trust cardiac rehab (if phase 4 programme N/A)
Personal data collected and recorded electronically	Age Gender Home address including postcode Ethnicity
Health/lifestyle/behavioural data collected and recorded electronically	Blood pressure Resting heart rate Blood sugar count average (if referred for diabetics) Peak flow (if referred for respiratory) Weight Height (optional) Body Mass Index (BMI) Body fat composition QoL visual analogue scale 0-10 Readiness to change questionnaire
Other information collected and recorded electronically	Referring health professional Client attendance register per programme/workshop Reason(s) for referral GP attended
Database software used for electronic data	Microsoft access
Outline of programme (how people are referred, what scheme entails, duration of programme, type of activities offered)	1. GP (or other health professional, majority GP) completes referral from (triplicate copy) for patient meeting inclusion criteria and sends to exercise referral team. Includes physical baselines. 2. Patient contacted by central office and asked to make first appointment. Given 10 working days to respond, if not sent reminder. 3. Patient phones in and appointment set. Waiting list of around one month to first appointment. TWO SEPARATE PROGRAMMES, ONE FOR LOWER RISK, ONE FOR MEDIUM/HIGH RISK a) medium/high risk 4. 45 min initial assessment (1 hour Jan 07 onwards). Baselines taken, QoL questionnaire, evaluation of current exercise status (0-7 based on 5x30mins) and readiness to change questionnaire. 5. Clients must attend 2 supervised sessions per wk. 6 weeks duration. 6. Final 30 min assessment after 6 weeks (can be offered option of repeat referral, stay on for another 6 weeks). Departure questionnaire, psychosocial, satisfaction survey, exit route destination and physical baselines repeated. b) low risk 4. Shorter induction. Take physical baselines and intro to how to use equipment. 5. 3 months subsidised gym membership for independent programme.

	Drop in assessment/advice clinic once a month. 6. Final assessment after 3 months, baselines repeated.
Inclusion criteria	Lower risk: Family history of heart disease De-conditioned Depression - mild/mod no medication Diabetes – non-insulin dependent, diet controlled Overweight - BMI 25-30 Osteo-Arthritis – mild/mod Osteoporosis – asymptomatic Hypertension – newly diagnoses, not on medication Smokers – without COPD or CHD CHD risk factors – 2 from inactive, hypertensive, smoker, family history, raised cholesterol Asthma – mild/mod, well controlled no other condition listed above Medium risk: Asthma – with health complications Cardiac disease – mild with no angina COPD – mild CVD – intermittent claudication Depression – medicated Diabetes Type I and Type II – oral therapy/well controlled insulin Hypertension – medicated (140-160 sys/ 90-95 dia) Surgical patients – prep or recovery, orthopaedic and general surgery, not cardiac Overweight – BMI 25-30 + other CHD risk factors Obesity – BMI>30 CHD risk factors – 3 from inactive, hypertension, smoker, family history, raised chol High/medium risk: Cardiac disease – stable angina no chest pain Arrhythmias Cardiac failure Cardiac surgery or MI – on completion of cardiac rehab prog Hypertension – medicated bp > 160/95, but lower than 180/100 CHD risk factors – 4 or more inactive, hypertensive, smoker, family history, raised cholesterol.
Exclusion criteria	Ischaemic heart disease Uncontrolled atrial/ventricular arrhythmia, uncontrolled sinus tachycardia (>120/min) or valvular Heart Disease Blood Pressure >180/100 Cardiomyopathy, ventricular aneurysm, uncontrolled cardiac failure Acute febrile illness Uncontrolled asthma Vertigo, unexplained dizziness, loss of consciousness Diabetes – poorly controlled particularly with Ketosis Established symptomatic cerebro-vascular disease
No. and type of participating ERS venues	4 in total, all leisure centres.

Table 4.7 Characteristics of the ERS running in Area 4

How long the scheme has been running	2000
Approximate no. of people referred per year	600
Cost to participant	£1.85 per class
Funding for the scheme (i.e. %PCT, %council, %private, grant or mainstream)	Total £200,000 per year; PCT mainstream £110,000, Council mainstream £60,000, Neighbourhood Renewal Funding £30,000.
Types of health professional who refer onto the scheme	General Practitioners Practice nurses Diabetic clinic staff Physiotherapists
Personal data collected and recorded electronically	Age Sex Home address including postcode Ethnicity

	Free prescriptions Disability
Health/lifestyle/behavioural data collected and recorded electronically	Collected at initial, mid point and final: Weight Height Body fat% BMI Peakflow BP Pulse 7 day exercise recall Smoking Alcohol Tobacco chewing Recorded once: Additional health problems Additional medication Exercises to avoid At final assessment: Self-rated health Self-rated improvement in health Change in eating habits Change in drinking habits Quality of service provided Level of support Gain from scheme 6 weeks after finishing programme: Self-rated health Self-rated improvement in health Continued to exercise and how often
Other information collected and recorded electronically	GP attended Completion rate Total referrals Referring health professsional Reason(s) for referral
Database software used for electronic data	Microsoft Access
Outline of programme (how people are referred, what scheme entails, duration of programme, type of activities offered)	1. GP (or other health professional, majority GP) completes referral from (triplicate copy) for patient meeting inclusion criteria. 2. Patient contacted by central office and asked to make first appointment. 3. Initial one-to-one appointment includes readiness to change interview, perceived health (scale 1-5), and physiological measurements. 4. 10 week course. 2 sessions per week, 20 session in total. Majority of sessions are daytime. Some ladies only sessions. 5. Assessment at 5 weeks. Baselines taken again. 6. Assessment at 10 weeks, end of programme. Baselines taken again.
Inclusion criteria	Must be sedentary (currently doing no exercise) and; Indicate a desire to increase physical activity – ready to take action to be more active and; Have one of the following medical conditions: Diabetes type I or II Controlled Hypertension PVD (without cardiac complications) And/or: Two or more coronary heart disease risk factors: BMI >30 Cholesterol >6.5mmol/l Current smoker Family history of Heart Disease Mild anxiety and mild depression
Exclusion criteria	Any cardiac problems (separate cardiac rehabilitation programme)
No. and type of participating ERS venues.	4 in total, all leisure centres.

Table 4.8 Characteristics of the ERS running in Area 5

Scheme started	2004
Approximate no. of people referred per year	1040
Cost to participant	Free
Funding for the scheme (i.e. total amount, breakdown PCT/council/private, grant or mainstream)	£222,000 per year in total; £100,000 – PCT, £40,000 – Council, £40,000 – Neighbourhood renewal fund, £12,000 – PCT falls prevention, £30,000 Partnerships for Older Peoples Projects (PoPPS) (DoH)
Types of health professional who refer onto the scheme	General Practitioners Practice nurses Nurse practitioners Consultants Health trainers Mental Health Workers Community Psychiatric nurse Occupational Therapists Physiotherapist Consultants/nurses in tertiary centres
Personal data collected and recorded electronically	Date of Birth Home address including postcode
Health/lifestyle/behavioural data collected and recorded electronically	None currently
Other information collected and recorded electronically	Reason(s) for referral Referring health professional GP attended Initial appointment date and attendance Whether participant attended final appointment
Database software used for electronic data	Microsoft excel, awaiting development of Microsoft access database
Outline of programme (how people are referred, what scheme entails, duration of programme, type of activities offered)	1. GP (or other health professional, majority GP) completes referral from (triplicate copy) for patient meeting inclusion criteria. 2. Patient contacted by central office and asked to make first appointment. 3. Initial one-to-one appointment includes motivational interview, physical activity assessment, (BP, heart rate if applicable), QoL measurement, activity plan developed. None of this information recorded electronically. 4. Attends a maximum of 3 classes per week for 8 weeks within a 3 month period (separate classes for different conditions). 5. 4 week follow-up phone call to check progress 6. 8 week postal follow-up with IPAQ and SF12 (not recorded electronically) 7. 9 month postal follow-up for long-term exercise adherence evaluation, IPAQ and SF12. (not recorded electronically)
Inclusion criteria	One of the following: Osteoporosis (T score -1 to -3.0, no history of low trauma fracture) Falls (history of falls, fear of falling, observed postural instability) CVD incl CVA/PVD/CHD (on CHD register and had an annual review with GP, CHD history but no recent event/surgery/intervention, completion phase 3 rehab, post MI, post cardiac surgery, post PCI, post CVA, PVD, Stable angina, Congestive heart failure) Obesity (BMI >30 <40) Diabetes (<11.1mmol/l, >7.8 mmol/l, type I type II) COPD (dyspnoea, scale 1-3) 60+ (sedentary, <30mins mod activity per wk) Mental health (neurotic disorders and psychotic disorders)
Exclusion criteria	Uncontrolled acute systemic illness Unstable angina

	Uncontrolled visual or vestibular disturbances Uncontrolled hypertension resting BP >180/100 Persistent tachycardia at rest (HR >100bpm) Angina at v low levels of activity Unstable/untreated congestive cardiac failure Shortness of breath Activity pericarditis/myocarditis Current febrile illness Uncontrolled pathologies COPD – dyspnoea scale level 4+5 Mental health – inc. risk of harm to others or self, personality disorder. Organic disorder.
No. and type of ERS venues	10 in total: 7 leisure centres, 3 community venues (1 of these a specialist community rehabilitation centre).

Table 4.9 Characteristics of the ERS running in Area 6

Scheme started	2000
Approximate no. of people referred per year	500
Cost to participant	£1 per session / £1.50 per session
Funding for the scheme (i.e. total amount, breakdown PCT/council/private, grant or mainstream)	£115,000 per year in total: £45,000 per year from PCT (staffing, venue hire, professional development, equipment) £70,000 per year council (coordinator and manager posts)
Types of health professional who refer onto the scheme	General Practitioner Practice nurse Physiotherapist
Personal data collected and recorded electronically	Age Sex Ethnicity Home address including Postcode
Health/lifestyle/behavioural data collected and recorded electronically	BP Chol Weight BMI Peak flow (asthmatic) At 1st assessment and final assessment: Dartmouth COOP BP Weight
Other information collected and recorded electronically	Referring health professional Reason(s) for referral GP attended
Database software used for electronic data	Microsoft access
Outline of programme (how people are referred, what scheme entails, duration of programme, type of activities offered)	1. GP (or other health professional, majority GP though) completes referral from (triplicate copy) for patient meeting inclusion criteria. 2. Patient contacted by central office and asked to make first appointment. 3. Initial one-to-one appointment includes Dartmouth COOP and physiological measurements. 4. Given a card to entitle them to 12 week programme. 5. Final assessment at end of 12 weeks, baselines retaken.
Inclusion criteria	Need all three: Not on CHD register Exercise less than 3 times a week Indicates a commitment to increasing activity levels Need one of: Controlled hypertension (,170 / <100) Controlled type I or type II diabetes Asthma or COPD Familial Hypercholesterolaemia Or…

	Need three from: BMI>30 Smoker Mild anxiety/depression Hypercholestrolaemia >6.5mmols
Exclusion criteria	Anyone with heart disease Anyone who is already taking part in physical activity more than 3 times a week
No. and type of ERS venue	5 in total: 3 leisure centres, 2 community venues.

Table 4.10 Characteristics of the ERS running in Area 7

Scheme started	1995
Approximate no. of people referred per year	1000
Cost to participant	Aqua £1.80 per session Gym £2.30 per session
Funding for the scheme (i.e. total amount, breakdown PCT/council/private, grant or mainstream)	£136,100 in total. £50,500 from PCT (also covers phase 4 cardiac rehab), £72,000 council mainstream funding for staff, £13,600 from private leisure service.
Types of health professional who refer onto the scheme	General Practitioners Practice nurses Adult therapy team (via GP) Physiotherapist (via GP)
Socio-demographic data collected and recorded electronically	Postcode Age Sex Ethnicity
Health/lifestyle/behavioural data collected and recorded electronically	Readiness questionnaire 7 day activity log Stages of change assessment Blood Pressure Resting Heart Rate Weight BMI Fat % Peak flow 7 day recall Stages of Change
Other information collected and recorded electronically	Reason(s) for referral GP attended Referring health professional Monitoring attendance at first and last session
Database software used for electronic data	Microsoft Access
Outline of programme (how people are referred, what scheme entails, duration of programme, type of activities offered)	1. GP completes referral form for eligible patient. Includes weight, height, BP, BMI. One copy sent to central scheme. 2. central scheme sends client a welcome letter. 3. client contacts the headquarters to arrange an initial consultation. 4. client attends pre-exercise assessment. Includes readiness to change, sub maximal exercise test to be recorded for baseline measurements, appointments made for mid and end assessment check. 5. clients attend maximum of 24 exercise sessions over a maximum period of 16 weeks.
Inclusion criteria (who is eligible to join the programme)	1 diagnosis or 3 risk factors: BMI >30<45 Borderline hypertension (BP <170/100) not receiving medication Controlled diabetes (well managed) Asthmatics and COPD (well managed) Menopausal women (with higher risk of osteoporosis)

	Patients with muscular skeletal injuries Experiencing mild depression or stress Severe and enduring mental health problems Stroke Continence and personal hygiene well managed Hypercholestrolaemia >6.5 mmols Smoker
Exclusion criteria (who cannot joint the programme)	All cardiac cases: Angina pectoris, intermittent claudication History of myocardial infarction Cardiac surgery, valve disease Arrhythmia, cardiac failure Hypertension over 170/100 mmHG or requiring medication COPD and emphysema BMI>45 Pregnancy Neurological conditions, need high level of supervision, Epilepsy, fit in past two years. (If not had fit in past two years can join the programme, except for swimming).
No. and type of ERS venues	5 in total: all leisure centres

There were similarities across the 7 schemes. All schemes operated through a partnership between the local authority and the PCT. The primary source of referral for all schemes was general practices. All programmes involved patients attending a venue (either a leisure centre of community venue such as a church hall) to participate in a series of physical activity sessions (with varying degrees of supervision). All schemes had clear inclusion and exclusion criteria (although the exact criteria varied) and all had written protocols and referral manuals. In terms of data collection, all used a mix of electronic and paper recording medium throughout. All schemes except one used Microsoft access software.

Consistent with the overview of ERSs across London presented in Table 4.2, there were also differences between the 7 schemes in terms of their size, the source and level of their funding, inclusion criteria for referral, types of activity sessions offered, the duration of the ERS programme, the number of sessions patients were expected to attend per week, the tariff paid by participants, and the number and type of health professionals who could refer patients to the programme.

The discussions with ERS mangers/coordinators suggested that the differences found in the inclusion of cardiac patients may have been due to variations in the skill-base of exercise referral programme delivery staff, as a high level of skills training is required before instructors can oversee cardiac patients. In certain instances, particular referral criteria reflected the source of funding for the scheme. For example, the scheme in Area received funding from an ‘older peoples’ budget, and as a result being both sedentary and over a certain age was sufficient to be referred onto the programme in this area.

The differences found between areas in the number and type of health professionals who could refer to the ERS and the volume of patients admitted onto each scheme per year are likely to be due to varying capacity in the local schemes. The variation in capacity may in turn have reflected differences in the extent to which schemes had become embedded in local service delivery through partnership working and engagement across health and local authority sectors.

Of the seven schemes outlined above, the schemes running in the two more advantaged PCTs (Areas 1 and 2) had on average £118,624 per year funding and the average tariff for participants (excluding upfront fees) was £2.69 per session. In contrast, the schemes running in more deprived areas (Areas 3-7) had on average higher funding (£185,020 per year) and the average tariff for participants (excluding upfront fees) was lower (£1.43 per session). This represents a difference of over £66,000 per year in funding, and a difference of £1.26 per session charged to participants.

A possible explanation for the funding variation (supported by funding sources reported in this scoping review by managers of schemes in Areas 4 and 5) is that schemes located in deprived areas had the option to apply for additional grant funding (attained as a result of their deprived status) from, for example Neighbourhood Renewal, to supplement mainstream financing to ensure better supported schemes. There are two possible explanations for the difference in tariff charged to participants. Firstly, because the more socioeconomically advantaged areas do not receive as much funding they may be forced to pass on more of the cost of running the service directly to the participants. Secondly, schemes may be setting tariffs to reflect the general socioeconomic circumstances of their participants. Schemes running in more socioeconomically advantaged areas can reasonably charge more as the majority of their clients can afford to pay more, in contrast to deprived areas where tariffs might be kept to a minimum in view of the lower level of disposable income likely to be available to the majority of participants in these areas.

4.4 Comparison to other studies

In 2005 Dr Foster[151] reported that 89% of primary care organisations in England had an Exercise Referral programme. This review conducted October 2005 - March 2006 found that the coverage was even higher in Greater London where 97% of areas had a scheme running or in development.

Postal surveys of all unitary authority areas in Wales in 2006 (95% response rate)[45], and health authorities in England with a South Asian population of at least 0.5% in 2002 (55% response rate)[324], provide descriptive information about ERSs against which the findings from this scoping review can be compared. In addition, two descriptive accounts of ERSs running in single areas (Crawley in Sussex, England[327], and Stockport in North-West England[280]) provide information for comparison.

The design and delivery of ERSs running in Greater London were broadly consistent with reports of other schemes: all were partnerships between health and local authority organisations; a range of health professionals referred onto the scheme; and clinical referral conditions were similar (for example, high blood pressure, asthma, muscular/joint problems, stress/anxiety and depression, being overweight/obese and diabetes[327]). All schemes ran at a subsidised cost to the participant. This scoping review found that the tariff for participants in London ERSs ranged from £0-£2.90. In the review of English areas with a high South Asian population, tariffs for participation varied from £1.00-£2.60[324]. In Wales the maximum charge was £2.70 per session[45]. The Crawley scheme was more expensive, varying between £2.50-£3.50 depending on the exercise venue chosen[327]. With the exception of Area 5 in this scoping review (which provided a free service), the Stockport scheme was the cheapest ERS reported in published literature. Patients were only asked to donate the prescription charge (£4.75 in 1992) at the start of their programme (excluding those exempt from prescription charges) and all subsequent sessions were free[280].

The diversity of ERS design and delivery (in terms of the level of funding, size of schemes, range of activities offered, length and number of sessions offered), reported in this scoping review was also noted in these previous accounts of ERSs[45;280;324]. For example, in this scoping review funding for ERSs running in Greater London ranged from no formal funding through to £300,000 per year (Table 4.2). In Wales, funding varied from less than £10,000 to over £150,000 a year[45].

Previous research has also reported on the lack of uniformity[45] and poor quality of data collection across schemes[160;324]. 57% of the schemes included in the Welsh survey monitored attendance at the scheme and 30% measured retention and continuing exercise participation after completion. As Table 4.3 indicates, the ERSs in Greater London performed comparably, if not slightly better, because of the 26 ERSs actively running in London at the time of the review, only 6 schemes (23%) did not collect any information about attendance or retention of patients.

4.5 Schemes to participate in the equity analysis

This scoping review uncovered that routine data collection was variable across the ERSs in Greater London[127]. Schemes in more deprived areas had on average more comprehensive data collection than schemes in less deprived areas.

Not all areas monitored outcome from the scheme. For those that did, a variety of outcomes were recorded and only a few schemes used validated measures. It was therefore not feasible to study equity of outcome from ERSs in this research using routine data. In any case, as explained in Chapter 2, further experimental evaluations of outcomes from ERSs are required[33]. An RCT is the most suitable study design for studying outcomes in the first instance, rather than an observational study design (which is the approach adopted in this current research and is ideally suited to process evaluation).

Instead, I decided therefore to focus on process elements of ERSs scheme (referral to, uptake of and completion of the scheme). Data on these elements were more consistently collected across ERSs than data on outcomes. To evaluate equity of access and use of the service, electronic information about patients from point of referral was essential to allow examination of patients who were referred to the service (accessed it) but did not take-up the intervention (use it). Therefore, I could only include the areas that collected data on patients from the point of referral in this research.

As a result of the findings from this scoping review with respect to the comprehensiveness and comparability of routine data collection by ERSs, I set the inclusion criteria for participation in the equity research as follows. Schemes eligible for inclusion were those that could provide electronic information on each person referred to the scheme including;

a) whether they attended their initial and final appointments,
b) socio-demographic characteristics of referred patients,
c) information about the clinical reason(s) for referral, and,
d) a record of the health professional or health centre that made the referral.

Eight ERSs across Greater London appeared from the scoping review to meet these criteria. Seven of these areas agreed to take part in further stages of this research. The reason for non-participation of the eighth was that senior management of the

commercial company who ran the scheme (in collaboration with the local authority and PCT) were not willing for the scheme to take part (personal communication).

Chapter 5

Methods

Chapter 5. Methods

5.1 Study Design

In order to examine the association between socioeconomic circumstance and ERS access and use I used an observational research design. I conducted cross-sectional analysis of patients referred, taking up and completing ERSs using information collected routinely by ERSs.

Justification for chosen study design

Whilst there are undeniably difficulties with using routine data which has not been collected in an academic context, nor with the research question in mind, I nevertheless felt that it was worthwhile to conduct observational research based on routine data in order to determine the equity of schemes running in a 'real life context' as part of standard service delivery. Whilst the scoping review uncovered that many areas in Greater London had poor data collection, there were 8 areas which appeared to have good data (Chapter 4). The full potential of these data were not being harnessed by the ERSs, as any existing reporting and evaluation did not extend beyond basic descriptive tabulations. This research therefore provided an opportunity to considerably extend the knowledge obtained from this valuable data source.

An alternative methodological approach would have been to conduct bespoke prospective data collection on referred patients, mirroring the routine data collected by schemes but perhaps also supplementing this with additional data items. This would have enabled me to have control over the content, quality and comprehensiveness of information collected. However, it was necessary to make a pragmatic assessment of what was realistically achievable in a three year PhD, with no project funding other than the stipend to cover the research student. It would simply have been too costly and time consuming to set up bespoke data collection to examine access and use of ERS, and a questionable use of resources given the perfectly adequate routine data available from a number of schemes. There were also numerous methodological advantages to the chosen study design (Chapter 7, Section 7.5.4). Pooling routine data from several ERSs created a large sample size for research, and also meant a broad geographic area was covered thus ensuring substantial representation of patients from across the range of socioeconomic circumstance experienced in the English population (Chapter 6).

I will now describe the preparatory stages undertaken before the equity research could commence including;

- attaining Ethical and Research and Development (R&D) approval
- obtaining data
- cleaning and reformatting ERS data to standardise content across areas
- combining ERS data together and adding information from external sources
- estimating 'need' for ERS in the population and then applying this estimation to the research dataset.
- excluding records prior to data analysis.

5.2 Ethical and R&D approval

NHS ethical approval for this research was obtained from the joint UCL/UCLH Committees on the Ethics of Human Research (Committee A) on 9th August 2006 (REC reference number 06/Q0505/65).

The conduct of this study conformed to relevant ethical and legal guidelines covering consent, confidentiality, and the storage of data, including the Data Protection Act 1998[328], the Department of Health's Research Governance Framework for Health and Social Care[329], and the Medical Research Council's (MRC) guidance on Personal Information in Medical Research[330].

Research and development approval was obtained from the following Primary Care Trusts (August 2006):

- South East London research consortium. Ref: RDLLB 305
- North Central London research consortium. Ref: 06/Q0505/65
- Tower Hamlets PCT. Ref: 06/Q0505/65
- Newham PCT. Ref: 06/Q0505/65
- Croydon PCT. Ref: C2006/18

Local councils did not have a systematic research and development application process for this type of research. Therefore, ERS managers of the participating areas were asked to sign a participation agreement form after reading the research protocol and documentation explaining the data protection, NHS Research and Development and NHS ethical procedures in place (Appendix D).

5.3 Data sources

There were two main data sources:

- ERS routine electronic data (source: ERS headquarters)
- General practice population data (source: Family Health Services (FHS) registrations system)

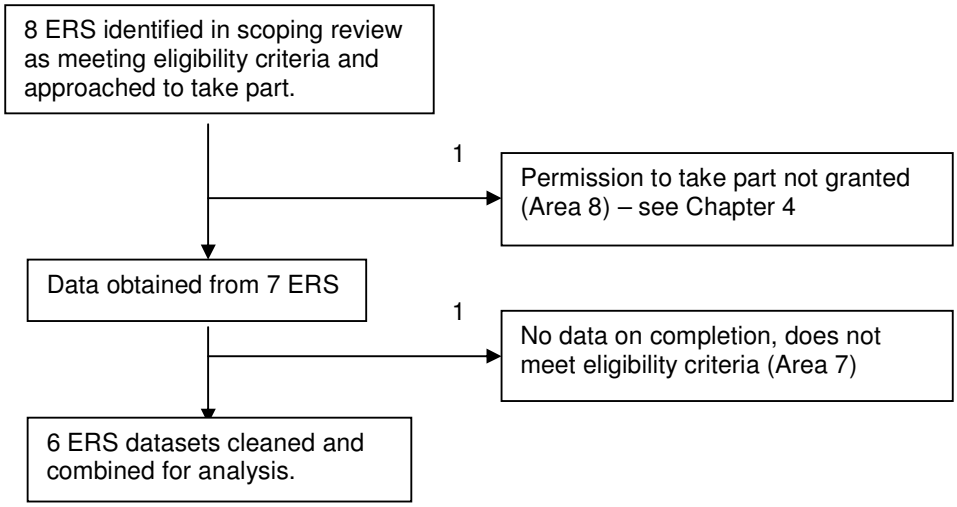
And several subsidiary data sources:

- National Statistics Postcode Directory (source: EDINA)
- Index of Multiple Deprivation 2004 (source: Department of Communities and Local Government)
- GP training status of London general practices (source: London training deanery)

5.3.1 Exercise Referral Scheme data

8 ERSs were identified in the scoping review as eligible for inclusion in the equity research, 7 of these schemes agreed to take part (Chapter 4). Each ERS was located within a PCT and every GP practice within that PCT was able to refer patients to the scheme. To obtain the electronic ERS data I visited each of the ERS headquarters. Although area 7 appeared to fit the inclusion criteria from discussions undertaken during the scoping review (Chapter 4), when I visited to obtain the dataset I found that, for the time-period under study, no electronic information was collected on whether patients completed the ERS programme. Therefore, area 7 no longer fitted the inclusion criteria and was excluded from further stages of the research (Figure 5.1).

Figure 5.1 Data collected from ERS headquarters



All schemes used either Microsoft Excel or Access software programmes. Data was obtained in these formats and then converted to STATA[331] files for analysis. Reflecting

the eligibility criteria (Chapter 4) the data obtained from the six areas was a subset of the routine information collected by the schemes over two years (April 2004 – March 2006), including for each referred patient:

- Date of birth
- Date of referral
- Gender (except for Area 5)
- Ethnicity (except for Area 2 and Area 5)
- Postcode of residence
- Reason(s) for referral
- Venue from which the referral was made
- Whether patient attended the initial ERS appointment
- Whether patient attended the final ERS appointment

These data items originated from, firstly, the paper referral form filled out by the referring health professional and, secondly, monitoring of attendance by exercise referral instructors at the exercise venues (see Chapter 4, Figure 4.2).

The addresses of all venues offering the ERS programme in each of the six PCT areas were obtained from the ERS headquarters. These included council and private leisure centres and community centres (see Chapter 4). I compiled these into an exercise venue dataset.

The 24 month study time period (April 2004 – March 2006) was chosen in order to maximise the time period and ensure a sufficiently large sample of referred patients to provide adequate statistical power for the analyses (see sample size calculation Section 5.9.2.4). Choosing a time-span covering two years also allowed any seasonal or annual fluctuations in referral activity to be accounted for[231]. March 2006 was the latest date that excluded 'active' patients (i.e. individuals still attending ERSs for whom measuring uptake or completion would be inappropriate). I chose April 2004 as the start of the study period because the scheme in Area 5 was not running prior to this and the format and data collection procedures of other schemes were different.

5.3.2 General practice population data

I required general practice population information in order to calculate referral risks to ERSs (Section 5.9.2.1). The Family Health Services (FHS) registration system collates information on total adult general practice population stratified by 5-year age groupings

and sex. I accessed this information through public health information managers working within the six PCT areas included in this research.

I sought population bases that corresponded with the ERS data I had from April 2004 – March 2006. Table 5.1 shows the general practice population data received from the six PCT areas. I examined the population numbers in those areas that provided sequential quarters of information and noted that the general practice populations did not fluctuate dramatically over time. Therefore, I chose to use the figures from December 2005 (with the exception of Area 1 and Area 6 which did not provide December 2005 figures, so I have used April 2006 and September 2005 respectively instead).

Table 5.1 General practice population provided by PCT information managers

Scheme area	Area 3	Area 4	Area 5	Area 2	Area 1	Area 6
					Jan-04	
	Mar-04	Mar-04				
	Jun-04	Jun-04	Jun-04			
	Sep-04	Sep-04	Sep-04			
	Dec-04	Dec-04	Dec-04	Dec-04		Dec-04
General Practice population data	Mar-05	Mar-05	Mar-05		Apr-05	
	Jun-05	Jun-05	Jun-05			
	Sep-05	Sep-05	Sep-05			**Sep-05**
	Dec-05	**Dec-05**	**Dec-05**	**Dec-05**		
	Mar-06	Mar-06	Mar-06		**Apr-06**	
	Jun-06	Jun-06				
	Sep-06	Sep-06	Sep-06			
	Dec-06	Dec-06				

Dates in bold are the quarters of data used for this research.

'Fringe patients' were included in the population figures. Fringe patients were those who attended a general practice in the PCT area but lived outside the PCT area within which the general practice was located. Because the ERSs were run on the basis of serving patients who attended general practices within the PCT area, irrespective of where they lived, it was appropriate to include fringe patients in order to obtain an accurate denominator for referral rates.

5.3.3 National Statistics Postcode Directory

The February 2006 National Statistics Postcode Directory (NSPD)[332] was used as a linking file (see Section 5.5 for explanation of data linkage). The NSPD data was obtained from the Edina website[333]. Edina is a JISC-funded national data centre which provides UK research institutions with access to data and research resources. The

NSPD assigns postcodes a point grid reference, to locate them within one LSOA. The NSPD was therefore used to enable patients and general practices based on their postcode to be assigned an area-measure of deprivation (IMD 2004), which is available at LSOA level. Secondly, the NSPD was used to obtain postcode co-ordinates of homes, general practices and ERS venues to enable the straight-line distance from home/referring GP to nearest participating ERS venue to be calculated.

5.3.4 Index of Multiple Deprivation 2004

As outlined in Chapter 4, none of the ERSs collected individual-level socioeconomic data (for example, a patient's education, income or living circumstances). I chose the Index of Multiple Deprivation (IMD) 2004[12] as the area-based measure of deprivation for this research (see Chapter 3). I obtained IMD 2004 data in Excel format from the Department for Communities and Local Government[224]. The IMD 2004 has been constructed at the smallest practicable spatial scale for which data are available, lower layer super output area (LSOA), covering around 1500 people[225]. Each LSOA in the country has been assigned an overall IMD 2004 score and also a rank (1=most deprived LSOA in the country, 32,482=least deprived LSOA in the country). I then divided the ranked LSOAs into quintiles, with an equal number of LSOAs in each group (1= most deprived quintile, 5=least deprived quintile).

IMD 2004 for referred patients

I used patient postcode to obtain an IMD quintile for each patient referred to the ERSs based on the IMD rank for the LSOA in which the patient resided. This IMD quintile refers to the deprivation position of the LSOA relative to the whole of England. The IMD quintile serves as a proxy for the deprivation experience of the referred patient in the absence of individual-level data about socioeconomic circumstance.

IMD 2004 for general practices

For the referral analysis (where the unit of analysis was general practice) I assigned a socioeconomic value to each general practice to serve as a proxy for the socioeconomic circumstance of registered patients. This meant that the analysis provided an indication of the extent to which equity was addressed at the organisational level of general practice, the main access point for entry to the scheme (Section 5.9.2.1).

The IMD 2004 can be used in two ways to derive a deprivation score by general practice.

Firstly, the LSOAs of the postcodes of the residential addresses for every patient on the general practice register can all be assigned an IMD 2004 score, and a weighted average of all of these scores calculated to provide an aggregate general practice deprivation score. Because the deprivation score of a general practice is intended to reflect the socioeconomic circumstance of the patients that the practice serves, this is the most accurate method of assigning deprivation by general practice. However, I did not have individual patient information for all registered patients and so I could not derive a measure of general practice deprivation in this way.

Secondly, the general practice can be assigned the IMD 2004 score and rank for the LSOA within which the practice postcode is located. I used this technique. The assumption here is that the level of deprivation experienced by the population in the locality of the practice is a reasonable proxy for the level of deprivation experienced by the whole registered practice population. This assumption would be invalid if, for example, the practice happened to be located in a relatively advantaged LSOA but drew the majority of its patients from a neighbouring more deprived LSOA.

Research has been conducted to compare the deprivation profile created by the practice postcode method of derivation and the more sophisticated population-weighted method[229]. This research found significant correlations between the two methods of assigning deprivation to general practices. If the practices in the study were not located in areas systematically more or less deprived than the surrounding area, then any error introduced by using the practice-postcode measure of deprivation as opposed to the more sophisticated population-weighted method would be random[229]. Therefore, by using the location-based method it is likely the analysis generated non-differential misclassification which would have resulted in an underestimation of the strength of any association between service access and deprivation. This was considered when interpreting the analysis results (Chapter 7, Section 7.5.4.2).

5.3.5 General practice training status data

Given the potential importance of service factors in determining service access and use (Chapter 3, Section 3.8) training status of general practices was identified as a potentially important confounder to consider in the analysis. I obtained a list of postgraduate training practices (i.e. practices providing training for doctors in the speciality of general practice) in the six participating PCT areas from the GP informatics unit at the London training deanery[334] in October 2007.

5.4 Cleaning and reformatting data

5.4.1 Exercise Referral Scheme data

Identification number

The individual ERSs all assigned a unique identifying number for each new referral to the scheme. I left this intact to provide a link back to the original data from my cleaned datafile but also created a new unique RecordID for each record which ran sequentially through the referrals across all of the six schemes.

Scheme area

As discussed in Chapter 4, there was considerable variability between ERSs and so scheme area was an important covariate to include in the analysis. I assigned the six ERS areas a number 1-6, and I marked all referred patient records in each of the six datasets with the respective scheme area number.

Date of Birth and Date of Referral

Dates were cleaned as follows.

Replacement:

- Nonsense dates (for example, contemporary dates of birth, referral dates in the future) were deleted.
- Dates of birth where century was incorrect were amended (for example, a date of birth of 2054 changed to 1954).
- Direct swaps where the date of birth had been entered into the date of referral column and visa versa were changed around.

Formatting:

- I changed all dates to dd/mm/yyyy format so that they were consistent across all records and compatible with transfer to STATA.

Calculating age at referral

Where possible, I subtracted the date of birth (DoB) from the date of referral (DoR) to calculate age at referral. The data supplied by Area 6, in addition, had an 'age at referral' variable included. Therefore, in Area 6, I have taken the age from the 'age' column if this was available but DoB or DoR missing. I used this technique for 21 records.

Sex

I coded Male/M and Female/F to 0 and 1 respectively for all of the six Exercise Referral datasets. Area 5 ERS did not record sex so I assigned this from patient first name. Initially I went through assigning sex-obvious names (for example, Sarah=1, Thomas=0). I then printed off a list of the remaining names and consulted with a group of colleagues from a range of ethnicities and nationalities to ascertain any other culturally specific sex-obvious names. Any names with ambiguous sex or unknown sex were left blank.

Ethnicity

Area 2 and Area 5 did not record patient ethnicity. Other areas use a variety of classifications. I re-categorised the ethnicity classifications used by different areas into a generic classification for this research. Table 5.2 demonstrates how the different ethnicity groupings map onto the classification I used for this research.

Table 5.2 Ethnicity classification

Research Categories	Area 6	Area 3	Area 4	Area 1
0=WHITE	White	White	A – British B – Irish C – Any other white	White British. White Irish. Any other white background.
1=MIXED	Mixed	Mixed	D – White & black Caribbean E – White & black African F – White & Asian G – Any other mixed	Mixed race – white and black. Caribbean Mixed race – white and black. African Mixed race – white and Asian. Mixed race – Any other mixed background.
2=ASIAN/ASIAN BRITISH	Asian or Asian British Asian or Asian Britsh	Asian or Asian British	H – Indian J – Pakistani K – Bangladeshi L – Any other Asian background	Asian or British Asian – Bangladeshi. Asian or British Asian – Indian. Asian or British Asian – Pakistani. Asian or British Asian – Any other mixed background. Sri Lankan.
3=BLACK/BLACK BRITISH	Black or Black British	Black or Black British	M – Caribbean N – African P – Any other Black background	Black – African Black – British Black – Caribbean Black – Any other black background
4=CHINESE / OTHER ETHNICITY	Chinese or other ethnic group	Chinese or other ethnic group	R – Chinese S – Any other ethnic background	Other Other ethnic groups – Chinese Other ethnic groups – any other ethnic groups
MISSING = NOT-STATED / UNKNOWN	Not specified	Unknown Not disclosed	Z – declined / not stated	

Scheme take up and completion

The six ERSs recorded uptake and completion information about scheme participants differently, and so each required specific cleaning procedures.

In Area 1, appointment dates were only recorded after attendance, and there was also a separate 'status' field, so these were used in combination to gain an accurate picture of attendance. Anyone who had 'achiever', 'cnc' (could not complete), or 'nonachiever' in the status column and / or a screening date, were recorded as taking up the service. Anyone with 'dna' (did not attend), 'dnj' (did not join), 'dnr' (did not reply) or had no

screening date were coded as not taking up the service. Anyone with 'achiever' in the status column I recorded as completing the scheme.

For schemes running in Areas 2 and 4, an appointment date was only recorded on the electronic system after the patient had attended the appointment. Therefore, a date in either the initial, mid or final assessments field was taken as indicating take up of the ERS, and a date in the final assessment field was taken as indicating scheme completion.

Area 3 already had tailor-made activity monitoring built in, using the following definitions so it was straight forward to create binary uptake and completion variables from this:

- Failed – did not attend the initial assessment;
- Withdrawn – attended the initial assessment and then failed to complete the programme;
- Complete – completed the programme.

In Area 5, data on whether an individual took-up or completed the ERS were recorded in two ways:

- The cells in the excel worksheet were colour-coded according to activity status (for example, orange=non-starter, purple=drop out, black=completer).
- Comments regarding a persons progress through the scheme were recorded in the 'notes' field, which was often more up-to-date than the colour-coding.

In order to accurately capture activity information for Area 5 I therefore had to reconcile the information from the colour-coding and the 'notes' field on a case by case basis.

For Area 6, assessment information recorded at ERS appointments (such as blood pressure, resting heart rate, physical activity score etc.) were taken as an indication that the person attended the session. Therefore patients were coded as taking up the ERS if they had assessment data for any of the sessions, and were coded as completing if they had assessment data for the final session.

Referral centre

I created a unique referral centre number for each general practice within the six PCTs. Referrals made from unknown locations or general practices outside the PCT within which the ERS was running were coded 1000. Referrals by non-general practice locations were coded 1001. Non-general practice referral locations are listed in Appendix E.

Clinical conditions for referral

The referral prerequisite for all schemes was that patients must be inactive and also have either risk factors for future disease or one of a range of current clinical conditions. Table 5.3 demonstrates how I translated the clinical referral reasons recorded for the different schemes into a generic classification for all areas. There were several ways in which reason for referral information was recorded by ERSs:

(i) Main reason for referral only recorded (Areas 2 and 5)

(ii) Main reason for referral and subsidiary reasons listed (Area 1)

(iii) Yes/no to a range of relevant referral medical conditions, no distinction between primary and subsidiary reasons (Areas 3, 4 and 6)

These differences have implications for how I analysed and interpreted the data across schemes. Because it was not possible to decipher for those areas with binary formatted data the primary reason for referral, I created a binary yes/no variable for each of the 7 referral domains. The 7 binary variables (yes/no) I created were as follows: referred for primary/secondary prevention of cardiovascular disease; diabetes; respiratory conditions; mental health conditions; musculoskeletal/neurological conditions; being overweight/obese; or due to old age (Table 5.3). Referral data presented in this format for Areas 2 and 5, were likely to be incomplete because individuals in these areas may also have had subsidiary reasons for referral that were not recorded electronically on the ERS central database.

Table 5.3 Reason for referral classification

Derived referral category	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
CARDIOVASCULAR DISEASE - PRIMARY / SECONDARY PREVENTION, YES/NO	Hyperlipidaemia Hypertension Peripheral vascular disease Stable angina Stroke Heart defect	Hyperlipidaemia High cholesterol Hypertension Peripheral vascular disease	Hypertension Raised blood pressure Cardiac Raised cholesterol Family history Smoker Diet	Established CHD Hypertension Peripheral vascular disease Raised cholesterol Tobacco user Family History Past hypertension Past Peripheral vascular disease	CHD Cerebrovascular accident	Existing CHD Family History Hypercholesterolaemia Hypertension Familial hypercholesterolaemia Smoker Ischemic heart disease Myocardial infarction Coronary Artery Bypass Graft Stable angina Angioplasty Valve Replacement Heart Failure
OBESITY / OVERWEIGHT, YES/NO	Obesity / overweight Hypothyroidism	Obesity / overweight		BMI >30	Obesity	Obesity
DIABETES, YES/NO	Type 1 Diabetes Type 2 Diabetes	Type 1 Diabetes Type 2 Diabetes	Type 1 Diabetes Type 2 Diabetes	Type 1 or 2 Diabetes Past Type 1 or 2 Diabetes	Impaired glucose tolerance or diabetes	Diabetes
RESPIRATORY, YES/NO	Asthma Respiratory problems Chronic asthma COPD	Respiratory problems	Asthma	Past COPD Asthma	COPD	Asthma
MENTAL HEALTH, YES/NO	Anxiety Depression Alcoholism Stress Schizophrenia	Depression / anxiety	Depression	Mild anxiety Mild depression Past anxiety/depression	Mental health	Mild depression
OLD AGE, YES/NO					Sedentary and over 60	Older people
MUSCULOSKELETAL / NEUROLOGICAL, YES/NO	Arthritis Back Pain Multiple sclerosis Osteoporosis Back/leg pain Chronic fatigue Downs Syndrome Parkinsons Knee pain Multiple sclerosis Neck pain	Arthritis Back pain Neurologica / Multiple Sclerosis Osteoporosis	Osteoporosis	Past epilepsy Past musculoskeletal problems	Osteoporsis & Osteopenia	Osteoarthritis Osteoporosis

Patient and practice postcodes

I looked up the correct postcodes for missing/incomplete/nonsense postcodes from address details (where supplied) using the Royal Mail postcode finder service www.royalmail.com/portal/rm. Where postcodes could not be verified, I recorded incomplete/nonsense postcodes as missing data. I reformatted postcodes as follows to enable accurate transfer of information from Excel to STATA;

- incorrect spacing (for example, S134LY changed to S13 4LY)
- incorrect capitalisation (for example, s13 4ly changed to S13 4LY)
- 'o' instead of zero (for example, CRO 4LY changed to CR0 4LY)

Postcodes for the general practices and exercise venues were either supplied by the ERS headquarters or I looked them up using www.nhs.uk (in the case of general practices) or www.google.co.uk.

5.4.2 General practice population data

Branch surgeries

The FHS general practice population figures for branch surgeries were supplied included with the general practice population figures for the main practice. There were 13 branch surgeries that made referrals to an ERSs. In cases where referrals were made by branch surgeries, to mirror the population information I combined the number of referrals from both the branch and the main surgery so that the numerator and denominator were consistent.

Practices with identical addresses

There were six instances where two different general practices shared a common name and address (for example, they were both located within the same health centre venue). Whereas the population bases for these practices could be distinguished on the basis of practice code and senior partner, the referral information did not distinguish between them. Therefore, I combined the population data and treated each of these general practices pairs within the analysis as single practices.

5.5 Data linkage

Having cleaned and reformatted all the data to ensure it was consistent across the six ERSs I combined the datasets together to create the composite ERS research dataset using the 'append' command in STATA. I then 'merged' in data from the other sources

(i.e. general practice population data, IMD 2004 data, GP training status data) through a technique called data linkage.

The basic principle of data linkage is exemplified in Figure 5.2 and Figure 5.3. Linkages were carried out sequentially, but for illustration I have shown all stages together on the same diagram. Each box represents a separate dataset and gives the name of the dataset together with the key variables that were merged into the dataset used in analysis. The dotted line identifies the linkage point, the linking variable being the variable that is common to both of the datasets. For example, linking home, general practice and venue postcode information to the NSPD allowed the Northing and Easting co-ordinates to be obtained for these postcodes. This enabled distance from home/referring general practice to the nearest ERS venue to be calculated (see later section). A further example, IMD 2004 rank and quintile were obtained for each home postcode and general practice postcode on the ERS dataset by linking the postcodes to an LSOA via the intermediary NSPD file.

The unit of analysis for the referral analysis was general practice-age-sex group (section 5.9.2.1). Therefore, I had to reconfigure the ERS dataset so that, rather than each row representing a single referred patient, patients were grouped together (using the STATA 'collapse') to give one row per age-sex group within each practice.

Figure 5.2 Data linkage undertaken to create dataset for uptake and completion analysis
(each row in main dataset corresponds to one referred patient)

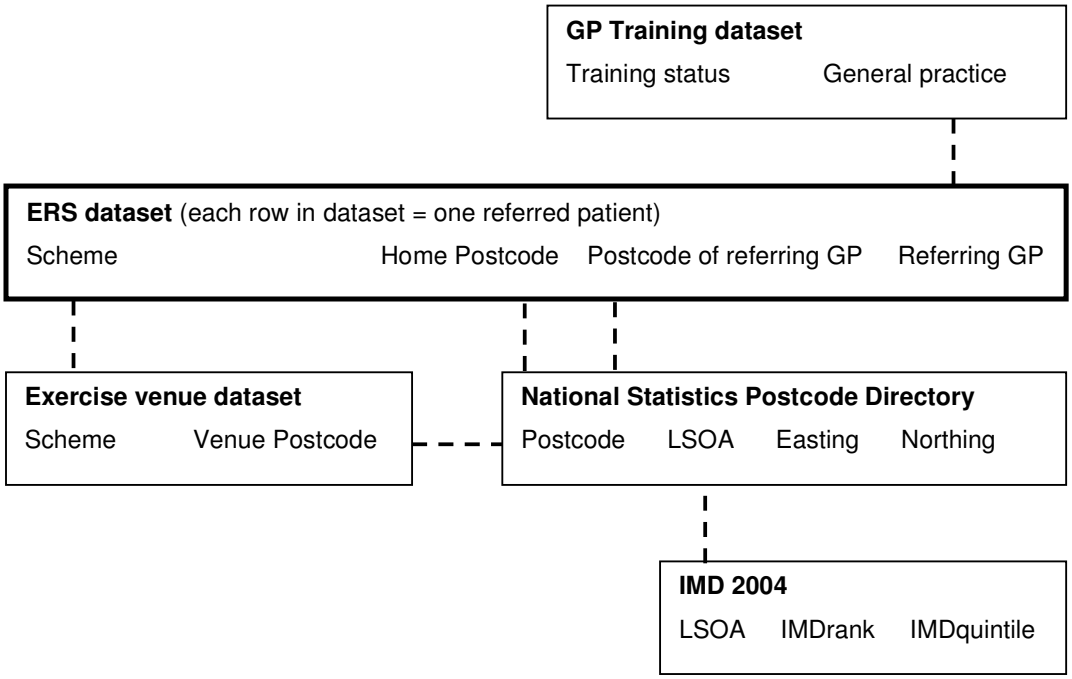
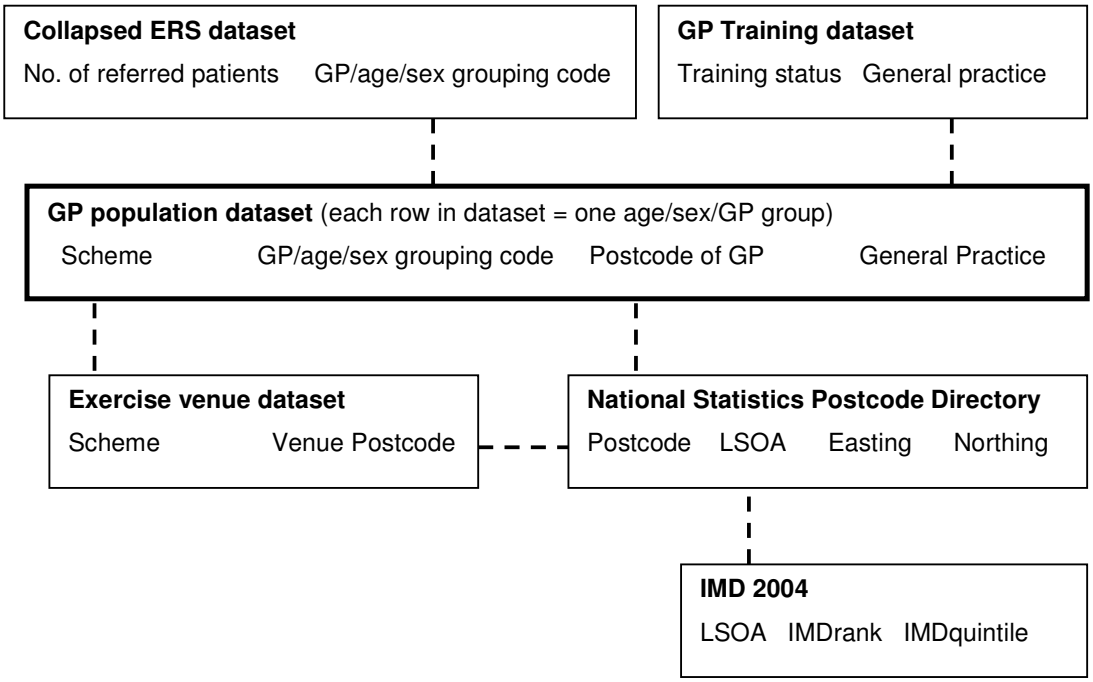


Figure 5.3 Data linkage undertaken to create dataset for referral analysis
(each row in main dataset corresponds to one age/sex/general practice grouping)



Calculating straight-line distances

Geographic access to the exercise facility was identified as possibly an important determinant of access and use of ERSs (Chapter 3, Section 3.8). I calculated straight-line distance from home and general practice respectively to nearest participating ERS venue as follows:

1. I assigned northing and easting co-ordinates for the three sets of postcodes (home postcodes, general practice postcodes, leisure centre postcodes) through linkage to the NSPD.
2. I calculated the distance (in km) between each home postcode and all the exercise referral venues in the given scheme area. So for example, for a patient referred to the scheme in Area 1, I calculated the distance between their home postcode and all of the participating exercise venues in Area 1. I calculated straight-line distances using Pythagoras' Theorem, utilising the co-ordinates for both the home and exercise venue postcodes.
3. I repeated step 2, this time for the distance between each general practice postcode and all of the exercise referral venues in the scheme area.

4. I created a separate variable which selected the shortest distance between the home and nearest participating ERS venue.
5. I repeated step 4, this time to select the shortest distance between the general practice and nearest participating ERS venue.

Road distance rather than straight-line distance would have better reflected geographic access to the service. I looked into obtaining this information, however it would have been very costly and required a more detailed understanding of how road distance related to 'access' (for example calculating road distance doesn't take account pedestrian only access routes). This added level of complexity was beyond the scope of this PhD project. Straight-line distance provided a crude indicator of the relative geographic accessibility of exercise venues.

5.6 Estimating need for Exercise Referral

5.6.1 Rationale

In order to evaluate the equity of ERSs, 'need' for ERSs must be quantified so that this can be incorporated into the referral analysis. As outlined in Chapter 3, Section 3.3, in this research 'eligibility' for ERSs was used as a proxy for need for Exercise Referral. Although the exact eligibility criteria varied between schemes, I composed a unified categorisation which applied across all schemes (see Table 5.3). There was no official register of patients on the general practice lists who were eligible for Exercise Referral so I had to estimate the numbers taking into account expected variation across the population in eligibility for Exercise Referral by age, sex and socioeconomic group. Eligibility for ERSs was anticipated to be higher in more compared to less deprived socioeconomic groups, and for older compared to younger people within the population because these groups are known to suffer more from the conditions[25;235] for which Exercise Referral is indicated and are less likely to engage in leisure-time physical activity[24;26;79;123]. Women also participate in lower levels of physical activity than men[24] and as a consequence may have higher eligibility for ERSs.

Section 5.6.2 explains the method I used to create synthetic estimates of the percentage of the population eligible for Exercise Referral using information on morbidity and lifestyle characteristics from the Health Survey for England (HSE) 2004(21). Given that the HSE is a nationally representative survey I took the eligibility I calculated by age, sex and deprivation from the HSE 2004 to represent the proportion of the English population eligible (i.e. 'in need') of Exercise Referral.

It was not necessary to factor differential need for ERSs across the population into the analyses of service uptake or completion. This was because the ERS programme content and structure was designed to be tailored to accommodate the specific needs of referred patients and therefore if the service was being delivered equitable it would be expected that once referred, uptake and completion of the service would be equal for patients from different socioeconomic groups.

5.6.2 Method

I used a technique outlined by Adams and White[335] to estimate the proportion of people within each age-sex-deprivation group who were eligible for Exercise Referral, based on information from the Health Survey for England 2004[336].

The Health Survey for England (HSE) is an annual survey providing data about the population living in private households in England and is used to obtain population estimates of particular health conditions and associated risk factors. I used the 2004 survey because it was the latest survey available with detailed physical activity information which had been organised into summary categories. The data year also corresponds well with the timeframe over which I obtained the ERS data (April 2004 – March 2006).

The random general population sample in the HSE 2004 was generated by selecting 6553 addresses from the Postcode Address File (PAF) in 312 wards, and up to ten adults and two children in each household were interviewed. The resulting database contains information for 8354 people (including children) in co-operating households who undertook the full HSE interview. The HSE 2004 dataset includes the weighting variable 'wt_int.' This is a combination of a household weight (which corrects for non-contact and refusal of households to participate) and a component which adjusts for individual non-response within households. Using this weighting helps to correct for selection bias and ensure the information in the survey is representative of the English population.

I selected variables corresponding to ERS eligibility criteria from the HSE (Table 5.4). I defined eligibility in terms of inactivity (exercising less than once a week) and also having either one or more of the clinical conditions for which Exercise Referral is indicated, or one or more risk factors for future cardiovascular disease (smoking, family history, Body Mass Index (BMI) of 25 or over) for which referral to the programme is judged appropriate.

Table 5.4 Variables extracted from the Health Survey for England 2004

Variable	Values	Description	Application
AGE	Continuous; whole years	Age at last birthday.	Used to derive 5 year age bands which correspond to those used for the exercise referral data.
AG16G10	Ordered categorical; 1=16-24 years old, 2=25-34 years, 3=35-44 years, 4=45-54 years, 5=55-64 years, 6=65-74 years, 7=75 years and over	10 year age groups	Used to determine eligibility by age group.
SEX	Binary; 1=men, 2=women	Sex	Used to determine eligibility by sex.
IMD2004	Ordered categorical; 1-5, 1=least deprived	Quintiles of Index of Multiple Deprivation, at Super Output Area level (applied via persons home postcode)	Area-based measure of deprivation which corresponds to that used for Exercise Referral data.
ADT30GP	Ordered categorical; 1=low, none/less than once a week. 2=medium, 1-4 times per week. 3=high, 5 or more times per week.	Summary activity level for those aged 16 and over – no. of times per week undertakes physical activity for 30 minutes at moderate intensity.	I identified those people who did a 'low' level of activity as representing sedentary/inactive people who would be eligible for Exercise Referral.
LONGILL	Binary; 1=yes, 2=no	Whether person has a longstanding illness	Used to identify those who are eligible, in combination with ILLSTEXT
ILLSTEXT 1 - 6	Categorical; 1-42 (see Table 5.5 for selected conditions)	Description of the type of longstanding illness the person has. Maximum of 6 named conditions.	I identified those with values 2,4,5,6,15,16,17,18,22,23,34,35 or 36 in any one of the 6 named longstanding illness variables as representing those that matched the clinical eligibility criteria for Exercise Referral.
BMIVG4	Ordered categorical; 1=Under 20, 2=20-25, 3=25-30, 4=Over 30	Body Mass Index	Individuals with value 3 or 4, BMI 25 or over, I identified as being overweight/obese and hence matching eligibility criteria.
FAMCVD	Binary; 1=yes, 2=no	Any member of immediate family with a history of CVD	Any individual with 'yes' has one of the risk factors making them eligible for Exercise Referral.
TOBANY	Binary; 1=yes, 2=no	Currently use any tobacco product	Those who use tobacco have one of the risk factors making them eligible for Exercise Referral.
WT_INT	Continuous	Weighting variable	Correcting to ensure the information in the survey is representative of the English population

Table 5.5 Health Survey for England 2004 eligible longstanding illness conditions

Exercise Referral medical condition categories used for this research (Table 5.3)	HSE 2004 Longstanding illness conditions	Data value
Primary / secondary prevention of CVD	Stroke / cerebral haemorrhage / cerebral thrombosis	15
	Heart attack / angina	16
	Hypertension / High blood pressure	17
	Other heart problem	18
Diabetes	Diabetes including hyperglycemia	2
Respiratory	Bronchitis / emphysema	22
	Asthma	23
Mental Health	Mental illness / anxiety / depression / nerves	4
Musculoskeletal / neurological	Arthritis / rheumatism / fibrositis	34
	Back problems / slipped disc / spine / neck	35
	Other problems of bones / joints / muscles	36
	Epilepsy / fits / convulsions	6
	Mental handicap	5

Having identified the required variables from the HSE 2004, I made a condensed version of the full dataset which only included the variables of interest. The next stage was to create a binary variable to indicate respondents who were / were not theoretically eligible for Exercise Referral in the HSE 2004 sample. This binary variable took the value 1 (yes) for all individuals who had:

a) Value 1 for the ADT30GP variable indicating they were inactive;

AND

b) Any one of the Longstanding illness conditions listed in Table 5.5

AND/OR

c) Any one of the three risk factors for future CVD (currently use tobacco products, family history of CVD or a BMI of 25 and over).

I then grouped the HSE 2004 respondents together according to their sex, IMD 2004 quintile of residence and their age group (10 year age bands; 16-24 years, 25-34 years etc. through to 75 and over) using the 'collapse' command in STATA. Following this, I generated the weighted proportion of the HSE 2004 sample in each 10 year age-sex-IMD quintile group who were / were not eligible for exercise referral (Table 5.6). As expected there was a trend of increasing eligibility with age and in general higher eligibility in females than males. The relationship with deprivation appeared more

complex, but overall, as predicted, greater eligibility was exhibited within the more deprived sectors of the population as a higher percentage of those in the most deprived IMD 2004 quintile were eligible for Exercise Referral in the HSE 2004 compared to those in the least deprived quintile.

Table 5.6 Weighted eligibility percentages

(by IMD 2004 quintile, 10 year age group and sex from the Health Survey for England 2004)

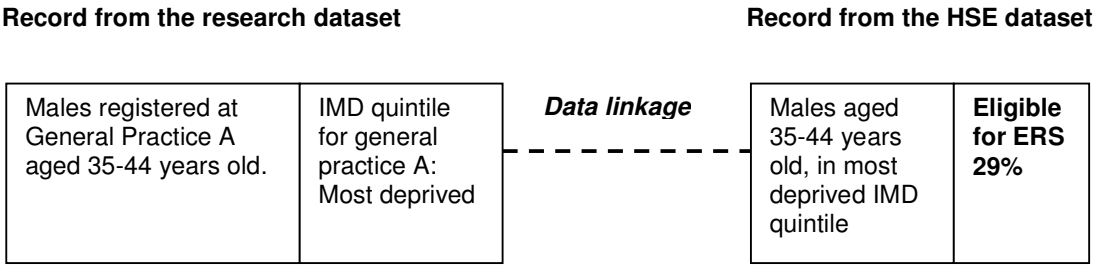
Age group	Sex	Quintile 1* (least deprived)		2		3		4		Quintile 5* (most deprived)	
		eligible (%wt)	n**	eligible (%wt)	n**	eligible (%wt)	n**	eligible (%wt)	n**	eligible (%wt)	n**
16-24	male	7.32%	69	10.25%	61	7.26%	46	9.55%	65	7.21%	50
	female	17.78%	64	19.05%	61	21.42%	68	13.01%	94	16.80%	77
25-34	male	20.90%	62	19.59%	86	14.72%	96	17.52%	111	18.60%	91
	female	10.79%	84	13.52%	98	10.50%	109	18.25%	129	23.85%	130
35-44	male	15.88%	150	17.84%	126	15.89%	91	20.49%	99	28.69%	69
	female	17.56%	182	17.70%	168	11.39%	115	19.73%	154	25.53%	127
45-54	male	22.01%	109	20.53%	101	22.43%	83	33.98%	86	39.60%	60
	female	23.17%	159	23.85%	140	23.17%	115	37.73%	106	35.29%	106
55-64	male	29.70%	125	31.26%	123	24.53%	96	33.78%	100	54.63%	64
	female	22.60%	134	32.04%	160	40.80%	108	36.83%	120	47.80%	99
65-74	male	38.97%	82	41.59%	104	47.98%	52	58.44%	68	67.63%	72
	female	41.59%	121	38.15%	117	41.61%	76	60.94%	98	68.13%	70
75 and over	male	57.39%	84	61.02%	68	52.62%	49	67.57%	38	73.06%	37
	female	69.23%	99	65.68%	92	74.41%	82	69.32%	89	70.15%	67
unweighted n			1524		1505		1186		1357		1119

*HSE orders quintiles the opposite way to the research dataset. So in this table 5=most deprived and 1=least deprived.

**n=includes eligible and non-eligible persons. Total unweighted N = 6691.

The next step was to apply these proportions to the general practice populations in the six participating areas to derive an estimate of the number of people within each general practice-age-sex group who were eligible for Exercise Referral. This was undertaken by linking the ERS dataset and the HSE 2004 dataset together, matching on age-sex-IMD 2004 group (Figure 5.4). This linkage was performed in STATA using the 'merge' command.

Figure 5.4 Example of data linkage process undertaken to apply the HSE 2004 derived eligibility estimates to the research dataset



Finally, to calculate the number of people eligible for Exercise Referral in each general practice in the research dataset I multiplied the population in each group by the percentage of that group eligible for Exercise Referral estimated from the HSE 2004. So, to exemplify this process, in General Practice A (located in the most deprived IMD quintile) there might be 300 males aged 35-44 years old. The number of males eligible for Exercise Referral in general practice A, aged 35-44, would be 300x0.29=87men. So, 87 would be the denominator for the referral risk, where the referral risks were calculated as follows:

$$\frac{\text{No. of males aged 35-44 years old referred by general practice A to ERS}}{\text{Total population of males aged 35-44 years old in general practice A eligible for ERS (i.e. 87 men)}}$$

5.6.3 Discussion

Given the unavailability of information on general practice registers about patients eligible for Exercise Referral, this approach to estimating eligibility on the basis of data from a nationally representative survey (HSE 2004) presented the next best alternative.

However, there are a number of limitations to the method I used to derive eligibility for ERSs.

Both activity level and the longstanding illness on the HSE 2004 were self-report. As Chapter 2 outlines, self-reported physical activity can be unreliable[75;89;90]. Measurement bias may be introduced if the accuracy of self-report of either physical activity or longstanding illness varies systematically by socioeconomic circumstance, age and sex of respondent. For example, it is perhaps more likely that a young person would report a certain health complaint as a longstanding illness, compared to an older person who may classify the same complaint as part of the inevitable 'ageing process' rather than as an 'illness'[337].

The HSE 2004 does not include people in communal establishments. This is especially an issue for the older age groups, where those living at home maybe healthier than those who do not, and so the eligibility percentages I obtained for these age groups maybe lower than if the sample was not restricted to those living in their own home. However, even within the oldest age groups, only a minority of the population live in residential/nursing homes[338] so the omission of these individuals from the HSE 2004 is not a major concern for the research.

5.7 Summary of data cleaning and preparation

This chapter so far has provided an overview of the preparatory stages I undertook before I could commence the equity research. These stages included; attaining Ethical and Research and Development (R&D) approval, obtaining data, cleaning and reformatting ERS data to standardise content across areas, combining ERS data together, adding information from external sources and estimating 'need' for ERS in the population and then applying this estimation to the research dataset.

By linking data from a number of sources I vastly increased the insight provided by the routine data available for this research. For example, linking data sources overcame the lack of socioeconomic monitoring at an individual level by providing an area-based measure of deprivation, and also enabled the training status of the general practice and distance from home/general practice to nearest ERS venue to be considered in the analysis. Furthermore, by employing a synthetic estimate technique to quantify eligibility for ERSs within the population I was able to conduct the equity analysis controlling (albeit imperfectly) for need, something which had not been attempted

before. The strengths of the research are discussed further in Chapter 7, Section 7.5.4.1.

The data preparation resulted in two datasets, one for the referral analysis (where the unit of analysis was a general practice, 5 year age-sex group), and one for the uptake and completion analyses (where the unit of analysis was individual patient). A specification of the variables included in the final datasets is provided in Appendix F.

5.8 Data exclusions

Prior to undertaking any analysis a number of records were excluded from the research datasets.

5.8.1 Out of area referrals

As a general rule, the catchment for each ERS was the general practices within that PCT. Very occasionally, the ERS accepted referrals from a neighbouring PCT (identified because the general practice referral venue was not a general practice within that PCT). For example, the ERS running in Area 3 received 19 patient referrals from general practices located in 5 neighbouring PCTs.

Because I do not have complete information on the provision of Exercise Referral or general practice population figures for these neighbouring areas these records were excluded prior to undertaking the analysis. 204 patients in total were excluded because referring venue was either unknown or out of area.

5.8.2 Re-referrals

I identified 437 instances of the same individual being referred more than once onto the Exercise Referral programme and these re-referrals were excluded prior to any analysis. This was necessary because re-referrals represent non-independent events. Independence of events was an assumption underlying the statistical techniques used in the analysis. I flagged records as duplicates if date of birth, gender and home postcode were identical for two or more records within a scheme area.

When a duplicate was identified I included the record with the earlier date of referral, excluding the later one (i.e. the re-referral). I anticipated that the data from the initial referral was most likely to reflect the experience of the majority of patients who pass through the scheme only once. The disadvantage to taking this approach was that the first experience of Exercise Referral for these individuals may have been atypical,

which is why they needed to be referred a second time. For example, the person might have dropped out due to the loss of a close relative. In this situation, it might have been best to take the later referral as the more typical experience. However, the reason for re-referral was not recorded and so it was not possible to ascertain this.

5.8.3 Inappropriate referrals

In all areas, the Exercise Referral scheme managers confirmed that referral forms were screened at the Exercise Referral headquarters, and any inappropriate referrals (for example, people with ineligible medical conditions) were returned back to the referrer and not entered onto the computer database (Chapter 4, Figure 4.2). For this reason I have assumed that all inappropriate referrals had already been screened out of the research dataset.

5.9 Analysis methods

I will now outline the methods used to obtain the descriptive results presented in Chapter 6 and then the main equity analysis results presented in Chapter 7.

5.9.1 Description of ERS areas and referred patients

The results of the descriptive analysis are presented in Chapter 6. Firstly, I tabulated and compared the socio-demographic, health and lifestyle characteristics of the six London Boroughs included in this study to Greater London overall, and to the rest of England. This comparison was carried out using routine statistics including information from the 2001 census and ONS demographic projections, routine national survey data (for example the Health Survey for England), Government benefit claimants data, and the Index of Multiple Deprivation 2004.

Secondly, I described the characteristics of patients referred in the research dataset in terms of percentage distributions across the analysis variables (for example, percentage of patients taking up and completing the schemes, percentage of patients in each IMD 2004 quintile, age group, sex, ethnic group and so forth). This description included a summary of proportion of patients with missing data for each of these variables.

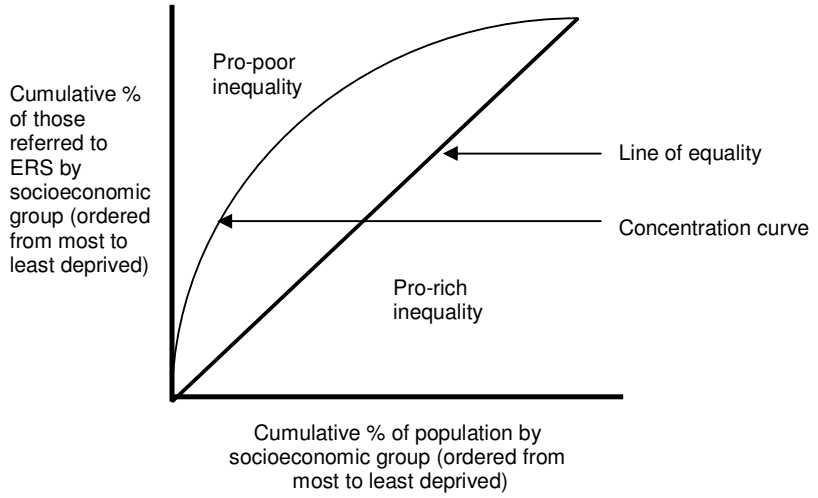
Thirdly, I created a proportionate breakdown of the socioeconomic characteristics of ERS participants and their respective PCT population averages. I established the statistical significance of any differences in the socioeconomic characteristics of referred individuals compared to their respective PCT populations using the Chi-squared test. I then used a disproportionality measure (the concentration curve and concentration index)[9] to show the extent of *inequality* in referral to Exercise Referral across socioeconomic groups.

The degree of socioeconomic inequality in health service use across a population can be displayed in a concentration curve and measured by the relative concentration index [9;18;339;340]. The concentration index has been used to measure and compare the extent of socioeconomic-related inequality in child mortality, child immunisation, child malnutrition, health subsidies and health care utilisation[22;340]. It has also been identified as a technique to use in Health Equity Audits which are routinely carried out in the NHS in England[200;341;342]. The concentration index is analogous to the Gini coefficient, used

in health economics to measure income inequality[18], and the concentration curve is analogous to the Lorenz curve[18].

The concentration index is derived from the concentration curve, where the population is first ordered by socioeconomic group, and the cumulative percentage of the population according to socioeconomic group (on the x-axis) is plotted against their share of health service use (on the y-axis)[9]. An example of a concentration curve is provided in Figure 5.5. The concentration index is defined as twice the area between the 45 degree line (line of equality) and the concentration curve[340]. It is a negative value if the concentration curve lies above the 45 degree line (indicating pro-deprivation inequality, a disproportionate concentration of service use amongst deprived groups)[18]. It is zero when there is no inequality (i.e. the concentration index matches the 45 degree line exactly).

Figure 5.5 A concentration curve



By plotting the cumulative percentage of the population and ERS referrals, the curves graphically display any inequality in a consistent way across areas, and the concentration index quantifies the extent of any inequality in a standard way. This enables a direct comparison to be made of whether the extent of any inequality in ERS referral varies between the 6 PCTs. This is more difficult to ascertain from a simple tabular comparison of the socioeconomic characteristics of the 6 PCT populations and their respective ERS referrals.

I drew concentration curves and calculated concentration indexes for each area to show the degree of socioeconomic inequality. The socioeconomic grouping across the population was measured by IMD 2004 quintile of deprivation and health service provision measured in terms of the proportion of people referred to ERSs in each IMD 2004 quintile. I calculated the concentration index and associated variance, standard error and t-statistic for each PCT area using an excel spreadsheet supplied by the World Bank, O'Donnell et al.[340]. I tested the accuracy of the spreadsheet by cross-checking the output with a manually calculated index score for one PCT area.

The techniques used to examine disproportionality do not adjust for variations in need for Exercise Referral across socioeconomic groups. As Chapter 3 outlines *equality* of referral does not imply *equity* of referral. To provide an equitable service (equal use for equal need[186]) a pro-deprivation gradient would be required to account for the greater eligibility for Exercise Referral found within deprived populations (see Table 5.6). Nevertheless, the examination of disproportionality provided a useful starting point from which to go on to examine inequity in service referral. For example, if the concentration curves were found to fall underneath the line of equality (generating positive rather than negative concentration index scores) this would indicate the likely presence of inequity in service provision given the distribution of eligibility for ERS across socioeconomic groups within the population.

Finally, a demographic comparison was undertaken. I cross tabulated the age, sex and ethnic characteristics of referred patients with the distributions of these characteristics within the local PCT population to examine the extent of disproportionality for these demographic characteristics. The variable of interest must be hierarchically ordered in order to calculate a concentration index and so I did not use this technique to study these demographic variables.

5.9.2 Equity analysis

The results of the main equity analysis are presented in Chapter 7. I undertook cross-sectional analysis of patients referred to ERSs over a 24 month period (April 2004-March 2006) using data from the six ERSs in Greater London which both collected sufficient routine data on patients referred to ERSs, and agreed to participate in the study (see Chapter 4).

5.9.2.1 Analysis covariates

Socioeconomic circumstance (the exposure of interest) was measured using IMD 2004 quintile of deprivation. Variables that might have confounded any relationship between deprivation and service access and use were also considered.

Use of ERSs has been previously reported to vary according to the age and gender of patients[29;145;231;232;280;343;344]. Clinical referral condition (for example, obesity, musculoskeletal conditions, diabetes, mental health problems, CVD) has also been reported to influence use of ERSs[231;280;343-345].

Reported barriers to participating in physical activity such as access to transport and the provision of leisure facilities are known to be socioeconomically patterned (Chapter 3) and so distance both from home and from the referring general practice to nearest participating ERS were included in the analysis. Distance might have influenced general practitioners awareness and involvement with the schemes, because having a leisure centre nearby might have reminded them about referring to the scheme.

GP training status was also included because quality of service is higher in training practices[320;321] and it was conjectured that such practices might have a greater propensity to engage with ERSs. Training practices are more commonly represented in less deprived areas[320;322].

As Chapter 4 explains, elements of service design and delivery varied between ERSs. These differences might have influenced whether patients were referred, took up or completed the ERS programme and because of this scheme area was considered as a potential confounder in the analysis. Due to the small number of PCT areas included in the analysis, 'scheme' was introduced as a fixed effect in the analysis.

Figure 5.6 summarises all of the covariates tested in the multivariate models.

Referral analysis

The exposure of interest for the referral analysis was IMD 2004 quintile of deprivation for each general practice (assigned via LSOA of practice postcode[229]). The other covariates were age group, sex, scheme area, distance from general practice to nearest participating ERS venue, and training status of general practice.

I calculated referral risk ratios to quantify the influence of general practice deprivation on likelihood of referral. The numerator for estimating referral risks was the total number of patients referred to Exercise Referral in a given five year age-sex-general practice group and the denominator was the total number of patients eligible for ERS within the five year age-sex-general practice group. Differences in eligibility across age-sex-IMD 2004 quintile groups were taken into account in the denominator for the referral risks, so any variation found in referral risks along these socio-demographic dimensions would not be explained by differential eligibility for ERSs.

It would have been valuable to assess whether patients' socioeconomic circumstance was associated with the likelihood of being referred to ERS (mirroring the level of analysis used to examine take up and completion of ERSs). However, in order to do this I would have required:

- Socioeconomic data on each patient registered at all of the 317 general practices within the 6 PCTs participating in this research.
- Information on morbidity and lifestyle characteristics in order to assess eligibility for Exercise Referral.
- Personal information such as name, date of birth, sex and address so that the patients referred to ERS across the 6 PCTs could be matched to their corresponding general practice records.
- Consent from every patient in all 317 practices (to conform with current ethical guidance).

This was not practical. Instead, I analysed referral at the level of the general practice. This pragmatic approach provided an indication of the extent to which equity was addressed at the organisational level of general practice, which was the main access point for entry to the ERSs. The phenomenon of the 'inverse care law' is often researched at the macro-level (service provider), rather than at the individual patient level[20].

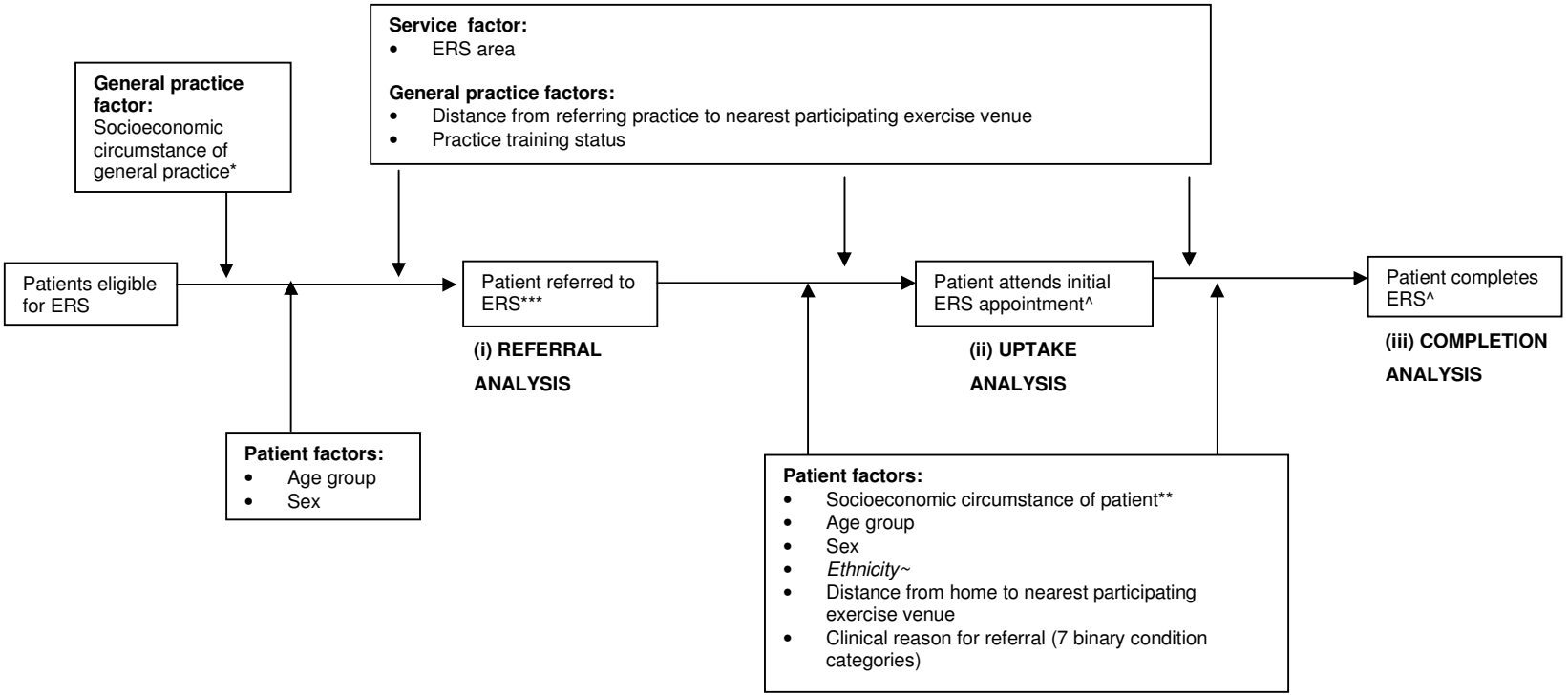
Uptake and completion analyses

The exposure of interest for both the uptake and completion analyses was IMD 2004 quintile for each patient (assigned via LSOA of home postcode). The other analysis covariates were age group, sex, scheme area, reason(s) for referral, distance from home to nearest participating ERS venue, distance from general practice to nearest ERS venue, training status of general practice.

I calculated odds ratios first with respect to take up of the service and then for completion of the scheme by those who had attended the first appointment. Prior to

undertaking the analysis, I excluded records from the ERS running in area 4 because uptake and completion were unreliably recorded in this area. Appendix G provides information on this exclusion.

Figure 5.6 Model showing all covariates tested to determine those which were associated with likelihood of (i) referral, (ii) uptake and (iii) completion of ERS



*exposure variable of interest – IMD 2004 quintile of general practice
**exposure variable of interest – IMD 2004 quintile of patient's home
***measured as sex/age group specific referral rates clustered within general practices
^measured at individual level accounting for clustering of patients within general practices – tookup / completed ERS (yes/no)
~ethnicity was only included in a sub-group analysis (Appendix G)

5.9.2.2 Statistical analyses

I performed the analysis using STATA SE version 9.2[331]. I used Generalised Estimating Equations (GEEs) to estimate i) risk ratios for referral to ERS ii) odds ratios for uptake of ERS and iii) odds ratios for completion of ERS across IMD 2004 quintiles. The null hypotheses for each of the outcomes were as follows:

- There is no association between general practice IMD quintile and risk of referral to ERS.
- There is no association between patient IMD quintile and odds of taking up ERS.
- There is no association between patient IMD quintile and odds of completing ERS.

GEEs were used in preference to standard regression models because they take account of clustering in estimating coefficients and standard errors. I assumed that patients within a general practice would be more similar to each other than to patients from different general practices given that they share the same local environment and the same provision of primary care services, and as such patients are clustered within general practices. The exchangeable correlation structure was used which assumed the correlations between pairs of observations in the same cluster were the same for all pairs in each cluster. This was appropriate because there was no reason to suppose the relationship between patients differed systematically across or within general practices.

I excluded re-referrals, out of area referrals, non-general-practice referrals (see section 5.8) and any records with incomplete data from the GEE analysis (Chapter 7, Figure 7.1). In addition, I excluded all referrals made by non-general practice locations (Appendix E) from the equity analysis. This was because the analysis of referral was undertaken at the general practice level, general practice being the main access route to the service. There was theoretical underpinning for using the deprivation score for a general practice to reflect the deprivation experience of a community (in the absence of individual level data)[229]. It would have been difficult and not necessarily valid to impute a deprivation score to reflect the community served by referral centres other than general practices, given these often have wider catchment areas (for example, hospitals). Therefore these referrals were excluded. Furthermore, by concentrating on general practice referrals I was able to adjust for clustering by general practice and use two general practice covariates (training status and distance to nearest participating ERS venue).

I produced cross-tabulations to describe take-up and completion of ERS by patients according to the analysis covariates. I fitted separate GEE models for each of the exposure covariates and the three outcomes (referral, uptake and completion) in turn to determine which variables were independently associated with the outcomes of interest. This univariate analysis stage assisted in confirming potential independent risk factors and factors which may have confounded any relationship between IMD 2004 quintile and referral, uptake or completion of ERS.

Secondly, for each of the three outcomes in turn, I initially fitted a GEE model with all the covariates which had been identified *a priori* as potential independent risk factors or confounders and the outcome of interest - the full model. I then used a backward elimination procedure to produce three final models which included IMD 2004 and only the covariates which were associated ($p \leq 0.05$) with the outcome. The backward elimination procedure operated as follows. The significance of each of the covariates in successive models was tested using the Wald test ($p \leq 0.05$). Variables which were not found to be associated were removed, in the order of least significance (i.e. the variable with the highest p-value from the Wald test was removed first, a new model was then run and significance retested, and once again the variable with the highest p-value from the new Wald test result was removed next). The successive models tested using this procedure are detailed in Appendix H.

Service access and use for those in each quintile was compared with the most deprived group (quintile 1, the baseline). I also ascertained whether there was a linear gradient in access and use across socioeconomic groups, performing a 'test for trend' analysis.

I did not introduce any interaction terms into the GEE modelling because I made no *a priori* hypotheses about the existence of effect modification between any of the covariates and the exposure and outcome of interest.

5.9.2.3 Additional sensitivity analyses

Altering the denominator for the referral risk

I calculated referral risks for the main analysis as follows:

$$\frac{\text{No. of referrals April 2004-March 2006 in given age/sex specific general practice group}}{\text{Total general practice population } \textit{eligible} \text{ for referral in given age/sex general practice group}}$$

The synthetic estimate technique used to derive the general practice population eligible for referral had not been tested in any prior research. In order to be confident in the results of the referral analysis I retested the relationship between the exposure covariates and referral risk, when the referral risk was based on a crude denominator (unadjusted for differences in eligibility across age, sex, and socioeconomic group) to check the direction and magnitude of any associations with deprivation were consistent with the analysis based on the eligible population. So, I calculated referral risks for the sensitivity analysis as follows:

$$\frac{\text{No. of referrals April 2004-March 2006 in given age/sex specific general practice group}}{\text{Total general practice population in given age/sex general practice group}}$$

Missing data

GEE models run on the assumption that any missing data is missing completely at random (i.e. the probability that an observation is missing is independent of all other observations). GEE sensitivity analysis was undertaken to assess any influence of missing outcome data. I generated a missing value indicator for missing outcome status (separately for uptake and completion) and ran GEE analyses to identify any covariates associated with this indicator. I then refitted the uptake and completion final GEE models including any covariates found to be related to missing outcome information. This addressed the problem of any outcome information not missing at random, validating the final models[346].

I also explored the extent to which the missing completely at random assumption held for the exposure variable of interest (IMD quintile). Multivariate analysis adjusted for clustering at the general practice level was undertaken to establish whether missing exposure information (IMD 2004 quintile) was missing at random or instead distributed systematically within the sample population with respect to the other analysis covariates.

Ethnicity

Ethnicity was not a covariate in the main analysis because less than half of the patients had information recorded for this variable (Appendix G). This was because only three of the five ERSs schemes included in the uptake and completion analyses collected ethnicity information. To investigate the potential importance of ethnicity as a confounder in the relationship between IMD 2004 quintile and uptake/completion of ERS, I repeated the uptake and completion GEE analyses for only those scheme areas that recorded ethnicity (Area 1, Area 3 and Area 6). I used a backward elimination procedure and the progression to the final multivariate model is shown in Appendix I. It was not possible to test at all the potential influence of ethnicity on the relationship between socioeconomic circumstance and referral to ERSs because I did not have access to general practice population data subdivided by age and sex and ethnicity from the FHS database which would have been required to carry out this analysis.

Referral route

I undertook multivariate logistic regression to determine whether deprivation was associated with likelihood of being referred via a non-general practice referral route.

5.9.2.4 Sample size calculations

I performed a sample size calculation prior to data collection (which was re-done after the visit to Area 7 established that this scheme did not meet the eligibility criteria, see Section 5.3.1).

Referral analysis

- Practice level covariates
    - Deprivation (quintiles, 1-5)
    - Exercise Referral Scheme (6 schemes)
    - Distance of practice from leisure centre (continuous, measured in metres)
    - Training status of practice (binary, yes/no)

- Age (continuous, measured in years). I planned to use the mid-point of each 5-year age band as the continuous variable (e.g. age band 20-25, mid point 22.5 years).
- Sex (binary, male/female)

Total number of coefficients: 13

The six PCT areas covered by the six ERSs included 325 GP practices. Each general practice were expected to provide registered population data by sex in 15, five-year age groups (15-19 years, 20-24 years, through to 85 years and over category), hence 30 age-sex categories in total. I intended to organise the referral information from the ERSs into 30 age-sex categories. For the planned analysis I intended to fit a model with the general practice level covariates described above, requiring estimation of 13 coefficients. Making the extreme assumption of no clustering by general practice (and treating referral rates as continuous), a minimum of 13x10 practices i.e. 130 observations would be required to estimate the 13 coefficients[347]. I expected to have 325x30 (i.e. 9750 observations), which was well above that number. However, referral rates by age and sex categories were anticipated to be correlated within general practices. To allow for this correlation, a larger sample size would be required. The anticipated sample size was much larger than what would be required if there was no correlation, so I concluded that there would be adequate data to undertake analysis allowing for the correlation within general practices.

Uptake and Completion analyses

Covariates:

- Individual level covariates
  - Deprivation (quintiles, 1-5)
  - Age at referral (continuous, measured in years)
  - Sex (binary, male/female)
  - Ethnicity (5 categories; White, Mixed, Asian, Black, Chinese/Other)
  - Referred for CVD primary or secondary prevention (binary, yes/no)
  - Referred because obese/overweight (binary, yes/no)
  - Referred because of diabetes (binary, yes/no)
  - Referred for respiratory conditions (binary, yes/no)
  - Referred for musculoskeletal/neurological conditions (binary, yes/no)
  - Referred for mental health reasons (binary, yes/no)
  - Referred due to old age (binary, yes/no)

    - Distance from home to nearest participating ERS venue (continuous, measured in metres)
- Practice level covariates
    - Exercise referral scheme (6 schemes)
    - Distance of practice from nearest participating ERS venue (continuous, measured in metres)
    - Training status of general practice (binary, yes/no)

Total number of coefficients: 25

To represent all the covariates in the model was expected to require estimation of 25 coefficients. If there was no correlation of patients within practices a minimum of 25x10 patients (i.e. 250) taking up or adhering to the scheme would be required to estimate the 25 coefficients in the model[348]. I expected there would be some correlation however between individuals and general practices. I calculated that the 6 ERSs in total would provide data on approximately 9000 referrals over the 24 month period (April 2004 – March 2006). Assuming a 60% take-up and 30% completion rate (based on previous research[158;231;232;254]), there would be 5400 expected to take up and 2700 expected to complete the scheme across the 300 practices which referred onto the scheme. Even if I factored in a high figure of 20% missing data (so, 4320 taking up and 2160 people completing the scheme) I concluded that this would still have been a sufficient sample to provide accurate estimates in the planned models.

Chapter 6

Description of participating Exercise Referral Scheme areas and referred patients

Chapter 6. Description of participating Exercise Referral Scheme areas and referred patients

6.1 Introduction

This chapter describes the local populations served by the participating ERSs and the characteristics of patients referred to the schemes. The descriptive analysis had three objectives:

Objective 1 - To describe the population in the participating areas
To describe the socio-demographic, health and lifestyle characteristics of the London PCT populations served by the six participating ERSs, and to compare these to the English population. This provided an indication of the diversity of socioeconomic circumstance covered in the research sample and an assessment of the likely generalisability of the research findings to other populations within England.

Objective 2 - To describe the referred patients and referring general practices
To describe the socio-demographic characteristics, clinical referral conditions and referral route of referred patients. These were compared to the characteristics of other ERSs reported in the literature, in order to assess how typical the sample ERSs were of others running in England. This enabled a judgment as to the likely applicability of the research findings to other ERSs.

Objective 3 - To measure the socioeconomic equality of referral to ERSs
To compare the socioeconomic characteristics of referred patients with the characteristics of their respective PCT populations in order to examine the extent of *inequality* in referral to ERSs across socioeconomic groups. This provided a useful basis from which to go on to examine *inequity* in service referral (presented in Chapter 7).

6.2 Objective 1 - Description of participating areas

6.2.1 Description of PCT populations

Socio-demographic characteristics

The study areas spanned across the range of deprivation experience for England (Table 6.1, Figure 6.1). PCT Areas 3 and 4 were two of the most deprived PCTs in the country, whereas PCT Areas 1 and 2 represented the more advantaged end of the spectrum. Area 5 and Area 6 were both towards the more deprived end of the spectrum, just under 50% of the total PCT populations lived within the 20% most deprived LSOAs within the country (Table 6.1).

The ethnic profiles of the areas included in this research were not representative of the distribution of ethnic groups across England overall. There was a much higher concentration of minority ethnic populations within the study PCT areas (Table 6.1). Over 30% of both Area 4 and Area 3 residents were from the Asian ethnic group, in contrast to just under 5% of the English population overall. Over 20% of Area 3's population had black ethnicity, compared to just over 2% in England overall. Similarly, compared to England, Area 6 had a much higher percentage of people with a mixed ethnicity, and Area 5 had a higher percentage of people with other/Chinese ethnic background. The ethnic distribution in Area 1 was similar to that of the Greater London region overall, again with higher representation of ethnic minority groups compared to England overall. Area 2 was less ethnically diverse, over 90% of its residents were in the white ethnic group (comparable to the proportion in England overall).

In general the Greater London population had a younger age distribution to the England average (Table 6.1) and so the London PCTs included in this research had a relatively young age structure (with the exception of Areas 1 and 2). Areas 3-6 all had over 45% of the total adult population (defined here as those aged 16 and over) in the youngest age group (16-39 years), compared to 32% of the population of England overall within this age group. Areas 1 and 2 had slightly older population structures. The sex distributions for the study areas were not drastically different to that of England, although notably Area 2 had a higher percentage of female residents compared to England overall and Area 4 had a lower percentage (Table 6.1).

Health and lifestyle characteristics

As would be expected given the PCT's relatively socioeconomically advantaged status, the morbidity and mortality variables in Table 6.2 indicate that Area 2 was the healthiest of the study areas, and that Area 2's residents displayed healthy lifestyle characteristics. The average life expectancy for males and females in Area 2 was higher than the average for England. Premature mortality from heart disease and stroke was significantly lower than for England overall, as was the prevalence of morbid conditions such as diabetes, mental health problems and hip fractures. Area 2 residents were less likely to smoke, or be obese compared to England. Area 1 also displayed a relatively positive picture. Male life expectancy was significantly better than the England average, and the prevalence of obesity, poor mental health and hip fracture was lower.

Areas 3-6, were all relatively unhealthy compared to England overall. All four areas had lower life expectancy for males and higher rates of premature death from heart disease and stroke compared to the England average. Female life expectancy and diabetes prevalence were both significantly worse than the England average for Area 3, Area 4 and Area 6. Mental health appeared to be worse in these areas (with the exception of Area 3). The expected prevalence of smoking was higher in Area 5 and Area 6 than England overall. In contrast, the prevalence of obesity was lower in all these areas compared to England (statistically significantly lower in Area 4, Area 5 and Area 6). The prevalence of diabetes in Area 5 was also significantly lower than the England average.

Physical activity participation displayed an interesting pattern across the participating areas. It was not, as might be expected, higher in Areas 1 and 2 (which had the most favourable profile in terms of morbidity, mortality and other lifestyle characteristics) compared to the other study areas. Instead, self-reported physical activity participation was significantly better in Area 5 compared to the England average, and was also relatively high in Area 6. All of the other study PCTs displayed participation levels similar to England, except for Area 3 which had significantly worse physical activity participation than the English average.

Table 6.1 Socio-demographic characteristics of London PCTs with ERSs included in this research compared to the Greater London region and England

Socio-demographic variable	England n (%)	London n (%)	Area 1 n (%)	Area 2 n (%)	Area 3 n (%)	Area 4 n (%)	Area 5 n (%)	Area 6 n (%)
Age*								
16-34 years	**12415827 (31.6)**	**2253109 (39.4)**	88300 (34.2)	69943 (29.6)	81508 (45.3)	78104 (51.7)	76548 (46.4)	103087 (47.9)
35-49 years	**10453465 (26.6)**	**1562455 (27.3)**	75838 (29.4)	65080 (27.5)	49541 (27.5)	35185 (23.3)	41216 (25.0)	58579 (27.2)
50-64 years	**8559958 (21.8)**	**1016701 (17.8)**	51400 (19.9)	51828 (21.9)	27181 (15.1)	19567 (12.9)	26173 (15.9)	28833 (13.4)
65-79 years	**5748035 (14.7)**	**653381 (11.4)**	31310 (12.1)	35911 (15.2)	16362 (9.1)	14462 (9.6)	15689 (9.5)	23616 (8.6)
80 years and over	**2059965 (5.3)**	**238209 (4.2)**	11291 (4.4)	13899 (5.9)	5458 (3.0)	3897 (2.6)	5528 (3.4)	6050 (2.8)
Sex*								
Males	**23,922,144 (48.78)**	**3,468,793 (48.4)**	159111 (48.1)	141785 (48.0)	119872 (49.2)	98178 (50.1)	95398 (48.2)	131152 (49.3)
Females	**25,216,687 (51.3)**	**3,703,298 (51.6)**	171476 (51.9)	153747 (52.0)	124019 (50.9)	97928 (49.9)	102622 (51.8)	135017 (50.7)
Ethnicity*								
White	**44,679,361 (90.9)**	**5,103,203 (71.2)**	231945 (70.2)	270666 (91.6)	96130 (39.4)	100799 (51.4)	144896 (73.2)	103,087 (47.9)
Mixed	**643,373 (1.3)**	**226,111 (3.2)**	12296 (3.7)	5516 (1.9)	8248 (3.4)	4873 (2.5)	7429 (3.8)	58,579 (27.2)
Asian	**2,248,289 (4.6)**	**8,866,693 (12.1)**	37380 (11.3)	7550 (2.6)	79302 (32.5)	71807 (36.6)	20551 (10.4)	28,833 (13.4)
Black	**1,132,508 (2.3)**	**782,849 (10.9)**	44076 (13.3)	8614 (2.9)	52653 (21.6)	12742 (6.5)	16 374 (8.3)	23,616 (8.6)
Chinese/other	**435,300 (0.9)**	**193,235 (2.7)**	4890 (1.5)	3186 (1.1)	7558 (3.1)	5885 (3.0)	8770 (4.4)	6,050 (2.8)
IMD 2004**								
% of people in region/borough living in 20% most deprived areas of England		**(26.5)*****	(12.3)	(5.7)	(76.7)	(81.7)	(48.6)	(48.0)

*Source: Census 2001, ONS, © Crown copyright[349]

**Source: APHO and Department of Health. From 'Health Profiles for London borough areas 2006' © Crown Copyright 2006[350]

***Source: Index of Multiple Deprivation full report- revised[12]

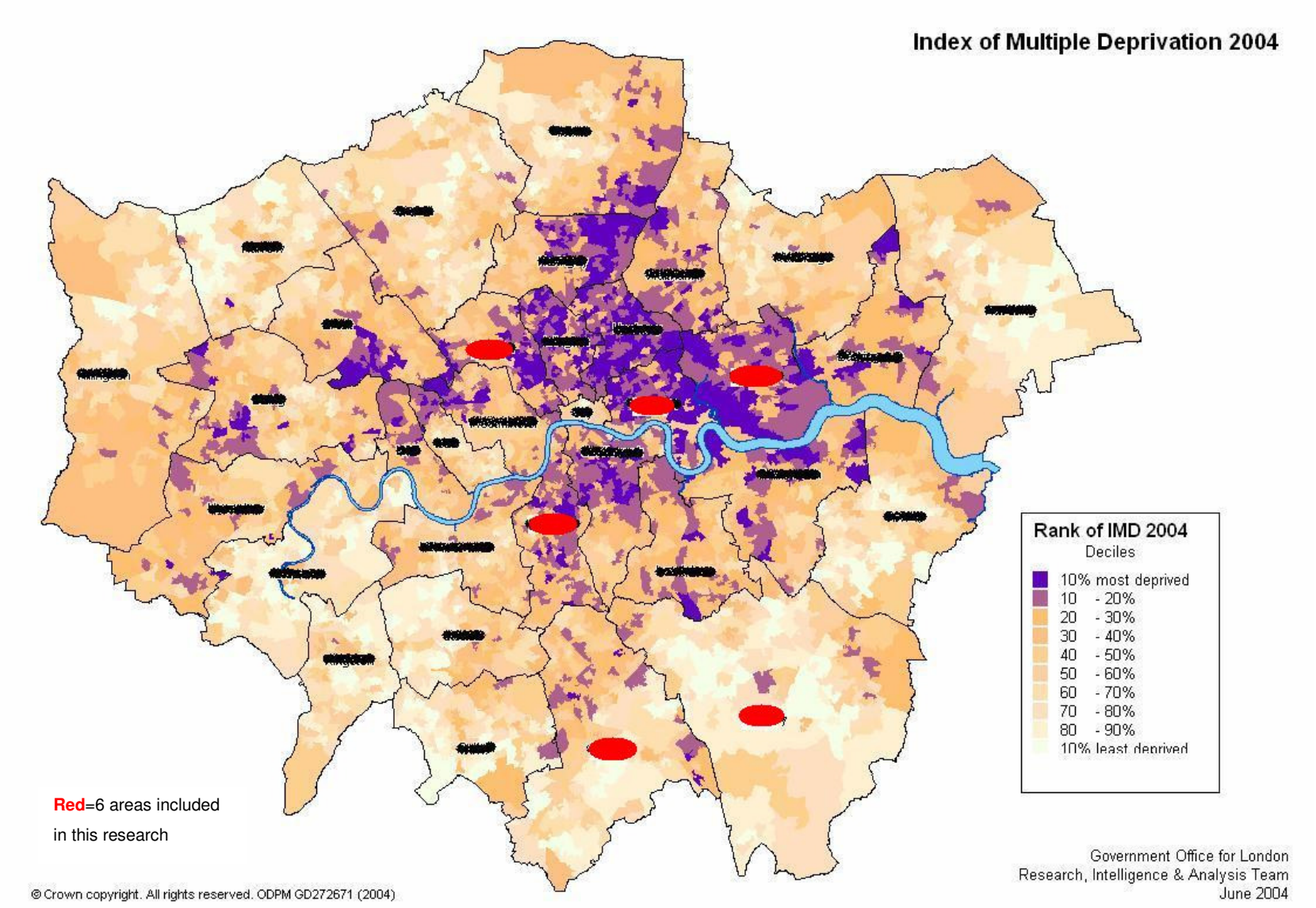
Table 6.2 ERS-relevant health and lifestyle characteristics of London PCTs with ERSs included in this research compared to England

Variable	Source[89]	Area						
		England	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
Adults who are physically active (participate in moderate sport or recreational activities for 40 minutes or more on 20 or more days in the previous 4 weeks)	Sport England Active Peoples survey 2006	**11.6%**	11.3%	11.1%	8.8%**	12.3%	14.2%*	14.8%
Adults who smoke	Modelled synthetic prevalence estimates from Health Survey for England 2000-2002	**26.0%**	24.9%	22.2%*	26.8%	29.4%	30.4%**	32.4%**
Obese adults (body mass index >30 kg/m2)	Modelled synthetic prevalence estimates from Health Survey for England 2000-2002	**21.8%**	19.7%*	19.5%*	20.9%	19.2%*	15.4%*	17.1%*
Male life expectancy – years (at birth, 2003-2005)	Office for National Statistics	**76.9**	77.5*	78.6*	74.9**	74.9**	75.7**	74.9**
Female life expectancy - years (at birth, 2003-2005)	Office for National Statistics	**81.1**	81.0	82.6*	78.8**	79.9**	81.6	79.8**
Early deaths from heart disease and stroke (deaths from all circulatory disease, classified by underlying cause of death (ICD10 I00 – I99), registered in 2003-05: directly standardised rate per 100,000 population aged under 75).	Office for National Statistics	**90.5**	93.2	64.5*	145.9**	141.5**	111.2**	120.0**
Diabetes prevalence, persons, all ages, June 2006, per 100 resident population	Quality and Outcomes Framework 2006	**3.7**	4.1**	3.3*	5.9**	4.7**	2.7*	4.0**
Mental health (claimants / beneficiaries of incapacity benefit / severe disablement allowance with mental or behavioural disorders, crude rate, males and females, working age, 2005, per 1000 working age population)	Department of Work and Pensions	**27.4**	22.9*	19.3*	28.1	32.7**	39.4**	34.8**
Older people: hip fracture (Hospital Admission for fracture neck of femur, 2005-06: directly age-standardised rate per 100,000 population aged 65 year and over)	Hospital Episode Statistics (HES), NHS Health and Social Care Information Centre.	**565.3**	454.0*	435.4*	413.8*	796.4**	641.5	473.6*

Source: APHO and Department of Health. From 'Health Profiles for London borough areas 2007' © Crown Copyright 2007[351]

*significantly better than England average (p<0.05) **significantly worse than England average (p<0.05)

Figure 6.1 Deprivation across wards in London



6.2.2 Discussion

The sampling frame for this research was Greater London, and consequently all areas included in the research were predominantly urban locations. Compared to England, routine statistics indicate that the study areas overall were; more deprived, more ethically diverse and younger, with a similar sex structure to England.

Although the combined study areas were more deprived than England on average, the inclusion of Areas 1 and 2 ensured the full range of deprivation experience across the country was represented in the research. This was important for the generalisability of the findings from this research (see section 6.3.4). Similarly, the ethnic diversity in the research areas meant that there was a sizable representation of all ethnic minority groups.

A range of health and lifestyle characteristics were displayed by the participating research areas. Area 1 and Area 2 populations had the most favourable health and lifestyle characteristics overall compared to the English average, a reflection of their relatively socioeconomically advantaged status.

In all PCT areas the prevalence of moderate physical activity was low. However, physical activity participation did not follow the expected pattern of Areas 1 and 2 having the most favourable profile. Routine monitoring of lifestyle characteristics is still relatively undeveloped in England[352]. The measure of physical activity participation reported in these routine statistics was based on self-report from a survey, and as Chapter 2 outlines self-report can be unreliable[75;89;90]. The threshold for deciding the level of engagement in activity which was deemed to represent a 'physically active' person was somewhat arbitrary, and the measure only included walking, sport and active recreation, excluding other forms of physical activity such as housework, DIY and occupational physical activity. As a result it is likely that the measure under-estimated total physical activity prevalence[89], more so perhaps in deprived areas, where there is a higher likelihood of people undertaking occupational-based physical activity as a result of being engaged in manual employment[44]. Furthermore, the measure of adults participating in physical activity was a crude proportion and no age-standardisation had been applied to adjust for differences in age structure between areas[89]. It is likely that a greater proportion of younger people undertake recommended levels of physical activity than older people[89] which is important given the relatively young age structure of the more deprived areas covered in this research

sample compared to the older age structure in the two more advantaged areas (Areas 1 and 2). Lack of age-standardisation may therefore partially explain why the pattern of physical activity participation across the study areas was inconsistent with the pattern displayed across the areas with respect to other health and lifestyle characteristics.

The lack of age-standardisation may also partially account for why obesity levels across the relatively deprived areas (Areas 3-6) were generally more favourable than the English population overall[89], as younger populations are overall less likely to be obese that older population groups[353]. Both the smoking and obesity prevalence information for PCTs was derived from synthetic estimates using HSE 2000-2002 data[89] as opposed to actual prevalence data obtained through, for example, a local lifestyle survey. Therefore, these variables must be interpreted with caution. Aside from lack of age-standardisation, the inaccuracy of synthetic estimates might also account for why obesity levels in some of the more deprived areas were reported to be significantly better than the English average.

6.3 Objective 2 - Description of referred patients and referring general practices

6.3.1 Introduction

The objective here was to describe the characteristics of referred patients included in the analysis dataset. The distributions of the characteristics of referred patients in this study were then compared to the characteristics of patients involved in other ERSs reported in the literature, in order to assess how typical the ERSs included in this research were of ERSs running in England. This enabled me to judge the likely external validity of this research. External validity can be defined as the extent to which research findings apply (or can be generalised) to persons, settings and times other than those that were the subject of study. A separate descriptive comparison of the attributes of the ERSs running in the six areas based on the findings of the scoping review (i.e. in terms of structure of the schemes, funding for the schemes and so forth) was presented in Chapter 4.

6.3.2 Description of patients and practices

The patient population described excluded, 204 out of area referrals and 437 re-referrals of the same patient to the ERS (see Chapter 5, Section 5.8, for explanation of these exclusions), leaving 10,100 referred patients. These 10,100 patients were those who had been referred by general practices and other referral centres, screened by the ERS headquarters to check eligibility, and once eligibility was confirmed, entered onto the central electronic database for the scheme. The completeness of routine data recording on the six ERSs central electronic systems was good overall. All variables except ethnicity and scheme completion had less than 10% missing information. The six scheme areas did not contribute equally to the total research dataset. Three quarters of all referrals were from ERSs in Areas 1-3.

Table 6.3 Characteristics of patients referred to ERSs

Variable		n (%)
TOTAL REFERRALS		**N=10,100 (100)**
IMD 2004 quintile (1=most deprived)	1	3848 (38.1)
	2	2351 (23.3)
	3	1212 (12.0)
	4	916 (9.1)
	5	1265 (12.5)
	Missing	*508 (5.1)*
Exercise referral scheme area	Area 1	2247 (22.3)
	Area 2	3224 (31.9)
	Area 3	2079 (20.6)
	Area 4	969 (9.6)
	Area 5	1021 (10.1)
	Area 6	560 (5.5)
	Missing	*0 (0)*
Took up ERS	Yes	5965 (59.1)
	No	3347 (33.1)
	Missing	*788 (7.8)*
Completed ERS	Yes	2093 (20.7)
	No	6381 (63.2)
	Missing	*1626 (16.1)*
Sex	Male	3008 (29.8)
	Female	6600 (65.3)
	Missing	*492 (4.9)*
Age group	16-35 years	1517 (15.0)
Median and mean age: 51 years	35-49 years	3010 (29.8)
Age range: 16-98 years	50-64 years	2984 (29.5)
	65-79 years	1737 (17.2)
	80 years and over	221 (2.2)
	Missing	*631 (6.3)*
Ethnicity	White	1748 (17.3)
	Mixed	97 (1.0)
	Asian/British Asian	1204 (11.9)
	Black/Black British	1153 (11.4)
	Chinese/Other	210 (2.1)
	Missing	*5688 (56.3)*
Distance from home to nearest participating ERS	0-499 metres	1760 (17.4)
Venue	500-999 metres	2801 (27.7)
Median distance: 1052 metres	1000-1499 metres	2247 (22.3)
	1500-1999 metres	1505 (14.9)
	2000 metres+	1279 (12.7)
	Missing	*508 (5.0)*
Referred for primary or secondary prevention of CVD	Yes	4301 (42.6)
	No	5510 (54.6)
	Missing	*289 (2.9)*
Referred because overweight / obese	Yes	2974 (29.5)
	No	6837 (67.7)
	Missing	*289 (2.9)*

Variable		n (%)
TOTAL REFERRALS		**N=10,100 (100)**
Referred because of diabetes	Yes	1728 (17.1)
	No	8083 (80.0)
	Missing	*289 (2.9)*
Referred because of respiratory condition	Yes	817 (8.1)
	No	8994 (89.0)
	Missing	*289 (2.9)*
Referred for mental health reasons	Yes	2109 (20.9)
	No	7702 (76.3)
	Missing	*289 (2.9)*
Referred because of old age	Yes	63 (0.6)
	No	9748 (96.5)
	Missing	*289 (2.9)*
Referred because of musculoskeletal / neurological	Yes	2866 (28.4)
Reasons	No	6945 (68.8)
	Missing	*289 (2.9)*
Referred by a general practice	Yes	7985 (79.1)
	No	1781 (17.6)
	Missing	*334 (3.3)*
	(Non-GP referrals 2115)	**N=7985 (100)**
Of those referred by general practice,	Yes	3359 (42.1)
referred by a training practice	No	4626 (57.9)
	Missing	*0 (0)*
Of those referred by general practice,	0-499 metres	2132 (26.7)
distance from referring general practice to nearest	500-999 metres	1777 (22.3)
participating ERS venue	1000-1499 metres	2319 (29.0)
Median distance: 1008 metres	1500-1999 metres	858 (10.8)
	2000 metres and over	899 (11.3)
	Missing	*0 (0)*
	(Non-starters 4135)	**N=5965 (100)**
Of those who took up ERS,	Yes	2093 (35.1)
completed ERS	No	3229 (54.1)
	Missing	*643 (10.8)*

Across all areas, out of all those referred to ERSs, 59.1% took up the scheme (attended the initial appointment), and 20.7% completed it (attended the final appointment).

People living in deprived circumstances were heavily represented in the Exercise Referral dataset, reflecting the overall constitution of the population in the PCT areas in which these ERSs were based (see Section 6.2). Over 60% of referred individuals lived in areas which were in the two most deprived IMD 2004 quintiles of deprivation in England.

Although ethnicity was recorded for less than half of referred individuals, Table 6.3 shows that there were a range of ethnic backgrounds represented within the dataset, a further reflection of the characteristics of the PCT populations from which ERS participants were drawn (Table 6.1). Over 20% of referred individuals in the research dataset were known to have either Asian/British Asian or Black/Black British ethnicities.

Referred individuals tended to be middle aged (median age 51 years, interquartile range 40-63 years) and the majority were female (65.3%). The clinical referral reasons were not mutually exclusive (a person could have more than one referral reason). A high proportion of people were referred for primary or secondary prevention of CVD (42.6%), and a sizable proportion referred for the other conditions; being overweight/obese (29.5%), musculoskeletal/neurological conditions (28.4%), mental health reasons (20.9%) and diabetes (17.1%). A minority of individuals were referred because of old age (0.6%) or because of respiratory conditions such as asthma or COPD (8.1%).

The majority of people were referred by a general practice onto the scheme (79.1%). Around half of the patients referred by this route were referred by a training general practice (42.1%). Approximately 16% of all General Practices across the 6 PCT areas were postgraduate training practices[334], so there appears to be disproportionately greater referral activity from these practices compared to non-training practices. In other words, around 1 in 6 general practices were training practices but nearly as many as 1 in 2 referrals were originating from such practices.

In general, both the patients home and the general practice which made the referral were situated in close proximity (under one mile, approximately 1500 metres) to a participating exercise venue (1052 metres was the median distance from the patient's home to the nearest ERS venue, and 1008 metres was the median distance from the referring general practice to nearest ERS venue).

In summary, there was modest uptake and low completion of ERS across the research dataset. Individuals living in deprived circumstances and from ethnic minority groups were heavily represented in the referrals to ERS. Referred individuals tended to be middle aged and the majority were female. The three commonest referral reasons were CVD prevention, obesity/overweight and musculoskeletal/neurological conditions. Referrals were predominantly made by general practices. Over 40% of patients

referred by this route were referred by a training general practice. Patients and general practices were mostly located relatively close to ERS venues.

6.3.3 Comparison to other studies

There have been a number of evaluations of ERSs across the UK (and also in Sweden and the US[279]) but all previous studies of ERSs have been limited to analyses of single schemes (Table 6.4). As outlined in Chapter 3, a 2003 systematic review of attendance at ERSs[160] identified that the characteristics of ERS participants were generally not well reported in previous studies, and tended to be limited to reporting of patients' age and sex[160]. A more recent systematic review of ERSs also highlighted this deficit in reporting[279]. Therefore, there is limited opportunity to compare the characteristics of referred patients in this research dataset to previous studies.

The characteristics of referred patients appear typical of the patients referred to other ERSs (where reported) in terms of; take up and completion rates, age, sex and the proportion of patients referred by general practices as opposed to other routes (Table 6.4). Consistent with previous studies, referred individuals tended to be middle aged and the majority were female. The proportion of patients taking up Exercise Referral was modest, and the proportion of patients completing Exercise Referral were low, but these were again consistent with previously reported participation levels for ERSs running in non-experimental contexts[160;279]. 79% of patients in the research dataset were referred from general practices, similar to the 72% of patients referred to the Somerset ERS through this route.

There were however several differences. Referred patients in this research were more deprived on average than referred patients in both the North West England scheme[231] and the Somerset scheme[232]. This reflects the fact that the PCT areas from which the ERS referrals were drawn for this research were on average more deprived than the English population (see section 6.2).

Whilst the proportion of patients referred for musculoskeletal conditions was consistent with previous accounts, there were differences in the proportions referred for CVD prevention and obesity. The discrepancy in referral for CVD prevention between this current study and the Somerset ERS[345], and between this study and the ERS in North West England[231] for obesity, may be explained by differences in data recording. The current research included all referral reasons as binary (yes/no) categories, whereas both of these previous studies only reported primary reason for referral[231;345]. It is likely

that a number of people referred primarily for obesity could also have been categorised as referred for CVD prevention, or vice versa. As only one reason was recorded in the Somerset and North West England ERS studies this may explain why a lower proportion of patients referred for CVD / obesity was reported respectively in these studies compared to this current research.

Table 6.4 Characteristics of referred patients compared to previous ERS studies

	This research	2006 ERS systematic review[160] 4 RCTs[146;148;283;354], 5 non-RCT evaluations[280;281;355-357]	2008 ERS systematic review[279;358] 6 RCTs[131;146;283;354;359;360], 11 non-RCT evaluations[97;280;281;356;357;361-366]	2005 ERS evaluation[$ 231]	2007 ERS evaluation[232;345]
Location	6 ERSs running in 6 PCTs in Greater London (analysis combined across the 6 areas)	2 health centres in Hailsham, Sussex[146] 12 GPs in Sheffield[283] 1 GP in Newcastle[148] 2 GPs in West London[354] ERS in Margate[281] ERS in Wirral[355] 2 ERSs in North West England (reported individually)[356] ERS in North Yorkshire[357] ERS in Stockport[280]	2 health centres in Hailsham, Sussex[146] 12 GPs in Sheffield[283] 2 GPs in West London[354] ERS in North West England[359] 1 GP in Reading[360] ERS in Barnet, London[131] ERS in Margate[281] 2 ERSs in North West England (reported individually)[356] ERS in North Yorkshire[357] ERS in Stockport[280] 2 GPs in Stockholm, Sweden[361] 14 GPs in North London[362] 2 GPs in Indianapolis, Indiana, US[363] 25 GPs in Sheffield[364] ERS in Glasgow[365] 2 ERSs in North West England (reported individually)[97] ERS in Scottish borders[366]	ERS in North West England[231]	ERS in Somerset[232;345]
Take up	59%	23-49% (RCTs) 43-79% (other evaluations)	26%-100%	79%	65%
Completion	21% of those referred, which is 35% of those who started programme.	12-56% (across all study types)	12-42%	N/R	31%
Mean age	51 years	Middle aged and older[146;148;281;354;356]	N/R	51 years	51 years
Females	65%	Around 60%[146;148;281;354;356]	N/R	60.8%	61.1%

	This research	2006 ERS systematic review[160] 4 RCTs[146;148;283;354], 5 non-RCT evaluations[280;281;355-357]	2008 ERS systematic review[279;358] 6 RCTs[131;146;283;354;359;360], 11 non-RCT evaluations[97;280;281;356;357;361-366]	2005 ERS evaluation[$ 231]	2007 ERS evaluation[232;345]
Referral reason:					
CVD prevention	43%	Referral reason poorly reported, weight reduction most common referral reason[355;356]	N/R	29.9%	16%
Overweight/obese	30%		N/R	10.4%	30%
Musculoskeletal	28%~		N/R	32.8%	26%
Referred by general practice	79%	N/R	N/R	100%	72%
Mean IMD 2004 score*	28.8	N/R	N/R	N/R	16.5
IMD 2004 quintile of referred patients**	IMD1 40.1% IMD2 24.5% IMD3 12.6% IMD4 9.5% IMD5 13.2% N=9592^	N/R	N/R	IMD1 21.9% IMD2 18.1% IMD3 23.3% IMD4 14.4% IMD5 22.3% n=5237^^	N/R
Ethnicity	17.3% white ethnicity	No previous research			
Distance:					
Home to nearest ERS venue	1052 metres (median)	No previous research			
GP to nearest ERS venue	1008 metres (median)	No previous research			
Of those referred by GP, referred by training practice	42.1%	No previous research			

N/R – not reported.

[$]Not included in 2008 review because this study only examined ERS uptake and adherence and the review was assessing outcomes from ERSs.

~current research also included neurological conditions in musculoskeletal category.

*higher score = more deprived. **IMD1 = 20% most deprived areas of England

^Of 10,100 referred patients, those with IMD recorded (n=9592). ^^data from table 4 in reference(8), patients referred with IMD and referral condition recorded (n=5237)

6.3.4 Generalisability

By conducting the research across six ERSs combined rather than restricting the analysis to a single ERS it can be argued that this research has more to offer in terms of generalisabilty than any previous empirical research into ERSs (all of which has been carried out on single schemes).

Overall the ERSs included in this research appeared typical of other ERSs running across the country in terms of; the age and sex distribution of referred patients, the levels of uptake and completion achieved by the ERS service, and the proportion of patients referred for certain conditions. This may mean the results can be generalised to other ERSs running in England.

This research only included schemes with relatively comprehensive routine data (Chapter 4), six out of a possible 30 schemes in Greater London were included. High quality data collection might have represented a high quality service in other respects, although this could not be verified in the research. Hence, the ERS sample in this research was perhaps biased towards higher quality ERSs. The findings of this research may only therefore be generalisable to other ERSs running across the country which conduct similarly high quality data collection.

The population served by the ERSs included in this sample was not representative of the English population overall, but the overall high levels of socioeconomic deprivation in the sample area made it a pertinent choice of location in which to conduct research on healthcare equity. The study population was drawn from a solely urban location which on the whole was more socioeconomically deprived and ethnically diverse than England overall (Section 6.2). The current research is likely therefore to be most generalisable to other ERSs serving socially diverse urban populations.

6.4 Objective 3 - Measuring the socioeconomic equality of referral to ERS

6.4.1 Comparison of referred patients and PCT populations

The objective here was to compare the socioeconomic characteristics of referred patients with the socioeconomic characteristics of their respective PCT populations. This analysis combined information from both the descriptive overview of the characteristics of the study area populations (presented in section 6.2) and the characteristics of patients referred to ERS within the research sample (presented in section 6.3).

Table 6.5 shows that in Area 1, Area 2, Area 4 and Area 6, there were disproportionately more referrals of individuals to ERSs living in more deprived circumstances relative to the distribution of deprivation found within the respective PCT areas (Chi-squared test $p \leq 0.01$).

Table 6.5 Percentage distribution of socioeconomic characteristics of people referred to ERS compared with their respective PCT population percentage distribution

	Area 1		Area2		Area 3		Area 4		Area 5		Area 6	
Variable	**ERS referrals**	**PCT population**	**ERS referrals**	**PCT population**	**ERS referrals**	**PCT population**	**ERS referrals**	**PCT population**	**ERS referrals**	**PCT population**	**ERS referrals**	**PCT population**
N	2074	340164	3013	299122	2069	247710	942	209322	990	217072	504	268120
IMD 2004*	p<0.001		p<0.001		p=0.90		p<0.001		p=0.11		P=0.011	
Quintile 1	16.9	12.5	8.2	5.6	76.9	77.0	90.0	80.8	53.3	50.0	56.0	50.1
Quintile 2	38.4	29.4	17.4	12.4	22.2	23.9	7.8	12.1	32.9	35.5	34.3	40.9
Quintile 3	26.8	26.9	15.9	16.0	0.6^	0	2.0	6.2	10.5	13.8	8.5	8.6
Quintile 4	9.1	14.4	23.0	25.0	0.2^	0	0.2	0.9	2.4	0.7	1.0	0.5
Quintile 5	8.8	16.9	35.6	41.0	0.1^	0	0	0	0.8^	0	0.2^	0

Quintile 1 refers to 20% most deprived lower-layer Super Output Areas (LSOAs) in England, quintile 5 refers to the 20% least deprived LSOAs.

PCT/Local authority population figures (coterminous with PCT) from 2001 census.

^The London PCT population statistics were based on residency, whereas the ERS dataset included all those referred to ERS by a general practitioner working within the PCT area. Therefore, these individuals must have attended a general practice in the PCT area but lived outside the area.

P-values for Chi-squared tests calculated on numbers in each group. In areas 3, 4 and 6 data from several quintiles were collapsed together to conduct the Chi-squared test to ensure the expected number in each cell was sufficient for the assumptions underlying the test to hold.

Figure 6.2 exemplifies how to interpret the concentration curve through a comparison of the same data presented in a disproportionality chart and a concentration curve. The concentration curves presented in Figure 6.3 and the associated concentration index's presented in Table 6.6 show the degree of socioeconomic inequality in referral to ERSs. In all areas the concentration curves were above the 45 degree line of equality and the concentration index were negative, indicating unequal referral with a disproportionate concentration of referrals to ERS amongst deprived groups. As outlined in section 6.2, several of the areas included in this research were predominantly deprived compared to England. This explains why, although there were five quintiles reflecting the deprivation experience across England, only two data points are visible for Area 3, and three data points visible for Areas 4, 5 and 6 (Figure 6.3). These areas contained no people from within the most advantaged quintiles in England, and hence 100% of the distribution of the population by deprivation was described by more deprived quintiles. In contrast, Areas 1 and 2 provided a spread of population across the deprivation quintiles.

The p-value from the T-test and confidence interval around the concentration index for Area 1 suggested that the inequality in referral across socioeconomic groups found in this area was statistically significant ($p<0.05$). The other concentration indexes, although all negative, were not statistically different to the line of equality. This was because the parameters were estimated based on grouped rather than individual level data, which resulted in far more conservative estimates of significance than would be achieved if the data had not been grouped into quintiles for the analysis (personal communication: Xander Koolman, Erasmus University Medical Centre Rotterdam, Netherlands). I only had access to population data by IMD 2004 grouped into quintiles, so it was not possible to obtain more sensitive parameter estimates based on individual-level data.

Table 6.6 Concentration index for each of the six participating areas

Area	Concentration index	Variance	Standard error	T-test	p-value for T-test	95% confidence interval
1	-0.175	0.003	0.053	-3.309	0.03	-0.32 to -0.03
2	-0.093	0.002	0.042	-2.190	0.09	-0.21 to 0.02
3	-0.006	<0.001	0.003	-1.722	0.33	-0.01 to 0.002
4	-0.095	0.007	0.085	-1.117	0.35	-0.24 to 0.06
5	-0.037	0.011	0.103	-0.362	0.74	-0.32 to 0.25
6	-0.051	0.002	0.044	-1.158	0.33	-0.17 to 0.07

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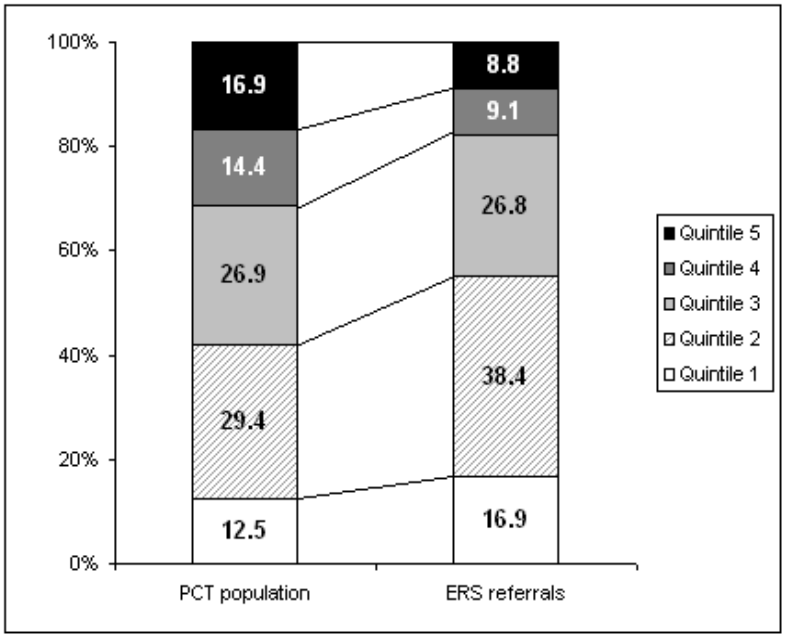
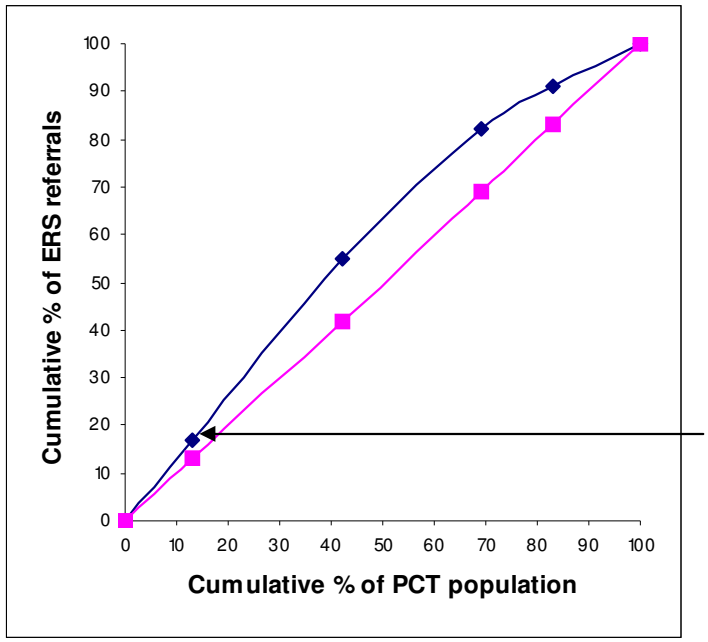
Figure 6.2 Comparison of ERS referrals and PCT population by IMD 2004 quintile for Area 1

(quintile 1 = 20% most deprived LSOAs in England)

Disproportionality chart for Area1



Concentration curve for Area1

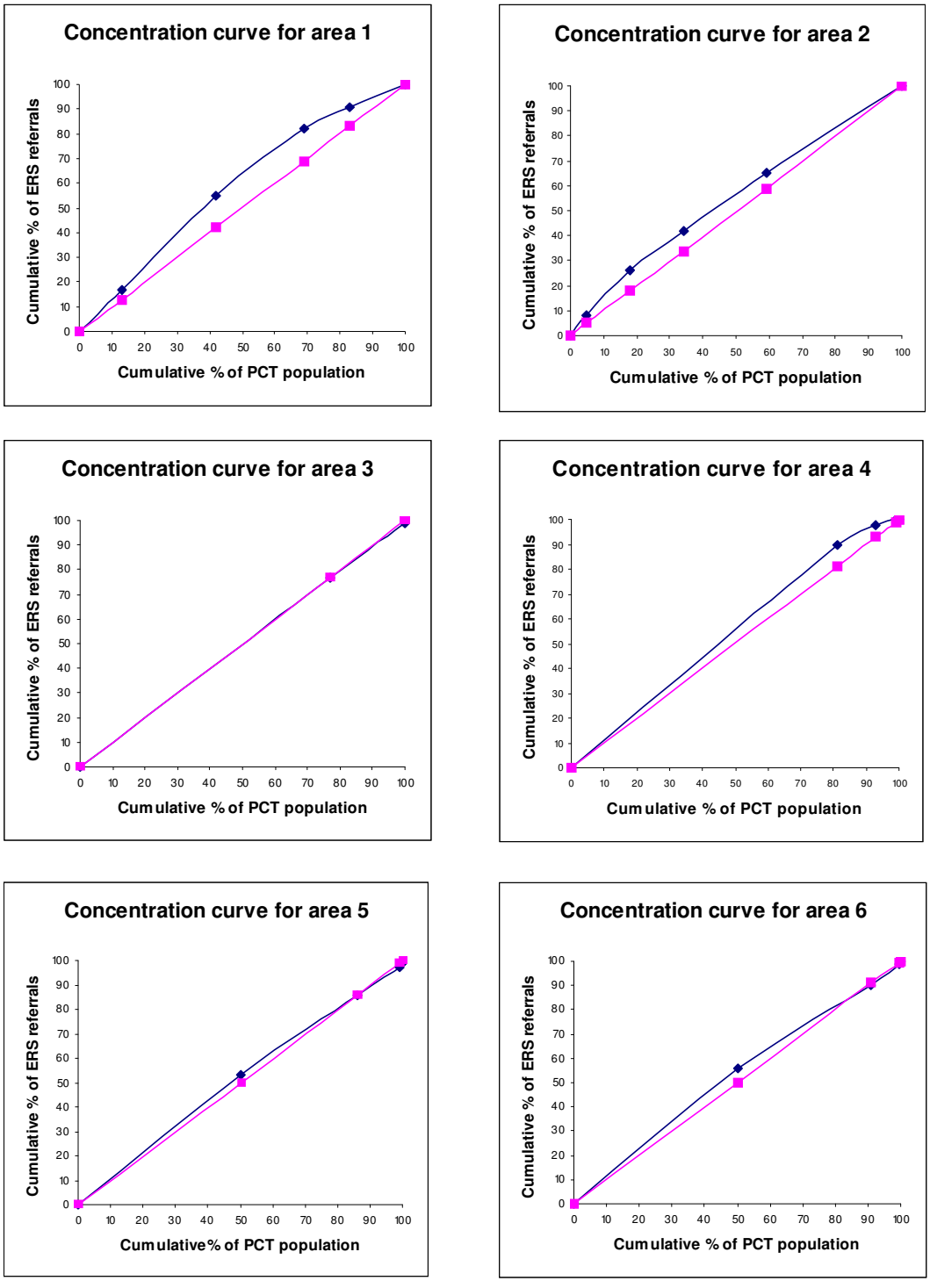


12.5% of the population lived in the most deprived quintile, whereas 16.9% of the patients referred to ERS were from this quintile.

Examining the convergence/divergence of lines joining the two bars together in the disproportionality chart indicated that in Area 1 the two most deprived quintiles (1 and 2) are over represented and the most advantaged quintiles (4 and 5) were under represented compared to their respective distributions within the population. This data translated into a concentration curve which lies above the line of equality, indicating a disproportionate concentration of referral to ERS amongst more deprived groups.

Figure 6.3 Concentration curves

(points = IMD 2004 quintiles of deprivation, ordered from most to least deprived, 0 through to 100%)



Interpretation

The finding of a greater proportion of referrals to ERS in deprived quintiles relative to the distribution across the PCT population was expected, given the greater need for Exercise Referral in more deprived groups within society. It cannot be ascertained from this analysis whether the extent of pro-deprivation bias reported was sufficient to compensate for the greater need for ERS found within deprived groups. Even with unequal referral in favour of patients from deprived groups this may still represent inequitable service access relative to need.

6.4.2 Comparison of demographic characteristics

I also compared the demographic characteristics (age, sex and ethnicity) of referred patients to their respective PCT populations. Table 6.7 shows that across all areas, a greater proportion of ERSs participants were in older age groups, (although there was under-representation of those aged 75 and over) compared to the proportionate age distribution in the respective PCT populations ($p<0.001$). A greater proportion of referrals were also females when compared to the sex distribution within the respective PCT populations ($p<0.001$).

There was a pattern across all scheme areas (most marked in Area 6) for the white ethnic group to have lower representation in referrals made to ERS, (when compared to the proportion of the total population in each respective PCT area with white ethnicity) and hence for ethnic minority groups to have greater representation. For example in Area 1, 70% of the PCT population was classified as belonging to the white ethnic group, whereas (for those with ethnicity recorded) only 53% of the referrals made to ERS in this area were people with white ethnicity. The divergence between the ethnic profile of the PCT population and of the referred patients was indicated by the strongly significant p-values for the Chi-squared tests presented in Table 6.7 ($p<0.001$).

6.4.3 Comparison to other studies

One previous study of a ERS in Somerset[232], compared the sociodemographic characteristics of referred patients with the characteristics of the area population. Consistent with the findings presented here, this study found that the proportion of referred patients that were female, from more deprived backgrounds (measured using the Townsend score), and from mid-old age was higher than their respective distributions within the county population[232]. Ethnicity was not examined.

Table 6.7 Percentage distribution of the demographic characteristics of people referred to ERS compared with their respective PCT population percentage distribution

	Area 1		Area2		Area 3		Area 4		Area 5		Area 6	
Variable	**ERS referrals**	**PCT population**	**ERS referrals**	**PCT population**	**ERS referrals**	**PCT population**	**ERS referrals**	**PCT population**	**ERS referrals**	**PCT population**	**ERS referrals**	**PCT population**
N	2132	258139	3084	236661	2059	180050	836	151215	1081	165154	377	220165
Age**	p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001	
16-34	17.3	34.2	14.8	29.6	16.4	45.3	22.1	51.7	12.6	46.4	12.5	47.9
35-49	30.8	29.4	27.5	27.5	39.9	27.5	38.5	23.3	23.3	25.0	35.3	27.2
50-64	30.1	19.9	34.5	21.9	32.1	15.1	28.7	12.9	26.1	15.9	32.4	13.4
65-79	20.2	12.1	21.7	15.2	11.1	9.1	10.3	9.6	25.6	9.5	19.1	8.6
80 and over	1.6	4.4	1.5	5.9	0.6	3.0	0.4	2.6	12.3	3.4	0.8	2.8
N	2106	330587	3112	295532	2072	243891	969	196106	843	198020	506	266169
Sex***	p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001	
Males	29.9	48.1	32.0	48.0	31.6	49.2	32.5	50.1	33.7	48.2	25.7	49.3
Females	70.1	51.9	68.0	52.0	68.4	50.9	67.5	49.9	66.3	51.8	74.3	50.7
N	1347	330587			1801	243891	820	196106			444	266169
Ethnicity***	p<0.001		Not recorded by ERS		p<0.001		p<0.001		Not recorded by ERS		p<0.001	
White	52.6	70.2			29.9	39.4	46.2	51.4			27.5	62.4
Mixed	3.0	3.7			0.7	3.8	2.1	2.5			6.3	4.8
Asian	8.9	11.3			40.3	32.5	41.5	36.6			4.1	4.6
Black	31.0	13.3			26.4	21.6	8.8	6.5			42.6	25.8
Other	4.5	1.5			2.8	3.1	1.5	3.0			19.6	2.5

Referred individuals with missing information for given socio-demographic characteristic are not presented.

Local authority population figures (coterminous with PCT) from 2001 census (**aged 16 and over, ***all ages).

Chapter 7

Examining socioeconomic differences in referral to and use of Exercise Referral Schemes

Chapter 7. Examining socioeconomic differences in referral to and use of ERSs

7.1 Introduction

National guidance emphasises the importance of ensuring that ERSs are delivered equitably and explicitly states that schemes should employ strategies to target and engage people from disadvantaged groups (Chapter 3, Section 3.6.1)[17]. There is higher eligibility for ERSs among more deprived socioeconomic groups because these groups suffer from more of the conditions[25] for which ERS is indicated and are less likely to engage in leisure-time physical activity[24;26] than those living in less deprived circumstances. Known barriers to participating in physical activity such as lack of money, access to transport and the provision of leisure facilities are socioeconomically patterned (Chapter 3, Section 3.8). Although people from deprived groups attend primary care more frequently than those from more advantaged socioeconomic groups,[18] (which accords with their greater need for care), they are less likely to use preventative[19] and specialist[20-22] health services (Chapter 3, Section 3.6.2). The observation that those in most need of health care are often the least well served in terms of receipt of such care is termed the 'inverse care law' (Chapter 3, Section 3.6.2)[23].

Chapter 6 has demonstrated that there was unequal referral to ERSs; higher proportions of referred patients than of the respective total PCT populations were found to be from the most deprived quintiles. It is not known whether the extent of this disproportionate referral of deprived patients was enough to match the greater eligibility for Exercise Referral within deprived groups, and hence whether the *unequal* service provision was representing *equitable* service provision or not. This chapter presents the findings of analysis undertaken to examine the equity of ERS access and use across socioeconomic groups, taking into account differential eligibility for Exercise Referral (a proxy for need) across the population. The analysis also controlled for confounding and took account of the clustering of referrals within general practices. The research presented in this chapter is published in the British Journal of General Practice[367].

7.2 Aim and objectives

The aim of this research was to examine the association of socioeconomic circumstance with referral to and use of Exercise Referral Schemes (ERSs). There were three objectives:

(i) To examine the association between the socioeconomic circumstance of the area within which a general practice was located and the likelihood of referring patients to ERSs.

(ii) To examine the association between patients' socioeconomic circumstance and the likelihood of attending the initial ERS appointment (uptake of the service).

(iii) To examine the association between patients' socioeconomic circumstance and the likelihood of attending the final ERS appointment (completing the service).

7.3 Hypotheses

Given evidence of the inverse care law operating with respect to preventive and specialist health services, and previous concern raised over the ability of ERSs to reach groups most in need, the hypotheses for this research were as follows:

Referral

General practices in more deprived localities will be less likely to refer eligible patients to ERSs than those situated in more socioeconomically advantaged localities.

Uptake

Patient's living in more deprived localities will be less likely to take up ERSs than those living in more socioeconomically advantaged localities.

Completion

Patient's living in more deprived localities will be less likely to complete ERSs than those living in more socioeconomically advantaged localities.

A detailed explanation of the mechanisms through which socioeconomic circumstance may influence ERS access and use to support these hypotheses was provided in Chapter 3. The study design and statistical methods for this research were covered in Chapter 5.

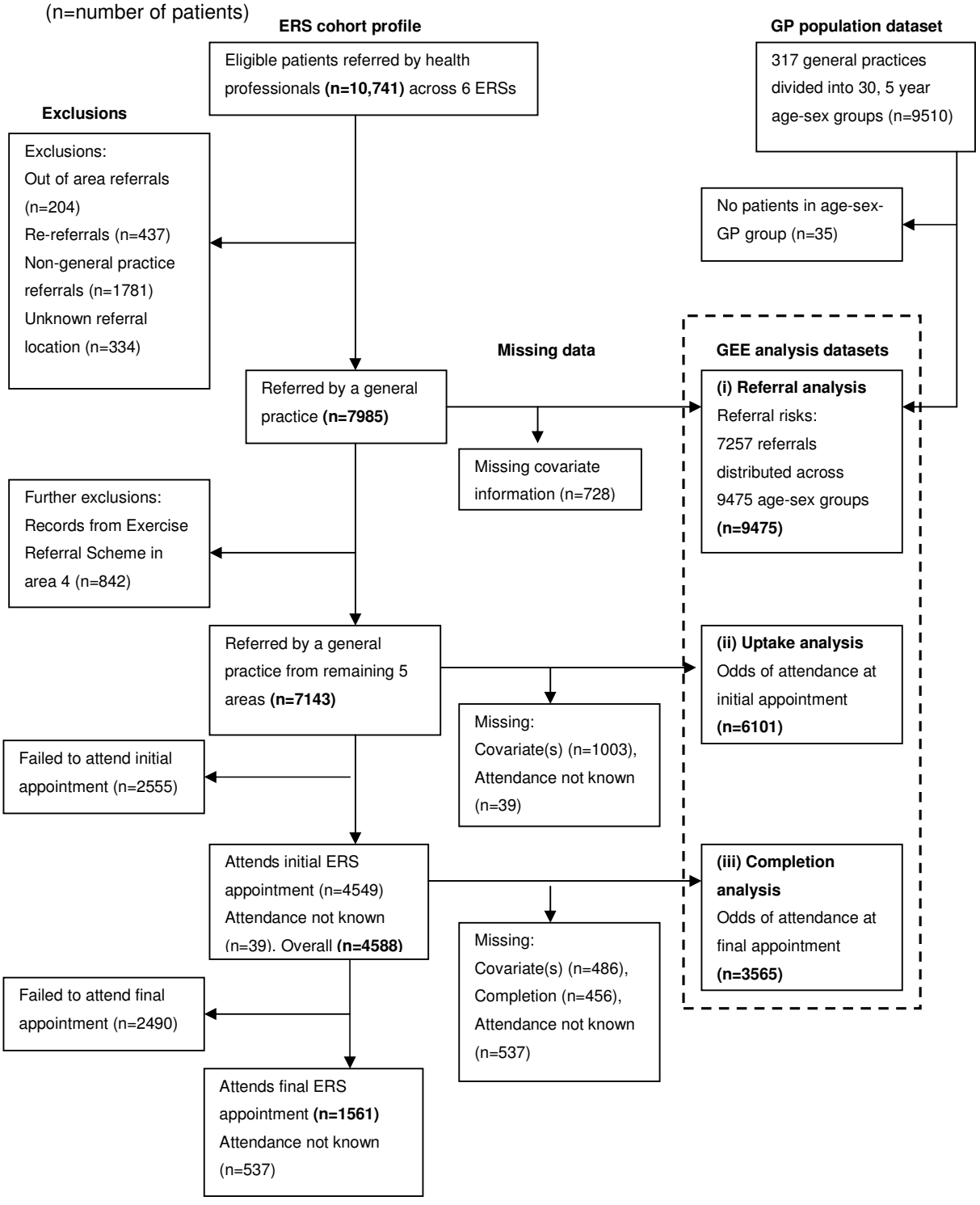
7.4 Results

7.4.1 Analysis sample

All 317 general practices from the six PCT areas were included in the analysis of referral to ERSs (Figure 7.1). After excluding Area 4, 6101 referred patients from the five schemes running in the remaining PCTs which reliably monitored scheme activity were included in the uptake analysis (Figure 7.1). 3565 patients from these five schemes who took up the service and had a record of completion status were included in the completion analysis (Figure 7.1).

Figure 7.1 Flow diagram illustrating reasons for exclusion of patients from the analysis and numbers of patients examined

(n=number of patients)



7.4.2 Descriptive and unadjusted analysis

Descriptive overview

A description of referred patients was provided in Chapter 6. Referral rates to the scheme were low. There were on average 6 patients referred for every 1000 patients on the general practice register (aged 16 years and over) across all 317 general practices included in this research. Using the denominator of *eligible* rather than *all* patients aged 16 years and over, there were on average 18 patients referred for every 1000 eligible patients.

Table 7.1 illustrates that the proportion of referred patients (with complete data collection for all fields N=6101, see Figure 7.1) who took up ERSs was broadly consistent across the schemes (between 63-69%). By contrast there were wide variations across schemes in the proportion of patients who completed the scheme, ranging from only 15% in Area 6 to 82% in Area 5. Across deprivation quintiles the proportions taking up ERSs were fairly consistent, between 64-68%. There was a gradient in completion across deprivation quintiles; 53.7% of patients completed the ERS in the most deprived quintile in contrast to only 21.4% of patients in the least deprived quintile. Proportions of patients who took up and completed ERSs increased with increasing age group. Around 50% of patients aged 16-30 years who were referred took up the service, and of those who took up the service 26.8% completed. The proportion of patients aged 75 and over who took up and completed the service were higher (71.3% and 51.8% respectively). A higher proportion of females than males attended the initial ERS appointment (67.3% compared to 61.2%), but the proportion of patients completing ERSs were similar for both sexes.

Slightly lower proportions of patients living further away from a participating exercise venue (or were referred from a general practice located further away from a venue) completed ERSs compared to those situated closer to exercise venues (Table 7.1). The proportion of patients taking up ERSs ranged from 60.2% of those referred for mental health reasons through to 71.0% of those referred for musculoskeletal/neurological problems. The proportions completing were notably higher for those referred due to old age (80.0%) although the numbers referred for this reason were comparatively small. The proportion completing was lowest for those referred because of being overweight/obese (28.2%). Similar proportions of people from training and non-training general practices took up and completed the ERSs.

A proportion breakdown of referred patients by IMD 2004 quintile and each of the additional analysis covariates is presented in Appendix J. The distribution of patients by age, sex, ethnicity, scheme area, reasons for referral, training status and distance from home/general practice to nearest participating ERS venue were all significantly different across IMD 2004 quintiles (Chi-squared test $p \leq 0.01$ for all covariates). This confirmed that the additional covariates identified *a priori* might indeed have been confounders in the association between socioeconomic circumstance and scheme access and use and so it was important to include these in the multivariate models.

Table 7.1 Distribution of patients (i) referred, (ii) taking up and (iii) completing ERS by analysis covariates

	(i) Patients referred to ERS with no missing take up or covariate information (N=6101) n	(ii) Patients who take up ERS (N=3998) n(%)	Patients who take up ERS with no missing completion or covariate information (N=3565) n	(iii) Patients who complete ERS (N=1404) n(%)
IMD quintile*				
1 (most deprived)	2335	1500 (64.2)	1422	764 (53.7)
2	1595	1052 (66.0)	881	339 (38.5)
3	786	514 (65.4)	395	102 (25.8)
4	575	384 (66.8)	348	88 (25.3)
5 (least deprived)	810	548 (67.7)	519	111 (21.4)
Age group (years)				
16-29	556	274 (49.3)	231	62 (26.8)
30-44	1624	996 (61.3)	866	297 (34.3)
45-59	2110	1414 (67.0)	1277	510 (39.9)
60-74	1550	1128 (72.8)	1027	450 (43.8)
75 and over	261	186 (71.3)	164	85 (51.8)
Sex				
Males	1778	1088 (61.2)	993	397 (40.0)
Females	4323	2910 (67.3)	2572	1007 (39.2)
Scheme area				
Area 1	1433	938 (65.5)	509	145 (28.5)
Area 2	1969	1319 (67.0)	1319	234 (17.7)
Area 3	1901	1194 (62.8)	1194	732 (61.3)
Area 5	464	321 (69.2)	317	260 (82.0)
Area 6	334	226 (67.7)	226	33 (14.6)
Distance in metres from GP to nearest ERS venue (metres)				
0-499	1520	982 (64.6)	821	366 (44.6)
500-999	1205	784 (65.1)	731	299 (40.9)
1000-1499	1889	1268 (67.1)	1165	495 (42.5)
1500-1999	731	460 (62.9)	411	133 (32.4)
2000 and over	756	504 (66.7)	437	111 (25.4)
Referred by a training practice				
No	3737	2450 (65.5)	2224	883 (39.7)
Yes	2364	1548 (65.5)	1341	521 (38.9)
Distance in metres from home to nearest ERS venue (metres)				
0-499	1031	669 (64.9)	569	261 (45.9)
500-999	1725	1116 (64.7)	1002	439 (43.8)
1000-1499	1554	1025 (66.0)	943	393 (41.7)
1500-1999	1007	651 (64.7)	581	174 (30.0)
2000 and over	784	537 (68.5)	470	137 (29.2)

	(i) Patients referred to ERS with no missing take up or covariate information (N=6101) n	(ii) Patients who take up ERS (N=3998) n(%)	Patients who take up ERS with no missing completion or covariate information (N=3565) n	(iii) Patients who complete ERS (N=1404) n(%)
Referred for CVD prevention				
No	3399	2207 (64.9)	1973	666 (33.8)
Yes	2702	1791 (66.3)	1592	738 (46.4)
Referred because overweight / obese				
No	4275	2799 (65.5)	2653	1147 (43.2)
Yes	1826	1199 (65.7)	912	257 (28.2)
Referred because of diabetes				
No	5023	3306 (65.8)	2967	1119 (37.7)
Yes	1078	692 (64.2)	598	285 (47.7)
Referred for respiratory reasons				
No	5607	3666 (65.4)	3269	1269 (38.8)
Yes	494	332 (67.2)	296	135 (45.6)
Referred for mental health reasons				
No	4890	3269 (66.9)	2931	1177 (40.2)
Yes	1211	729 (60.2)	634	227 (35.8)
Referred for old age				
No	6071	3977 (65.5)	3545	1388 (39.2)
Yes	30	21 (70.0)	20	16 (80.0)
Referred for musculoskeletal / neurological problems				
No	4562	2906 (63.7)	2610	1076 (41.2)
Yes	1539	1092 (71.0)	955	328 (34.4)

*For referral this is IMD quintile of general practice, for uptake and completion this is IMD quintile of patient's home.

The unadjusted association between IMD 2004 and referral, uptake and completion of ERSs

The analysis presented in Table 7.2 is clustered by general practice but unadjusted for the potential confounding effects of other variables. Differential eligibility for Exercise Referral by age, sex and socioeconomic circumstance had been taken into account because the denominator for the referral analysis was those eligible for Exercise Referral (see Chapter 5). IMD 2004 quintile was associated with referral and completion but not uptake of ERSs in the preliminary analysis. The association between IMD quintile and referral was inconsistent and there was a non-linear trend across quintiles (p=0.028, trend p=0.25). Univariate analysis suggested IMD 2004 was not statistically significantly associated with the likelihood of taking up ERSs (p=0.68, trend p=0.15). In contrast, there was a significant relationship between odds of completion and deprivation quintile (p=0.009, trend=0.002). For every quintile increase in IMD, moving from the most to least deprived quintile, the likelihood of completing the service decreased by around 10% (OR 0.90, 95% CI 0.84-0.96). Those in the most

affluent quintile were a third less likely to complete than those in the most deprived (OR 0.67, 95% CI: 0.52-0.86).

The unadjusted association between other covariates and referral, uptake and completion of ERSs

Age was strongly related to referral, uptake and completion of ERSs in the unadjusted analyses. Referral rates amongst eligible patients aged 75 and over were the lowest of any group (RR 0.36, 95% CI: 0.24-0.55) but otherwise referral increased with age. Age had a consistent positive relationship with both uptake and completion (OR 1.02, 95% CI: 1.01-1.02, for every increasing year of age, for both analyses).

Eligible females patients were over twice as likely as males to be referred to ERSs (RR 2.30, 95% CI: 2.14-2.46) in the unadjusted analysis. Females were also around 30% more likely to take up the intervention (OR 1.29, 95% CI: 1.15-1.44). However, sex was not associated with likelihood of completing ERSs (OR 1.02, 95% CI: 0.88-1.19).

The six PCT areas varied considerably in their likelihood of referring patients to ERSs, and in the likelihood of patient's completing the ERS programme (Table 2). For example, eligible patients in Area 6 had much lower odds of being referred to ERS than those in Area 1 (RR 0.18, 95% CI 0.13-0.27). The odds of completion in Area 5 were over 11 times those of patients in Area 1 (OR 11.68, 95% CI: 7.85-11.39).

The unadjusted analyses indicated for every 100 metre increase in distance from general practice to ERS venue, the likelihood of eligible patients being referred increased fractionally (RR 1.01, 95% CI: 1.00-1.02), as did likelihood of patients taking up the ERS referral (OR 1.01, 95% CI: 1.00-1.02). In contrast, the likelihood of completing the scheme decreased slightly with every 100 metre increase in distance from the general practice to nearest ERS venue (OR 0.97, 95% CI: 0.96-0.99).

There was no evidence of an association between distance from the patients' home to ERS venue and odds of taking up or completing ERSs (see Table 7.2). Furthermore, there was no evidence of an association between training status of the general practice and likelihood of referral, uptake or completion of ERSs in the preliminary analysis (Table 7.2).

The seven clinical reasons for referral were tested to examine their independent influence on likelihood of both taking up and completing ERS. Patients referred for musculoskeletal/neurological conditions were more likely to take up ERSs and patients

referred because of old age or due to CVD prevention were more likely to complete. In contrast, those referred for being overweight/obese were less likely to complete, and those referred for mental health reasons were less like to both take up and complete the scheme than those not referred for this reason (Table 7.2).

Table 7.2 Unadjusted analysis – independent models showing relationship between each exposure variable and (i)referral, (ii)uptake, and (iii)completion of ERS

	(i) Risk ratios for referral to ERS			(ii) Odds ratios for take up of ERS			(iii) Odds ratios for completion of ERS		
Exposure variable	**n (N=9475)**	**Risk Ratio**	**95% CI**	**n (N=6101)**	**Odds Ratio**	**95% CI**	**n (N=3565)**	**Odds Ratio**	**95% CI**
IMD quintile~	**(p=0.028)**	**Trend (p=0.25)**		**(p=0.68)**	**Trend (p=0.15)**		**(p=0.009)**	**Trend (p=0.002)**	
1 (most deprived – baseline)	4415	1		2335	1		1422	1	
2	2364	0.69	0.46-1.03	1595	1.06	0.92-1.22	881	0.80	0.67-0.96
3	1286	1.09	0.79-1.51	786	1.04	0.85-1.28	395	0.69	0.54-0.88
4	420	1.58	1.05-2.38	575	1.11	0.88-1.41	348	0.80	0.58-1.09
5 (least deprived)	990	1.07	0.79-1.45	810	1.20	0.94-1.52	519	0.67	0.52-0.86
Trend - for each quintile increase in IMD 2004	9475	1.05	0.97-1.14	6101	1.04	0.99-1.10	3565	0.90	0.84-0.96
Age group	**(p<0.001)**			**(p<0.001)**	**Trend (p<0.001)**		**(p<0.001)**	**Trend (p<0.001)**	
16-29 years (baseline)	1902	1		556	1		231	1	
30-44 years	1902	2.05	1.79-2.36	1624	1.66	1.33-2.06	866	1.21	0.97-1.52
45-59 years	1902	2.64	2.25-3.09	2110	2.10	1.69-2.60	1277	1.52	1.19-1.94
60-74 years	1899	2.20	1.84-2.62	1550	2.67	2.16-3.30	1027	2.18	1.68-2.83
75 years and over	1870	0.36	0.24-0.55	261	2.49	1.77-3.51	164	2.14	1.48-3.09
Trend – for each year increase in age	NT**			6101	1.02	1.01-1.02	3565	1.02	1.01-1.02
Sex	**(p<0.001)**			**(p<0.001)**			**(p=0.757)**		
Males (baseline)	4737	1		1778	1		993	1	
Females	4738	2.30	2.14-2.46	4323	1.29	1.15-1.44	2572	1.02	0.88-1.19
Scheme area	**(p<0.001)**			**(p=0.179)**			**(p<0.001)**		
Area 1 (baseline)	2002	1		1433	1		509	1	
Area 2	1590	1.40	1.01-1.93	1969	1.12	0.90-1.39	1310	0.53	0.41-0.69
Area 3	1938	1.34	0.97-1.84	1901	0.91	0.76-1.09	1194	3.96	3.07-5.11
Area 4	1196	0.65	0.44-0.95	NI*			NI*		
Area 5	1279	0.31	0.19-0.50	464	1.19	0.92-1.55	317	11.68	7.85-17.39
Area 6	1470	0.18	0.13-0.27	334	1.13	0.84-1.52	226	0.42	0.28-0.64
Distance in metres from GP to nearest ERS venue	**(p=0.045)**			**(p=0.090)**			**(p=0.013)**		
Trend – for each 100 metre increase in distance	9475	1.01	1.00-1.02	6101	1.01	1.00-1.02	3565	0.97	0.96-0.99
Referred by a training practice	**(p=0.128)**			**(p=0.62)**			**(p=0.418)**		
No (baseline)	7105	1		3737	1		2224	1	
Yes	2370	1.24	0.94-1.63	2364	0.96	0.82-1.13	1341	0.86	0.61-1.23
Distance in metres from home to nearest ERS venue	NT**			**(p=0.20)**			**(p=0.25)**		
Trend – for each 100 metre increase in distance				6101	1.01	1.00-1.01	3565	0.99	0.99-1.00

(continues)

	(i) Risk ratios for referral to ERS			(ii) Odds ratios for take up of ERS			(iii) Odds ratios for completion of ERS		
Exposure variable	**n (N=9475)**	**Risk Ratio**	**95% CI**	**n (N=6101)**	**Odds Ratio**	**95% CI**	**n (N=3565)**	**Odds Ratio**	**95% CI**
Referred for CVD prevention	NT**			**(p=0.189)**			**(p<0.001)**		
No (baseline)				3399	1		1973	1	
Yes				2702	1.08	0.96-1.21	1592	1.29	1.13-1.47
Referred because overweight / obese	NT**			**(p=0.644)**			**(p<0.001)**		
No (baseline)				4274	1		2653	1	
Yes				1826	0.97	0.86-1.10	912	0.72	0.62-0.83
Referred because of diabetes	NT**			**(p=0.604)**			**(p=0.828)**		
No (baseline)				5023	1		2967	1	
Yes				1078	0.96	0.83-1.11	598	0.98	0.83-1.16
Referred for respiratory reasons	NT**			**(p=0.469)**			**(p=0.706)**		
No (baseline)				5607	1		3269	1	
Yes				494	1.09	0.86-1.37	296	0.95	0.73-1.24
Referred for mental health reasons	NT**			**(p<0.001)**			**(p=0.025)**		
No (baseline)				4890	1		2931	1	
Yes				1211	0.75	0.66-0.86	634	0.83	0.71-0.98
Referred for old age	NT**			**(p=0.742)**			**(p=0.017)**		
No (baseline)				6071	1		3545	1	
Yes				30	1.12	0.58-2.15	20	1.99	1.13-3.51
Referred for musculoskeletal/neurological problems	NT**			**(p<0.001)**			**(p=0.938)**		
No (baseline)				4562	1		2610	1	
Yes				1539	1.36	1.17-1.58	955	0.99	0.87-1.14

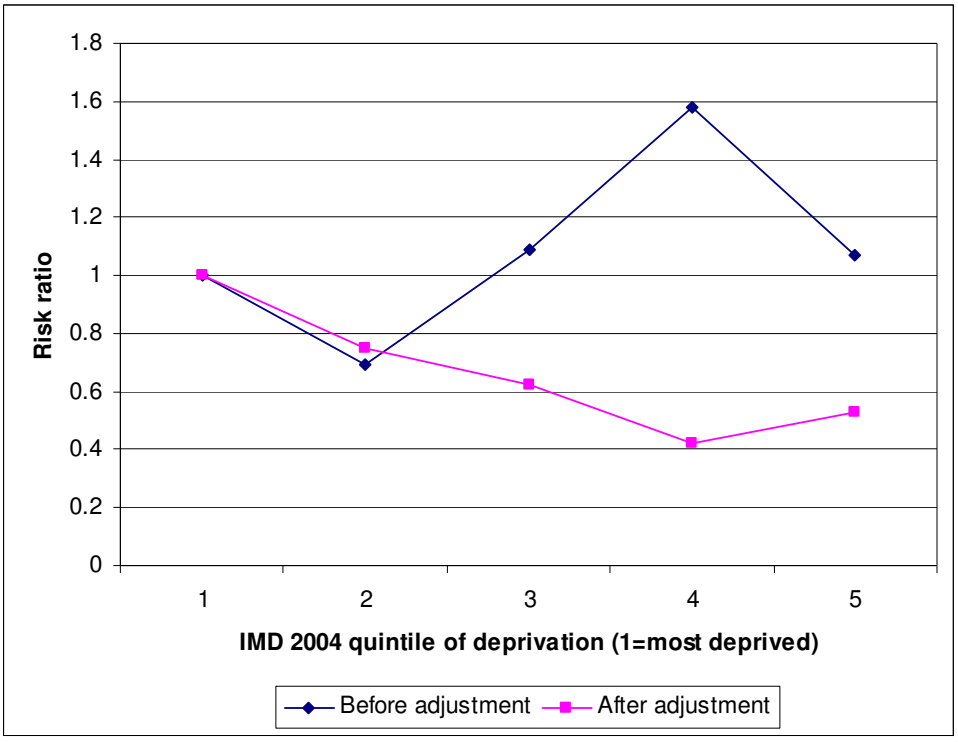
~model (i) – IMD quintile of general practice, models (ii) & (iii) – IMD quintile of patient's home.
*Not included (NI): Area 4 data excluded from uptake and completion analyses. **Not tested (NT): These variables were unavailable for the referral analysis.

7.4.3 Adjusted analysis

The adjusted association between IMD and referral, uptake and completion of ERSs

After accounting for variations in ERS eligibility and controlling for factors found to be associated with referral (age group, sex, scheme area) there was a socioeconomic gradient in referral risk across General Practices (Table 7.3). Details of the multi-variate GEE model are provided in Appendix H. General Practices serving more deprived communities were more likely to refer eligible patients to ERSs compared to those serving less deprived communities (adjusted trend p=0.001). For every one unit increase in IMD quintile (going from most to least deprived quintile) the likelihood of referral reduced by approximately 15%, adjusted risk ratio 0.84 (95% CI: 0.76-0.93). Practices located in the most socioeconomically advantaged areas were half as likely to refer eligible patients to ERSs compared to those situated in the most deprived areas (risk ratio 0.53, 95% CI: 0.37-0.76). The change in parameter values for IMD 2004 after adjustment (Figure 7.2) was attributable mainly to the influence of scheme area. It was only after adjusting for scheme did the pro-deprivation gradient in referral emerge. This was likely to be because Area 2 had a high risk of referral and mainly contained practices serving more socioeconomically advantaged communities, and Area 5 had a low risk of referral and mainly contained practices serving more deprived communities.

Figure 7.2 Risk ratios for referral to ERSs before and after adjusting for the confounding effects of age group, sex and scheme area



After controlling for factors found to be associated with uptake (age group, sex, being referred for musculoskeletal/neurological conditions) there was no evidence of an association between likelihood of taking up ERSs and the socioeconomic circumstance of referred patients (adjusted p=0.85, adjusted test for trend p=0.89). This finding was consistent with the unadjusted analysis (Table 7.3).

After controlling for factors found to be associated with completion (age group, scheme area, being referred for prevention of cardiovascular disease and/or diabetes, and the training status of general practice) there was no evidence of an association with patient between likelihood of completing ERSs and the socioeconomic circumstance (adjusted test for trend p=0.20) (Table 7.3). This finding was not consistent with the univariate analysis which had indicated a linear association between IMD 2004 quintile and completion of ERS. The difference in findings from the univariate and multivariate analysis highlights the importance of carrying out adjusted analysis, as again scheme area was an important confounder in the association. In the adjusted analysis, those in the second and third most deprived quintiles had slightly lower odds of completion than the baseline (most deprived) quintile, and those in the two most affluent quintiles (4 and 5) had higher odds of completion than the most deprived quintile (Table 7.3). However, no statistically significant association was observed overall (adjusted p=0.06), and no linear gradient in completion was observed (adjusted test for trend p=0.20).

The adjusted association of other covariates with referral, uptake and completion of ERSs

In the adjusted analysis the likelihood of being referred, taking up and completing ERSs increased as age increased, peaking for those aged 60-74 years. Females were more likely to be referred and take up ERSs, but there was no evidence of an association between sex and likelihood of completing the scheme (Table 7.3). The six PCT areas varied considerably in their likelihood of referring patients to ERSs, and in the likelihood of patient's completing the ERS programme. Patients in Area 2 had the highest likelihood of referral but the lowest likelihood of completing the scheme. In contrast, patients in Area 5 had the lowest likelihood of referral but the highest likelihood of completing the scheme (Table 7.3). The association between scheme and referral was strengthened for Areas 2 and 5 in the adjusted analysis. Similarly, in the completion analysis, all of the scheme parameters were further from 1.0 in the adjusted compared to the unadjusted models.

In terms of clinical referral conditions;

- Patients referred for musculoskeletal/neurological reasons were more likely to take up ERSs,
- Patients referred for CVD prevention were more likely to complete ERSs,
- Patients referred for diabetes were less likely to complete ERS.

Distance from either home or referring general practice to the nearest ERS venue were not found to be associated with either referral, uptake or completion of ERS. The training status of the referring general practice was not found to be associated with either referral or uptake, but there was a weak negative association with likelihood of scheme completion ($p=0.05$). This weak association was not found in the unadjusted analysis. A consequence of including a large number of covariates in the multivariate analysis was that the probability of obtaining a statistically significant p-value just by chance increased with the number of tests performed. The weak association between training status and completion does not have any strong theoretical justification, and may therefore be a chance finding.

Table 7.3 Final multivariate models showing the fully adjusted association between IMD 2004 and (i) referral (ii) uptake and (iii) completion of ERS*

	(i) Risk ratios for referral to ERS			(ii) Odds ratios for take up of ERS			(iii) Odds ratios for completion of ERS		
Exposure variable	**n (N=9475)**	**Risk ratio**	**95% CI**	**n (N=6101)**	**Odds ratio**	**95% CI**	**n (N=3565)**	**Odds ratio**	**95% CI**
IMD quintile~	**(p=0.004)**	**Trend (p=0.001)**		**(p=0.85)**	**Trend (p=0.89)**		**(p=0.060)**	**Trend (p=0.20)**	
1 (most deprived)	4415	1		2335	1		1422	1	
2	2364	0.75	0.53-1.05	1595	1.05	0.93-1.21	881	0.89	0.71-1.11
3	1286	0.62	0.40-0.95	786	0.94	0.77-1.15	395	0.92	0.63-1.34
4	420	0.42	0.24-0.72	575	0.99	0.78-1.25	348	1.47	0.96-2.24
5 (least deprived)	990	0.53	0.37-0.76	810	1.05	0.83-1.33	519	1.23	0.84-1.79
Trend - for each quintile increase in IMD 2004	9475	0.84	0.76-0.93	6101	1.00	0.95-1.06	3565	1.06	0.97-1.17
Age group	**(p<0.001)**			**(p<0.001)**			**(p<0.001)**		
16-29 years	1902	1		556	1		231	1	
30-44 years	1902	2.30	2.01-2.62	1624	1.67	1.34-2.08	866	1.30	0.96-1.77
45-59 years	1902	2.79	2.39-3.26	2110	2.09	1.68-2.61	1277	1.77	1.27-2.46
60-74 years	1899	2.21	1.87-2.63	1550	2.67	2.14-3.33	1027	2.91	2.04-4.16
75 years and over	1870	0.34	0.25-0.48	261	2.43	1.70-3.46	164	2.71	1.65-4.46
Sex	**(p<0.001)**			**(p<0.001)**			NFM^		
Males	4737	1		1778	1				
Females	4738	2.74	2.52-2.96	4323	1.33	1.18-1.49			
Scheme area	**(p<0.001)**			NFM^			**(p<0.001)**		
Area 1	2002	1					509	1	
Area 2	1590	2.18	1.57-3.02				1319	0.43	0.32-0.58
Area 3	1938	1.16	0.81-1.64				1194	4.45	3.28-6.03
Area 4	1196	0.68	0.45-1.03				NI***		
Area 5	1279	0.06	0.01-0.42				317	13.49	8.78-20.72
Area 6	1470	0.19	0.13-0.28				226	0.45	0.29-0.70
Referred for musculoskeletal / neurological reasons	NT**			**(p=0.036)**			NFM^		
No				4562	1				
Yes				1539	1.18	1.01-1.38			
Referred for diabetes	NT**			NFM^			**(p=0.007)**		
No							2967	1	
Yes							598	0.76	0.63-0.93

(continues)

	(i) Risk ratios for referral to ERS			(ii) Odds ratios for take up of ERS			(iii) Odds ratios for completion of ERS		
Exposure variable	**n (N=9475)**	**Risk ratio**	**95% CI**	**n (N=6101)**	**Odds ratio**	**95% CI**	**n (N=3565)**	**Odds ratio**	**95% CI**
Referred for primary or secondary CVD prevention	NT**			NFM^			**(p=0.020)**		
No							1973	1	
Yes							1592	1.22	1.03-1.45
Training general practice	NFM^			NFM^			**(p=0.048)**		
No							2224	1	
Yes							1341	0.81	0.65-1.00

*Other factors associated with outcome ($p \leq 0.05$) and which are therefore included in the final model also reported. ~ model (i) - IMD quintile of general practice, models (ii) & (iii) - IMD quintile of patient's home. **Not tested (NT): These variables were unavailable for the referral analysis. ***Not included (NI): Area 4 data excluded from analysis. ^Not in final model (NFM): variables did not improve fit of the model, as were found to be unassociated with the outcome of interest and therefore were not retained in the model.

7.4.4 Additional sensitivity analyses

7.4.4.1 Denominator for referral risk

The purpose of using synthetic estimates of ERS eligibility in the referral analysis was to adjust for differential 'need' for ERSs across socio-deomographic groups (age, sex and socioeconomic circumstance). Table 7.4 displays the results of two analyses:

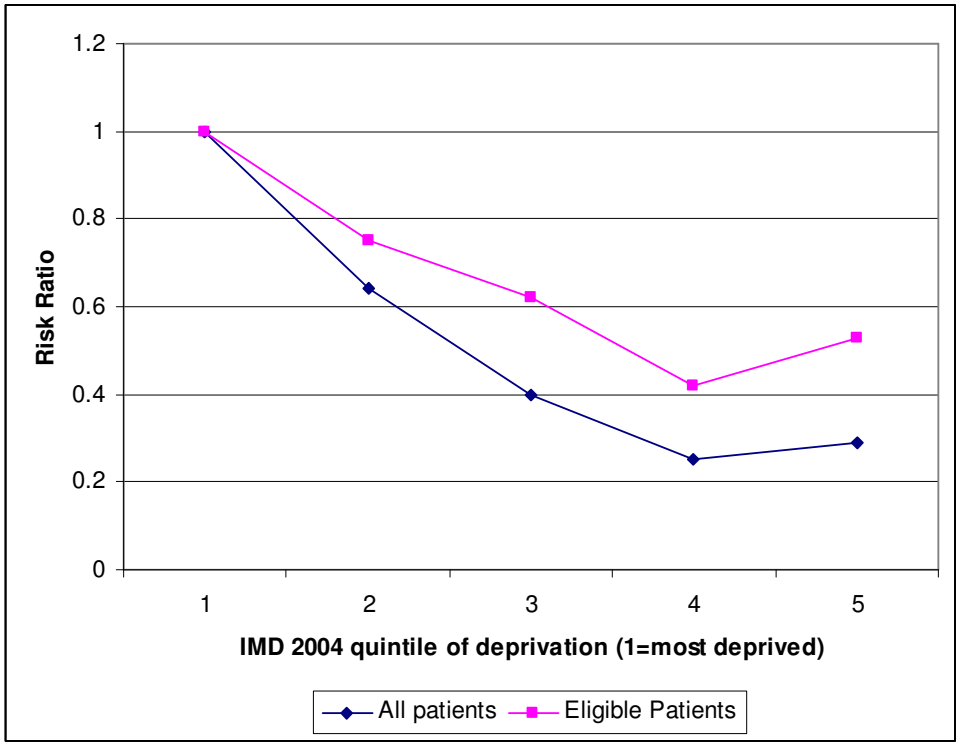
a) The denominator for the referral risks was all eligible patients i.e. the analysis was adjusted for differential 'need' for ERSs across the population (a repeat of the results presented in Table 7.3 from the main analysis).

b) The denominator for the referral risks was all patients i.e. the analysis has not been adjusted for differential 'need' for ERSs across the population. This was a sensitivity analysis.

In analysis (b) the same covariates were found to be associated with risk of referral to ERS scheme as were found in the main analysis. With respect to IMD 2004, the direction of the relationship was consistent across both analyses; general practices situated in more deprived locations were more likely to refer to ERSs than those situated in more advantaged circumstances (Figure 7.3). However, the gradient was more extreme in analysis (b) where the denominator had not been adjusted for need; for every one unit increase in IMD quintile (going from most to least deprived quintile) the risk of referral reduced by approximately 30% (adjusted RR 0.72; 95% CI: 0.64-0.80).

Age had a consistent pattern of association across both analyses, with the exception of those aged 75 and over. The analysis unadjusted for need (b) showed that this age group had elevated referral risks compared to those aged 16-29 years, whereas (a) demonstrated that when eligibility (a proxy for need for ERS) had been factored into the analysis, patients aged 75 and over were less than half as likely to be referred as those in the youngest age group (Table 7.4).

Figure 7.3 Comparison of risk ratios* for referral to ERSs calculated using different denominators



*adjusted for age, sex and scheme area

Table 7.4 Referral risk ratios (fully adjusted) calculated for (a) eligible patients (b) all patients

		(a) Referral Risk Denominator: patients eligible for ERS		(b) Referral Risk Denominator: all patients	
Exposure variable	**n (N=9475)**	**Risk Ratio**	**95% CI**	**Risk Ratio**	**95% CI**
IMD quintile		**(p=0.004) Trend (p=0.001)**		**(p<0.001) Trend (p<0.001)**	
1 (most deprived – baseline)	4415	1		1	
2	2364	0.75	0.53-1.05	0.64	0.47-0.87
3	1286	0.62	0.40-0.95	0.40	0.27-0.60
4	420	0.42	0.24-0.72	0.25	0.15-0.42
5 (least deprived)	990	0.53	0.37-0.76	0.29	0.20-0.41
Trend - for each quintile increase in IMD 2004	9475	0.84	0.76-0.93	0.72	0.64-0.80
Age group		**(p<0.001)**		**(p<0.001)**	
16-29 years	1902	1		1	
30-44 years	1902	2.30	2.01-2.62	2.80	2.48-3.15
45-59 years	1902	2.79	2.39-3.26	5.73	4.97-6.61
60-74 years	1899	2.21	1.87-2.63	6.80	5.84-7.93
75 years and over	1870	0.34	0.25-0.48	1.72	1.29-2.29
Sex		**(p<0.001)**		**(p<0.001)**	
Males (baseline)	4737	1		1	
Females	4738	2.74	2.52-2.96	2.68	2.49-2.88
Scheme area		**(p<0.001)**		**(p<0.001)**	
Area 1 (baseline)	2002	1		1	
Area 2	1590	2.18	1.57-3.02	2.21	1.62-3.03
Area 3	1938	1.16	0.81-1.64	1.13	0.82-1.58
Area 4	1196	0.68	0.45-1.03	0.66	0.45-0.97
Area 5	1279	0.06	0.01-0.42	0.10	0.03-0.30
Area 6	1470	0.19	0.13-0.28	0.18	0.12-0.27

7.4.4.2 Missing data

Missing information about attendance at initial ERS appointment

39 individuals (0.5% of all patients referred by general practices) had missing information on attendance at the initial ERS appointment (uptake of ERS) and were excluded from the GEE uptake analysis for this reason. Data missing completely at random was an assumption underlying the GEE analysis method, however I found this assumption did not hold with respect to a number of analysis covariates in the ERS dataset (Appendix K). Patients with missing take-up information were more likely to be from a more deprived IMD 2004 background, be older and to have been referred either due to mental health reasons, or due to old age. Patients with missing take up information were less likely to be referred for CVD primary or secondary prevention.

The final GEE uptake model was repeated including those variables that were found to be associated with missing uptake information that were not already included in the final model (Table 7.5). None of the additional variables altered the odds ratios or p-values reported in main analysis.

Table 7.5 Multivariate analysis of take up of ERSs repeated to include variables found to be associated with missing take up information*

		Main analysis		Further adjusted analysis including additional variables found to be associated with missing take up information*	
Exposure variable	**n (N=6101)**	**Odds ratio**	**95% CI**	**Odds ratio**	**95% CI**
IMD quintile		**(p=0.85)**		**(p=0.85)**	
1 (most deprived)	2335	1		1	
2	1595	1.05	0.93-1.21	1.05	0.91-1.21
3	786	0.94	0.77-1.15	0.94	0.77-1.15
4	575	0.99	0.78-1.25	0.99	0.78-1.25
5 (least deprived)	810	1.05	0.83-1.33	1.05	0.83-1.33

*Being referred for CVD primary or secondary prevention, for a mental health condition or due to old age were all associated with missing information about take up of ERSs. The other covariates included in the final GEE model were also included here (i.e. age group, sex and referred for musculoskeletal/neurological conditions)

Missing information about attendance at final ERS appointment

537 individuals had missing information on attendance at the final ERS appointment (completion) and were excluded from the GEE completion analysis for this reason. The data missing completely at random assumption appeared to hold in the main with respect to missing completion information (Appendix K). Only one covariate, being referred for mental health appeared to be significantly associated with missing completion information in the multivariate sensitivity analysis; those with missing information about scheme completion were around 20% more likely to have been referred because of a mental health condition (p=0.05, Appendix K).

The final GEE completion model was repeated to include the mental health variable, so the analysis was also fully adjusted for any variables found to be associated with missing outcome data. The introduction of the mental health variable (for which missing completion information was non-randomly distributed) did not alter the substantive results of the main analysis (Table 7.6).

Table 7.6 Multivariate analysis repeated to include variable found to be associated with missing completion information*

		Main analysis		Further adjusted analysis including additional variable found to be associated with missing completion information*	
Exposure variable	**n (N=3565)**	**Odds ratio**	**95% CI**	**Odds ratio**	**95% CI**
IMD quintile		**(p=0.060)**		**(p=0.061)**	
1 (most deprived)	1422	1		1	
2	881	0.89	0.71-1.11	0.89	0.72-1.11
3	395	0.92	0.63-1.34	0.92	0.63-1.34
4	348	1.47	0.96-2.24	1.47	0.96-2.24
5 (least deprived)	519	1.23	0.84-1.79	1.23	0.84-1.79

*Being referred because of a mental health condition was found to be associated with missing information on completion. The other covariates included in the final GEE model were also included here (i.e. age group, scheme areas, referred for diabetes, referred for CVD prevention, training status of general practice.

Missing exposure of interest (IMD 2004 quintile)

Multivariate analysis adjusted for clustering at the general practice level was undertaken to establish whether missing exposure information (IMD 2004 quintile) was missing at random or instead distributed systematically within the sample population with respect to the other analysis covariates. Those who took up the ERS intervention were around 30% less likely to have missing information about IMD 2004 quintile than those who did not take up the intervention (adjusted OR 0.69, 95% CI: 0.56-0.85) (Appendix K).

7.4.4.3 Ethnicity

Sensitivity analysis of a sub-group of the study population established that the lack of an association between IMD 2004 and odds of taking up Exercise Referral remained when ethnicity was removed from the multivariate analysis. This suggests that, although ethnicity was an independent risk factor for uptake (p<0.001, see Table 7.7), it did not appear to be operating as a confounder in the relationship between IMD 2004 quintile and take up of ERSs.

Ethnicity did not appear to be an independent risk factor for completion (p=0.22, see Table 7.7), nor was it confounding any association between IMD 2004 and completion of ERS. I ascertained this because removing ethnicity from the multivariate analysis did not alter the relationship between IMD quintile and likelihood of completing ERS.

Given that ethnicity did not appear to be operating as a confounder, in either the uptake or completion analyses, the fact that this variable had to be omitted from the main analysis may not be a major concern.

Table 7.7 Multivariate analysis showing the adjusted association between IMD 2004 and uptake and completion of ERS with the ethnicity covariate included

	Odds ratios for take up of ERS[a]			Odds ratios for completion of ERS[b]		
Exposure variable	**n (N=2810)**	**Odds ratio**	**95% CI**	**n (N=1715)**	**Odds ratio**	**95% CI**
IMD quintile	**(p=0.74)**			**(p=0.054)**	**Trend (p=0.98)**	
1 (most deprived)	1564	1		992	1	
2	823	0.96	0.78-1.20	491	0.76	0.58-0.99
3	265	0.79	0.38-1.65	141	0.93	0.56-1.53
4	84	2.91	0.47-18.26	48	1.71	0.87-3.36
5 (least deprived)	74	0.90	0.28-2.94	43	1.04	0.45-2.41
Trend - for each quintile increase in IMD 2004				1715	1.00	0.84-1.19
Ethnicity	**(p<0.001)**			**(p=0.22)***		
White	1029	1		608	1	
Mixed	53	1.52	0.56-4.09	33	1.06	0.46-2.47
Asian/British Asian	750	1.02	0.81-1.29	439	0.89	0.66-1.19
Black/Black British	870	1.73	1.29-2.32	576	1.21	0.93-1.58
Chinese/Other	108	0.54	0.32-0.92	59	0.92	0.46-1.84

a - analysis also adjusted for age, sex, scheme area, referred for musculoskeletal/neurological reasons. All of these covariates were significantly associated with uptake of ERSs in the multivariate sub-group analysis.

b - analysis also adjusted for age, sex, scheme area, referred for diabetes. All of these covariates were significantly associated with completion of ERSs in the multivariate sub-group analysis.

^Not in final model (NFM): variables did not improve fit of the model, as were found to be un-associated with the outcome of interest and therefore were not retained in the model.

*Although ethnicity was not found to be significantly associated with completion of ERS, I have retained this covariate in the multivariate model, because the purpose of this sensitivity analysis was to explore the influence of ethnicity in relation to the outcome and exposure of interest.

7.4.4.4 Alternative referral routes

1781 patients were excluded from the main analysis because they were not referred by a general practice (Figure 7.1). Re-introducing these individuals to the analysis dataset (N=8446), a comparison of individuals referred/not referred by a general practice was carried out using multivariate logistic regression to establish whether those referred by general practices tended to come from an atypical spectrum of socioeconomic circumstance.

Those in the least deprived quintile were over 70% more likely to have been referred by a non-general practice route, compared to those from the most deprived quintile (adjusted OR 1.76, 95% CI: 1.39-2.22). There was a linear gradient across IMD quintiles; for every one quintile increase in IMD (moving from most to least deprived) the odds of being referred by an alternative non-general practice route increased (adjusted OR 1.15, 95% CI: 1.09-1.21).

Table 7.8 Odds ratios* for being referred to ERSs via a non-general practice route

		Likelihood of being referred by non-general practice route	
Exposure variable	**n (N=8446)****	**Odds Ratio**	**95% CI**
IMD quintile		**(p<0.001) Trend (p<0.001)**	
1 (most deprived – baseline)	3372	1	
2	2040	1.23	1.04-1.51
3	1066	1.52	1.22-1.89
4	810	1.69	1.32-2.15
5 (least deprived)	1158	1.76	1.39-2.22
Trend - for each quintile increase in IMD 2004	8446	1.15	1.09-1.21

*analysis adjusted for age, sex and scheme area all of which were significantly related to likelihood of being referred by non-general practice route $p \leq 0.05$ and hence retained in the final multivariate logistic regression model.

**N is individuals referred by general practice and non-general practice routes, excluding re-referrals (n=437) and records with missing data for any of the analysis covariates (n=1858).

7.5 Discussion

7.5.1 Main findings

General practices within areas of deprivation were more likely to refer to ERSs than their counterparts in more socioeconomically advantaged areas. This was the case after accounting for the greater levels of eligibility for ERSs present within deprived communities and controlling for the effects of age, sex and scheme area. These findings suggest that, contrary to the *a priori* hypothesis, ERSs do not comply with the inverse care law[23]. Once given access to the system, there was no evidence of an association between patient socioeconomic circumstance and likelihood of either taking up or completing the scheme in the adjusted analysis. These finding are again at odds with the *a priori* hypotheses that patients living in more deprived localities would be less likely to both take up and to complete ERSs than those living in more socioeconomically advantaged localities.

It is important to consider the strengths and limitations of this research before reaching a conclusion about the equity of the service, because the results may be attributable to statistical artifact, bias or residual confounding.

7.5.2 Methodological considerations

There were four main strengths of this research. Firstly, the cross-scheme analysis enabled a wide range of potential confounders to be examined. Secondly, the use of GEEs enabled clustering of referrals within general practices to be taken into account. Thirdly, the analysis examined equity across the whole ERS pathway from referral through to completion. Fourthly, the analysis accounted for differential eligibility for ERS across the population.

The constraints placed upon this research by inadequacies in routine ERS data (see Chapter 4) resulted in several limitations. The measurement of certain dimensions in the analysis (scheme participation, geographic access and reason for referral) could have been improved with more comprehensive and precise information. There was some missing data which may have resulted in selection bias. It was not possible to control for the effect of a potentially important confounder (ethnicity), or to fully account for patient need for Exercise Referral, in the referral analysis.

Finally, both the potential problem of ecological fallacy (owing to the use an area-based measure of deprivation (IMD 2004) as a proxy indicator for patient socioeconomic circumstance), and the exclusion of patients referred to ERSs through non-general practice routes, must be considered when interpreting the research findings.

These strengths and limitations are now discussed in detail.

7.5.2.1 Strengths

Cross-scheme analysis

No previous research has explicitly examined the equity of ERS provision. In contrast to all previous empirical research into ERSs which has focused on single schemes, this research examined six ERSs across Greater London in a combined analysis. It was unfortunate that the cross-scheme analysis was limited to including only six of the possible 30 ERSs established across Greater London due to inadequate routine data in the other areas (Chapter 4). Nevertheless, the resulting sample size of referred patients from the six areas meant there was sufficient power to include in the analysis a wide range of variables which I considered *a priori* could be related to socioeconomic circumstance and to access to, and use of, ERSs, and hence might have confounded any relationship between socioeconomic circumstance and service access and use. These included several variables which have not been examined at all before in relation to ERS access and use (distance from home/general practice to nearest participating ERS venue, the training status of the general practice and ethnicity of referred patients). The combined analysis also meant that it was possible to include scheme area as a fixed effect in the analysis to identify any differences across schemes in the likelihood of patients being referred, taking up and completing the programme. As Chapter 4 explained, there was considerable variability between schemes in terms of their design and delivery and indeed 'scheme' was found to be an important confounder in the relationship between socioeconomic circumstance and referral to, and completion of, the programme.

Controlling for clustering

This analysis used Generalised Estimating Equations to take account of clustering of referrals within general practices. This technique has not been applied in any previous examinations of ERSs. Accounting for clustering widens the confidence intervals for estimates to allow for the greater sampling variability of clustered over unclustered data. This in turn reduced the chance of false positive findings (i.e. Type 1 error, suggesting there is a significant association between an exposure and outcome when

in fact there is not). Hence, the robust statistical techniques employed strengthen the confidence with which the findings can be interpreted as demonstrating a true rather than an artefactual association between socioeconomic circumstance and ERS access and use.

Analysis across the ERS pathway

This research is the first to examine factors associated with the likelihood of referral to ERSs, enabling the association between socioeconomic circumstance and service access and use to be examined across the whole ERS pathway (referral, uptake and completion). Referral risks were generated at the general practice level by combining grouped information on patients referred to ERSs with population data from general practices. It would have been valuable to have examined the association between socioeconomic circumstance and likelihood of referral at the patient level as well but this was impractical (Chapter 5, Section 5.9.2.1).

Analysis adjusted for eligibility

An innovative approach to quantify eligibility for Exercise Referral across general practice populations was applied in order to control for the different levels of clinical need for the ERS intervention across the population. This was a strength of the research because it is necessary to take account of need for a service across the population to assess equity. The synthetic estimation technique used to derive eligibility had not been applied previously in ERS research, and therefore it was important to check the accuracy of the estimates created. The results of the sensitivity analysis undertaken using the crude denominator (total adult population, see section 7.5.4.1) were consistent with the referral analysis adjusted for eligibility, suggesting the estimations of eligibility for Exercise Referral were appropriate. As expected, the gradient in referral likelihood across socioeconomic quintiles was stronger in the sensitivity analysis based on total population rather than 'eligible' patients only. General practices serving deprived populations should have higher referral rates to the service to account for higher need for the service within their practice populations. The fact that this gradient remained (but was shallower) in the main analysis (which adjusted for differential eligibility across socioeconomic groups) indicated that variations in referral risks across socioeconomic groups could not be explained purely by differences in eligibility (a proxy for need) for the service.

7.5.2.2 Limitations

Measurement

With more comprehensive or precise data I could have improved the measurement of the following dimensions in the analysis.

Firstly, there was potential misclassification in the seven binary 'reason for referral' covariates for patients from the schemes running in Areas 2 and 5. Because no secondary reason for referral was recorded in these instances, patients may have been misclassified to not having a given referral reason when in fact they did have the condition (i.e. it was simply not recorded by the ERS, see Chapter 5). The resulting measurement bias would, if anything, have diluted any effect of referral reason on use of the service, which may explain why few reasons for referral appeared to be significantly associated with scheme take up or completion.

Secondly, as outlined in Chapter 5, straight-line distances from home/general practices to nearest ERS venue will have provided only a crude indicator of geographic accessibility. Furthermore, physical proximity is only one aspect of accessibility. No relationship was found between distance from either home or referring general practice to the nearest ERS venue and likelihood of referral, uptake or completion of ERSs in the adjusted analyses. This is most likely explained by the fact that all schemes were running in urban areas, and all schemes offered at least four exercise venues (Chapter 4). As a result, distances between home/general practice to participating venues were generally low (62% of referred individuals lived within a mile of an ERS venue and 78% of referring general practices were located within a mile of an ERS venue, see Chapter 6) suggesting good geographic accessibility of ERS venues for all patients. However, the lack of an association between the distance variables and scheme access and use may alternatively be due to inadequately capturing this dimension within the analysis because straight-line distances will underestimate actual distance travelled. If road rather than straight-line distances had been considered the results may have been different.

Thirdly, I used attendance at initial and final assessments because these were the only markers of participation that were available for all of the six areas. When interpreting the results I am therefore making the implicit assumption that all those who 'dropped out' between the first and final assessments can be grouped together, and all those who completed the scheme attended regularly and had equal levels of adherence[160]. In terms of health outcomes, it may be the total number or frequency of sessions,

rather than attendance at given points, which was most important, and so it would have been preferable to analyse these measures of scheme participation as well if they had been available.

Ethnicity information

The inclusion of ethnicity at all in this research is a strength given it has not been considered before in ERS research. Nevertheless, the association between ethnicity and service uptake and completion could only be examined for a sub-group of the sample. Reassuringly the sub-group analysis indicated that ethnicity was not an important confounder in the relationship between socioeconomic circumstance and uptake or completion of ERSs. However, ethnicity may have been an important confounder in the referral analysis but I could not examine this because general practice population data subdivided by age, sex and ethnicity together was not available. General practitioners may have been more likely to refer patients from certain ethnic minority groups owing to the higher prevalence of certain clinical conditions for which Exercise Referral is indicated within these groups (for example higher prevalence of Coronary Heart Disease in Asian groups[368]). As Chapter 6 outlines, ethnic minority groups had greater representation in terms of ERS referrals when compared to the respective distributions of these groups within the local populations. Those from ethnic minority groups are more likely to live in deprived areas[184] and so ethnicity may have confounded the relationship found between ERS referral and socioeconomic circumstance.

Missing data

There was a high level of data completeness for the analysis covariates (Chapter 6, Table 6.3) and so the extent of any selection bias resulting from excluding patients due to missing information was likely to have been minimal. The high level of data completeness was in part due to the thorough process of data cleaning and reformatting and also due to relatively comprehensive data collection carried out by the six ERSs. Although relatively small numbers, if missing data were not missing at random but were systematically distributed within the dataset this could nevertheless have biased the results. However, sensitivity analysis undertaken for outcome data not missing at random using GEE[346] did not alter the substantive results for the association between socioeconomic circumstance and uptake or completion, and so any bias in missing data, did not seem to be adversely influencing the associations of interest. Missing information on IMD 2004 was not found to be distributed at random with respect to patient attendance at the first ERS appointment (Appendix K). This was a potential source of selection bias. However, owing to the small proportion of patients

missing IMD 2004 data overall (5% of all referrals, Chapter 6, Table 6.3) any bias resulting from this was likely to be minor.

As outlined in Chapter 4 (Figure 4.2) paper flows were generally paper based and so there was the potential for some information to be lost in transit. Any bias resulting from lost referral forms in the post was likely to be random with respect to the exposure of interest (deprivation status of the patient), but may have been systematic with respect to one of the outcomes of interest (take up of the intervention) as people who were more likely to take up the intervention might reasonable have been more likely to chase the status of their referral and to obtain a re-referral to replace the missing form. This might have artificially inflated up take rates overall. However, the extent of missing data due to loss in transit is likely to be low.

Inadequate controlling for need in the referral analysis

This analysis took account of *eligibility* for Exercise Referral because it was not possible to examine referral, uptake and completion having taken account of *clinical need* for the scheme. Eligibility is only a proxy for patient need for ERSs and does not take account of, for example, differences in the ability to benefit from ERSs across socioeconomic groups in the population. A comprehensive assessment of need for Exercise Referral depends upon evidence of the effectiveness of the intervention (i.e. the ability to benefit) for different conditions and risk factors. As Chapter 2 explains, NICE guidance has recently highlighted the lack of such evidence and recommended that commissioners should only endorse schemes that are part of controlled studies to determine effectiveness[33;35]. Such research requires the collection of standard data on health outcomes. I was unable to examine associations between socioeconomic circumstance and health outcomes because of the heterogeneity of outcome measures currently collected by schemes (Chapter 4). This was coupled with poor reliability amongst some ERSs in their recording of patients' post-intervention health status (Chapter 4). Because eligibility was only a proxy for need it was likely that the analysis did not fully account for differences in need for ERSs across socioeconomic groups. This might explain why a deprivation-gradient in referral risk to ERSs was observed in the multivariate analysis.

Issues for interpretation

The relationship between socioeconomic circumstance and likelihood of referral to ERSs was studied using an area-based measure of socioeconomic circumstance for each general practice (based on postcode of general practice), which was taken as a

proxy for the deprivation experience for the population served by that practice (see Chapter 3)[229].

Uptake and completion were examined at the patient-level using an area-level indicator of deprivation because individual-level data on patients' socioeconomic circumstance (such as employment or educational attainment) was not recorded by the ERSs.

Findings from analyses based on area-measures of deprivation are often used to make inferences about the types of individuals accessing and using services. A major limitation with using an area-based measure of deprivation as a proxy for individual level socioeconomic circumstance, however, is the potential for misclassification[217;369;370]. Misclassifying an individual's level of deprivation on the basis of their area of residence (for example, labeling an individual as deprived because they live in an area which is classified overall as deprived, but in fact they themselves are advantaged) is frequently referred to as the problem of ecological fallacy[226-228]. If individuals do not conform to the socioeconomic profile of their residential area, or if the location of the general practice does not accurately reflect the profile of registered patients there may be over or under-estimation of the effect being examined[217].

Using a measure of socioeconomic circumstance derived from the location of the general practice has been shown to result in a weaker effect size for associations found between socioeconomic circumstance and mortality, when compared to using a measure based on individual-level patient data[229]. Hence there is likely to be non-differential misclassification of deprivation in the referral analysis resulting from using the location of the general practice as a proxy for the deprivation experience of the practice population[229]. The significant gradient in referral risk across deprivation quintile reported in this research may therefore, if anything, be an underestimate of the true relationship between patient socioeconomic circumstance and likelihood of referral to ERSs.

When conducting analysis based on area-level data it is not possible to confirm that, for example, ERSs are being accessed and used by deprived individuals within deprived areas. To minimise the divergence between individual and area characteristics the smallest area level (the LSOA) for which IMD 2004 is available was selected for the analysis. Nevertheless, even within a population of this size, there maybe considerable population heterogeneity and hence the problem of misclassification may be substantial.

A further issue I considered when interpreting the results of this research was that patients referred by non-general practice routes were excluded from the analysis. The sensitivity analysis presented in Section 7.5.4.4 found that patients residing in more advantaged socioeconomic locations were more likely to be referred to ERSs via non-general practice routes. It may be the case that people from different socioeconomic backgrounds have different access pathways to ERSs. Hence, practices serving more socioeconomically advantaged areas did not need to refer patients, because these patients were being referred by other means. However, the proportion of total referrals from general practices was far greater than the proportion of referrals from non-general practice routes (approximately 80% of all referrals came from general practices). Therefore, the socioeconomic bias in referrals made through the general practice route, was likely to outweigh any counteracting bias in referrals from non-general practice routes of those from more advantaged socioeconomic circumstances.

7.5.3 Comparison to other studies

As outlined in Chapter 3, previous research in this area is scarce[160] and has produced conflicting results. The two previous observational studies which examined factors association with participation in ERSs running as part of routine service delivery[231;232] were both conducted on single schemes, did not consider the breath of confounders included in this analysis and did not adjust for clustering of referrals within general practices.

In common with this research, the study conducted in North-West England found that, after adjusting for age and sex, patient deprivation status had no influence on the odds of attending the first ERS appointment[231] and both the Hailsham RCT[146] and the study of the scheme in rural Somerset (analysis adjusted for age, sex and rurality)[232] found that deprived patients were just as likely to complete the scheme as their more advantaged counterparts.

In contrast to the results presented here, deprived patients in Somerset were less likely to take up their initial ERS appointment[232], and the London study found patients who cited lack of money as a barrier to exercise had one quarter the odds of completing the ERS programme than those who did not perceive lack of money as a barrier[29]. Lacking money to exercise maybe viewed as a proxy indicator of material deprivation.

7.5.4 Explanation of results

The pro-deprivation gradient found in referral to ERSs might reflect that the service was accessible to deprived patients in line with ERS policy[17]. Instead, all or part of the pro-deprivation gradient in referral might be explained by; firstly, inadequate controlling for patient need for ERSs in the analysis, secondly, the presence of some residual confounding because ethnicity could not be controlled for in the analysis and, thirdly, because socioeconomically advantaged individuals were accessing the service via non-general practice routes. This latter explanation would not fully account for the findings given the lower volume of referrals from non-general practice routes overall.

None of the limitations outlined in section 7.5.4.2 suggest an artefactual explanation for the apparent lack of association between patient socioeconomic circumstance and both uptake and completion of ERSs found in this analysis. Hence, it is likely that use of ERSs was irrespective of the socioeconomic circumstances of patients.

However, ecological fallacy remains as an inherent limitation to the interpretation of all three analyses (referral, uptake and completion) because they have all used an area-based measure of deprivation. To investigate the extent of the problem of ecological fallacy, Chapter 8 describes research undertaken to enhance the understanding of socioeconomic inequalities in service utilisation at small-area level using a geodemographic segmentation tool (ACORN).

Chapter 8

The validity and added value of using ACORN as a measure of socioeconomic circumstance

Chapter 8. The validity and added value of ACORN

8.1 Introduction

8.1.1 Small area measurement of deprivation

Area-based measures of deprivation are used, for three main reasons. Firstly because an individual's health can be influenced by the socioeconomic characteristics of the neighbourhood in which he or she lives, above and beyond his or her own individual-level socioeconomic circumstance (for example crime or pollution levels in an area)[217-221]. There is ongoing debate as to the relative importance of individual (composition) and place (context) characteristics, and also around how valid it is to view these as mutually exclusive phenomena[136;226;371]. When both area and individual measures of deprivation are available, multi-level statistical modeling techniques can be used to tease apart the relative influence of area and individual level factors, although these must be used with caution to ensure robust and theoretically-grounded analyses are conducted[372]. Secondly, area-based measures are invaluable in service planning for prioritizing resource allocation and providing geographically targeted services to areas of greater need overall[9;373]. For example, government initiatives such as Sure Start[143] and Health Trainers[100] have been initially implemented in deprived localities. As Field et al. explain[374] pg. 294:

"The ability to identify and measure spatial variations in need, access and provision, and determine their effect on utilization is therefore vital to help inform the decisions of individual service providers and to help plan a national service that reduces inequalities in health outcome."

Thirdly, area measures can be used as proxies for individual level indicators of socioeconomic circumstance, when individual measures are unavailable[217]. This is the case in the current research on ERSs where the area-based measure IMD 2004 has been used.

As explained in Chapter 7, a major limitation with using area-based measures as a proxy for individual level socioeconomic circumstance is the potential for misclassification[217;369;370] and committing ecological fallacy (for example, labeling an individual as deprived because they live in an area which is classified overall as deprived, but in fact they themselves are socioeconomically advantaged[226-228]).

Ecological fallacy is an inherent limitation to the interpretation of the analysis results presented in Chapter 7. It is important to ascertain the likely extent of the problem of ecological fallacy, as this will influence how confident I can be in inferring that it is deprived individuals living within deprived areas who are accessing and using ERSs.

A recent example of the ecological fallacy in action was seen in the early stages of the Sure Start initiative; relatively less deprived parents and their children within the community were benefiting from the services (which were geographically located in areas which overall were classified as deprived) rather than the most disadvantaged and 'hard to reach' members of these communities[375]. This finding is plausible because the Inverse Equity Hypothesis proposed by Victora states that health service programmes may, to begin with, be more likely to reach advantaged rather than deprived people[376]. This has the potential to initially exacerbate existing health and healthcare inequalities between advantaged and deprived groups but the gap closes once use of the service reaches saturation in more advantaged sectors of the population. The Inverse Equity Hypothesis also applied to the English cervical screening programme throughout the 1990s[377].

If area populations are homogeneous in socioeconomic terms then the problem of ecological fallacy is likely to be small[378]. However, as Harris and Longley explain, in recent years the scale and pace of urban change have led to a situation where households of diverse means and circumstances may be found living in close proximity to one another[378]. This research is based in London, and London is renowned for its high level of population diversity, where the housing market is such that advantaged individuals are often physically located very near to deprived individuals[379]. The IMD 2004 used within this research is derived at one of the smallest administrative area levels (LSOA, with an average population of 1500 people)[12]. LSOAs were generated to take into account measures of population size, mutual proximity and social homogeneity[6]. Nevertheless, even within a population of this size, there maybe considerable population heterogeneity and hence the problem of misclassification maybe substantial. The issue of population heterogeneity has led some to argue[378] pg. 1073:

"In these changed circumstances conventional deprivation indicators fail adequately to detect within and between small area variations in socioeconomic and environmental conditions…adequate representation of diversity requires a greater sensitivity to difference at fine scales."

The larger the geographic area the greater the potential misclassification and the larger the problem of ecological fallacy will be[217]. The extent of this problem may be reduced by using measures based on smaller area units where there is less opportunity for variation within the local population[380]. There have been previous calls for research looking into the use of commercially available geodemographic segmentation tools as measures of deprivation[223]. The need for a deprivation measure at a finer level of geographical resolution stimulated the agenda for the research presented here. This Chapter describes a methodological investigation undertaken to assess the validity and value of using a commercial geodemographic segmentation tool (ACORN) to enhance understanding of socioeconomic inequalities in service utilisation at small-area level. ACORN was chosen as the focus of this current research because it is one of the most established geodemographic segmentation tools available and also because I had a contact within the organisation that produces ACORN (CACI) who could arrange access to the data free of charge for this academic purpose.

8.1.2 Geodemographic segmentation tools

Geodemographic segmentation tools (alternatively known as 'geodemographic classifications,' 'geodemographics' or 'socio-demographic classifications') group the population according to socio-demographic and lifestyle characteristics. These are invariably produced at small area level (usually at postcode level). The geodemographics industry has grown over the past 20 years, as commercial companies have capitalised on the availability of census information (the licence fee for commercial firms was removed for the 2001 census[381]) and other administrative data, together with commercial lifestyle information (for example from surveys carried out by commercial firms, sales and warranty records) to construct these classifications. Table 8.1 provides a list of UK geodemographic classifications[381].

Table 8.1 UK geodemographic systems available in 2006 (adapted from [381])

Company/organisation	Classification
ONS (publicly available)	OAC
CACI	ACORN
CACI	Health ACORN
Claritas	PRIZM
EuroDirect	CAMEO
Experian	Mosaic UK
Acxion	Personicx Geo
AFD Software	Censation
Allegran	Gnuggets
Beacon Dodsworth	P^2 People and Places
Business Geographics	Locale
The Clickworks/TRAC	SONAR
GeoBusiness	Locale
ISL	RESIDATA Lifetypes
Streetwise Analytics	Likewise

Geodemographics were primarily developed by the commercial sector to support the move away from mass marketing to niche marketing, where certain sectors of the population are targeted for specific products or services (for example using geodemographics to produce an intelligent mail-shot system to target addresses housing anticipated purchasers of a product)[382]. Although the development of geodemographics was motivated by private-sector uses, these tools have increasingly been employed in the public sector to profile the lifestyle and assets of populations. This profiling process is central to the application of social marketing techniques[383], which are recommended by the Government to achieve behaviour change in populations[384].

ACORN developed by CACI was one of the first commercial geodemographic segmentation tools in the UK[1;381;382]. The ACORN classification is used by[1]:

- **Financial organisations** – to understand customers, cross-sell product ranges, set branch targets, predict loyal customers, plan network strategies.
- **Retailers** – to locate stores, plan product ranges, assess refurbishments, target local marketing for stores.
- **Media owners** – to support advertisement sales, evaluate sales potential, develop new markets.
- **Fast moving consumer goods market (FMCG)** – to drive customer communications, in-store marketing, ranging and product distribution.
- **Public sector** – to target services to areas of need, inform policy decisions.

Over 400 variables containing lifestyle, asset and demographic information are used to build ACORN[1]. 30% of these are obtained from the 2001 census and the rest from CACI's consumer lifestyle databases[1]. ACORN uses this lifestyle, asset and demographic information to divide the population into 57 types, which are aggregated up into 17 groups and 5 broad categories. ACORN provides an indication of relative likelihood that people living within certain postcodes display certain characteristics, it does not provide an absolute measure of the numbers or proportion of people in a given postcode who have a given characteristic.

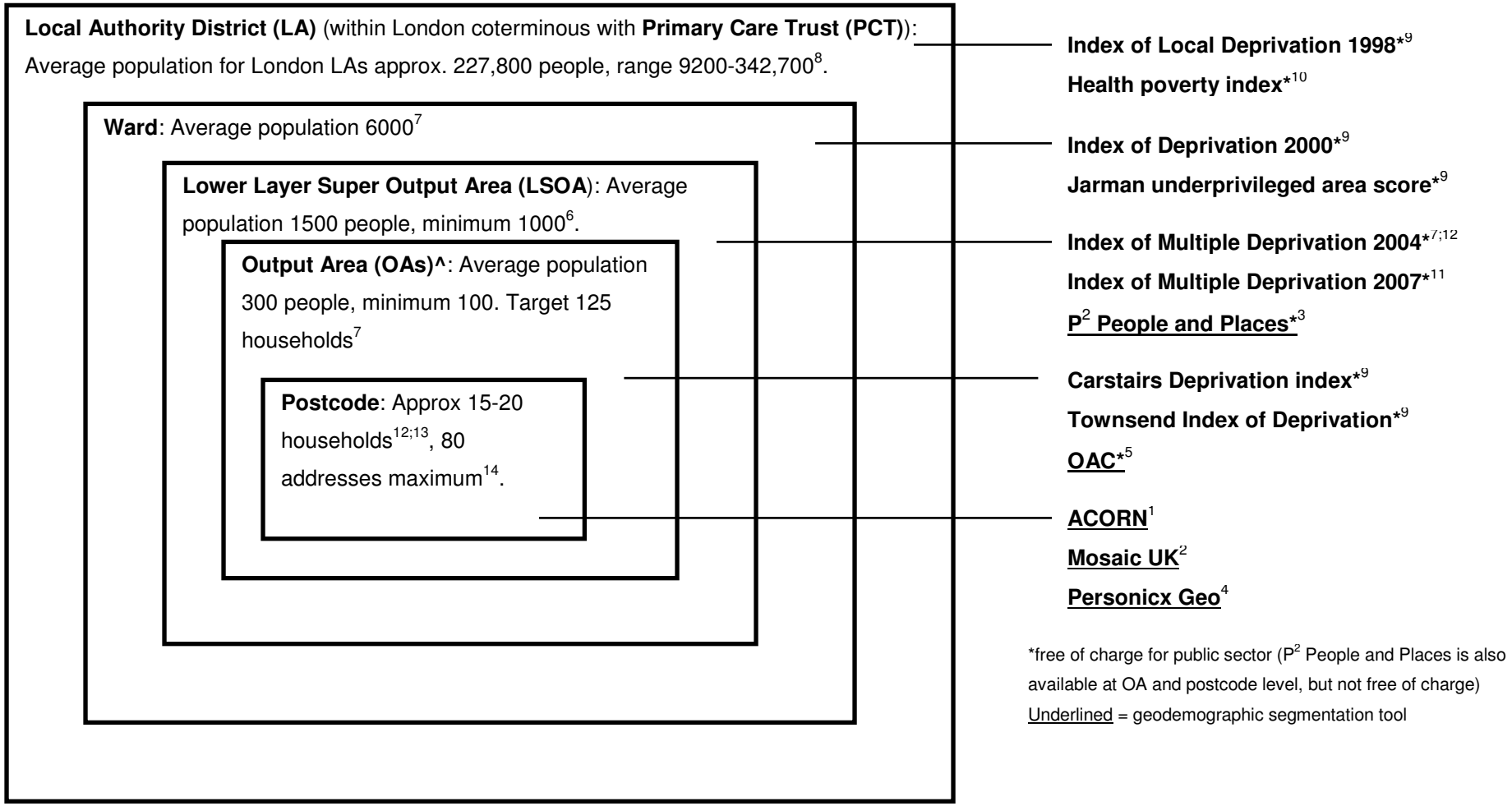
A cursory examination of the ACORN categories would suggest they are hierarchically ordered reflecting the experience of socioeconomic circumstance across the population (Table 8.2). Although the headings of these five categories appear to relate primarily to income or wealth, (consistent with notions of material deprivation), the broad range of indicators which lie behind these categories suggest instead that they may in fact reflect degrees of multiple deprivation. ACORN appears to have potential as a measure of socioeconomic circumstance, but research is required to test its validity in this regard.

Table 8.2 ACORN classification categories[1]

	Category	% UK population
1.	Wealthy Achievers	25.4
2.	Urban Prosperity	11.5
3.	Comfortably Off	27.4
4.	Moderate Means	13.8
5.	Hard-Pressed	21.2

Figure 8.1 provides an overview of the different geographical areas and the approximate number of households/persons within each. It also shows the smallest area at which various deprivation measures and geodemographic segmentation tools are ordinarily applied. ACORN classifies the population at postcode level, therefore ACORN has greater geographic resolution than area-based measures of socioeconomic circumstance such as the IMD 2004 which operate at LSOA level. Given the apparent potential of ACORN as a measure of socioeconomic circumstance this geodemographic classification tool may therefore have utility in enhancing understanding of socioeconomic inequalities in service utilisation at small-area level.

Figure 8.1 Comparison of size of geographic areas and the smallest level upon which a number of area-based measures of deprivation and geodemographic segmentation tools are ordinarily applied



*free of charge for public sector (P^2 People and Places is also available at OA and postcode level, but not free of charge)
Underlined = geodemographic segmentation tool

^From 1966-1991 census enumeration districts were the smallest area at which census results were available (approx 183 households). They were primarily designed for operational rather than statistical purposes and were reconfigured for each census. They were superseded for 2001 census output purposes by output areas.

8.2 Aims

The aims of this research were twofold:

1. To examine ACORN's validity as a measure of socioeconomic circumstance.
2. To assess ACORN's value, in combination with an established deprivation index (IMD 2004), for examining socioeconomic variations in use of a healthcare intervention (ERSs).

The research assessing the validity of ACORN as an area measure of deprivation was undertaken jointly with my colleague Jessica Sheringham. This research is currently in press with the journal Sexual Health. I undertook part of the content validity assessment and all of the research covering objective two independently.

8.3 Method

8.3.1 Validity of ACORN as an area measure of socioeconomic circumstance

We considered three types of validity - content, criterion and construct validity (Table 8.3)[223].

Table 8.3 Approaches to assessing validity[223]

Approach	Description
Content	Are the variables and domains selected to construct the index appropriate for the measurement of deprivation?
Criterion	How does the instrument compare with a 'gold standard'?
Construct	Does the instrument detect predicted associations?

8.3.1.1 Content validity

The variables and domains used to construct ACORN were assessed in terms of how well they corresponded to widely accepted notions of socioeconomic circumstance and deprivation. The definitions used for these concepts to guide the assessment of content validity were consistent with those adopted in the rest of this thesis (see Chapter 3). The similarities and differences in the domains included in the ACORN classification and a well established deprivation index (IMD 2004) were identified.

8.3.1.2 Criterion validity

Criterion validity normally involves comparing the performance of an instrument against a 'gold standard'. However, no gold standard exists for measuring deprivation. In these circumstances, Carr-Hill et al. report studies which test criterion validity by correlating one measure against another[223]. The agreement between IMD 2004 and ACORN applied to the English population was examined to provide a measure of criterion validity. The two measures are at different geographical resolutions and so it was anticipated that we might not find exact correlation between the two. Indeed, any 'added value' of ACORN was anticipated to be in terms of whether it uncovered any population heterogeneity in socioeconomic circumstance at small-area level which was being masked by IMD 2004. Nevertheless, if the distribution of ACORN was totally inconsistent with IMD 2004 this would lead us to question its criterion validity as a measure of socioeconomic circumstance.

STATA SE version 9.2[331] was used for data linkage and analysis. The 2007 ACORN dataset including the English population at postcode level was linked to the IMD 2004 scores at LSOA level[224] through the National Statistics Postcode Directory (Feb 2007)[332]. The National Statistics Postcode Directory assigns postcodes a point grid reference, to locate them within one LSOA. Records were excluded if they related to areas outside England or if they related to postcodes assigned ACORN type 0 or 6 (either postcodes with no resident population (e.g. PO boxes) or communal residences (e.g. prisons)).

The ranks of the IMD 2004 scores were grouped into quintiles, with IMD1 used to represent the 20% most deprived LSOAs in England. The five ACORN categories were cross-tabulated against the IMD 2004 quintiles for the English population and a weighted Kappa statistic was calculated to measure agreement. Because IMD 2004 and ACORN are used here as ordinal scales of socioeconomic circumstance, Kappa was weighted to take into account both absolute concordance (where both tools classified the population at the same relative level, for example 'hard pressed' in ACORN and the most deprived quintile in IMD 2004) and relative concordance (to indicate the extent to which ACORN and IMD 2004 were at variance). Linear weighting was used, based on the assumption that the relative distances between categories in both indices can be treated as the same.

8.3.1.3 Construct validity

Construct validity in this context refers to the extent to which the instrument detects predicted associations between health and deprivation. The ERS dataset is a service dataset, it does not include a measure of health and so construct validity could not be determined using ERS data. Instead, the construct validity of ACORN as a measure of socioeconomic circumstance was tested using a dataset from the National Chlamydia Screening Programme (NCSP) in collaboration with Jessica Sheringham who was using this dataset for a separate research project. The NCSP has been recently established in England to reduce the prevalence of chlamydia among 15-24 year olds through early detection and treatment of those most at risk of infection[385]. The research dataset comprised records from the NCSP's fourth year of operation, from April 2006 to March 2007. This dataset provided a measure of health outcome - chlamydia positivity (i.e. number of records with a positive test result as a proportion of all records with positive or negative test results)[386].

To assess construct validity, associations between the health outcome, chlamydia positivity, and deprivation, assigned using both IMD 2004 and ACORN, were compared. Chlamydia has been shown previously to be more prevalent in deprived areas[387-389] and so if a measure is accurately capturing socioeconomic variations we would expect to find highest positivity in the most deprived group and lowest positivity in the least deprived group. The NCSP dataset was linked via patients' postcode of residence to ACORN and IMD 2004 to examine the extent to which ACORN detects predicted associations between deprivation and chlamydia positivity. Records were excluded if postcodes were absent, incomplete or not possible to match to the ONS postcode directory dataset. Associations between ACORN and chlamydia positivity were compared with associations between IMD 2004 and positivity.

8.3.2 Added value of ACORN as an area measure of socioeconomic circumstance

The objective was to apply ACORN in combination with IMD 2004 to achieve a finer degree of geographical discrimination within IMD 2004 quintiles. This was to assess whether ACORN could detect any heterogeneity in socioeconomic circumstance at small-area level. I assigned each person in the ERS research dataset (N=6101, see Figure 7.1, Chapter 7) an ACORN category corresponding to the postcode in which they lived. This was done by linking the ERS research database and the ACORN dataset on the patient postcode variable. The analysis examined ERS use (attendance

at the first and final ERS appointment). Therefore, records from Area 4 were excluded (see Appendix G for further information about this exclusion).

Firstly, I created a breakdown of the proportions of people who took up and proportions of people who completed ERSs by ACORN category, within each IMD 2004 quintile. This was in order to determine whether, for example, service users from LSOAs (average population 1500 people) classified as the 20% most deprived in the country by IMD 2004, were in fact from deprived 'hard pressed' areas measured at a finer degree of geographical discrimination (postcodes, approximately 80 households), as identified by ACORN. When inconsistency was identified between IMD 2004 and ACORN, further investigation into the attributes of specific ACORN Types which make up the ACORN Category in question was undertaken to establish whether the discrepancy between IMD 2004 and ACORN represented either heterogeneity in socioeconomic circumstance at small-area level or a misclassification of postcodes by ACORN.

8.4 Results

8.4.1 Validity of ACORN as an area measure of socioeconomic circumstance

8.4.1.1 Content validity

Here we sought to answer the question; are the variables and domains selected to construct the index appropriate for the measurement of deprivation?

Taking the starting point that the domains included in IMD 2004 are appropriate to measure deprivation, Table 8.4 provides a comparison of the domains covered by IMD 2004 and ACORN, showing that both cover key aspects of socioeconomic circumstance but vary in other domains. Both ACORN and IMD 2004 draw on information from the 2001 Census. While IMD 2004 makes use of other public sector data sources (e.g. benefit claims systems and Hospital Episode Statistics (appendix C), ACORN incorporates information from a range of consumer surveys about assets and lifestyle[1;12]. The large degree of agreement between IMD 2004 and ACORN in this respect lends support to the conclusion that ACORN has content validity as a measure of socioeconomic deprivation.

Table 8.4 Domains included in ACORN and IMD 2004

Domain	IMD 2004	ACORN
Income	✓	✓
Employment	✓	✓
Health, disability	✓	✓
Education, skills and training	✓	✓
Living environment	✓	✓
Crime	✓	X
Barriers to services, housing	✓	X
Lifestyle	X	✓
Assets	X	✓
Demographic profiles	X	✓

I then examined all of the 285 variables which are included in ACORN and reported on the CACI website[*390], and grouped them as follows:

(i) **Frequently used census-derived measures of socioeconomic status. 78 variables (27% of all variables reported).** These variables are used in other well-known deprivation indices (for example, Townsend Index of Deprivation, Carstairs Deprivation Index, Index of Multiple Deprivation[9;223]). These variables are also collected in surveys when socioeconomic status is measured on an individual level.

(ii) **Non-census derived economic variables which are indicators of income/wealth. 53 variables (19% of all variables reported).** These take advantage of commercial sources of information (for example from surveys, warranty returns) that contain additional information to that which is available from the census, administrative databases or publicly-funded surveys, especially in terms of affluence and income[391].

(iii) **Non-census derived indicators of asset preference/possession. 21 variables (7% of all variables reported).** These provide an additional measure of socioeconomic circumstance in material terms[9].

(iv) **Interests/lifestyle choices which are possibly socioeconomically patterned. 103 variables (36% of all variables reported)** Following from Bourdieu's socio-cultural analysis of life in France[392], there has been much research on the extent, and the mechanisms through which social class influences tastes, cultural consumption and lifestyles[393;394] and hence may be a

[*] Although the ACORN user guide[1] explains that 400 variables are used to construct ACORN, information is only available from CACI on 285 variables, and these are listed in appendix L. In addition information on data source for each variable is not provided by CACI. I therefore distinguished those that did / did not originate from the 2001 census by a process of elimination, based on knowledge of the contents of the 2001 census.

pathway to differential service use and health outcomes. For example, significant associations between social class (based on own occupation) and newspaper readership have been reported, which remain even after taking account of educational attainment (which serves as a proxy for information-processing capacity)[393]. Those from professional/managerial roles are more likely to read what are traditionally referred to as 'broadsheet' newspapers (for example, the Telegraph) and those in manual occupations more likely to read tabloid newspapers (for example, The Sun)[393]. A further example is the inequality that exists across socioeconomic groups in the propensity to adopt the lifestyle behaviour of leisure-time physical activity (Chapter 2).

(v) **Demographic variables. 30 variables (11% of all variables reported).** Age, ethnicity and religion.

Grouping ACORN variables in this way demonstrates the good content validity of ACORN because, (with the exception of 11% of all reported variables which are demographic variables,) 53% of variables closely reflect aspects of socioeconomic circumstance and can be viewed as markers of relative advantage/deprivation, and a further 36% of variables contain lifestyle information which may be socioeconomically patterned. Therefore, the majority of variables within ACORN measure either material (income, assets, housing) or social (employment, education, recreation) deprivation, both of which feature in Shaw et al.'s ([9]pg. 5) definition of deprivation (Chapter 3).

Table 8.5 below presents a selection of representative variables which are included in the ACORN classification[1;390] grouped as above. These have been extracted from the Table in Appendix L which lists all 285 variables. A comparison of the index scores for the following two ACORN Types is provided:

- Type 1 (affluent mature professionals, large houses)
- Type 56 (multi-ethnic, crowded flats)

The Index Scores can be interpreted as follows. 100 represents the UK average and is the reference group. The Index shows the relative propensity of people living in postcodes classified as a given ACORN Type of displaying a given attribute, characteristic, or interest[1]. For example, Type 1 has an Index value of 246 for 'higher managerial/professional occupations.' This indicates that people living in postcodes classified as ACORN Type 1 are nearly two and a half times more likely to be employed in a higher managerial/professional job than the UK population average. In contrast, Type 56 has an Index value of 62 for this variable. This indicates that people

living in postcodes classified as ACORN Type 56 are 38% less likely to be employed in a higher managerial/professional job than the UK population average.

Table 8.5 A selection of ACORN variables and a comparison of Index Scores for ACORN Type 1 and Type 56[1;390]

Variable	Index Scores	
	Category 1, Group A, Type 1	Category 5, Group Q, Type 56
1. FREQUENTLY USED CENSUS-DERIVED MEASURES OF SOCIOECONOMIC STATUS / DEPRIVATION / DISADVANTAGE		
Socioeconomic classification		
Higher managerial/professional occupations	246	62
Working status		
Looking for work	43	229
Educational qualifications		
No or unknown qualifications	47	115
Tenure		
Rented from council or housing association	6	342
Dwelling size		
1-2 room household	15	342
Household composition		
1 non-pensioner adult dependent kids (single parent)	31	259
Car ownership		
0 cars or vans	15	208
2. NON-CENSUS DERIVED ECONOMIC VARIABLES WHICH ARE INDICATORS OF INCOME/WEALTH		
Family income		
Family Income £0-9999	43	140
Investments and savings		
Have Stocks and Shares	224	36
Credit cards		
Monthly credit card spend 250+	305	59
Financial and insurance		
Health insurance with BUPA	324	46
Food shopping		
Spend over 75 per week	223	86
3. NON-CENSUS DERIVED INDICATORS OF ASSET PREFERENCE/POSSESSION		
White and brown goods		
Have tumble dryer or washer/dryer	122	79
Have PC	158	97
4. INTERESTS/LIFESTYLE CHOICES WHICH ARE POSSIBLY SOCIOECONOMICALLY PATTERNED		
Holidays		
Winter snow	317	66
Interests		
Exercise / Sport	141	99
Eating out		
Regularly eat evening meal in pub/restaurant	151	43
Travel to work		
Travel to work(study) by train/tube/tram/bus	76	336
Newspaper readership		
The Sun	36	156
Telegraph	271	69

This detailed examination of the variables which are included in the ACORN classification and a comparison of Index Scores for two ACORN Types representing the extreme ends of the classification (Type 1 is within the wealthy achiever category and Type 56 is within the hard pressed category) corroborates the initial speculation that the five categories within the ACORN classification represent five ordered categories of socioeconomic circumstance (Table 8.2)[1].

An examination of Index Scores across Types within Categories (not shown) suggests that, whilst the five broad categories are ordered according to socioeconomic circumstance, the ACORN Groups and ACORN Types within these categories are not ordered along this dimension. Table 8.6 provides an example of the Groups and Types contained within ACORN's most deprived Category 'hard pressed'. Instead, Groups and Types appear to be delineated in terms of demographics (age, ethnicity), household composition (single, families, older people) and housing type (terrace, semi-detached, high-rise flats). For example, postcodes classified as Type 55 (multi-ethnic purpose built estates) are no more or less socioeconomically deprived than Type 49 (large families and single parents, many children).

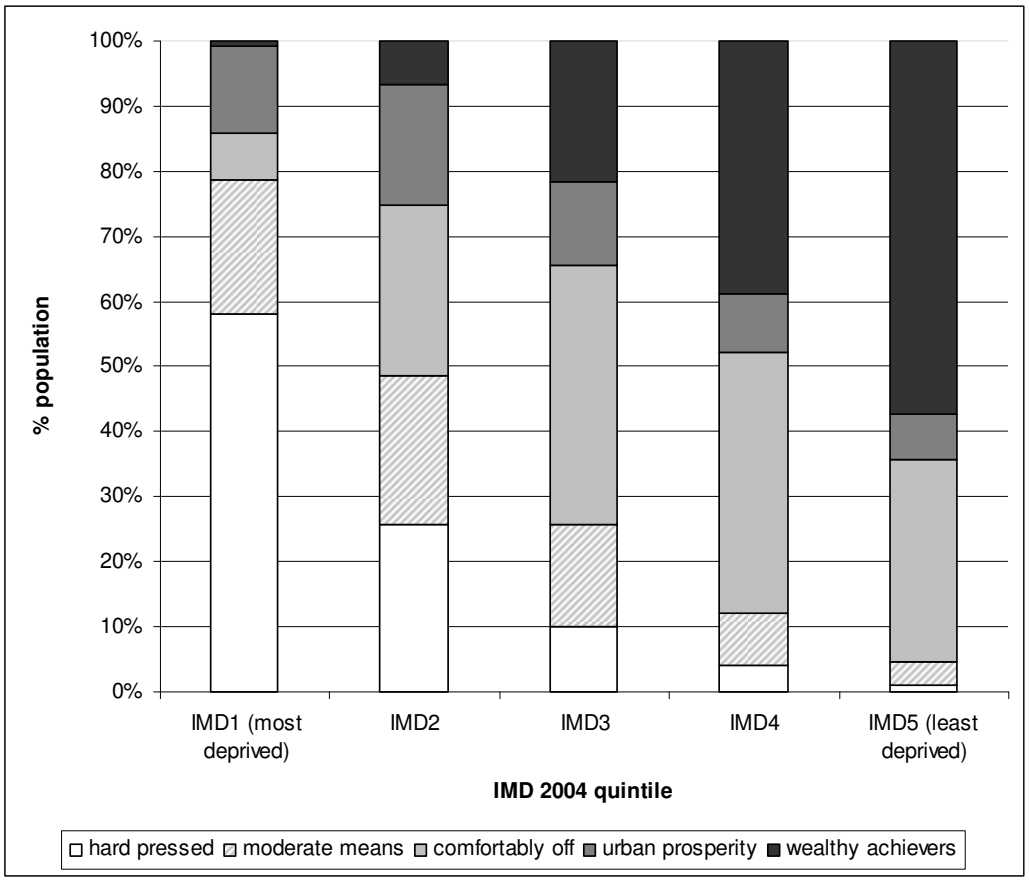
Table 8.6 Groups and Types within the most deprived ACORN category 'hard pressed'[1]

Group	Type
N – Struggling families	44 – Low income larger families, semis
	45 – Low income, older people, smaller semis
	46 – Low income, routine jobs, terraces and flats
	47 – Low income families, terraced estates
	48 – Families and single parents, semis and terraces
	49 – Large families and single parents, many children
O – Burdened singles	50 – Single elderly people, council flats
	51 – Single parents and pensioners, council terraces
	52 – Families and single parents, council flats
P – High-rise hardship	53 – Old people, many high-rise flats
	54 – Singles and single parents, high-rise estates
Q – Inner city adversity	55 – Multi-ethnic purpose built estates
	56 – Multi-ethnic, crowded flats

8.4.1.2 Criterion validity

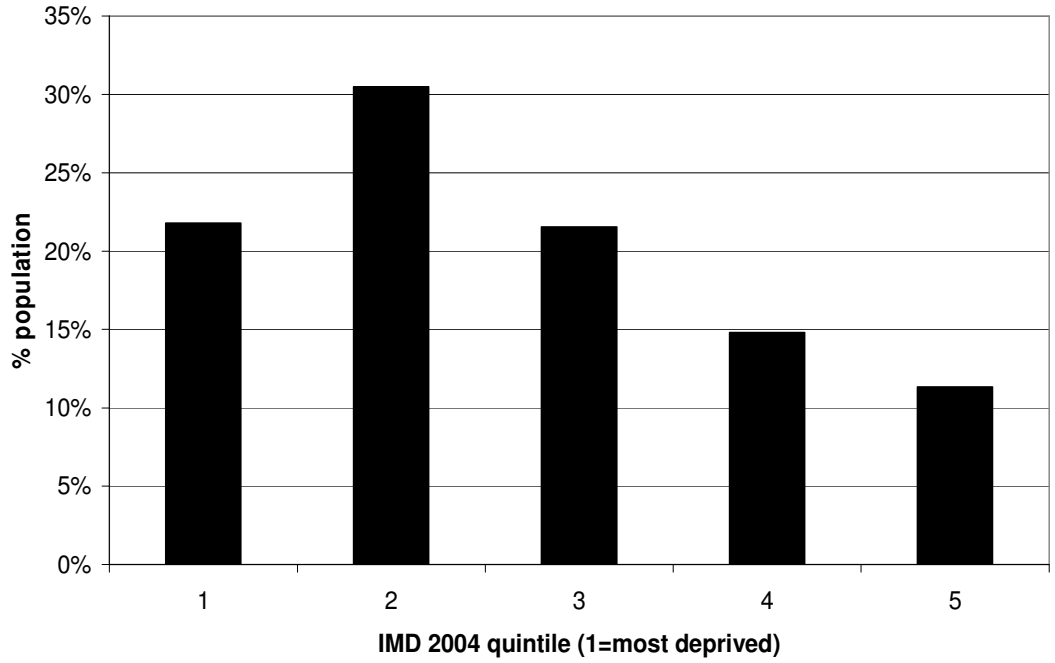
Here we sought to answer the question; how does the instrument compare with a 'gold standard'? Figure 8.2 shows the distribution of IMD 2004 quintiles against ACORN Categories for the English population. The extreme Categories of ACORN corresponded well to IMD 2004 in their segmentation of the population showing good criterion validity. Of all those living within the most deprived IMD 2004 quintile, 58% lived in postcodes classified by ACORN as 'hard pressed' whereas only 1% lived in postcodes classified by ACORN as 'wealthy achievers' (Figure 8.2). Conversely, of those living in the least deprived IMD 2004 quintile, 57% lived in postcodes classified as 'wealthy achiever' and only 1% lived in 'hard pressed' postcodes. The intermediate categories of ACORN were more evenly distributed across quintiles. The weighted Kappa statistic of 0.415 (95% CI: 0.415-0.416) supported the moderate agreement overall found between ACORN and IMD 2004.

Figure 8.2 Distribution of ACORN and IMD 2004 across the English population



The distribution of 'urban prosperity' (ACORN's second most advantaged Category) was not as expected across the IMD 2004 quintiles. Figure 8.2 shows that 13% of people living in the most deprived IMD 2004 quintile were located in postcodes classified by ACORN as 'urban prosperity,' and 19% of those in IMD quintile 2 were classified as such. This compares to only 7% of those living in the least deprived IMD quintile classified as 'urban prosperity,' and 9% of those living in the second least deprived quintile (IMD quintile 4) classified as such. Figure 8.3 shows the distribution of the population in the 'urban prosperity' category by IMD 2004 quintile. The distribution is heavily skewed towards deprived IMD 2004 quintiles, with over 50% of the English population living in postcodes classified in ACORN's urban prosperity category residing in the two most deprived IMD 2004 quintiles of deprivation measured at LSOA level.

Figure 8.3 Distribution of the English population living in postcodes classified in ACORN's 'urban prosperity' Category, by IMD 2004 quintile



8.4.1.3 Construct validity

Here we sought to address the question; does the instrument detect predicted associations? The NCSP dataset contained 145,975 records of screened individuals, of which it was possible to assign ACORN categories and IMD 2004 quintiles to 118,558 (81.2%). It was not possible to assign the remaining records due to missing, incomplete or incorrect postcodes. 2,788 records with no conclusive Chlamydia test result were also excluded.

Table 8.7 shows variations in chlamydia positivity by IMD 2004 quintile and ACORN Category. Both classifications exhibited similar gradients with the most 'deprived' (i.e. IMD quintile 1 and hard pressed) areas having higher positivity rates. Using IMD 2004, the proportion with a positive test result varied from 12.00% (95% CI: 11.69-12.32) in most deprived quintile to 9.13% (95% CI: 8.59-9.70) in the least deprived quintile. Using ACORN, positivity varied from 12.26% (95% CI: 11.91-12.61) in ACORN's 'hard pressed' category to 9.27% (95% CI: 8.81-9.75%), in the 'wealthy achievers' category. This resulted in an unadjusted relative risk of a positive test result between the most and least deprived areas of 1.32 (95% CI: 1.23-1.40) for IMD 2004 and 1.32 (95% CI: 1.25-1.40) for ACORN, indicating that both classifications captured socioeconomic gradients in chlamydia infection. This finding lends support to the conclusion that ACORN has construct validity as a measure of socioeconomic deprivation.

Table 8.7 Chlamydia positivity by IMD 2004 quintile and ACORN category

IMD 2004 quintiles	% (95% CI)	ACORN categories	% (95% CI)
1 (most deprived)	12.00 (11.69-12.32)	Hard pressed	12.26 (11.91-12.61)
2	10.84 (10.46-11.24)	Moderate means	11.56 (11.07-12.06)
3	9.99 (9.53-10.46)	Comfortably off	10.98 (10.57-11.41)
4	10.78 (10.24-11.34)	Urban prosperity	9.57 (9.16-10.00)
5 (least deprived)	9.13 (8.59-9.70)	Wealthy achievers	9.27 (8.81-9.75)
Relative risk most versus least deprived	1.32 (1.23-1.40)		1.32 (1.25-1.40)

8.4.2 Added value of ACORN as an area measure of socioeconomic circumstance

The ERS dataset used in Chapter 7 to analyse take up of ERS contained 6101 individuals with complete covariate information, of which it was possible to assign ACORN categories to 6099 (99.97%). A further 28 people were excluded because they were classified as residing in ACORN categories 0 or 6 (i.e. communal establishments or primarily non-residential addresses). 6071 individuals were therefore included in the ACORN analysis of referral to ERS, of which 3982 (60.6%) attended their initial appointment. 3551 individuals had completion status recorded, and of these 1393 attended the final appointment and so completed the ERS (39.2%). Tables 8.8 – 8.10 show that, in line with the findings on criterion validity there appears to be a close correspondence at the extreme ends of the two classifications. For example, no one referred to ERSs who lived in the most deprived quintile lived in postcodes classified in the 'wealthy achiever' ACORN Category. Conversely, only 2 people referred to the ERSs who lived in the least deprived quintile lived in postcodes classified in the 'hard pressed' ACORN Category.

Table 8.8 Number (%) of individuals referred to ERS within each IMD 2004 quintile by ACORN category

	IMD 2004 quintile (1=most deprived)					
ACORN category	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	Total n (%)
Hard pressed	1010 (43.5)	328 (20.8)	79 (10.1)	7 (1.2)	2 (0.3)	1426 (23.5)
Moderate means	577 (24.8)	297 (18.8)	100 (12.8)	72 (12.5)	75 (9.3)	1121 (18.5)
Comfortably off	25 (1.1)	141 (8.9)	262 (33.5)	230 (40.0)	244 (30.1)	902 (14.9)
Urban prosperity	711 (30.6)	812 (51.4)	299 (38.2)	137 (23.8)	98 (12.1)	2057 (33.9)
Wealthy achiever	0 (0.0)	3 (0.2)	42 (3.4)	129 (22.4)	391 (48.3)	565 (9.3)
Total	**2323 (100)**	**1581 (100)**	**782 (100)**	**575 (100)**	**810 (100)**	**6071 (100)**

Table 8.9 Number (%) of individuals who took up ERS within each IMD 2004 quintile by ACORN category

	IMD 2004 quintile (1=most deprived)					
ACORN category	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	Total n (%)
Hard pressed	636 (42.5)	208 (19.9)	54 (10.6)	3 (0.8)	1 (0.2)	902 (22.7)
Moderate means	375 (25.1)	185 (17.7)	58 (11.4)	46 (12.0)	51 (9.3)	715 (17.96)
Comfortably off	15 (1.0)	99 (9.5)	169 (33.1)	145 (37.8)	170 (31.0)	598 (15.0)
Urban prosperity	469 (31.4)	550 (52.7)	201 (39.3)	92 (25.5)	60 (11.0)	1372 (34.5)
Wealthy achiever	0 (0)	2 (0.2)	29 (5.7)	98 (25.5)	266 (48.5)	395 (9.9)
Total	**1495 (100)**	**1044 (100)**	**511 (100)**	**384 (100)**	**548 (100)**	**3982 (100)**

Table 8.10 Number (%) of individuals who completed ERS within each IMD 2004 quintile by ACORN category

	IMD 2004 quintile (1=most deprived)					
ACORN category	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	Total n (%)
Hard pressed	295 (38.9)	47 (14.1)	10 (9.9)	2 (2.3)	0 (0)	354 (25.4)
Moderate means	217 (28.6)	72 (21.6)	9 (8.9)	8 (9.1)	9 (8.1)	315 (22.6)
Comfortably off	3 (0.4)	19 (5.7)	25 (24.8)	33 (37.5)	30 (27.0)	110 (7.9)
Urban prosperity	244 (32.2)	195 (58.4)	53 (52.5)	17 (19.3)	11 (9.9)	520 (37.3)
Wealthy achiever	0 (0)	1 (0.3)	4 (4.0)	28 (31.8)	61 (55.0)	94 (6.8)
Total	**759 (100)**	**334 (100)**	**101 (100)**	**88 (100)**	**111 (100)**	**1393 (100)**

The criterion validity test demonstrated that over 50% of the English population living in postcodes classified in ACORN's urban prosperity category resided in the two most deprived IMD 2004 quintiles of deprivation (Figure 8.3). This was reflected in the distribution of individuals who accessed and used the ERS service. Tables 8.8-8.10 indicate that 30.6% of patients referred, 31.4% of those who took up and 32.2% of those who completed ERSs living in the most deprived quintile (as classified by IMD 2004) were in fact living in postcode areas deemed to be relatively advantaged by ACORN - from the 'urban prosperity' Category. This may indicate that IMD 2004 is not calculated at a small enough geographic scale to adequately pick up patterns of deprivation. The analysis combining ACORN with IMD 2004 may therefore be uncovering population heterogeneity in socioeconomic circumstance at small-area level and highlighting that ecological fallacy may indeed hinder the interpretation of results from the main analysis presented in Chapter 7 to a considerable extent. Figure 8.4 demonstrates for one LSOA in one of the study areas included in this research how ACORN may be picking up heterogeneity in socioeconomic circumstance within the population at small-area level. Alternatively however, the apparent within area heterogeneity in socioeconomic circumstance uncovered by ACORN may be spurious. The validity of this specific ACORN Category may be weak and so ACORN may be misclassifying postcodes as advantaged when in fact they are composed of deprived individuals.

Figure 8.4 Variations in socioeconomic circumstance within one lower-layer Super Output Area in London

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In order to determine which of the two explanations was more plausible I investigated further the properties of the ACORN 'urban prosperity' Category by examining the 11 ACORN Types (Types 13-23) which make up this Category. Firstly I examined how each Type profiled against the IMD 2004 quintiles. Secondly, I scrutinised the Index Scores of key indicators of socioeconomic circumstance (for example, occupational status, income and education) for these Types. Based on these two investigations I made a judgement as to the extent to which the Types conformed to ACORN's classification of them into the 'urban prosperity' category, i.e. whether these Types did indeed characterise individuals who were socioeconomically advantaged or not. I arranged the Types into 4 sets (Figures 8.5-8.15) based on this judgement. The chart in each figure indicates, for all of the English population classified as living in postcodes assigned a given ACORN type, the percentage distribution across IMD 2004 quintiles. The table in each figure shows the Index Scores for selected variables which were examined to see if the Scores reflected predicted associations. For example, because CACI had classified a Type as belonging to the relatively advantaged ACORN Category 'urban prosperity' one might expect it to be characterised by individuals with high education and income.

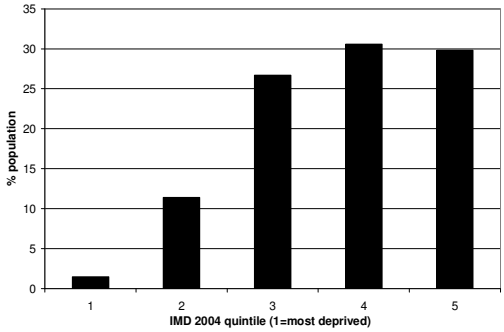
Comparison of the 11 ACORN Types which make up ACORN's 'urban prosperity' Category

Set A

- Distribution skewed towards more advantaged IMD quintiles.
- Majority of Index Scores indicate socioeconomically advantaged circumstances.
- ACORN Types 13 and 14 match this description.

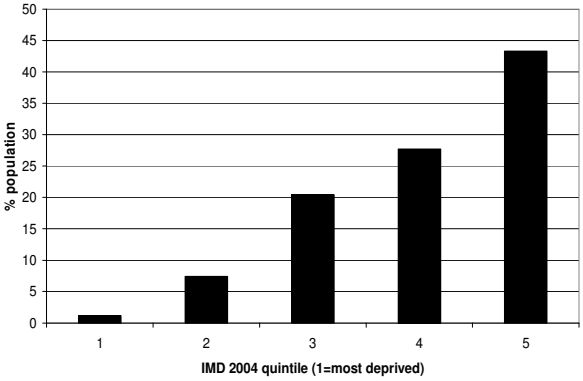
These Types support the explanation that the validity of ACORN is good. They suggest ACORN and IMD will both consistently describe individuals from these postcodes as socioeconomically advantaged.

Figure 8.5 Type 13 - well off professionals, larger houses and converted flats



	Index
Higher managerial/professional occupations	264
Looking for work	67
No or unknown qualifications	37
Degree or comparable	264
Rented from council or housing association	20
Family income £0-9999	55
Family income £50000+	389
Monthly credit card spend 250+	213

Figure 8.6 Type 14 – older professionals in detached houses and apartments



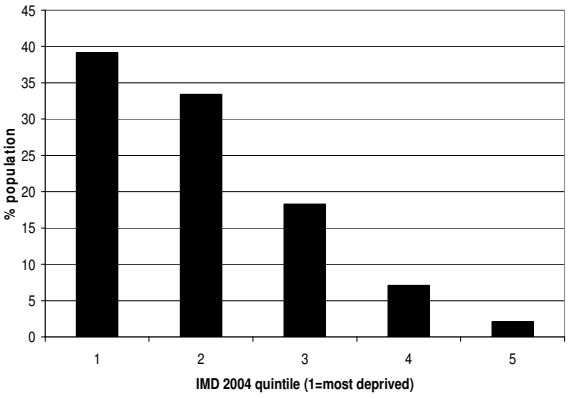
	Index
Higher managerial/professional occupations	213
Looking for work	62
No or unknown qualifications	53
Degree or comparable	205
Rented from council or housing association	25
Family income £0-9999	64
Family income £50000+	231
Monthly credit card spend 250+	158

Set B

- Distribution spread across IMD quintiles or skewed towards more deprived quintiles i.e. does not show bias toward more advantaged quintiles.
- Majority of Index Scores indicate socioeconomically deprived circumstances.
- ACORN Type 22 matches this description.

The validity of Classifying this ACORN Type within the 'urban prosperity' Category is poor. Although labelled as 'urban prosperity' the Index Score and distribution by IMD suggest in fact these postcodes consist of deprived individuals. This suggests that ACORN and IMD 2004 may in fact be consistently reporting the deprivation experience of the population (it is merely that this deprivation is being been labelled incorrectly by ACORN).

Figure 8.7 Type 22 – low income singles, small rented flats



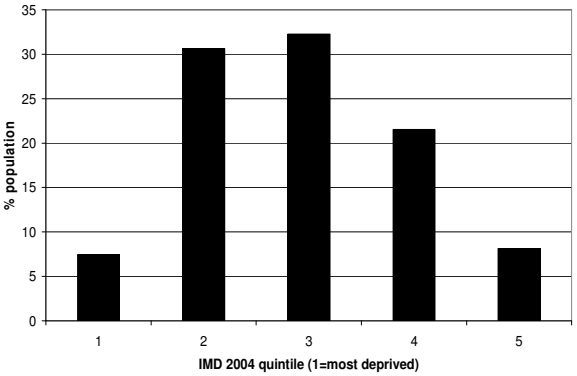
	Index
Higher managerial/professional occupations	*68*
Looking for work	*157*
No or unknown qualifications	99
Degree or comparable	*86*
Rented from council or housing association	101
Family income £0-9999	120
Family income £50000+	*43*
Monthly credit card spend 250+	*39*

Set C

- Distribution spread across IMD quintiles or skewed towards more deprived quintiles i.e. does not show bias toward more advantaged quintiles.
- Majority of Index Scores indicate socioeconomically advantaged circumstances (both in material and educational terms).
- ACORN Types 15, 16, 18 and 19 match this description.

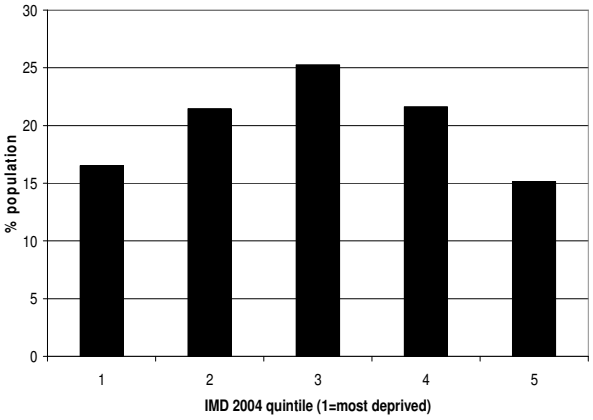
These Types support the explanation that ACORN is picking up heterogeneity of socioeconomic circumstance at small area level (i.e. due to being calculated over a larger area, IMD 2004 is misclassifying individuals from these postcodes as deprived when in fact they are socioeconomically advantaged, i.e. illustrating the problem of ecological fallacy).

Figure 8.8 Type 15 – affluent urban professionals, flats



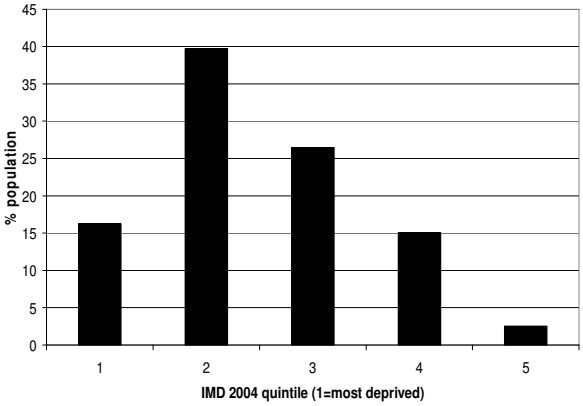
	Index
Higher managerial/professional occupations	279
Looking for work	96
No or unknown qualifications	38
Degree or comparable	283
Rented from council or housing association	52
Family income £0-9999	51
Family income £50000+	419
Monthly credit card spend 250+	278

Figure 8.9 Type 19 – suburban privately renting professionals



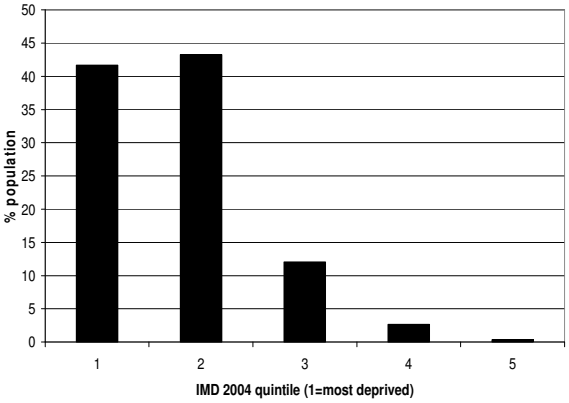
	Index
Higher managerial/professional occupations	227
Looking for work	84
No or unknown qualifications	46
Degree or comparable	220
Rented from council or housing association	44
Family income £0-9999	68
Family income £50000+	170
Monthly credit card spend 250+	144

Figure 8.10 Type 16 – prosperous young professionals, flats



	Index
Higher managerial/professional occupations	299
Looking for work	*114*
No or unknown qualifications	32
Degree or comparable	302
Rented from council or housing association	71
Family income £0-9999	50
Family income £50000+	362
Monthly credit card spend 250+	182

Figure 8.11 Type 18 – multi-ethnic young, converted flats



	Index
Higher managerial/professional occupations	166
Looking for work	*157*
No or unknown qualifications	66
Degree or comparable	208
Rented from council or housing association	*156*
Family income £0-9999	79
Family income £50000+	177
Monthly credit card spend 250+	118

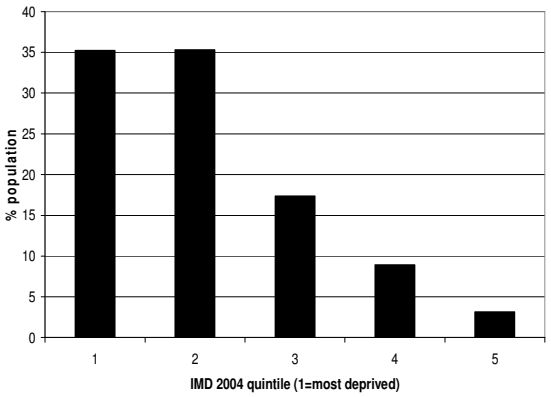
Set D

- Distribution spread across IMD quintiles or skewed towards more deprived quintiles i.e. does not show bias toward more advantaged quintiles.
- The Index Scores indicate people living in these postcodes are relatively advantaged in terms of education but relatively deprived in terms of material assets or income. Inhabitants of these postcodes are more likely to have a degree or comparable educational qualification than the UK average, but are less likely to have material resources, for example a high income or high monthly credit card spend. Inhabitants may be described as 'skills rich but materially poor.'
- ACORN Types 17, 20, 21 and 23 match this description.

These Types support the explanation that ACORN is picking up heterogeneity of socioeconomic circumstance at small area level. ACORN is uncovering the specific type of deprivation experienced by individuals within an overall deprived area; people within these postcodes may be described as 'skills rich but materially poor' rather than

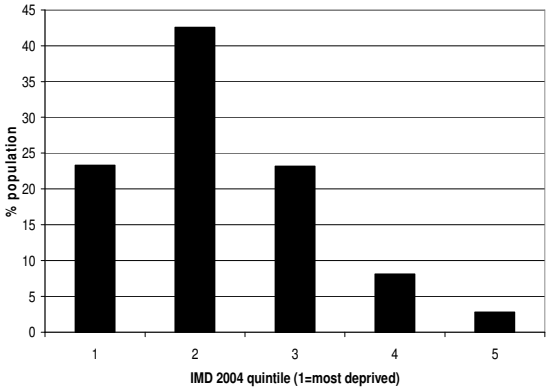
multiply deprived. Because these people are 'skills rich' it is reasonable for CACI to have chosen to classify inhabitants of these postcodes in the relatively advantaged 'urban prosperity' Category. However, from a health service research perspective, the fact that these inhabitants are likely to also face material deprivation is important.

Figure 8.12 Type 17 – young educated workers, flats



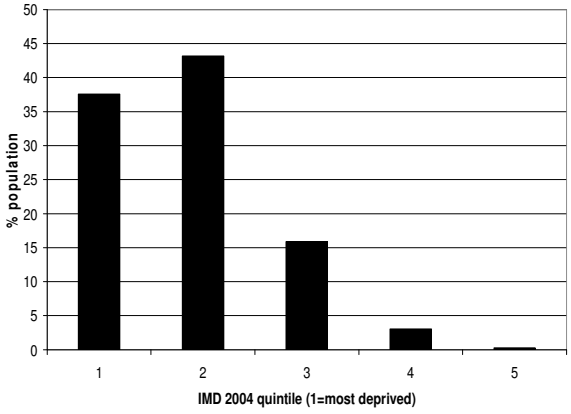
	Index
Higher managerial/professional occupations	140
Looking for work	*140*
No or unknown qualifications	53
Degree or comparable	173
Rented from council or housing association	91
Family income £0-9999	104
Family income £50000+	*54*
Monthly credit card spend 250+	*71*

Figure 8.13 Type 20 – student flats and cosmopolitan shares



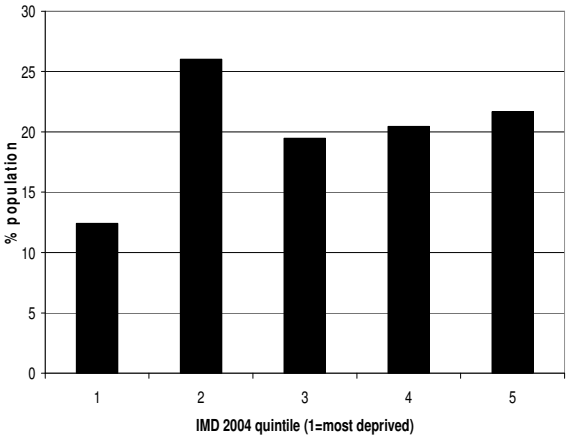
	Index
Higher managerial/professional occupations	110
Looking for work	*108*
No or unknown qualifications	52
Degree or comparable	154
Rented from council or housing association	64
Family income £0-9999	129
Family income £50000+	*87*
Monthly credit card spend 250+	*48*

Figure 8.14 Type 21 – singles and sharers, multi-ethnic areas



	Index
Higher managerial/professional occupations	100
Looking for work	*150*
No or unknown qualifications	92
Degree or comparable	133
Rented from council or housing association	*118*
Family income £0-9999	90
Family income £50000+	109
Monthly credit card spend 250+	*67*

Figure 8.15 Type 23 – student terraces



	Index
Higher managerial/professional occupations	*86*
Looking for work	*73*
No or unknown qualifications	39
Degree or comparable	104
Rented from council or housing association	61
Family income £0-9999	113
Family income £50000+	*47*
Monthly credit card spend 250+	*13*

The classification of the 11 ACORN Types making up the 'urban prosperity' Category into four sets (A-D) suggests a range of plausible explanations for the lack of correspondence between IMD 2004 and the ACORN classification demonstrated by the presence of a high proportion of 'urban prosperity' within the most deprived IMD quintile.

In order to determine which of these alterative explanations was more likely to explain the high occurrence of the 'urban prosperity' Category in those accessing and using ERSs who lived in areas classified as 'most deprived' by IMD 2004 (Tables 8.8 - 8.10) I examined the relative distribution of the ACORN Types within the population referred, taking up and completing ERSs classified in the most deprived IMD 2004 quintile.

Table 8.11 Percentage breakdown by ACORN Type of all patients referred, taking up, and completing ERSs who lived in the most deprived IMD 2004 quintile

ACORN Category	Set	ACORN Type*	n (%) of those referred N=2323 (100)	n (%) of those who took up ERS N=469 (100)	n (%) of those who completed ERS N=244 (100)
Urban Prosperity	A	13	3 (0.1)	2 (0.1)	2 (0.3)
		TOTAL IN SET	***3 (0.1)***	***2 (0.1)***	***2 (0.3)***
	B	22	13 (0.6)	9 (0.6)	3 (0.4)
		TOTAL IN SET	***13 (0.6)***	***9 (0.6)***	***3 (0.4)***
	C	15	29 (1.3)	18 (1.2)	11 (1.5)
		16	29 (1.3)	19 (1.3)	10 (1.3)
		18	131 (5.6)	102 (6.8)	47 (6.2)
		19	2 (0.2)	1 (0.1)	1 (0.1)
		TOTAL IN SET	***191 (8.4)***	***140 (9.4)***	***69 (9.1)***
	D	17	15 (0.7)	9 (0.6)	8 (1.1)
		21	489 (21.2)	309 (20.7)	162 (21.3)
		TOTAL IN SET	***304 (21.9)***	***318 (21.3)***	***170 (22.4)***
Comfortably off		31	23 (1.0)	14 (0.9)	3 (0.4)
		35	2 (0.1)	1 (0.1)	0 (0.0)
Moderate means		37	178 (7.7)	110 (7.4)	64 (8.4)
		38	356 (15.3)	236 (15.8)	144 (19.0)
		39	4 (0.2)	2 (0.1)	1 (0.1)
		40	20 (0.9)	13 (0.9)	2 (0.3)
		41	3 (0.1)	1 (0.1)	0 (0.0)
		43	16 (0.7)	13 (0.9)	6 (0.8)
Hard Pressed		44	12 (0.5)	8 (0.5)	0 (0.0)
		45	17 (0.7)	12 (0.8)	0 (0.0)
		46	4 (0.2)	3 (0.2)	1 (0.1)
		47	17 (0.7)	10 (0.7)	0 (0.0)
		48	22 (1.0)	15 (1.0)	2 (0.3)
		49	43 (1.9)	26 (1.7)	6 (0.8)
		50	15 (0.7)	10 (0.7)	4 (0.5)
		51	24 (1.0)	18 (1.2)	8 (1.1)
		52	25 (1.1)	16 (1.1)	2 (0.3)
		53	22 (1.0)	12 (0.8)	1 (0.1)
		54	6 (0.3)	4 (0.3)	1 (0.1)
		55	370 (15.9)	233 (15.6)	117 (15.4)
		56	433 (18.6)	269 (18.0)	153 (20.2)

*any ACORN Types not found within those referred to ERSs within the most deprived IMD 2004 quintile are omitted.

The breakdown in Table 8.11 shows that the majority of patients in the urban prosperity category can be grouped in Set D (the majority within Type 21). Therefore this suggests that ACORN is picking up heterogeneity of socioeconomic circumstance at small area level in that it is identifying the specific nature of deprivation experienced by individuals accessing and using ERSs in the most deprived areas. A fifth of the individuals accessing and using ERSs in deprived areas may be more accurately described as 'skills rich but materially poor' (or at least that they live in postcode areas

who's inhabitants can be most accurately described as this – Set D). For example, Type 21 is characterised by material deprivation; high unemployment, low monthly credit card spend and high council renting relative to the UK population average. However, inhabitants of postcodes assigned this ACORN Type are also likely to be well educated (the Index Score indicates that people in this Type are 33% more likely to have a degree or comparable qualification than the UK population on average).

Another partial explanation is that IMD 2004 is misclassifying individuals from these postcodes as deprived when in fact they are socioeconomically advantaged in both in terms of skills and material resources – Set C. This explanation applies to approximately 8% of patients who lived in the most deprived IMD 2004 quintile and who were referred to ERSs and around 9% of those who used the service. For example, Type 18 is characterised by socioeconomic advantage; people living in these postcodes are more likely to be employed in higher managerial positions and earn over £50,000 a year than the UK population average and are over twice as likely than the UK population overall to have a degree or comparable qualification.

8.5 Discussion

8.5.1 Main findings

ACORN had good content and construct validity and moderate criterion validity as an area-level measure of socioeconomic circumstance. Variables used to construct the ACORN classification include many that correspond well to accepted definitions of deprivation and this demonstrated the content validity of the classification. The criterion validity of ACORN was demonstrated by the moderate agreement of ACORN with IMD 2004 in its segmentation of the population. The extreme ends of the ACORN classification (the 'hard pressed' and 'wealthy achiever' Categories) appeared to have the closest correspondence with their respective IMD 2004 quintiles. ACORN's association with a health outcome, chlamydia positivity, was of the expected magnitude and direction and this supported the construct validity of the ACORN classification.

The ability of ACORN to measure area-level socioeconomic circumstance at a finer geographical resolution than IMD 2004 was found to provide more in depth insight into socioeconomic patterns of service access and use of ERSs than that which was afforded by using IMD 2004 alone. 31% of individuals referred to ERSs who lived within the most deprived IMD quintile, lived in postcodes classified by ACORN as relatively advantaged (the 'urban prosperity' Category), thus suggesting that ecological

fallacy might be an important consideration for the interpretation of results from the main analysis presented in Chapter 7. However, further analysis of the 'urban prosperity' Category by ACORN Type indicated the problem of ecological fallacy in the research sample was unlikely to be extensive. This was because only 8% of all referred patients living in the most deprived IMD 2004 quintile were residing in areas which appeared to be socioeconomically advantaged both in material and skills terms (i.e. Set C, ACORN Types 15, 16, 18 or 19). Instead, ACORN was uncovering the specific nature of deprivation experienced by a fifth of patients who were accessing and using ERSs in the most deprived IMD 2004 quintile. These patients came from postcodes who's inhabitants can be characterised as 'skills rich but materially poor'; they are lacking income but not education. The majority of other patients accessing ERSs who lived in the most deprived IMD 2004 quintile could be characterised as multiply deprived, both in skill and material terms (i.e. residing in postcodes classified by ACORN as either 'hard pressed' or 'moderate means').

8.5.2 Comparison to other studies

As far back as 1988 the need to scrutinize the quality of ACORN was raised[395]. However, no previous research evaluating the validity of ACORN as a measure of socioeconomic circumstance was identified. A small number of studies[396-401] have employed ACORN uncritically as a measure of socioeconomic circumstance without questioning the appropriateness or validity of using the classification for this purpose. Nevertheless, the results of some of this research provides insight into the content, criterion and construct validity of the classification, against which the results of this research can be compared. This previous research, however, was all conducted on an earlier version of ACORN based on the 1991 census that divided the population into six rather than five categories, and so the results are not directly comparable to the ones presented here. Nevertheless, the fundamental components of the ACORN classification and basic principles behind its construction have not altered drastically over the years[381] and so these previous findings are still of some value.

With respect to content validity, Hedges et al.[402] and Bowling et al.[403] agree with the conclusion made here, that the Categories within ACORN are hierarchical, differentiated according to level of socioeconomic circumstance. The construct validity of ACORN (ability to detect expected associations) reported here with respect to Chlamydia positivity is supported by previous research[401;402;404]. Hedges et al. report adjusted analyses for Health Survey for England respondents (1995 and 1996) showing that, in line with predicted associations between health and deprivation, those

living in the more advantaged ACORN Categories had better respiratory health, lower levels of smoking and lower levels of obesity than the less advantaged Categories[402]. Respondents in the most deprived Category, had the poorest self-reported health, highest prevalence of longstanding illness and highest prevalence of elevated blood pressure[402]. The ACORN classification also corresponded well to the socio-demographic characteristics of respondents. For example, 49% of adults classified by ACORN as living in the most deprived Category reported living in council rented accommodation, compared to only 4% of those in the most advantaged ACORN Category[402]. Morgan and Chinn in 1983 compared ACORN with the Registrar General's social class classification on measures of health and service use in a sample of 5500 primary school children in England[404]. ACORN was shown to differentiate at least as well as social class on the selected outcome measures[404]. A third study conducted in 1998 on data from primary care databases showed that, in line with *a priori* hypotheses, the prevalence of ischaemic heart disease increased across ACORN Categories, and was highest in ACORN's most deprived Category[401].

Very limited research has been undertaken assessing the added value of using ACORN in combination with an established measure of socioeconomic deprivation to monitor inequalities. Morgan and Chinn reported ACORN's utility in highlighting small geographic areas with particularly high rates of morbidity[404]. The added value of ACORN as a measure of socioeconomic circumstance alongside IMD 2004 for health service research has been tested by Jessica Sheringham and me for the National Chlamydia Screening Programme (NCSP)[386]. With ACORN we demonstrated that screening coverage was highest in deprived areas and in the most deprived locations (postcodes) within these areas. This finding may be explained by the distribution of screening settings, which have been shown to be concentrated in deprived areas[386].

8.5.3 Methodological considerations

Only 30% of the variables in the ACORN classification are from the census, the remaining lifestyle, income and assets information is derived from customer surveys and information from sales and warranty returns[1]. These data sources are likely to contain multiple response and sampling biases and are unlikely to be representative of the English population[13;378]. Systematic response bias is likely to occur because certain groups in society are more likely to buy products for which warranty returns are filled in, more willing or able to complete surveys, and more likely to be responsive to the incentives frequently offered for returning these questionnaires[378]. As a result, information from these sources is likely to be more comprehensive for

socioeconomically advantaged members of society[381]. Given the predominance of these data sources within geodemographic segmentation tools such as ACORN, these classifications may therefore be more accurate at profiling the attributes of advantaged rather than deprived groups, given they are likely to have more complete information to work with about these groups.

Unfortunately due to commercial sensitivities these commercial data are not publicly available or verifiable so no quality assurance can be undertaken and the extent of sampling and response bias is unknown. Furthermore, with the exception of the publicly funded OAC classification[405], the exact methodology and decision algorithms used to combine variables to produce commercial geodemographic tools such as ACORN are not disclosed. As well as limited information about methodology, the published Index Scores for each ACORN Type do not list; the exact data source for each variable, the sample size upon which the Index Score was derived, the confidence intervals for the Score, or the degree of imputation required for postcodes with missing information. Without confidence intervals it is impossible to be certain of the significance of a given Index Score. For example, an Index Score of 177 is meaningless if it is based on a very small sample with wide confidence intervals and as a result the true value could lie anywhere from substantially below to substantially above the national average.

Further issues with small-area measures include stability[381;406], accuracy[406] and confidentiality[7]. Stability is an issue because migration of just a small number of people into or out of a neighbourhood may substantially alter the socioeconomic characteristics of a given postcode area. Classifications at this level need to be frequently updated, which is a problem when an important source of data is the decennial census[381]. Due to small sample sizes and migration, the accuracy of small-area measures may be low, and assumptions must be made to create measures at this level. These assumptions maybe acceptable to commercial companies who are aiming to produce a product that is 'actionable' and 'fit for purpose'[378], but they maybe less palatable to public sector users and academics who demand a high level of data integrity, quality assurance and rigour. Confidentiality, and the problem of individual disclosure is frequently cited as a concern about undertaking analysis at small area level. However, ACORN publishes Index Scores for postcodes rather than estimates of prevalence. These Index Scores give an estimate of the relative propensity of people in these areas to have certain characteristics relative to the UK average, rather than a quantification of the exact numbers of people displaying given characteristics in

an area which would leave open the opportunity for potentially identifying individuals through disclosure by differencing[7]. Disclosure by differencing refers to the situation where by overlaying different geographic areas, it is possible to produce a novel geographic area by subtracting one from the other and as a result isolate specific households or persons[407].

As well as ecological fallacy, a further consideration when using area-based measures is the modifiable areal unit problem[408]. This shows that analytical conclusions may differ substantially according to how data are aggregated and where boundaries between areas are drawn[408]. A number of studies have looked at whether the scale upon which deprivation measurement is made influences judgements about relative health inequalities[409;410]. Woods et al. studied cancer survival comparing 11 different measures of socio-economic deprivation derived at different geographic scales. They found that the geographic level at which deprivation was measured had an important influence on the interpretation of inequalities in breast cancer survival across social groups. For example, they found the deprivation gap in crude survival was 25% smaller when estimated with larger geographic units, due to a dilution effect caused by the larger population of the larger area, and the associated increase in social heterogeneity[409]. However, contrary to this, a study conducted in the Netherlands examining general health found that the geographic level of the deprivation measure (neighbourhood, postcode sector or borough) had hardly any impact on the size of health inequalities calculated[410]. This difference may be because the Netherlands has more socioeconomically homogeneous areas than England. One conclusion as to the best way to address this problem is to use a variety of measures, which split neighbourhoods differently when trying, for example, to establish whether there are area-associations with health or healthcare use. Therefore, using two deprivation measures together, (as has been carried out here using ACORN and IMD 2004 in combination) may be looked upon favourably not only in terms of understanding the extent to which ecological fallacy may pose a problem for interpretation, but also in terms of addressing the modifiable areal unit problem.

ACORN provides greater geographical resolution than IMD 2004, however there may still be population heterogeneity within postcodes. For example, it is not possible to confirm that ERSs were being accessed by 'skills rich, materially poor' *individuals* within areas classified by ACORN as 'urban prosperity,' only that a number of patients accessing and using the scheme came from postcodes who's inhabitants were likely to display these characteristics. This research attempted to maximise the knowledge

gleaned from available information; in this case postcode information for patients referred to ERSs. Employing ACORN at postcode level in combination with IMD 2004 was the next best alternative to individual level data as it provided an indication of the likely extent of the problem of ecological fallacy. However, the use of individual data on socioeconomic status should be encouraged wherever and whenever possible (for example when designing tools to monitor service use, or bespoke surveys), as this is the only way to totally eliminate the problem of ecological fallacy.

8.5.4 Explanation of results

The reason that ACORN was found to have good validity as an area-based measure of deprivation is because, as outlined in the introduction, geodemographics have been developed to support companies target products and services to certain sectors of the population. If ACORN did not successfully segment the population in a way which was insightful, commercial companies would stop buying the product. Given, consumption and lifestyle choices are inextricably linked to socioeconomic circumstance, it is no surprise therefore that ACORN serves as a valid measure of socioeconomic circumstance.

A fifth of the people who were accessing and using ERSs in overall deprived areas could be described as 'skills rich but materially poor' (i.e. lacking income but not education). The high level of education means these individuals may not have faced psycho-social barriers to participation as they are likely to have had good health literacy, and may also have good self-efficacy. However, these same individuals may have faced material barriers such as having insufficient income to pursue private exercise opportunities, and therefore been ideal candidates for the ERS intervention which focused on alleviating material barriers to exercise. This explanation is expanded further in Chapter 9.

8.5.5 Conclusions

This research has validated the geodemographic segmentation tool ACORN as a measure of socioeconomic circumstance. It has also demonstrated the added value of using two deprivation measures at different geographic resolutions in tandem to obtain a deeper insight into socioeconomic variations in health service access and use.

The results illustrate the limitations of using deprivation measures such as IMD 2004 at LSOA level in isolation, as these may be inadequate to capture variations in socioeconomic experience in places such as London which are characterised by high

levels of population heterogeneity at small-area level. The analysis by ACORN Type of patients referred in the most deprived IMD 2004 quintile suggests that it is reasonable to infer that the pattern of scheme referral, uptake and completion found in this research is reflecting that ERSs were on the whole being accessed and used by deprived patients living in deprived areas.

Although ACORN has been shown to be a valid measure of socioeconomic circumstance, it would not be appropriate or desirable to abandon the use of established, publicly available area-based deprivation measures such as IMD 2004 in favour of geodemographic segmentation tools such as ACORN. IMD 2004 is a freely available, widely accepted, and well used measure of deprivation enabling direct comparison of results between studies. Commercial tools are expensive to purchase, they have not been designed with the sole purpose of measuring socio-economic deprivation, and the methodology used to construct them is not transparent. It is much more advisable therefore to use these additional sources of socioeconomic information alongside established measures. As Harris and Longley explain (pg. 1090):

"The coarser scale public sector data do provide an immensely valuable framework against which the characteristics of more 'uncertain' information sources can be gauged."[378]

Aside from the utility of ACORN as a measure of socioeconomic circumstance at small areas level there is also potential to use ACORN as a tool to inform future ERS practice. For example, within the most deprived IMD 2004 quintile, identifying geographical areas with high concentrations of 'hard pressed' ACORN types could be useful for deciding the location of ERS venues. In addition, lifestyle and assets information, such as email and mobile phone usage, may enable the application of social marketing techniques to select the most appropriate language and media to communicate with target audiences to publicise ERSs.

Chapter 9

Explanation and Implications

Chapter 9. Explanation and Implications

9.1 Thesis findings

General practices within areas of deprivation were more likely to refer to ERSs than their counterparts in more socioeconomically advantaged areas. This was the case after accounting for the higher levels of eligibility for ERSs within socioeconomically deprived communities. This pro-deprivation gradient in referral may have altered if need for ERSs could have been fully taken into account or if ethnicity could have been controlled for in the analysis (Chapter 7). Once referred, there was no evidence of an association between patient socioeconomic circumstance and the likelihood of taking up or completing the scheme.

The analysis of ACORN in combination with IMD 2004 found that approximately 9% of patients who were referred and used ERSs living in the most deprived IMD 2004 quintile resided in postcode areas which I assessed to be characterised by socioeconomically advantaged individuals (ACORN Types 15, 16, 18 or 19). Therefore, it is reasonable to infer that the pattern of scheme referral, uptake and completion found in this research is reflecting that ERSs were on the whole being accessed and used by deprived patients living in deprived areas.

These findings suggest that ERSs do not comply with the inverse care law[23], which has been commonly reported for preventive health services[19;20]. The claim that leisure-centre based schemes are unlikely to recruit people from deprived groups and that people from such groups are unlikely to adhere to exercise programmes[31;411] is not substantiated by this research.

9.2 Explanation of results

The pro-deprivation gradient in referral and the lack of socioeconomic gradient in completion of ERSs both emerged after scheme area was controlled for in the analysis and so these findings cannot be explained by differences between schemes. A commonality across all schemes was that they subsidised participation and offered good geographic accessibility. The scoping review confirmed that all ERSs charged patients a subsidised tariff or no tariff to participate in the scheme. All provided exercise opportunities at four or more venues, increasing the likelihood that at least one venue would be within walking distance of patients' homes. A plausible explanation for the research findings therefore is that the ERSs reduced material

barriers to access and use. ERSs focused efforts on alleviating 'external' barriers to exercise (ability to pay and lack of transport) previously identified as obstacles to participation in physical activity for people from socioeconomically deprived groups[28].

The analysis by ACORN demonstrated that a fifth of patients referred and using ERSs in the most deprived quintile were 'skills rich but materially poor' (ACORN Type 21), and the majority of the remaining patients in this quintile resided in postcodes characterised by inhabitants who were multiply deprived, both in terms of education and material resources (ACORN Categories 'Hard Pressed' and 'Moderate Means'). Hence, all of these patients were likely to have faced material barriers to exercise.

It is likely that general practitioners would have been aware (for example, through local referral manuals and ERS publicity) that the schemes were subsidised and therefore appropriate for patients who were motivated to change their physical activity habits but faced material barriers to doing so. This may in part explain why referral rates were higher for general practices serving deprived communities.

One of the most important findings to emerge from the cross-area analysis was the wide variations between schemes in the likelihood of patients being referred and completing Exercise Referral. This variation was perhaps unsurprising given the diverse characteristics of the schemes (Chapter 4). It was beyond the scope of this research with the available data to assess which particular features of scheme design and delivery were making a difference to patterns of service referral and use.

9.3 Conclusion

The National Quality Assurance Framework for ERSs emphasised the importance of ensuring that ERSs are delivered equitably and explicitly stated that schemes should employ strategies to engage people from disadvantaged groups[17].

Can I conclude that access to and use of ERSs was equitable? ERSs appeared to be addressing the greater need for the intervention within deprived groups[17], and if anything showing a pro-deprivation gradient in referrals which was in line with Government policy around tackling health inequalities[184]. ERSs also appeared to be successful in terms of ensuring equity of use, given that uptake and completion of the service was irrespective of the socioeconomic circumstance of patients. The findings from this research may be generalisable to other high quality ERSs running in socially-diverse urban areas (Chapter 6).

9.4 Policy and practice implications

Wolff and De-Shalit advocate status enhancement policies as a means of reducing inequalities[412]. Status enhancement policies are those which change the environment for everyone, for example by providing a subsidised service for all people with a defined need irrespective of material assets. This, they argue, will be a successful approach due to the lack of stigma attached to interventions which universally improve people's opportunities. I suggest that ERSs provide an example of a successful application of this approach.

However, it is important to set the positive findings of this equity research in context. ERSs and other interventions targeted at changing individual lifestyle behaviours, if effective, will only ever form part of the solution to increasing population physical activity levels and reducing inequalities. ERSs offer little scope to register any significant impact at the population-level[34;145;231]. This is because only a small proportion of people within the population are exposed to the schemes[413]. In this study on average only 18 out of every 1000 eligible patients were referred. The scheme with the highest likelihood of completion for patients was also the scheme with the lowest risk of referral. Hence, the schemes which were most successful in terms of securing adherence achieved the lowest penetration into the population[305]. On Rose's continuum of prevention ERSs may best be viewed as a "high-risk prevention" strategy rather than a population-based prevention strategy[414]. Therefore, if effective, ERSs should only be maintained in conjunction with other initiatives as part of a holistic, multi-level approach to physical activity promotion[270]. For example, environmental changes are also required to reduce the physical and social barriers to everyday opportunities for physical activity[77;80;265;415;416].

If ERSs, in combination with a range of other measures are going to have a profound impact on physical activity behaviour across the population, a single Government Department or cross-Departmental agency must take overall responsibility for the strategic direction of the physical activity agenda and be held accountable for the achievement of an overarching physical activity target[98].

Finally, better concordance between policy and evaluation must be achieved for future public health interventions. This can be secured through controlled, evaluated roll-outs of interventions. Future interventions should ensure realistic outcomes are identified and measured, national minimum datasets are developed and electronic data capture and transfer is encouraged. These steps will minimise unnecessary variability between

initiatives running in different areas (which hinders evaluation), whilst still providing room for local ingenuity and the tailoring of programmes to meet local needs.

9.5 Research implications

First and foremost, the apparent success of ERSs in promoting physical activity amongst more deprived groups underlines the need to evaluate their effectiveness in improving health and in reducing health inequalities as recommended by the National Institute for Health and Clinical Excellence[33]. Research to date suggests that ERSs have a small effect on increasing physical activity in sedentary people, but it is not certain that this small benefit is an efficient use of resources[279]. Research is needed therefore to examine the long-term effectiveness of ERSs in achieving desired outcomes, the cost-effectiveness of the intervention, and also critically from an equity perspective whether the ability to benefit from the service differs according to the socioeconomic circumstances of patients or according to the clinical conditions for which patients are referred initially. Evidence on ability to benefit would provide an indication of need for the service and how this varies across the population. This information could then be applied in future equity research to enable stronger conclusions to be drawn as to whether access to the service is consistent with need.

Secondly, this research has focused on the equity of ERSs for patients from different socioeconomic groups, but investigation of the equity of schemes in respect of other socio-demographic dimensions (age, sex and ethnicity) is warranted. For example, there was insufficient information to judge whether the apparent 'under-referral' of patients in the eldest age group represented age discrimination, patient preference or was merely a consequence of contraindications to exercise in extreme old age. This constitutes a potentially illuminating area of investigation.

Thirdly, in order to capitalise fully on the findings of this research, it is important to understand why ERSs are not conforming to the inverse-care law. The factors which are enabling a pro-deprivation gradient in referral to ERSs need to be identified. Research is also required to determine why no socioeconomic gradient is seen in the use of ERSs. This will enable the salient factors to be emulated in other contexts (for example, in allied services such as slimming on referral[417]) to ensure equitable services are provided.

Finally, although the problem of ecological fallacy is inherent in all research which is constrained to using area-based measures of deprivation, this study has demonstrated

how ACORN can be used to examine the likely extent of ecological fallacy. This technique could be applied in other contexts to gain further insight into the specific nature of socioeconomic experience at small-area level.

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Ref Type: Journal (Full)

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Appendices

Appendices

A. Glossary of abbreviations

BMI	Body Mass Index
CHD	Coronary Heart Disease
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
CVD	Cardiovascular Disease
DH	Department of Health
DoB	Date of Birth
DoR	Date of Referral
ERS	Exercise Referral Scheme
FHS	Family Health Services
GEEs	Generalised Estimating Equations
GP	General Practice
HCP	Health Care Professional
HSE	Health Survey for England
IMD	Index of Multiple Deprivation
LSOA	Lower Layer Super Output Area
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
NQAF	National Quality Assurance Framework for Exercise Referral
NSPD	National Statistics Postcode Directory
OR	Odds Ratio
PCT	Primary Care Trust
RCT	Randomised Controlled Trial
R&D	Research and Development
RR	Risk Ratio
UK	United Kingdom

B. Methods used to obtain literature to inform this research

A number of relevant areas of literature to inform this research were identified:

- Literature on exercise referral schemes
- Literature on physical activity promotion in the UK
- Literature on equity definitions, concepts and measurement
- Literature on defining and measuring socioeconomic status
- Literature on socioeconomic equity of healthcare, in particular primary care, preventative health services, health promotion and specialist services.
- Literature on factors influencing participation in physical activity (and why these may vary across socioeconomic groups)
- Literature on factors influencing access and use of healthcare services (and why these may vary across socioeconomic groups)
- Literature on factors influencing HCP referral behaviour and decision making

a) Literature searchers using electronic databases

The following databases were searched to obtain information on the subject areas outlined above:

- MEDLINE – Standard medical database covering 4300 journal titles. It has well developed indexing using MeSH terms. Updated weekly.
- WEB OF SCIENCE – Searches across Science Citation index, Social Sciences Citation Index, Arts and Humanities Citation index. Multidisciplinary series of databases. Updated weekly.
- CINAHL – Authoritative source of information for the professional literature of nursing, allied health, biomedicine and healthcare.
- COCHRANE – Includes databases of systematic reviews, reviews of effectiveness, controlled trials and review methods. Key resource in evidence-based medicine. Updated quarterly.
- EMBASE – European equivalent of Medline, stronger emphasis on European medical and health journals. Updated weekly.
- International Bibliography of the Social Sciences (IBSS) – Produced by LSE and covers anthropology, economics, political science and sociology and includes references to articles, book titles, chapters and reviews. Updated weekly.

- System for information on grey literature (SIGLE) – Includes reports, dissertations and other grey literature not normally found in other databases. Updated 6 monthly.
- PSYCHINFO – Produced by the American Psychological Association, covers psychology of health, sociology and anthropology. Includes both journals and books. Updated weekly.

Below are examples of the thesaurus and text word searches that were used to retrieve articles written about ERSs.

MEDLINE

Search date: October 2005, updated October 2006

Search	Terms	Articles
#15	((explode "Family-Practice" / all SUBHEADINGS in MIME,MJME,PT) or (gp) or (general adj practitioner) or (practice adj nurse)) and (explode "Referral-and-Consultation" / all SUBHEADINGS in MIME,MJME,PT) and ((explode "Health-Promotion" / all SUBHEADINGS in MIME,MJME,PT) or (explode "Exercise-Therapy" / all SUBHEADINGS in MIME,MJME,PT))	50
#14	(explode "Health-Promotion" / all SUBHEADINGS in MIME,MJME,PT) or (explode "Exercise-Therapy" / all SUBHEADINGS in MIME,MJME,PT)	43370
#13	(explode "Family-Practice" / all SUBHEADINGS in MIME,MJME,PT) or (gp) or (general adj practitioner) or (practice adj nurse)	70227
#12	(green prescription) or (exercise referral) or (exercise on prescription) or (exercise on referral)	51
#11	green prescription	15
#10	exercise referral	17
#9	exercise on prescription	19
#8	exercise on referral	1
#7	Gp	18570
#6	general adj practitioner	9585
#5	practice adj nurse	771
#4	explode "Family-Practice" / all SUBHEADINGS in MIME,MJME,PT	49170
#3	explode "Health-Promotion" / all SUBHEADINGS in MIME,MJME,PT	28059
#2	explode "Referral-and-Consultation" / all SUBHEADINGS in MIME,MJME,PT	38805
#1	explode "Exercise-Therapy" / all SUBHEADINGS in MIME,MJME,PT	15454

CINAHL

Search date: October 2005, updated October 2006

Search	Terms	Articles
#16	("Referral-and-Consultation" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE) and ((explode "Exercise-" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE) or (explode "Physical-Activity" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE)) and ((explode "Family-Practice" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE) or (gp) or (explode "Primary-Health-Care" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE) or (general adj practitioner) or (practice adj nurse))	16
#15	(explode "Exercise-" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE) or (explode "Physical-Activity" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE)	30111
#14	(explode "Family-Practice" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE) or (gp) or (explode "Primary-Health-Care" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE) or (general adj practitioner) or (practice adj nurse)	31217
#13	"Referral-and-Consultation" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE	6608
#12	explode "Family-Practice" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE	3698
#11	explode "Primary-Health-Care" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE	11533
#10	explode "Exercise-" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE	25658
#9	explode "Physical-Activity" / all TOPICAL SUBHEADINGS / all AGE SUBHEADINGS in DE	5956
#8	(green prescription) or (exercise referral) or (exercise on prescription) or (exercise on referral)	86
#7	green prescription	15
#6	exercise referral	41
#5	exercise on prescription	37
#4	exercise on referral	2
#3	Gp	12624
#2	general adj practitioner	2117
#1	practice adj nurse	3939

EMBASE

Search date: October 2005, updated October 2006

Search	Terms	Articles
#14	((gp) or (explode "general-practitioner" / all SUBHEADINGS in DEM,DER,DRM,DRR) or (general adj practitioner) or (explode "primary-medical-care" / all SUBHEADINGS in DEM,DER,DRM,DRR) or (practice adj nurse)) and (explode "patient-referral" / all SUBHEADINGS in DEM,DER,DRM,DRR) and (("exercise" / all SUBHEADINGS in DEM,DER,DRM,DRR) or ("physical-activity" / all SUBHEADINGS in DEM,DER,DRM,DRR))	78
#13	(gp) or (explode "general-practitioner" / all SUBHEADINGS in DEM,DER,DRM,DRR) or (general adj practitioner) or (explode "primary-medical-care" / all SUBHEADINGS in DEM,DER,DRM,DRR) or (practice adj nurse)	92811
#12	explode "general-practitioner" / all SUBHEADINGS in DEM,DER,DRM,DRR	23577
#11	explode "primary-medical-care" / all SUBHEADINGS in DEM,DER,DRM,DRR	23141
#10	explode "patient-referral" / all SUBHEADINGS in DEM,DER,DRM,DRR	19338
#9	("exercise" / all SUBHEADINGS in DEM,DER,DRM,DRR) or ("physical-activity" / all SUBHEADINGS in DEM,DER,DRM,DRR)	83460 (cont.)
#8	(green prescription) or (exercise referral) or (exercise on prescription) or (exercise on referral)	57
#7	green prescription	14
#6	exercise referral	18
#5	exercise on prescription	25
#4	exercise on referral	1

#3	Gp	49921
#2	general adj practitioner	6659
#1	practice adj nurse	242

I did not rely solely on literature searches within electronic databases for literature retrieval. This is because the nature of the subject matter meant that I could not be sure that the search terms were adequately sensitive or specific enough to pick up key articles related to this research. Therefore, a range of other techniques proved useful.

b) Latest journal alerts

Physical activity is a fast-moving policy and research area. As a result there are a lot of papers being published around this topic. Therefore, email updates of table of contents for key public health and health services research journals provided a good mechanism to keep up-to-date with the rapidly developing evidence base in this area.

c) 'Snowballing' from key papers identified within the literature

It proved valuable to identify key papers and 'snowball' references from these using either the bibliographies of these papers, or using the 'cited reference search' facility within electronic journals and the Web of Science database. There is also the option within Medline and other databases to select 'search related articles' which finds articles similar to the origin paper (although the exact search mechanism used to find these is not stated explicitly).

d) Press releases and websites of key organisations

Given this is an applied area of research, it was important to keep abreast of latest policy developments. Therefore press releases from for example, the Department of Health, National Institute for Health and Clinical Excellence and British Heart Foundation were monitored, as was coverage of topics relevant to my research in broadsheet newspapers.

e) Personal communication with experts in the field

Known authors in the field were contacted by email for information on papers in press or in progress. Contacts were made at: conferences (for example, following the presentation of findings from the initial stages of this research at the 15th UK Public Health Association conference in Edinburgh, March 2007); seminars (for example, ESRC seminar series – Pathways to Obesity, Chandos House, London, October 2007), and workshops (for example, National Social Marketing Centre and Association of Public Health Observatories Geodemographics workshop, Department of Health, London, March 2008).

C. Variables used to construct the domains of the IMD 2004

Full details available from[12;224].

Income Deprivation Domain
Adults and children in Income Support households (2001).
Adults and children in Income Based Job Seekers Allowance households (2001).
Adults and children in Working Families Tax Credit households whose equivalised income (excluding housing benefits) is below 60% of median before housing costs (2001).
Adults and children in Disabled Person's Tax Credit households whose equivalised income (excluding housing benefits) is below 60% of median before housing costs (2001).
National Asylum Support Service supported asylum seekers in England in receipt of subsistence only and accommodation support (2002).

Employment Deprivation Domain
Unemployment claimant count (JUVOS) of women aged 18-59 and men aged 18-64 averaged over 4 quarters (2001).
Incapacity Benefit claimants women aged 18-59 and men aged 18-64 (2001).
Severe Disablement Allowance claimants women aged 18-59 and men aged 18-64 (2001).
Participants in New Deal for the 18-24s who are not included in the claimant count (2001).
Participants in New Deal for 25+ who are not included in the claimant count (2001).
Participants in New Deal for Lone Parents aged 18 and over (2001).

Health Deprivation and Disability Domain
Years of potential life lost (1997-2001).
Comparative illness and disability ratio (2001).
Measures of emergency admissions to hospital (1999-2002).
Adults under 60 suffering from mood or anxiety disorders (1997-2002).

Crime Domain
Burglary (4 recorded crime offence types, (April 2002-March 2003).
Theft (5 recorded crime offence types, April 2002-March 2003, constrained to CDRP level).
Criminal damage (10 recorded crime offence types, April 2002-March 2003).
Violence (14 recorded crime offence types, April 2002-March 2003).

Education, Skills and Training Deprivation Domain
Sub Domain: Children/young people
Average point score of children at Key Stage 2 (2002).
Average point score of children at Key Stage 3 (2002).
Average point score of children at Key Stage 4 (2002).
Proportion of young people not staying on in school or school level education above 16 (2001).
Proportion of those aged under 21 not entering Higher Education (1999-2002).
Secondary school absence rate (2001-2002).
Sub Domain: Skills
Proportion of working age adults (aged 25-54) in the area with no or low qualifications (2001)).

Barriers to Housing and Services Domain
Sub Domain: Wider barriers
Household overcrowding (2001).
LA level percentage of households for whom a decision on their application for assistance under the homeless provisions of housing legislation has been made, assigned to SOAs (2002).
Difficulty of Access to owner-occupation (2002).
Sub Domain: Geographical barriers
Road distance to GP premises (2003).
Road distance to a supermarket or convenience store (2002).
Road distance to a primary school (2001-2002).
Road distance to a post-office (2003).

The Living Environment Deprivation Domain
Sub Domain: The 'indoors' living environment
Social and private housing in poor condition (2001).
House without central heating (2001).
Sub Domain: The 'outdoors' living environment
Air quality (2001).
Road traffic accidents involving injury to pedestrians and cyclists (2000-2002).

D. Participation consent form

Consent form signed by managers of all participating Exercise Referral Schemes (Sarah McBeath maiden name for Sarah Sowden).

PARTICIPATION AGREEMENT

Title of Project: **Evaluating the equity of exercise referral schemes**

Name of Researcher: **Sarah McBeath (principal supervisor Prof Rosalind Raine)**

Contact details: **Sarah McBeath**
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Please initial box

1. I confirm that I have read the covering letter and protocol for the above study. ☐
2. I understand what is required of _____exercise referral scheme in order to participate in this research. ☐
3. I agree for _____exercise referral scheme to participate in this research. ☐

_____	_____	_____
Name of exercise referral coordinator	Date	Signature
_____	_____	_____
Name of researcher	Date	Signature

When completed, 1 for exercise referral coordinator, 1 for UCL researcher

E. Non-general practice referral centres

All referrals made by non-general practice locations were coded as 1001 and excluded from the equity analysis.

Non-GP referral centre
Camden Reach team
Royal Free hospital
St Mary's hospital
South Camden Reach team
Cardiac rehabilitation physiotherapists
St Luke's Hospital
Islington Reach team
ASH
GPDA physiotherapist
Occupational therapy department
Royal Free Osteoporosis team
Community team learning and disabilities unit
John Orwell Sports Centre
Mile End & Royal hospital (Diabetic C)
Mile End hospital
St Clements hospital
St George's Pools
Tiler Leisure Centre
White chapel sports centre
York Hall
Dorothea (Diabetes service)
Lambeth Hospital
Exit class
Princess Royal University hospital, Cardiac rehabilitation unit
Princess Royal University hospital, Respiratory rehabilitation unit
Princess Royal University hospital, Neurology department
Princess Royal University hospital, Rheumatology department
Orpington hospital, Physiotherapy falls department
Orpington hospital, Physiotherapy back pain department
Dietetics department
Diabetes centre, Orpington Business centre
Beckenham hospital, Pain Relief unit
Beckenham hospital, Physiotherapy department
Beckenham hosptial, Rheumatology department
Mottingham Community Clinic
St Paul Cray Clinic community dieticians
Shewsbury Road Diabetes Clinic
Newham General Hospital, Cardiac Rehabilitation department
Shewsbury Road, Newham Chest Clinic
Dr Gelding, Newham General Hospital
Stratford Workshops, Long Term Conditions Team
Lennard Road Back Clinic
Assertive outreach
Bethlem Royal Hospital
Broad Green Centre
Central West Resource centre
Coast Westways
Community Dietician
Community Mental Health
Crescent Resource Centre
Croydon PCT
Diabetes Department
Diabetes Dietician
Dietetic Department
Elderly rehab
Kings College
Mayday Hospital
Mayday Hospital Physiotherapy department
Mental Health
Neurological Rehabilitation department
Occupational Health
Public Health
Purley Hospital
Purley Physiotherapy department
Purley resource centre
Recovery and Rehabilitation
Tamworth resource centre
Westways resource centre
Windsor house
Woodleigh community centre

F. Final datasets for analysis

Table F.1 Variables in dataset for referral analysis

(each row corresponds to one 5 year age-sex-general practice group)

Variable	Level	Type	Description	Values
Key	5 year age-sex-gp group		Unique identifier for each 5 year age-sex-gp group	
Referrals	5 year age-sex-gp group	Continuous	Number of referrals	
Population	5 year age-sex-gp group	Continuous	Total GP list size	
Needprop	5 year age-sex-gp group	Continuous	Proportion of patients eligible for referral to ERS (derived from HSE 2004)	
Needpop	5 year age-sex-gp group	Continuous	Number of people on GP list eligible for referral to ERS	
Age	5 year age-sex-gp group	Continuous	Average age of individuals within the 5 year age-sex-gp group	
Agegrp	5 year age-sex-gp group	Ordered categorical	5 year age bands for age at referral	0=16-19 yrs 1=20-24 2=25-29 3=30-34 4=35-39 5=40-44 6=45-49 7=50-54 8=55-59 9=60-64 10=65-69 11=70-74 12=75-79 13=80-84 14=85+
Sex	5 year age-sex-gp group	Binary	Sex	0=male 1=female
Refresearch	General practice	Categorical	Unique identifier for each general practice	
Imdscore	General practice	Continuous	IMD 2004 score based on LSOA of general practice postcode	
Imdrank	General practice	Continuous	IMD 2004 rank based on LSOA of general practice postcode (1=most deprived)	
Imdquint	General practice	Ordered Categorical	IMD 2004 quintile based on SOA of general practice postcode (quintile 1=20% most deprived LSOA in England) (quintile 5=20% least deprived LSOA in England)	0=quintile 1 1=quintile 2 2=quintile 3 3=quintile 4 4=quintile 5
Shortdist	General practice	Continuous	Shortest distance from postcode of general practice to nearest participating exercise venue	
Training	General practice	Binary	Training status of referring general practice	0=no 1=yes
Scheme	PCT	Categorical	ERS area	1=Area 1 2=Area 2 3=Area 3 4=Area 4 5=Area 5 6=Area 6

Table F.2 Variables in dataset for uptake and completion analysis

(each row in dataset corresponds to one referred patient)

Variable	Level	Type	Description	Values
ID	Individual		Unique record identifier for combined research dataset	
Refresearch	General practice		Unique identifier for referral venue	1000=out of area/unknown GP 1001=non-GP
Re-referral	Individual	Binary	Re-referral of same individual to ERS	0=no 1=yes
Refgp	Individual	Binary	Referred by general practice	0=no 1=yes
Takeup	Individual	Binary	Whether person attends initial appointment	0=no 1=yes
Complete	Individual	Binary	Whether person completes the programme	0=no 1=yes
IMDscore	Individual	Continuous	IMD 2004 score based on LSOA of home postcode	
IMDrank	Individual	Continuous	IMD 2004 rank based on LSOA of home postcode (1=most deprived)	
IMDquint	Individual	Ordered categorical	IMD 2004 quintile based on LSOA of home postcode (quintile 1=20% most deprived LSOA in England) (quintile 5=20% least deprived LSOA in England)	0=quintile 1 1=quintile 2 2=quintile 3 3=quintile 4 4=quintile 5
Ethnicity	Individual	Categorical	Ethnic group referred person belongs to	0=White 1=Mixed 2=Asian/Asian British 3=Black/Black British 4=Chinese/other ethnic group
Age	Individual	Continuous (years)	Age at referral	
Agegrp	Individual	Categorical	10 year age bands for age at referral	0= 16-24 years 1= 25-34 2= 35-44 3= 45-54 4= 55-64 5= 65-74 6= 75-84 7= 85+
Sex	Individual	Binary	Sex of referred person	0=male 1=female
CVD	Individual	Binary	Referred for primary or secondary prevention of CVD	0=no 1=yes
Weight	Individual	Binary	Referred because overweight/obese	0=no 1=yes
Diabetes	Individual	Binary	Referred because of diabetes	0=no 1=yes
Respiratory	Individual	Binary	Referred because of asthma/COPD/other respiratory condition	0=no 1=yes
MentalHealth	Individual	Binary	Referred because of mental health problems	0=no 1=yes
Ageing	Individual	Binary	Referred because of old age	0=no 1=yes
Muscneuro	Individual	Binary	Referred because of musculoskeletal/neurological	0=no 1=yes

Variable	Level	Type	Description	Values
			conditions	
Shortestdist	Individual	Continuous (metres)	Shortest distance from home postcode to nearest participating exercise venue	
Homedistcat	Individual	Ordered categorical	Shortest distance from home postcode to nearest participating exercise venue (grouped)	0=0-499 metres 1=500-999 metres 2=1000-1499 metres 3=1500-1999 metres 4=2000+ metres
Shortestrefdist	General practice	Continuous (metres)	Shortest distance from postcode location of referring general practice to nearest participating exercise venue	
Refdistcat	General practice	Ordered categorical	Shortest distance from referring general practice to nearest participating exercise venue (grouped)	0=0-499 metres 1=500-999 metres 2=1000-1499 metres 3=1500-1999 metres 4=2000+ metres
Training	General practice	Binary	Training status of referring general practice	0=no 1=yes
Scheme	Primary Care Trust	Categorical	ERS area	1=Area 1 2=Area 2 3=Area 3 4=Area 4 5=Area 5 6=Area 6

G. Exclusions prior to undertaking GEE analysis

Take up and completion

Table G.1 summarises missing uptake and completion data across the six ERSs during 24 month study period (April 2004 – March 2006).

Table G.1 Missing information on uptake and completion by ERS

Scheme	Total records N	Take up missing n (%)	Completion missing n (%)
Area 1	2247	19 (0.85)	850 (37.83)
Area 2	3224	0 (0)	0 (0)
Area 3	2079	5 (0.24)	5 (0.24)
Area 4	969	719 (74.20)	719 (74.20)
Area 5	1021	24 (2.35)	31 (3.04)
Area 6	560	21 (3.75)	21 (3.75)
Total	**10100**	**788 (7.80)**	**1626 (16.10)**

Area 1 had comprehensive recording of take-up of the intervention, but less so for completion status as this was missing for over a third of participants. Area 2 had no missing information on scheme uptake or completion. This was because it was assumed that any person without a take-up / completion appointment date recorded indicated that the person did not attend that appointment, rather than that the data was missing (i.e. they attended the appointment but for some reason this was not entered onto the system). The exercise referral scheme manager confirmed that a missing date represented failure to attend. I was confident in this assumption given that Area 2 had high data completeness across all variables so there was no reason to suspect that activity monitoring by the scheme was any different.

Area 4 had high levels of missing information about the take-up and completion status of its ERS participants. Furthermore, the information that was available on take-up of the service may have been inaccurate, because only 2 people were recorded as not taking up the service (Table G.2). This resulted in a proportion of patients taking up the intervention which was far higher in Area 4 (99%) compared to the other scheme areas (between 60-70%). There was no reason identified during the scoping stage of this work (see Chapter 5) to suggest that Area 4 would have atypically high uptake rates, and for this reason I felt it was more reasonable to interpret this as indicative of a problem with the data recording system, rather than a true reflection of take-up rates in Area 4 ERS. Because of these

concerns over data accuracy and completeness Area 4 patients were omitted from the uptake and completion analyses.

Table G.2 Take up of ERS by scheme area

Scheme	Attends initial appointment		
	No	Yes	Total
	n (%)	n (%)	N* (%)
Area 1	853 (38.29)	1375 (61.71)	2228 (100)
Area 2	1196 (37.10)	2028 (62.90)	3224 (100)
Area 3	776 (37.42)	1298 (62.58)	2074 (100)
Area 4	2 (0.80)	248 (99.20)	250 (100)
Area 5	326 (32.70)	671 (67.30)	997 (100)
Area 6	194 (35.99)	345 (64.01)	539 (100)

*those will missing information for take-up excluded from total N.

Ethnicity

Table G.3 shows the completeness of ethnicity recording by scheme area over the 24 month study period April 2004-March2006. The overall completeness of ethnicity recording was low (44%) due to Area 2 and Area 5 schemes which did not record ethnicity at all. Area 6, Area 4 and Area 3 all had reasonable completeness for this variable and ethnicity was recorded for 60% of referrals in Area 1.

Table G.3 Missing information on ethnicity by ERS

Scheme area	Total records N	Ethnicity data missing n (%)
Area 1	2247	900 (40.05)
Area 2	3224	3224 (100)
Area 3	2079	278 (13.37)
Area 4	969	149 (15.38)
Area 5	1021	1021 (100)
Area 6	560	116 (20.71)
Total	**10100**	**5688 (56.32)**

Due to the incompleteness of ethnicity recording, this variable was excluded from the main GEE analysis, but was included in an additional sensitivity analysis.

H. GEE models

Table H.1 – Table H.3 outline the successive GEE models run for i) referral, ii) uptake and iii) completion analyses. A backward elimination technique was used to ultimately arrive at the final GEE models, which include only those covariates significantly ($p \leq 0.05$) related to the respective outcomes (referral, uptake and completion). At each stage the least significant variable was dropped from the model. IMD 2004 quintile was the exposure variable of interest and this has been retained in all models, regardless of significance. The p-value for this variable is shown for each separate model. The results of the final models are presented in Chapter 7.

Table H.1 Progression to final GEE model – (i) referral analysis

Model no.	Exposure variables in model	Significant in model ($p \leq 0.05$)	Not significant in model	Variable to drop to progress to next model
1 (full)	IMD quintile, age group, sex, scheme, shortest ref dist, training status of general practice	**IMD quintile (p=0.008)** Age group Sex Scheme	Shortest ref distance. Training status of general practice.	Training status of general practice
2	IMD quintile, age group, sex, scheme, shortest ref distance	**IMD quintile (p=0.009)** Age group Sex Scheme	Shortest ref distance.	Shortest ref distance
3 (final)	IMD quintile, age group, sex, scheme	**Age group (p<0.001)** **Sex (p<0.001)** **Scheme (p<0.001)** **IMD quintile (p=0.004)** **IMD quintile – test for trend (p=0.001)**		

Table H.2 Progression to final GEE model – (ii) uptake analysis

Model no.	Exposure variables in model	Significant in model ($p \leq 0.05$)	Not significant in model	Variable to drop to progress to next model
1 (full)	IMD quintile, scheme, sex, cvd, weight, diabetes, resp, mental, old age, muscneuro, training, age group, shortest home dist, shortest ref dist	Sex Age group	All other covariates **IMD quintile (p=0.816)**	Weight
2	IMD quintile, scheme, sex, cvd, diabetes, resp, mental, old age, muscneuro, training, age group, shortest home dist, shortest ref dist	Sex Age group Mental health	All other covariates **IMD quintile (p=0.816)**	Old age
3	IMD quintile, scheme, sex, cvd, diabetes, resp, mental, muscneuro, training, age group, shortest home dist, shortest ref dist	Sex Age group Mental health	All other covariates **IMD quintile (p=0.814)**	CVD
4	IMD quintile, scheme, sex, diabetes, resp, mental, muscneuro, training, age group, shortest home dist, shortest ref dist	Sex Age group Mental health	All other covariates **IMD quintile (p=0.812)**	Respiratory
5	IMD quintile, scheme, sex, diabetes, mental, muscneuro, training, age group, shortest home dist, shortest ref dist	Sex Age group Mental health	All other covariates **IMD quintile (p=0.813)**	Shortest home distance
6	IMD quintile, scheme, sex, diabetes, mental, muscneuro, training, age group, shortest ref dist	Sex Age group Mental health Distance referring GP to nearest ERS venue	All other covariates **IMD quintile (p=0.823)**	Training status
7	IMD quintile, scheme, sex, diabetes, mental, muscneuro, age group, shortest ref dist	Sex Age group Mental health Distance referring GP to nearest ERS venue	All other covariates **IMD quintile (p=0.818)**	Scheme area
8	IMD quintile, sex, diabetes, mental, muscneuro, age group, shortest ref dist	Sex Age group Mental health	All other covariates **IMD quintile (p=0.811)**	Diabetes
9	IMD quintile, sex, mental, muscneuro, age group, shortest referral distance	Sex Age group	All other covariates **IMD quintile (p=0.837)**	Shortest ref distance
10	IMD quintile, sex, mental, muscneuro, age group	Sex Age group Musculoskeletal / neurological	Mental health **IMD quintile (p=0.852)**	Mental health
11 (final)	**IMD quintile, sex, muscneuro, age group**	**Sex ($p<0.001$)** **Age group ($p<0.001$)**	**IMD quintile (p=0.852)**	

		Musculoskeletal / neurological (p=0.036)	**IMD quintile test for trend (p=0.890)**	

Table H.3 Progression to final GEE model – (iii) completion analysis

Model no.	**Exposure variables in model**	**Significant in model (p ≤ 0.05)**	**Not significant in the model**	**Variable to drop to progress to next model**
1 (full)	IMD quintile, scheme, sex, cvd, weight, diabetes, resp, mental, old age, muscneuro, training, age group, shortest home dist, shortest ref dist	Scheme Age group Diabetes GP training status	All other covariates **IMD quintile (p=0.053)**	Shortest ref dist
2	IMD quintile, scheme, sex, cvd, weight, diabetes, resp, mental, old age, muscneuro, training, age group, shortest home dist	Scheme Age group Diabetes GP training status	All other covariates **IMD quintile (p=0.052)**	Shortest home dist
3	IMD quintile, scheme, sex, cvd, weight, diabetes, resp, mental, old age, muscneuro, training, age group	Scheme Age group Diabetes GP training status	All other covariates **IMD quintile (p=0.052)**	Respiratory
4	IMD quintile, scheme, sex, cvd, weight, diabetes, mental, old age, muscneuro, training, age group	Scheme Diabetes GP training status Age group CVD	All other covariates **IMD quintile (p=0.058)**	Old age
5	IMD quintile, scheme, sex, cvd, weight, diabetes, mental, muscneuro, training, age group	Scheme Diabetes GP training status Age group	All other covariates **IMD quintile (p=0.060)**	Mental health
6	IMD quintile, scheme, sex, cvd, weight, diabetes, muscneuro, training, age group	Scheme Diabetes GP training status Age group CVD	All other covariates **IMD quintile (p=0.058)**	Muscneuro
7	IMD quintile, scheme, sex, cvd, weight, diabetes, training, age group	Scheme Diabetes GP training status Age group CVD	All other covariates **IMD quintile (p=0.054)**	Weight
8	IMD quintile, scheme, sex, cvd, diabetes, training, age group	Scheme Diabetes GP training status Age group CVD	All other covariates **IMD quintile (p=0.054)**	Sex
9	**IMD quintile, scheme, cvd, diabetes,**	**Scheme (p<0.001)**	**IMD quintile**	

(final)	**training, age group**	**Diabetes (p=0.007)** **GP training status (p=0.048)** **Age group (p<0.001)** **CVD (p=0.020)**	**(p=0.060)** **IMD quintile test for trend (p=0.20)**

I. GEE models for ethnicity sensitivity analysis

Table I.1 Progression to final GEE model - for uptake analysis on reduced dataset which includes ethnicity covariate

Model no.	Exposure variables in model	Significant in model (p ≤ 0.05)	Variable to drop to progress to next model
1 (full)	IMD quint, scheme, sex, ethnicity, cvd, weight, diabetes, resp, mental, old age, muscneuro, training, age group, shortest home dist, shortest ref dist	Scheme, Muscneuro, Age group Sex, Ethnicity	Weight
2	IMD quint, scheme, sex, ethnicity, cvd, diabetes, resp, mental, old age, muscneuro, training, age group, shortest home dist, shortest ref dist	Scheme, Muscneuro, Sex, Age group, Ethnicity	Respiratory
3	IMD quint, scheme, sex, ethnicity, cvd, diabetes, mental, old age, muscneuro, training, age group, shortest home dist, shortest ref dist	Scheme, Muscneuro, Sex, Age group, Ethnicity	Distance from home to nearest ERS venue
4	IMD quint, scheme, sex, ethnicity, cvd, diabetes, mental, old age, muscneuro, training, age group, shortest ref dist	Scheme, Muscneuro, Sex, Age group, Ethnicity	Diabetes
5	IMD quint, scheme, sex, ethnicity, cvd, mental, old age, muscneuro, training, age group, shortest ref dist	Scheme. Muscneuro, Sex, Age group, Ethnicity	Mental health
6	IMD quint, scheme, sex, ethnicity, cvd, old age, muscneuro, training, age group, shortest ref dist	Scheme, Muscneuro, Sex, Age group, Ethnicity	Training status
7	IMD quint, scheme, sex, ethnicity, cvd, old age, muscneuro, age group, shortest ref dist	Scheme, Muscneuro, Sex, Age group, Ethnicity	Old age
8	IMD quint, scheme, sex, ethnicity, cvd, muscneuro, age group, shortest ref dist	Scheme, Muscneuro, Sex, Age group, Ethnicity, CVD	Distance from general practice to nearest ERS venue
9 (final)	**IMD quint, scheme, sex, ethnicity, cvd, muscneuro, age group**	**Scheme (<0.001)** **Muscneuro (p<0.001)** **Sex (p<0.001)** **Age group (p<0.001)** **Ethnicity (p<0.001)** **CVD (p=0.046)** **IMD quintile (p=0.74)**	

Table I.2 Progression to final GEE model – for completion analysis on reduced dataset which includes ethnicity covariate

Model no.	Exposure variables in model	Significant in model ($p \leq 0.05$)	Variable to drop to progress to next model
1 (full)	IMD quint, scheme, sex, ethnicity, cvd, weight, diabetes, resp, mental, muscneuro, training, age group, shortest home dist, shortest ref dist	Scheme, Diabetes, IMD quint, Age group	Respiratory
2	IMD quint, scheme, sex, ethnicity, cvd, weight, diabetes, mental, muscneuro, training, age group, shortest home dist, shortest ref dist	Scheme, Diabetes, IMD quint, Age group	Distance from general practice to nearest ERS venue
3	IMD quint, scheme, sex, ethnicity, cvd, weight, diabetes, mental, muscneuro, training, age group, shortest home dist	Scheme, Diabetes, IMD quint, Age group	Weight
4	IMD quint, scheme, sex, ethnicity, cvd, diabetes, mental, muscneuro, training, age group, shortest home dist	Scheme, Diabetes, Age group	Muscneuro
5	IMD quint, scheme, sex, ethnicity, cvd, diabetes, mental, training, age group, shortest home dist	Scheme, Diabetes, Age group	Distance from home to nearest ERS venue
6	IMD quint, scheme, sex, ethnicity, cvd, diabetes, mental, training, age group	Scheme, Diabetes, Age group	Mental health
7	IMD quint, scheme, sex, ethnicity, cvd, diabetes, training, age group	Scheme, Diabetes, IMD quint, Age group	CVD
8	IMD quint, scheme, sex, ethnicity, diabetes, training, age group	Scheme, Diabetes, IMD quint, Age group	Training status
9	IMD quint, scheme, sex, ethnicity, diabetes, age group	Scheme, Age group	Sex
10 (final)	**IMD quint, scheme, ethnicity, diabetes, age group**	**IMD quint ($p=0.054$)** **Diabetes ($p=0.032$)** **Scheme ($p<0.001$)** **Age group ($p<0.001$)** **Ethnicity ($p=0.22$)**	

J. Patients by IMD 2004 quintile and analysis covariates

Table J.1 Proportion breakdown of IMD 2004 quintile of referred patients by each of the additional analysis covariates included in the analysis.

		IMD 2004 quintile of deprivation (1=most deprived)				
		1	2	3	4	5
	N=6101*					
	N (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Age group (years)	**p<0.001**					
16-29	556 (100)	213 (41.6)	177 (31.8)	63 (11.3)	34 (6.1)	51 (9.2)
30-44	1624 (100)	757 (46.6)	458 (28.2)	166 (10.2)	114 (7.0)	129 (7.9)
45-59	2110 (100)	831 (39.4)	547 (25.9)	273 (12.9)	189 (9.0)	270 (12.8)
60-74	1550 (100)	454 (29.3)	345 (22.3)	240 (15.5)	208 (13.4)	303 (19.6)
75 and over	261 (100)	62 (23.8)	68 (26.1)	44 (16.9)	30 (11.5)	57 (21.8)
Sex	**p=0.007**					
Males	1778 (100)	700 (39.4)	467 (26.3)	186 (10.5)	172 (9.7)	253 (14.2)
Females	4323 (100)	1634 (37.8)	1128 (26.1)	600 (13.9)	403 (9.3)	557 (12.9)
Scheme area						
Area 1	1433 (100)	253 (17.7)	565 (39.4)	384 (26.8)	118 (8.2)	113 (7.9)
Area 2	1969 (100)	165 (8.4)	341 (17.3)	321 (16.3)	448 (22.8)	694 (35.3)
Area 3	1901 (100)	1454 (76.5)	430 (22.6)	11 (0.6)	4 (0.2)	2 (0.1)
Area 5	464 (100)	270 (58.2)	151 (32.5)	41 (8.8)	2 (0.4)	0 (0.0)
Area 6	334 (100)	193 (57.8)	108 (32.3)	29 (8.7)	3 (0.9)	1 (0.3)
Distance in metres from GP to nearest ERS venue (metres)	**p<0.001**					
0-499	1520 (100)	550 (36.2)	400 (26.3)	209 (13.8)	131 (8.6)	230 (15.1)
500-999	1205 (100)	512 (42.5)	316 (26.2)	112 (0.3)	112 (0.3)	128 (10.6)
1000-1499	1889 (100)	841 (44.5)	515 (27.3)	136 (7.2)	136 (7.2)	173 (9.2)
1500-1999	731 (100)	287 (39.3)	203 (27.8)	66 (0.0)	66 (9.0)	80 (10.9)
2000 and over	756 (100)	145 (19.2)	161 (21.3)	130 (17.2)	130 (17.2)	199 (26.3)
Referred by a training practice						
No	3737 (100)	1465 (39.2)	900 (24.1)	477 (12.8)	361 (9.7)	534 (14.3)
Yes	2364 (100)	870 (36.8)	695 (29.4)	309 (13.1)	214 (9.1)	276 (11.7)
Distance in metres from home to nearest ERS venue (metres)	**p<0.001**					
0-499	1031 (100)	476 (46.2)	272 (26.4)	158 (15.3)	68 (6.6)	57 (5.5)
500-999	1725 (100)	650 (37.7)	559 (32.4)	216 (12.5)	118 (6.8)	182 (10.6)
1000-1499	1554 (100)	675 (43.4)	379 (24.4)	169 (10.9)	151 (9.7)	180 (11.6)
1500-1999	1007 (100)	336 (33.4)	256 (25.4)	128 (12.7)	111 (11.0)	176 (17.5)
2000 and over	784 (100)	198 (25.3)	129 (16.5)	115 (14.7)	127 (16.2)	215 (27.4)
Referred for CVD prevention	**p<0.001**					
No	3399 (100)	1076 (31.7)	894 (26.3)	485 (14.3)	402 (11.8)	542 (16.0)
Yes	2702 (100)	1259 (46.6)	701 (25.9)	301 (11.1)	173 (6.4)	268 (9.9)
Referred because overweight / obese	**p<0.001**					
No	4275 (100)	1865 (43.6)	991 (23.2)	408 (9.5)	405 (9.5)	606 (14.2)
Yes	1826 (100)	470 (25.7)	604 (33.1)	378 (20.7)	170 (9.3)	204 (11.2)
Referred because of diabetes	**p<0.001**					
No	5023 (100)	1756 (35.0)	1282 (25.5)	675 (13.4)	537 (10.7)	773 (15.4)
Yes	1078 (100)	579 (53.7)	313 (29.0)	111 (10.3)	38 (3.5)	37 (3.4)
Referred for respiratory reasons	**p<0.001**					
No	5607 (100)	2054 (36.6)	1468 (26.2)	745 (13.3)	550 (9.8)	790 (14.1)
Yes	494 (100)	281 (56.9)	127 (25.7)	41 (8.3)	25 (5.1)	20 (4.1)
Referred for mental health reasons	**p<0.001**					
No	4890 (100)	1809 (37.0)	1250 (25.6)	651 (13.3)	482 (9.9)	698 (14.3)
Yes	1211 (100)	526 (43.4)	345 (28.5)	135 (11.2)	93 (7.7)	112 (9.3)

		IMD 2004 quintile of deprivation (1=most deprived)				
		1	2	3	4	5
	N=6101* N (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Referred for old age						
No	6071 (100)	2326 (38.3)	1583 (26.1)	778 (12.8)	574 (9.5)	810 (13.3)
Yes	30 (100)	9 (30.0)	12 (40.0)	8 (26.7)	1 (3.3)	0 (0.0)
Referred for musculoskeletal / neurological problems	**p<0.001**					
No	4562 (100)	1894 (41.5)	1221 (26.8)	524 (11.5)	389 (8.5)	534 (11.7)
Yes	1539 (100)	441 (28.7)	374 (24.3)	262 (17.0)	186 (12.1)	276 (17.9)

*All patients referred to ERS with complete co-variate information

K. Missing data sensitivity analysis

Table K.1 Multivariate model indicating covariates associated^ with missing take up information (n=6124)

Covariate	OR*	95% CI
IMD rank*	**(p=0.030)^**	
Trend – for each 100 rank increase in IMD rank	0.99	0.99-1.00
Age*	**(p<0.001)^**	
	1.05	1.02-1.07
Sex	**(p=0.75)**	
Male (baseline)	1	
Female	0.87	0.37-2.04
Distance in metres from referring general practice to nearest ERS venue	**(p=0.26)**	
Trend – for each 100 metre increase in distance	1.03	0.98-1.08
Training status of general practice	**(p=0.15)**	
No (baseline)	1	
Yes	2.40	0.72-8.01
Distance in metres from home to nearest ERS venue	**(p=0.62)**	
Trend – for each 100 metre increase in distance	0.99	0.94-1.04
Referred for CVD	**(p=0.002)^**	
No (baseline)	1	
Yes	0.06	0.01-0.37
Referred due to overweight/obese	**(p=0.21)**	
No (baseline)	1	
Yes	1.70	0.74-3.87
Referred for diabetes	**(p=0.27)**	
No (baseline)	1	
Yes	0.34	0.05-2.32
Referred for respiratory reasons	**(p=0.09)**	
No (baseline)	1	
Yes	2.61	0.85-7.99
Referred for mental health reasons	**(p=0.001)^**	
No (baseline)	1	
Yes	2.96	1.53-5.73
Referred due to old age	**(p=0.005)^**	
No (baseline)	1	
Yes	6.32	1.73-23.18
Referred for musculoskeletal/neurological conditions	**(p=0.33)**	
No (baseline)	1	
Yes	0.54	0.16-1.87

*The small number of records with missing uptake information (0.5% of all patients referred by general practices) caused an unbalanced dataset and as a result the analysis encountered convergence issues with the categorical variables age group, IMD quintile and scheme area. To resolve the convergence issues, IMD rank (a continuous variable) and age (a continuous variable) were used in the model instead of their respective categorical variables. ERS area was omitted.

Table K.2 Multivariate model indicating covariates associated with missing completion information (n=4021)

Covariate*	OR*	95% CI
IMD quintile	**(p=0.38)**	
1 (baseline)	1	
2	1.20	0.88-1.65
3	1.34	0.85-2.11
4	1.14	0.76-1.72
5	1.02	0.70-1.50
Age group	**(p=0.18)**	
16-29 years (baseline)	1	
30-44 years	0.93	0.64-1.35
45-59 years	0.76	0.51-1.13
60-74 years	0.67	0.45-0.99
75 years and over	0.94	0.52-1.70
Sex	**(p=0.57)**	
Male (baseline)	1	
Female	1.05	0.89-1.24
Distance in metres from referring general practice to nearest ERS venue	**(p=0.86)**	
Trend – for each 100 metre increase in distance	1.00	0.97-1.03
Training status of general practice	**(p=0.31)**	
No (baseline)	1	
Yes	1.38	0.74-2.60
Distance in metres from home to nearest ERS venue	**(p=0.66)**	
Trend – for each 100 metre increase in distance	1.00	0.98-1.01
Referred for CVD	**(p=0.32)**	
No (baseline)	1	
Yes	0.89	0.70-1.12
Referred due to overweight/obese	**(p=0.90)**	
No (baseline)	1	
Yes	0.98	0.75-1.29
Referred for diabetes	**(p=0.91)**	
No (baseline)	0.98	0.71-1.35
Yes		
Referred for respiratory reasons	**(p=0.59)**	
No (baseline)	1	
Yes	1.08	0.82-1.42
Referred for mental health reasons	**(p=0.05)**	
No (baseline)	1	
Yes	1.21	1.00-1.48
Referred due to old age	**(p=0.18)**	
No (baseline)	1	
Yes	1.99	0.74-5.38
Referred for musculoskeletal/neurological conditions	**(p=0.83)**	
No (baseline)	1	
Yes	1.04	0.75-1.43

* ERS scheme area covariate not included in the model due to unresolved convergence issues.

Missing IMD quintile (exposure) information

Multivariate analysis testing the association between each exposure covariate and missing IMD quintile information was undertaken (Table K.3). The analysis was undertaken first on the dataset used to analyse take up of ERS, and separately on the dataset used to

analyse completion of ERS (i.e. with those who did not attending the initial ERS appointment excluded). Home postcode was used to obtain measures of both IMD 2004 and also the distance to nearest ERS venue covariate. Therefore, individuals with missing IMD quintile information also had missing information for the home distance covariate, and hence this covariate was not included in the analysis presented in Table K.3.

There were variations across scheme areas in the likelihood of having missing IMD 2004 information (Table K.3). Patients who took up the ERS intervention were around 30% less likely to have missing information about IMD 2004 quintile than those who did not take up the intervention (adjusted OR 0.69, 95% CI: 0.56-0.85). Patients referred for weight reasons were less likely to have missing IMD 2004 information than patients who were not (adjusted OR 0.61, 95% CI: 0.44-0.84, (N=6389), adjusted OR 0.50, 95% CI: 0.29-0.86, (N=3705)). Patients referred for mental health or musculoskeletal/neurological conditions were also less likely to have missing information on IMD 2004 quintile than those who were not referred for these conditions.

Table K.3 Multivariate analysis* testing covariate association with missing IMD quintile information

	Dataset used to analyse take up of ERS (N=6389)		Dataset used to analyse completion of ERS (N=3705**)	
Covariate	**OR***	**95% CI**	**OR**	**95% CI**
Take up/completion of ERS	**(p=0.001)**		**(p=0.69)**	
No (baseline)	1		1	
Yes	0.69	0.56-0.85	0.91	0.57-1.44
Age group	**(p=1.00)**		**(p=0.96)**	
16-29 years (baseline)	1		1	
30-44 years	1.07	0.69-1.68	1.27	0.48-3.33
45-59 years	1.07	0.70-1.64	1.33	0.47-3.80
60-74 years	1.07	0.65-1.78	1.40	0.47-4.15
75 years and over	1.14	0.55-2.36	1.62	0.45-5.80
Sex	**(p=0.58)**		**(p=0.30)**	
Male (baseline)	1		1	
Female	0.92	0.68-1.25	0.79	0.51-1.23
Scheme	**(p<0.001)**		**(p<0.001)**	
Area 1 (baseline)	1		1	
Area 2	0.69	0.45-1.06	0.79	0.43-1.48
Area 3	0.03	0.01-0.08	0.40	0.01-0.14
Area 5	0.37	0.21-0.66	0.33	0.14-0.80
Area 6	0.59	0.32-1.07	0.75	0.35-1.63
Distance in metres from referring general practice to nearest ERS venue	**(p=0.26)**		**(p=0.27)**	
Trend – for each 100 metre increase in distance	1.01	0.99-1.02	1.01	0.99-1.02
Training status of general practice	**(p=0.16)**		**(p=0.16)**	
No (baseline)	1		1	
Yes	1.33	0.89-1.98	1.45	0.87-2.44
Referred for CVD	**(p=0.11)**		**(p=0.67)**	
No (baseline)	1		1	

	Dataset used to analyse take up of ERS (N=6389)		Dataset used to analyse completion of ERS (N=3705**)	
Covariate	**OR***	**95% CI**	**OR**	**95% CI**
Yes	0.79	0.59-1.05	0.89	0.51-1.53
Referred due to overweight/obese	**(p=0.003)**		**(p=0.012)**	
No (baseline)	1		1	
Yes	0.61	0.44-0.84	0.50	0.29-0.86
Referred for diabetes	**(p=0.10)**		**(p=0.18)**	
No (baseline)	1		1	
Yes	0.70	0.46-1.07	0.59	0.27-1.29
Referred for respiratory reasons	**(p=0.97)**		**(p=0.95)**	
No (baseline)	1		1	
Yes	1.01	0.58-1.75	0.97	0.40-2.37
Referred for mental health reasons	**(p=0.053)**		**(p=0.40)**	
No (baseline)	1		1	
Yes	0.70	0.49-1.00	0.77	0.42-1.41
Referred due to old age	**(p=0.58)**		**(p=0.96)**	
No (baseline)	1		1	
Yes	0.61	0.10-3.62	0.94	0.12-7.63
Referred for musculoskeletal/neurological conditions	**(p=0.051)**		**(p=0.27)**	
No (baseline)	1		1	
Yes	0.72	0.52-1.00	0.72	0.40-1.29

*Multivariate analysis with all covariates included.
**Only included individuals who took up their initial ERS appointment.

L. ACORN variables and comparison of index values

Table L.1 ACORN variables reported by CACI and a comparison of Index Scores for Type 1 and Type 56[1;390]

Variable	Category 1, Group A, Type 1	Category 5, Group Q, Type 56
1. FREQUENTLY USED CENSUS-DERIVED MEASURES OF SOCIOECONOMIC STATUS		
Socioeconomic classification		
Higher managerial/professional occupations	246	62
Lower managerial/professional occupations	139	70
Intermediate and supervisory occupations	84	74
Routine occupations	33	100
Full time students in termtime	103	190
Looking for work - more than 2 years	28	260
No SeC for other reasons incl never worked	97	133
Working status		
Full time working	104	72
Full time working - self employed	182	57
Full time working - male	108	66
Full time working - female	96	83
Part time working	101	72
Part time working - male	98	167
Part time working - female	102	57
Looking for work	43	229
Looking for work - less than 2 years	54	178
Looking for work - more than 2 years	28	260
Looking for work - never worked	19	454
Full time students in termtime	103	190
FT students in termtime - econ active	94	165
FT students in termtime - econ inactive	109	205
Part time students in termtime - econ inactive	66	341
Housewife or househusband	109	200
Retired	123	56
Long term ill	31	131
Industry		
Agriculture workers	99	16
Manufacturing/mining/construction workers	72	54
Retail workers	81	102
Other workers	116	119
Educational qualifications		
No or unknown qualifications	47	115
GCSEs or comparable	90	81
A-levels or comparable	123	109
Degree or comparable	206	104
Tenure		
Owned outright	166	21
Owned with mortgage	113	34
Rented from council or housing association	6	342
Rented privately	46	104
Other tenure	72	100
Dwelling size		
1-2 room household	15	342
3-4 room household	17	172
5-6 room household	46	68
7+ room household	374	23
Dwelling height		
Basement	90	134
Ground floor	112	53
Floor 1-4	19	387
Floor 5+	2	936
Density measures		
Population per households	114	113
Rooms per households (all Hhs)	148	77
Rooms per households (Priv hhs)	130	68
Communal population	117	56
Population per hectare	27	364

Household size		
1 person household	50	103
2 person household	119	70
3-4 person household	122	106
5+ person household	133	207
Household composition		
1 non-pensioner adult dependent kids (single parent)	31	259
1 pensioner adult no kids	64	71
1 non-pensioner adult no kids	37	132
1 non-pensioner adult dependent kids	31	259
1 non-pensioner adult non-dep kids only	58	159
2 pensioner adults no kids	161	31
2 non-pensioner adults no kids	131	40
2 non-pensioner adults dependent kids	146	86
2 non-pensioner adults non-dep kids only	136	59
3+ non-pensioner adults no kids	61	203
Other household composition	95	289
House type		
Detached house or bungalow	352	8
Semi-detached house or bungalow	41	17
Terraced house or bungalow	12	53
Purpose built flat	10	462
Converted flat	43	177
Household spaces mainly over shops	27	122
Mobile and temporary household spaces	40	42
Car ownership		
0 cars or vans	15	208
1 car or van	67	82
2 cars or vans	212	27
3 cars or vans	299	20
4+ cars or vans	361	19
2. NON-CENSUS DERIVED ECONOMIC VARIABLES WHICH ARE INDICATORS OF INCOME/WEALTH		
Family incomes		
Family Income £0-9999	43	140
Family Income £10000-19999	57	103
Family Income £20000-29999	79	72
Family Income £30000-39999	120	74
Family Income £40000 - 49999	189	79
Family Income £50000+	506	45
Investments and savings		
Have an ISA	158	48
Have Stocks and Shares	224	36
Have a Unit trust	315	17
Have company pension scheme	137	42
Have Private Personal Pension scheme	156	36
Have high interest investments	266	32
Have regular savings plan	161	55
Have child savings plan	130	87
Have guaranteed income bonds	263	41
Have Lump Sum Investment	268	34
Have funeral plan	91	95
Credit cards		
Have credit card with UK bank	155	90
Have credit card with UK new player	173	49
Have credit card with US player	127	122
Dissatisfied with some aspect of credit cards	95	143
Credit card limit 0-999	82	156
Credit card limit 1000-2499	76	102
Credit card limit 2500-4999	141	89
Credit card limit 5000+	300	36
Monthly credit card spend 0-50	71	87
Monthly credit card spend 51-100	110	83
Monthly credit card spend 101-250	107	86
Monthly credit card spend 250+	305	59
Financial and insurance		
Have a mortgage	112	29
0-10 years left on mortgage	138	40
11+ years left on mortgage	87	38
Have re-mortgage	73	0
Have mortgage protection	109	31
Have accident insurance	135	59
Have home contents insurance	106	42

Have life assurance/ insurance	126	50
Have motor insurance	145	37
Have travel insurance	272	42
Health insurance with BUPA	324	46
Health insurance with Norwich Union healthcare	220	75
Health insurance with PPP	326	65
Health insurance with Prime Health	274	93
Company pays for PMI	209	71
Personally pay for PMI	189	76
Internet account with e-bank	240	69
Internet account with traditional bank	186	97
Have National Savings account	250	42
Food shopping		
Spend 0 to 25 per week	74	99
Spend 25 to 44 per week	64	117
Spend 45 to 59 per week	87	83
Spend 60 to 74 per week	112	94
Spend over 75 per week	223	86
3. NON-CENSUS DERIVED INDICATORS OF ASSET PREFERENCE/POSSESSION (ASSETS FREQUENTLY USED TO MEASURE SOCIOECONOMIC STATUS)		
Cars		
Bought main car new	230	34
Company Car	244	23
Company car user/chooser	259	22
Keeps main car in garage	213	22
Keeps main car on driveway /road	133	40
Car insurance 0-300	105	31
Car insurance 300-500	155	75
Car insurance 500+	172	122
Has motorbike	75	8
Has scooter	111	42
Likely to spend 0-5000 on main car	44	69
Likely to spend 5000-10000 on main car	89	45
Likely to spend 10000-20000 on main car	245	38
Likely to spend 20000+ on main car	604	21
White and brown goods		
Have microwave	104	92
Have tumble dryer or washer/dryer	122	79
Have dishwasher	266	47
Have cable TV	74	112
Have video	105	93
Subscribe to cable TV or cable phone	59	111
Have satellite TV	121	84
Have digital TV	102	85
Have DVD Player	118	107
Have digital camera	170	74
Have PC	158	97
Have laptop computer	302	77
Have Mac / iMac	291	118
4. INTERESTS/LIFESTYLE CHOICES WHICH ARE POSSIBLY SOCIOECONOMICALLY PATTERNED		
Internet		
Use internet for email	168	67
Use home PC for careers/job planning	141	97
Use home PC for education/reference	170	83
Use home PC for home finance	207	55
Use home PC for playing computer games	142	85
Use home PC for home shopping	178	71
Use digital TV to make purchases/bookings	123	108
Use internet to source credit card	94	55
Use internet to buy insurance	125	156
Use internet to buy financial services	213	74
Use internet to buy investments / ISAs	506	98
Use internet to arrange personal loan	84	0
Use internet to buy gifts	173	72
Use internet to buy/research cars	208	43
Use internet to make leisure and holiday bookings	215	68
Use internet for shopping: books/cds	183	54
Use internet for shopping: clothing/fashion	143	105
No internet purchase in last year	121	112
1-3 internet purchases in last year	116	96
4+ internet purchase in last year	189	55

Have internet savings account	196	122
Have internet access via TV	67	128
Holidays		
Camping / Caravanning	80	79
Hotel / Hotel Package	128	72
Self-catering	117	86
Weekend break	165	79
Winter snow	317	66
Winter sun	169	68
UK / Ireland	115	73
Europe / Med	145	75
USA / Canada	218	85
Rest of the World	181	127
Preferred charities		
Contribute by covenant or direct debit to charity	178	99
Animal welfare	97	79
Children	123	92
Disabled	105	75
Disaster relief	177	74
Elderly	123	79
Environment	168	92
Medical	161	65
Third world	162	95
Wildlife	132	64
Interests		
Eating Out	109	82
Foreign travel	155	84
Gourmet food / Wine	209	107
Home computing	94	131
Snow skiing	304	39
Theatre / Arts	166	100
Cinema	130	85
Exercise / Sport	141	99
Magazine subscriber	179	64
Angling	55	57
Horseracing	70	102
Charity / Voluntary work	131	120
Cookery	78	143
Bingo	22	124
Current Affairs	166	183
DIY	79	98
Environment / Wildlife	106	71
Fine arts / Antiques	226	85
Fashion / Clothes	94	152
Football	82	118
Football pools	73	89
Gardening	125	38
Hiking / Walking	128	40
Listening to music	67	121
National Trust	189	32
Photography	116	135
Reading books	96	94
Rugby	169	47
Golf	217	37
Self improvement / Education	96	182
Sewing / Needlecrafts	91	100
Birdwatching	164	35
Music - classical / opera	192	84
Music – easy listening	95	98
Music - eighties	80	102
Music - light classical	169	79
Music - rock and roll	106	92
Reading historical works	153	139
Religious activities	159	141
Eating habits		
Regularly eat evening meal in pub/restaurant	151	43
Regularly eat lunch in pub/restaurant	90	30
Visits coffee bar 3+ times per week	74	70
Eat brown/wholemeal/granary bread	131	98
Travel to work		
Work from home (Scotland: work/study from home)	167	88
Travel to work(study) by foot/cycle	43	118
Travel to work(study) by train/tube/tram/bus	76	336

Travel to work(study) by car/motorcycle	108	43
Travel to work(study) by other means	75	91
Newspaper readership		
Daily express	101	92
The Sun	36	156
Telegraph	271	69
The Guardian	154	230
The Sunday Times	323	81
Financial Times	285	194
General shopping		
Wines by mail order	177	64
Wine buyer (6+ bottles per month)	279	62
Family uses herbal medicines/health foods	121	121
Family uses vitamins/minerals/supplements	125	107
Use home delivery service for weekly shopping	126	184
Buyer of environmentally friendly/recycled products	111	93
Catalogue spend 500+ in last year	44	110
5. DEOMOGRAPHIC VARIABLES		
Age		
Aged 0-4	83	161
Aged 5-14	109	139
Aged 15-19	103	128
Aged 20-24	61	140
Aged 25-29	42	133
Aged 30-44	83	106
Aged 45-59	140	63
Aged 60-64	128	64
Aged 65-74	113	58
Aged 75-84	91	49
Aged 85+	103	41
Ethnicity		
White	103	52
Asian	75	468
Asian - Indian	114	204
Asian - Pakistani	38	252
Asian - Bangladeshi	13	2071
Black	18	1297
Black – Caribbean	15	929
Black - African	22	1743
Chinese	106	343
Mixed	81	411
Other ethnic	117	584
Religion		
No religion	84	79
Christian	105	70
Muslim	44	802
Jew	463	169
Sikh	99	143
Hindu	125	224
Buddhist	104	384
Other or did not state religion	84	141