# Pay for performance, inequalities, and diabetes care

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**Abstract**

Background: The Quality and Outcome Framework (QOF) is a major pay for performance scheme that was introduced in 2004 in the UK. The introduction of QOF is a unique opportunity to evaluate the impact of pay for performance on inequalities and in particular on ethnic inequalities. This thesis examines the impact of QOF on ethnic inequalities and on patients with and without comorbidities in diabetes management.

Methods: (1) Interrupted time series analysis of electronic medical record data of diabetes patients registered with 29 family practices in South West London for the years 2000 to 2007. (2) Cross-sectional study to examine the association between ethnicity, concordant and discordant comorbidity status and intermediate outcomes (HbA1c, blood pressure, total cholesterol).

Results: The quality of diabetes care, as measured by the QOF indicators, has improved substantially throughout the study period, especially for the process aspect of care. The introduction of QOF was associated with initial additional improvements in systolic blood pressure in white and black patients but this was only sustained in black patients. Initial improvements in diastolic blood pressure in white and in cholesterol in black and white patients were not sustained in the post-QOF period. There was no beneficial impact of QOF on HbA1c in any ethnic group. The presence of ≥2 cardiovascular comorbidities was associated with similar blood pressure control among white and South Asian patients when compared with whites without comorbidity but with worse blood pressure control among black patients.

Conclusion: The QOF scheme did not appear to address important inequalities in diabetes management over time. Targeted quality improvement strategies may be required to improve health care in vulnerable populations.

# TABLE OF CONTENTS

# List of Figures

# List of Tables

# List of Boxes

## Abbreviations

| | |
|---|---|
| ACCORD | Action to Control Cardiovascular Risk in Diabetes |
| AOR | Adjusted Odds Ratio |
| BP | Blood Pressure |
| BMI | Body Mass Index |
| BMA | British Medical Association |
| CHD | Coronary Heart Disease |
| CKD | Chronic Kidney Disease |
| COPD | Chronic Obstructive Pulmonary Disease |
| CONDUIT | Cutting Out Needless Deaths Using Information Technology |
| CI | Confidence Interval |
| GPRD | General Practice Research Database |
| HbA1c | Glycated hemoglobin |
| HR | Hazard Ratio |
| HSE | Health Survey of England |
| IDF | International Diabetes Federation |
| IOM | Institute of Medicine |
| NHS | National Health Service |
| NICE | National Institute for Clinical Excellence |
| NSF | National Service Framework |
| OHA | Oral Hypoglycaemic Agent |
| QOF | Quality and Outcome Framework |
| QMAS | Quality Management and Analysis System |
| SES | Socioeconomic status |
| SMR | Standardized Mortality Ratio |
| UKPDS | United Kingdom Prospective Diabetes Study |
| WHO | World Health Organization |

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## Declaration of originality

The work presented here is my own. I have received advice from my supervisors Christopher Millett and Azeem Majeed. Gopalakrishnan Netuveli and John Lee advised me on the interrupted time series analysis.

# 1.0 Introduction

## 1.1 Definition of diabetes

Diabetes mellitus is a chronic disease characterized by hyperglycemia because of insulin deficiency, or insulin resistance. It is one of the leading causes of death in many developed and developing countries. Diabetes is an expensive chronic disease and, if not managed correctly, it can lead to long-term complications such as cardiovascular diseases, lower limb amputation, kidney failure, blindness and may lead to death.

The World Health Organization (WHO) criteria for the diagnosis of diabetes mellitus is a fasting blood glucose of ≥7.0 mmol/l or a 2-hour glucose level of ≥11.1 mmol/l following an oral glucose tolerance test. Recently glycated hemoglobin (HbA1c) is being advocated as a measure for the diagnosis of diabetes. The American Diabetes Association published a position statement to recommend a cut-off value of 6.5% for the diagnosis of diabetes. This should be confirmed with a repeat test of HbA1c (1). Similarly, the WHO recently recommended the use of HbA1c as a diagnostic measure for diabetes (2).

Diabetes is divided into three main types: Type-1 diabetes (formally known as insulin-dependent diabetes), which results from the destruction of beta cells in the islet cells of Langerhans in the pancreas. This results in insulin deficiency and patients need daily insulin administration. Type-2 diabetes (formally known as non-insulin dependent diabetes) mainly affects adults and account for ~90% of the diagnosed cases. It is characterized by ineffective action of insulin.

Gestational diabetes is glucose intolerance first identified during pregnancy, and may or may not require insulin treatment (3).

The rising prevalence of diabetes, its long-term complication, its economic cost and inequalities in the quality of diabetes care make it a priority for governments to improve the performance of their health system and invest in preventing and improving the quality of diabetes care as effective treatment and coordination between health professionals leads to reductions in fatal complications (4). The following section discusses these issues including the secondary prevention efforts. However, primary prevention of diabetes is beyond the scope of this thesis.

## 1.2 Incidence, prevalence, consequences, and cost of diabetes

### 1.2.1 Incidence and prevalence of diabetes

The prevalence of diabetes is increasing globally and is a major challenge in both developed and developing countries. Wild et al., estimated that the worldwide prevalence of diabetes will increase from 2.8% in 2000 to 4.4% in 2030 among all age groups (171 million in 2000 to 366 million in 2030) (5). Show et al., provided an updated estimate using a larger number of studies than that previously used. They estimated that worldwide prevalence of diabetes is set to increase to 7.7% (439 million adults) in 2030 from 6.4% in 2010 (285 million adults) (6). This is lower than estimate by Danaei et al, of 347million adults in 2008 (7). In the United States 28.6 million (7.8% of the population) were estimated to have diabetes in 2007 (8). Similar increases are evident in Europe.

The International Diabetes Federation (IDF) has estimated the prevalence of diabetes in Europe in 2010 to be 8.5% and to increase to 10.0% in 2030 (9). Similar to the United States and other European countries, the United Kingdom (UK) has experienced a marked rise in the incidence and prevalence of diabetes over the past two decades. Using data from 208 practices in England and Wales, which contributed to the General Practice Research Database (GPRD), Ryan et al., estimated the incidence of diabetes over a period of five years from 1994 to 1998. The age standardised incidence rate increased from 17.6 per 10,000 person-years in 1994 to 22.1 per 10,000 person-years in 1998. The largest absolute increases in the rate of new cases were observed among individuals aged between 65 and 74 years, but the authors did not distinguish between type-1 and type-2 diabetes (10). A more recent study that used data from the Health Improvement Network Database and covered 300 practices found an overall increase in diabetes incidence of 63% from 1996 to 2005. Throughout the study period, the incidence of type-1 diabetes was 0.13 (95% Confidence Interval (CI): 0.12–0.14) per 1000 person-years and the incidence of type-2 diabetes increased from 2.60 (95% CI: 2.47–2.74) per 1000 person-years in 1996 to 4.31 (95% CI: 4.21–4.42) per 1000 person-years in 2005. These increased with age and were similar for both sexes. However, this changed for adults aged more than 40 years, where men had a higher incidence than women. The prevalence of diabetes increased from 2.8% in 1996 to 4.3% in 2005, an overall increase of 54% across the study period. The prevalence increased by 0.4% in individuals aged 10-19 years and 17% in individuals aged 70-79 years (11). Data from 240 practices covering 4 million patients found an

increase in the age-standardised incidence from 1.82 per 1000 person-years in 1994 to 3.31 per 1000 person-years in 2003. The trend in incidence was similar in both sexes but the absolute age-standardised rate was higher in men then women in all years. Similarly, the age-standardised prevalence rate increased from 16.2 per 1000 person-years in 1994 to 28.7 per 1000 person-years in 2003. This was higher in men than women in every year (12). Recent data from the Health Survey of England (HSE) showed a similar picture of increases in prevalence. The prevalence rose from 2.9% to 6.5% among men and 1.9% to 4.5% among women between 1994 and 2009, respectively. This picture was similar among younger adults but there were larger increases among older adults. The prevalence increased between 1994 and 2009 from 7.5% to 19.5% and 5.2% to 12.7% among men and women aged 75 and older, respectivley (13). These estimates are lower than estimates by the APHO (Association of Public Health Observatory), which applied age-sex-ethnic specific reference prevalence rate to local population in a prevalence model to estimate the prevalence of diagnosed and undiagnosed diabetes in England. Estimates of total diabetes in 2010 were 7.4% with an expected increase to 9.5% in 2030. These were adjusted for age, sex, ethnicity, and deprivation (14). These figures were also higher than figures derived from the Quality and Outcome Framework (QOF). Estimates of prevalence in England were 3.3%, 3.6%, 3.7%, 3.9%, 5.1%, and 5.4% in 2004, 2005, 2006, 2007, 2008 and 2009 respectively. All ages were used until 2007, followed by adults only from 2008, hence, the increased prevalence in 2008.

### 1.2.2 Consequences of diabetes

Diabetes is a major cause of premature mortality around the world. Roglic et al., found that almost four million deaths in 2010 are attributable to diabetes (6.8% of all-cause mortality) (15). In Europe more than 630,000 individuals are expected to die from diabetes in 2010. Figure 1 shows the percentage of mortality in 2010 broken by age and sex.

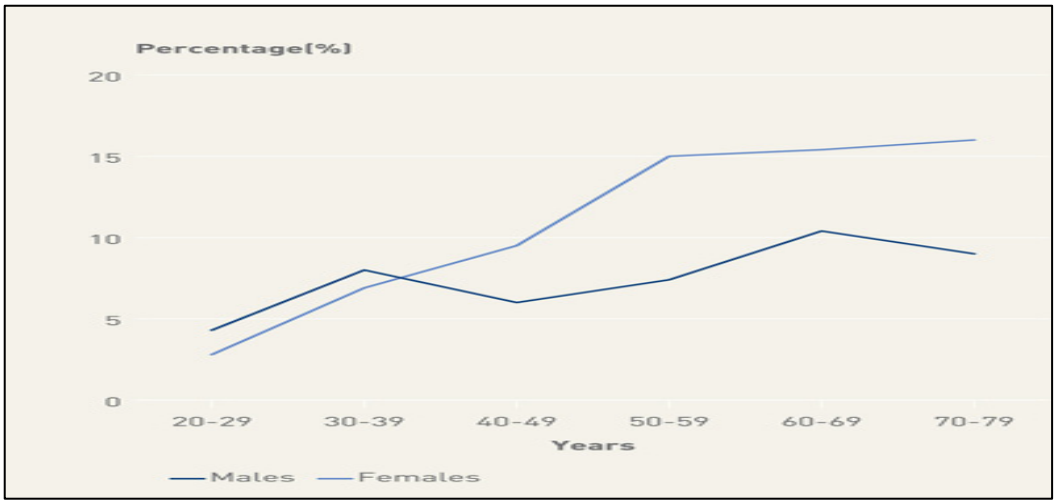


*Figure 1 Percentages of all-cause mortality attributable to diabetes by age and sex in 2010 in Europe*

Source: International Diabetes Federation

Using data from GPRD in 2006, Mulnier et al., found the hazard ratio (HR) for all-cause mortality in type-2 diabetes patients was 1.93 (95% CI: 1.89–1.97) when compared with individuals without diabetes (16). Likewise, using the same database, Soedamah-Muthu et al., found that the hazard ratio of all-cause mortality in type-1 diabetes was 3.7 (95% CI: 3.2–4.3), when compared to those without it (17).

Cardiovascular disease:

People with diabetes have a substantially elevated risk of cardiovascular disease morbidity and mortality (18). Life expectancy in diabetes is substantially lower (by 5 to 10 years) when compared to those without (19), and though the overall cardiovascular mortality is declining, a similar picture is not evident in patients with diabetes (18). A 3.5-year follow-up of 1,298 subjects selected from a Finish population found that 14.8% of type-2 diabetes patients and 3.4% non-diabetic subjects suffered myocardial infarction or died from coronary heart disease (20). A follow-up of the Framingham heart study participants from 1950 to 2005 found that all-cause mortality rates have declined throughout the period for patients with and without diabetes but patients with diabetes had a 2 fold higher mortality rate than individuals without diabetes (21). Diabetic patients who develop a cardiovascular disease have a worse prognosis of survival when compared to non-diabetics with cardiovascular disease. A 19 months follow-up found a mortality rate of 25% in diabetic patients who survived an acute myocardial infarction, compared to 8% in non-diabetic patients (22).

In the Multiple Risk Factor Intervention Trial, men with diabetes had a 2 to 3 fold higher risk of cardiovascular disease than men without diabetes (23).

In the United States the prevalence of ischemic heart disease was higher in persons aged 18 to 44 years with diabetes, when compared with those without it (2.7% vs. 0.2%) (24). Individuals with diabetes may have a risk of heart attack similar to non-diabetic individuals with previous heart attack. Patients with diabetes and no history of myocardial infarction have a high risk of dying from coronary heart disease similar to patients without diabetes and with a history of myocardial infarction (HR: 1.4; 95% CI: 0.7–2.6). This findings did not change

even after further adjustment to smoking status, hypertension, and levels of cholesterol and triglycerides (HR: 1.2; 95% CI: 0.6-2.4) (25). This is in contrast to a study carried out in Tayside, Scotland, patients who had myocardial infarction were at higher risk of dying (HR: 1.33; 95% CI: 1.14–1.55), when compared to patient with diabetes (26). This finding is in keeping with a recent prospective study carried out in south Europe. The hazard ratio for the 10-year follow-up for all-cause mortality was lower for the diabetic group than the non-diabetic group with myocardial infarction: 0.39 (95% CI: 0.32–0.46) (27). This is also in keeping with a recent meta-analysis of 13 studies which found an overall odds ratio of 0.56 (95% CI: 0.53–0.63) for patients with diabetes when compared to patients without diabetes with prior myocardial infarction (28).

Retinopathy:

Damage to the small blood vessels in the eye is another complication of diabetes. This can lead to visual impairment and blindness. A survey conducted between 2005 and 2008 in the United States found a prevalence of 28.5% (95% CI: 24.9%–32.5%) and 4.4% (95% CI: 3.5%–5.7%) for diabetic retinopathy and vision-threatening diabetic retinopathy, respectively (29). The WHO estimated that diabetic retinopathy accounts for 4.8% of blindness worldwide (30). In 2007-08, diabetic retinopathy was the second commonest cause of blindness and accounted for 6.3% of blindness in England and Wales (31).

Nephropathy:

Diabetes is a major risk factor of kidney disease and if damage to the kidneys occurs, it might lead to kidney failure. Individuals with diabetes are more than

twice as likely to have persistent microalbuminuria (32). The United Kingdom Prospective Diabetes Study (UKPDS) found an annual progression rate of 2%, 2.8%, and 2.3% from the time of type-2 diagnosis to microalbuminuria, from microalbuminuria to macroalbuminuria, and from macroalbuminuria to renal replacement therapy, respectively (33). In the UK, diabetic nephropathy accounted for 24% of kidney failure in 2008 making it by far the most common cause for kidney failure (34).

Neuropathy:

Diabetic neuropathy is another complication of diabetes and can affect 30–50% of patients with diabetes (35). It can lead to functional impairment, and subsequently, to foot ulceration and lower-limp amputation (36). It leads to increased number of visits to health care providers and increased morbidity. For example, in the United States patients with diabetic neuropathy were more likely to be unable to work due to physical limitation (Odds Ratio (OR): 3.23; 95% CI: 1.60–6.52), or had four or more health care visits in the previous year (OR: 2.25; 95% CI: 1.32–3.83) than patients with diabetes alone (37).

Lower extremity amputation:

Non-traumatic lower extremity amputations are a serious complication of diabetes. In 2004-05, an analysis in England, using HSE, found a relative risk of lower extremity amputation of 20.5 (95% CI: 19.7–21.3) in patients with diabetes, when compared with those without diabetes. This was not significantly different from the 2007-08 relative risk of 21.2 (95% CI: 20.4–22.1) (38).

### 1.2.3 Cost of diabetes

Diabetes accounts for a large proportion of healthcare expenditure in the world. The IDF has estimated the global healthcare expenditure on diabetes prevention and management to be $376 billion in 2010, and is projected to reach $490 billion in 2030. Estimates from the UK showed that the cost of hospital care attributable to diabetes was 8.7% of the National Health Service (NHS) budget (39). These estimates were updated again in 2004 to 12.1% of acute hospital care (40). Analysis of the treatment cost for type-1 and type-2 diabetes in primary care setting showed a rise in trend between 1997 and 2007. For example, the overall prescribing cost for type-1 diabetes rose from £573 to £1014 per person per year (pppy), and increased from £391 to £740 pppy for type-2 diabetes (41).

## 1.3 Comorbidity

The presence of more than one clinical condition is a common feature in patients with diabetes. For example, Analysis of 422 practices from the GPRD in 2005 found that 17.3% of patients had no comorbidity, 32.4% had at least one comorbid condition and 21.9% had two co-morbid conditions (42). However, there has been limited research examining association between diabetes management and comorbidity (43). This can be explained by the lack of agreement on how to define and measure comorbidity (44). Valderas et al (45), identified four major distinctions that affect the definition of a comorbidity:

- The nature of the health condition. For instance, in the case of depression and anxiety and if they are considered as a separate entity.

- The relative importance of the condition. Which condition will be the index condition can be affected by factors such as the specialty of the attending physician, the condition that resulted on the patient seeking care and the research question.
- Chronology. Considering whether the comorbid conditions occurred at the same time or across a period of time can also be a factor. In addition, the sequence of the appearance of the comorbid conditions can have significant affect on treatment.
- Burden of illness. Comorbidity has been used to measure the burden of illness, this lead to the use of scales for the measurement of the combined burden of specified disease such as the Charlson index and the Cumulative Illness Rating Scale.

Furthermore, different classification systems are used to which can have an effect on clinical care and research (45). For example, in the past, studies that examined the effect of comorbidity have focused on one specific disease while others have used simple counts of disease without any kind of classification. Piette and Kerr (46), proposed classifying comorbid conditions into concordant and discordant conditions. Concordant condition was defined as “a condition that represent parts of the same overall pathophysiologic risk profile and are more likely to be the focus of the same disease and self management plan” (e.g. diabetes and hypertension), whereas discordant conditions are “conditions that are not directly related in either their pathogenesis or management” (e.g. diabetes and asthma). Other studies have used an index to measure comorbidity, however there is no single index agreed upon as a universal measure for comorbidity. For example, a review of methods to measure comorbidity found 12 different indexes used to measure comorbidity (47).

These complexities in the definition and measurement of comorbidities make it difficult to reach a conclusion on the association between diabetes care and comorbidity. For instance, Hudon et al, found no association between comorbidity, measured using the cumulative illness rating scale, and glycaemic control in a sample of diabetes patients in Canada (48). In a study conducted in the United States, Bae et al, found that diabetes patients with comorbidities were more likely to have HbA1c test and eye examination (49). Similarly, HbA1c and lipid testing differed only slightly according to comorbidity status for diabetes patients enrolled in a Medicare managed care health insurance plan (50). However, Greenfield et al. (51), used the Total Illness Burden Index and found that patients with a high level of comorbidity may not benefit from intense glycaemic control compared to patients with a lower level of comorbidity. Analysis of data from GPRD found that patients with comorbidity were more likely to reach the treatment target of HbA1c and cholesterol, but less likely to reach the blood pressure target, when compared to patients without comorbidity (42).

Furthermore, patients with comorbid conditions are increasingly becoming the rule; not the exception (52-54); such patients can be complex to manage, have a higher risk of additional morbidity and mortality and represent a growing cost for health systems (46). A follow-up of 741,847 patients between 1999 and 2004 in United Stated found the risk of death for patients with one condition to be 1.45 (95% CI: 1.41–1.49), when compared to patients with four or more conditions: 4.07 (95% CI: 3.95–4.19) (55). Patients with comorbidity also receive several medications to manage their conditions, which put them at risk of

adverse drug events. A survey conducted in the United States found that for each additional medication, the number of adverse events per patient increased by 10% (95% CI: 6–15) (56). Analysis of data from the United States Medicare Chronic Condition Data Warehouse found nearly 30% of people with diabetes suffer from at least one co-morbid chronic condition and the average payment per beneficiary increased from $2,820 for patients with no co-morbid condition to $7,172 and $14,931 for patients with one or two co-morbid conditions respectively (57). In the UK, the mean cost for a patient with diabetes only was £434 per year, £999 per year for one co-morbidity, £1,641 per year for two co-morbidities, and £2,462 for three co-morbidities per year (58).

## 1.4 Secondary prevention

Prevention of diabetes complication includes the control of potentially modifiable risk factors. These include control of blood glucose levels, blood pressure and lipid levels. Further screening for retinopathy, nephropathy, and neuropathy is essential for the early identification and management of diabetic complications.

Glucose control:

Tight glucose control is effective in reducing microvascular and, to some extent macrovascular complications. HbA1c is a useful marker of glucose control over prolonged periods of time (59). Several clinical trials have showed that reduction in HbA1c levels corresponds to reductions in retinopathy, nephropathy, neuropathy and cardiovascular end-points. The UKPDS showed that intensive therapy for type-2 diabetes with sulphonylureas or insulin achieved a median

HbA1c of 7.0% compared to median HbA1c of 7.9% in the conventional treatment group at a 10-year follow-up. Patients in the intensive treatment group had an overall microvascular complication rate reduction of 25% (p=0.009). Glycaemic control had a less substantial impact on macrovascular complications. When compared with the conventional group, the intensive treatment group had a 16% (p=0.052) risk reduction in myocardial infarction and 6% (p=0.44) in all-cause mortality (60). A prospective observational study by the UKPDS group, found a reduction of 37% (95% CI: 33–41) in the risk of microvascular complication and a reduction of 14% (95% CI: 8–21) in the risk of myocardial infarction for each 1% reduction in HbA1c (61). A meta-analysis of 10 prospective cohort studies found a relative risk of 1.18 (95% CI: 1.10–1.26) for total cardiovascular disease with each one-percentage point increase in HbA1c (62).

A 10-year post trial monitoring of the UKPDS participants found significant relative reductions in the sulphonylurea–insulin group of 24% (p=0.001) for microvascular disease when compared with conventional therapy. Furthermore, a significant risk reduction emerged in the sulphonylurea-insulin group of 15% (p=0.014) for myocardial infarction and 13% (p=0.007) for all-cause mortality (63).

Recently, a debate was triggered with regard to pursuing glycaemic control below 7% as measured by HbA1c, when compared with adequate glycaemic control in type-2 diabetes (64). This was raised as a result of the Action to Control Cardiovascular Risk in Diabetes (ACCORD) trial in 2008, which found an

association between tight glucose control (HbA1c achieved was 6.4%) and higher all-cause mortality, when compared with the conventionally treated group (HbA1c achieved was 7.5%) (65). Conversely, two other major trails (Action in Diabetes and Vascular Disease: Preterax and Diamicron Modified Release Controlled Evaluation Trial and the Veterans Affairs Diabetes Trial) found no significant increase in mortality in the intensive control group (66, 67). A meta-analysis of these trials and others including UKPDS found lower rate of cardiovascular events but no effect on the mortality in the intensive group, when compared with the standard group (68). Finally, analysis using the General Practice Research Database (GPRD) found a U-shaped association between levels of HbA1c and all-cause mortality, a finding that supports that of the ACCORD study (69).

Blood pressure:

Follow-up of a median of 8.4 years in the UKPDS showed a significant reduction in blood pressure in patients assigned to the tight blood pressure control group (mean blood pressure: 144/82 mm Hg), when compared with those with less tight control (mean blood pressure: 154/87 mm Hg). This difference was associated with a reduction in risk of diabetes-related end points by 24% (95% CI: 8–38), death related to diabetes by 32% (95% CI: 6–51), stroke by 44% (95% CI: 11–65) and microvascular end points by 37% (95% CI: 11–56). However, there was no significant reduction in all-cause mortality or myocardial infarction (70). Unlike glucose control, no legacy effect was found for blood

pressure control after a median follow-up of eight years post-trial monitoring (71).

The Appropriate Blood Pressure Control in Diabetes trial was established to assess whether the effect of lowering the blood pressure in normotensive patients is associated with lower cardiovascular incidence. At a mean follow-up of 5.3 years, normotensive patients in the intensive group had lower incidence of stroke, when compared with the moderate therapy group (1.7% vs. 5.4%, p=0.03) (72). Analysis from the Irbesartan Diabetic Nephropathy Trial found a decreased risk in cardiovascular mortality of 39% with a 20 mm Hg reduction in systolic blood pressure (73).

A 10 mm Hg increase in systolic blood pressure increases the risk for end stage renal disease or death by 6.7% (p=0.007) (74), and the UKPDS illustrated better retinopathy outcomes in the tight blood pressure control group (mean blood pressure: <150/85 mm Hg) when compared with less tight control (mean blood pressure: <180/95 mm Hg) (75).

Lipid control:

Lipid lowering is essential in the prevention of cardiovascular disease in patients with diabetes. The UKPDS found an association between coronary disease risk and LDL-cholesterol or total cholesterol levels (76). The Collaborative Atorvastatin Diabetes Study found a 37% (p=0.001) reduction rate in any major cardiovascular end point, and 27% (p=0.059) in all-cause mortality in diabetes patients without high concentration of LDL-cholesterol assigned to lipid lowering treatment (77).

The latest evidence comes from the Cholesterol Treatment Trialists' Collaboration. A meta-analysis of 14 randomized trials identified a linear relationship between the absolute reductions in LDL-cholesterol and reductions in the incidence of coronary and other major vascular events irrespective of their lipid profile. For example, a reduction of 1 mmol/l of LDL-cholesterol was associated with 9% reduction in all-cause mortality. This was similar to the reductions seen in patients without diabetes (78).

Smoking cessation:

Smoking is a modifiable risk factor that can increase the already raised risk of macro and micro-vascular complications in diabetes patients. For instance, findings from UKPDS demonstrate that patients who smoke have a higher risk of developing coronary heart disease (HR: 1.41; 95% CI: 1.06–1.88) (76). A meta-analysis of 17 trials of offering brief smoking cessation advice to patients compared to no advice found a significant increase in the rate of smoking cessation (RR: 1.66; 95% CI: 1.42–1.94) among the advice group (79).

## 1.5 Prevalence, incidence and health outcomes of diabetes in ethnic minority patients

Before discussing the prevalence, incidence and health outcomes of diabetes in ethnic minorities, it is essential to review the concept of ethnicity and policies that have been undertaken to reduce health inequalities in the UK.

### 1.5.1 Definition of ethnicity

Ethnicity is a complex concept that arises from differences such as race, culture and religion and has been used commonly in research (80). Definitions of ethnicity groups include one or more of the following (81):

- "Share a common origin or social background;
- Share a cultural and traditions that are distinctive, maintained between generations, and lead to a sense of identity and group;
- Have a common language or religious tradition."

There are several methods to allocate individuals into ethnic groups. For instance, the 1991 UK Census included a self-determined ethnic question. Coding of ethnic groups in the 1991 census included 'black other' and 'any other ethnic group' in case individuals did not feel they fit in the pre-coded options. However, due to several limitations, such as the lack of recognition of the Irish group, the coding of ethnicity in the 2001 census has been expanded (Box 1 and 2) (82). According to the 2001 census, 4% of the population is Asian or Asian British, 2% are black or black British.

*Box 1 The 1991 census ethnic categories*

Ethnic groups:

1. White
2. Black-Caribbean
3. Black-African
4. Black Other *please describe*
5. Indian
6. Pakistani
7. Bangladeshi
8. Chinese
9. Any other ethnic group *please describe*

*Box 2 The 2001 census ethnic categories*

Ethnic groups:

A. White
- British
- Irish
- Any other white background, *please write in*

B. Mixed
- White and black Caribbean
- White and black African
- White and Asian
- Any other mixed background, *please write in*

C. Asian or Asian British
- Indian
- Pakistani
- Bangladeshi
- Any other Asian background, *please write in*

D. Black or Black British
- Caribbean
- African
- Any other black background, *please write in*

E. Chinese and other ethnic group
- Chinese
- Any other, *please write in*

Ethnic minorities have disproportionate burden of chronic diseases. For example, in England men and women born in East Africa, West/South Africa, Scotland and Ireland have the highest all-cause mortality rate. Ischemic heart disease rates are higher in people born in the Indian subcontinent (83).

Strategies to reduce health inequalities in the United Kingdom:

Reducing health inequalities has been on the agenda of many developed countries (84). The Black report (85), commissioned in 1977 by the then Labour government, was an influential report that put inequalities on the political agenda in the UK (86). The report found that inequalities have persisted despite the introduction of the NHS in 1948. However, the Conservative government largely

ignored the recommendations of the report when it was published in 1980. In 1998, the government published the Acheson report (87). The report is considered a "fundamental source document for the United Kingdom government thinking on the causes of health inequalities and how to tackle them" (86). The report found widening gap between social classes despite an improvement in health measures such as life expectancy. The committee made a number of recommendations including the following key ones:

- All policies likely to have an impact on health should be evaluated in terms of their impact on health inequalities;
- A high priority should be given to the health of families with children;
- Further should be taken to reduce income inequalities and improve the living standards of poor households.

The report also stated that targeting prevalent health conditions will result in most gains in reducing inequalities and improving average health may not benefit those in most need without any targeted efforts. The widening gap in inequalities found in the report might be because improvements reach more affluent groups faster than deprived groups. Such explanations, have been illustrated by Victoria et al, who developed the "inverse equity hypothesis" which states that "new interventions will initially reach those of higher socioeconomic status and only later affect the poor" (88). However, such a hypothesis has not been tested to a great extent in chronically ill patients in the UK.

The government responded to the Acheson report by producing two key documents. The white paper "Our Healthier Nation" (89), which produced a programme to promote healthier living and reduce inequalities. The NHS plan

document (90), set a map for the reform of the NHS. It stressed out the need to reduce inequalities in access to health services and to improve child health. In addition, it targeted prevalent conditions through improved prevention and control. Finally, the government established national health inequalities targets to narrow the gap in infant mortality and life expectancy at birth.

### 1.5.2 Prevalence, incidence and outcome of diabetes in ethnic minorities

Incidence of diabetes is higher in ethnic minorities when compared to the white group. For example, using data from a large database (551 practices) in the UK, the age standardised incidence of type-2 diabetes was 7.90 (95% CI: 6.73–9.08) per 1000 person years for Indian women and 9.60 (95% CI: 8.35–10.8) per 1000 person years for Indian men, compared to 4.13 (95% CI: 4.08–4.17) per 1000 person years for white women and 5.31 (95% CI: 5.26–5.36) per 1000 person years for white men (91).

Analysis of the same database suggests that, when compared to the white group, the hazard ratio for risk of type-2 diabetes was 1.71 (95% CI: 1.48–1.96) for Indian women, 1.92 (95% CI: 1.70–2.18) for Indian men, 2.15 (95% CI: 1.83–2.51) for Pakistani women, 2.53 (95% CI: 2.20–2.92) for Pakistani men, 4.07 (95% CI: 3.24–5.11) for Bangladeshi women, 4.53 (95% CI: 3.67–5.59) for Bangladeshi men, 0.79 (95% CI: 0.69–0.91) for Black Caribbean women, 0.95 (95% CI: 0.82–1.10) for Black Caribbean men, 0.80 (95% CI: 0.66–0.97) for Black African women, 1.69 (95% CI: 1.42–2.02) for Black African men. These values were adjusted for age, BMI, family history and smoking status (91).

People from an ethnic minority background have higher diabetes prevalence rates. For example, in the Unites States (92), the 2010 prevalence of diabetes in non-Hispanic white, Asian Americans, Hispanic/Latinos, non-Hispanic blacks was 7.1%, 8.4%, 11.8%, 12.6%, respectively. Further, Asian Americans, Hispanic/Latinos, non-Hispanic blacks have a higher risk of being diagnosed with diabetes of 18%, 66%, 77%, respectively, when compared to non-Hispanic white.

The Coventry diabetes study, in the UK, found the age adjusted prevalence of non-insulin dependent diabetes to be 3.2% (95% CI: 2.6–4.0) and 4.7% (95% CI: 4.0–5.5) for Europeans males and females, compared to 12.4% (95% CI: 11.0–13.8) and 11.2% (95% CI: 10.0–12.5) in South Asian males and females (93). The Southall survey in the UK found an age-adjusted prevalence of diabetes in South Asians almost four times higher than that in Europeans (94). The 2004 HSE showed a higher prevalence of diabetes among black Caribbeans, Indians, Pakistanis, and Bangladeshis than in the general population. This was true for men (ranging from 7.3% to 10.1%) and women (ranging from 5.2% to 8.6%) (95).

Furthermore, ethnic minorities with diabetes have worse outcomes. Swerdlow et al., conducted a prospective cohort study in the UK on 828 South Asians with type-1 diabetes. The standardized mortality ratio (SMR) was 3.9 (95% CI: 2.0–6.9) in men and 10.1 (95% CI: 5.6–16.6) in women among the South Asian group, when compared with 2.7 (95% CI: 2.6–2.9) in men and 4.0 (95% CI: 3.6–4.3) in women for the non-South Asian group (96). An 11-year follow-up of the Southall diabetes survey in the UK found a mortality rate ratio of 1.80 (95%

CI: 1.03–3.16) for circularity disease (South Asian vs. European) and 2.02 (95% CI: 1.04–3.92) for ischemic heart disease. Furthermore, South Asians were more likely than Europeans to report a history of myocardial infarction (OR: 3.8; 95% CI: 1.8–8.0) and have laser treatment for retinopathy (OR: 1.7; 95% CI: 1.1–2.8) (97). Gill and colleagues reported that black Caribbean patients have higher SMR compared to the rest of the population and individuals born in China have comparable SMR to the general population (98). A similar study was undertaken to compare African Caribbean's and Europeans. The risk ratio for all-cause mortality was 0.41 (95% CI: 0.23–0.73) for African Caribbean's vs. Europeans. However, this was no longer significant after further adjustment for sex, body mass index, and smoking (99).

Complications such as the risk of lower-extremity amputation were found to be lower in some ethnic minorities group. For example, between 1992 and 1997 no ethnic differences were found between African Caribbeans and Europeans (relative risk: 0.67 (95% CI: 0.32–1.40)) (100). South Asians had a higher incidence rate of end stage renal failure (486.6; 95% CI: 185.1–788.1 per million person-years per year) than white patients (35.6; 95% CI: 17.0–54.2) in Leicestershire (101). Finally a cross-sectional study conducted in central England by the United Kingdom Asian Diabetes Study found that South Asian patients have a higher prevalence of diabetic retinopathy than white Europeans (45 vs. 37%, $p<0.05$) (102).

## 1.6 Quality of health care in the UK

This section discusses the quality of diabetes care delivered to ethnic minorities in the UK. However, it is essential to have an overview of the quality of care, including definitions, dimensions, levels, and assessment of quality of care.

### 1.6.1 Definition of quality of care

The concept of quality has been discussed in the literature to a considerable extent and many definition of quality of care exist (Table 1) and the choice depends on the level of analysis or perspective of the stakeholder (103, 104).

*Table 1 Definitions of Quality*

| Author | Definition |
|---|---|
| Donabedian (1980) | Quality of care is the kind of care, which is expected to maximize an inclusive measure of patient welfare, after one has taken account of the balance of expected gains and losses that attend the process of care in all its parts. |
| Institute of Medicine (1990) | The degree to which health services for individuals and population increase the likelihood of desired health outcomes and are consistent with current professional knowledge. |
| Department of Health (1997) | Doing the right thing, to the right people, at the right time, and doing things right first time. |
| Council of Europe (1997) | The degree to which the treatment dispensed increases the patient's chances of achieving the desired results and diminishes the chances of undesirable results, having regard to the current state of knowledge. |

One of the most commonly cited definitions of quality of care is the one put forward by the Institute of Medicine (IOM), which has been adopted by many organisations in the United States. In 1990, the IOM reviewed over 100 definitions and parameters of quality of care. Accordingly, quality of care was defined as "the degree to which health services for individuals and population

increase the likelihood of desired health outcomes and are consistent with current professional knowledge" (105). The definition includes a "measure of scale, wide range of elements of care, and individuals and populations as targets. It is goal-oriented, links process with the outcome, highlights the importance of differing perspectives, and finally highlights the importance of evidence-based medicine" (105).

### 1.6.2 Dimensions of quality of care

The definition of quality of care consists of different dimensions or themes that can be used to judge the delivered quality. For instance, in their influential report, "Crossing the Quality Chasm", IOM defined quality along seven themes: effectiveness, efficiency, safety, equity, patient centeredness, timeliness and satisfaction (106). Others have included dimensions such as access and appropriateness (107-109). Table 2 presents examples of quality of care dimensions.

Even though definitions of quality of care vary depending on the setting, some themes are common between them. Effectiveness questions whether the intervention in a place produced the intended effects. However, efficiency questions whether the intended effects were achieved by the least amount of resources used. Access is another theme present in quality definitions, except the one put forward by IOM. Access can be seen as the percentage of population in need of health care, whom could actually can get them (110).

*Table 2 Dimensions of Quality of Care*

| | Donabedian | IOM | Department of health | Leatherman (Quest for quality) | Council of Europe |
|---|---|---|---|---|---|
| Effectiveness | X | X | X | X | X |
| Efficiency | X | X | X | | X |
| Access | X | | X | X | X |
| Safety | X | X | | | X |
| Equity | X | X | X | X | |
| Appropriateness | X | | | | X |
| Timeliness | | X | X | X | |
| Acceptability | | | | | X |
| Satisfaction | | X | X | | X |
| Responsiveness | | X | | X | |

IOM defines patient safety as "freedom from accidental injury due to medical care, or medical errors." (111). It is seen as an important component of quality of care dimensions; however, sometimes, quality and safety are used synonymously because some view it as a pre-requisite to quality (106), while others believe the two are indistinguishable (112).

Equity of care is the absence of variations in the quality of care between groups with different personal characteristics such as sex, ethnicity, geographic location, and socioeconomic status (106). Whitehead, in her widely cited 1992 paper, defined health inequity as "differences in health that are not only unnecessary and avoidable but in addition unfair and unjust." (113). She further defined equity in health care "as equal access to available care for equal need, equal utilization for equal need, equal quality of care for all." (113).

Equity is different, but frequently confused with, equality. Health equity concentrates on the process that drives a specific kind of health inequality, a kind that has systematic differences in health between the groups that are considered to be unjust or unfair, i.e., not all health inequalities are unfair or unjust (114). Important distinct aspects of equity are noted in the literature:

vertical equity, which is different treatments for different need, and horizontal equity, which is equal care for equal need, which is the one commonly used in practice (115). However, difficulties in defining the need for care can make this problematic (116).

### 1.6.3 Levels of quality of care

Similar to the diversity in the definition of quality, assessment of quality of care can take place at different levels. One concept, proposed by the Council of Europe, assesses quality at central (country or district), local (hospital or practices), and individual level (117). Donabedian proposed a more comprehensive model. He presented measurement of quality of care at four levels. At the core, care that is delivered by providers can be assessed by the technical aspect of it and by the management of interpersonal relationship. The second level includes the characteristics of the care setting. The third level, focuses on the implementation of care and the final level focuses on the care received by the community (108).

### 1.6.4 Measurement of quality of care

Donabedian's framework for the measurement of quality of care has been the basis for much of the work in this field. Donabedian proposed a structure–process–outcome model, and argued that "good structure increases the likelihood of good process, and good process increases the likelihood of good outcome." (108). Structure is the characteristic of the setting where delivery of care takes place (e.g., facilities, equipment, information system,

human resources). Process refers to the transaction in giving and receiving care either related to the patient (e.g., checking the blood pressure of a patient, checking the smoking of status of patient), or to the organization (e.g., managing waiting list). Outcome is the results of health care on the health of the patients and population, such as mortality and morbidity (108).

Shaw and Kalo matched the different dimensions of quality with Donabedian's structure–process–outcome model. Table 3 presents some of the examples proposed by them (118).

*Table 3 Dimensions in the assessment of quality of care*

| | Dimension of quality of care |
|---|---|
| Structure | Fairness in sharing costs and benefits (Equity)<br>Responsiveness to the needs of populations (access) |
| Process | Reduction of risk (Safety)<br>Use of time and resources (efficiency) |
| Outcome | Clinical outcome (Effectiveness)<br>Meeting expectations of patients (satisfaction) |

Even though Donabedian's model is commonly referred to, there is a debate on the relative merit of the process and outcome measures. For example, some commentators believe that process measures are more sensitive than outcome measures as a poor outcome does not necessarily mean poor provision of care (119). Giuffrida et al., noted that outcome measures can be influenced by factors that are outside the control of the health care providers such as socio-economic status (120). Although, in theory, these can be adjusted for, such information is not always available in the medical record (121). In addition, outcome measures usually take time to show a difference in the quality of care, e.g. myocardial

infarction, while process of care is immediate (122) and it is difficult to assess outcome measures in small practices. Nevertheless, outcome measures are more focused on the patient, when compared with process measures that focus on the service (123). Outcome measures are more meaningful to the patients and encourages a longer term view by the providers (124). In primary care, it is recognized that the use of process measures that are linked to effective outcome (also referred to as intermediate outcomes) are the most useful measures available (125).

### 1.6.5 Quality improvement in the UK

Since the late 1990s, the UK government has embarked on an ambitious quality improvement agenda within the NHS. A key objective of this agenda is to improve the management of common chronic diseases, such as diabetes, in primary care. Standards setting and monitoring, target setting, regulation and payment reform were some of the key functions introduced over the years to improve the quality of health care in the NHS.

The National Service Frameworks (NSFs) were launched in the late 1990s to define and set national standards for a number of common conditions. On an average, two NSFs were introduced per year. For example, NSFs for cancer and coronary heart disease were introduced in 2000 and NSFs for older people and diabetes were introduced in 2001. The NSF for diabetes includes a set of standards and key interventions. For instance, standard four refers to clinical care of adult patients and states that “All adults with diabetes will receive high-quality care throughout their lifetime, including support to optimize the control of

their blood glucose, blood pressure and other risk factors for developing the complications of diabetes". In addition, it includes a strategy to enhance disease registers in primary care, a prerequisite to the delivery of systematic, high-quality care (126).

The National Institute for Clinical Excellence (NICE) was set up to produce evidence-based guidelines and health technology assessment. It was merged with the Health Development Agency and was consequently renamed National Institute for Health and Clinical Excellence (still abbreviated as NICE) in 2005. NICE publishes detailed guidelines that inform the development of NSFs and diabetes management. For example, NICE recommends that "Simvastatin 40 mg or equivalent for all patients with type-2 diabetes aged over 40 irrespective of experience of cardiovascular disease" (127).

Furthermore, the United Kingdom has well-developed systems for auditing performance and regulation of healthcare locally through local commissioning organisations (Primary Care Trusts), and nationally through the Healthcare Commission (now replaced by the Care Quality Commission) that monitors the quality of healthcare organization against specific standards in key areas, such as cost effectiveness, safety, public health, patient focus, and accessible and responsive care (128). Another relevant organisation is the National Patient Safety Agency (NPSA) that leads on initiatives to improve patient safety, investigates the performance of individual clinical practitioners, and ensures that research is carried out safely.

## 1.7 Ethnic inequalities in diabetes care

In developed countries, there are signs of improvements in the quality of care being delivered for individuals with diabetes (129-131). However, the gap between ethnic groups in diabetes care is a continuing challenge. In the United States, improvements seen between 1999–2003 in Medicare managed care enrollees with diabetes failed to close the differences between white and black patients and in some quality measures it increased. For example, differences between white and black patients in the control of HbA1c increased from 4% in 1999 to 7% in 2003 (132).

Similarly, in the UK, the quality of diabetes care has improved substantially. For example, a study of 42 general practices in England between 1998 and 2003 found considerable improvements in three chronic conditions including diabetes. These include significant improvement in cholesterol control (≤5 mmol/l) from 21.5% in 1998 to 52% in 2003 and control of blood pressure (≤145/85 mm Hg) from 21.8% in 1998 to 35.8% in 2003. However, there was no significant improvement in HbA1c control (133). These findings are similar to those of another study of 74 general practices in England and Wales, which examined the intermediate outcome measures between 1994 and 2001. Achievement of national targets for cholesterol and blood pressure increased significantly over this period ($p<0.001$), with no significant improvement in glycaemic control (134).

These improvements were not uniform across all groups and evidence of persisting inequalities exists. For example, patients from deprived areas were less likely to have a recording of HbA1c or achieve HbA1c target levels, when

compared with those from affluent areas (135). In a secondary analysis of the HSE 2004, Nazroo and colleagues found no evidence of ethnic inequalities in glycaemic control, except for the Pakistani group (Relative Risk Ratio 1.95; 95% CI: 1.03–3.68). However, the small sample size may explain the non-significant findings in the other ethnic groups (136). Furthermore, Millett and colleagues carried out an analysis of time trend using the HSE between 1999 and 2004 and found that South Asian group had lower improvement in cholesterol control (2.7%; 95% CI: 1.9–3.5), when compared with the white group, while the black and Irish group had greater improvements. With regard to blood pressure control, improvements were lower in the black group (13.9%; 95% CI: 13–14.8) but higher in the Irish and south Asian groups, when compared with the white group (137). In addition, Mukhopadhyay et al., found higher levels of HbA1c and smaller improvements in the south Asian group, when compared with European patients between 1991 and 2003 (138).

McElduff and colleagues, examined the trend in changes in the intermediate outcome indicators between 1995 and 2001 to compare the care delivered to Europeans and south Asians in primary and secondary care setting in North-West England. They found that both the groups had significant increases in the measurement of intermediate targets, but the Europeans had greater improvement, when compared with the south Asian group, with respect to cholesterol and blood pressure measurements. In addition, they observed higher levels of HbA1c in the south Asian group, when compared with the European group (139).

## 2.0 Financial Incentives and quality improvement

Many countries have sought to use provider payments as a policy lever to bring about improvements in the delivery of care. Each payment method sends an economic signal to the provider, potentially shaping their behaviour. This relationship between the provider and the purchaser has been explained through the principal-agent theory. As Robinson puts it “the essence of incentive contracting is the effort by one individual or organization (the principal) to induce and reward certain behaviors by another (the agent)” (140). There have been, traditionally, four main ways for paying providers in primary care settings, with each having its advantages and drawbacks: Line item budget, salary, fee-for-service and capitation. Additionally, other payment methods used in hospital settings are also discussed here.

Payments can be categorized into a time based, service based, or population based. Time based include payments that reward providers regardless of time spent in delivering the service, e.g. budget and salary. With service-based payments, the provider is remunerated according to the number of services provided, e.g. fee for service. Lastly, population based payments are payments that depends on the size of the population served by the provider, e.g. capitation (141). Another way to examine provider payments is whether the payment is retrospective or prospective. Retrospective payments are made after the service has been provided (e.g. fee for service), while prospective payments are made or agreed upon before the services are provided (e.g. capitation) (142).

## 2.1 Provider payment methods

Line item budget

Providers are paid an amount of money for a period of time, usually a year. The total budget is broken down into different items such as salaries, equipments, and medicines. Usually providers cannot transfer funds across lines, thus limiting the incentive for the provider to be efficient but it is preferred with government-run facilities, such as Egypt, Bahrain, Saudi Arabia, as it offers the strong administrative control. Providers usually have the incentive to spend all funds by the end of the financial year (143).

Salary

In this method, providers are paid an income for specific hours irrespective of the number of patients they treat. As such there is no incentive to over or under provide services. It is one of the most neutral forms of payment. There may be a need to use rules and regulation and other quality improvement strategies that enhances the delivery of high quality of care. However, this may lead to improvement in quality of care or result in lower quality of care (144).

Fee-for-service

In this method, the provider is reimbursed for every service provided. Such services include doctor consultation, lab test, x-ray test and other medical products. So there is an incentive for the provider to provide more care. It can be further broken down to two types. If there is no fixed-fee schedule and services are not bundled, the providers can bill the purchaser for all costs. If

there is a fixed-fee and services are bundled the provider is paid per encounter which provides an incentive to limit services provided in each encounter. Although fee-for-service encourages the overprovision of services regardless of their effectiveness, it has its advantages. First, it can easily be implemented. Second, it reflects the services performed more accurately. Third, it can improve access to underserved population since providers do not have incentive to under provide services (143).

Capitation

The provider receives a fixed amount of money for each patient for a particular time (e.g. one year) to provide a specific service. It was introduced in the 1990s to address the cost escalation issue associated with fee for service. Thus it generates an incentive for the provider to provide as little as possible, an opposite effect to fee for services. The provider may also try and shift the financial risk to someone else by referring the patient to a hospital or a specialist care (143). If capitation is not risk adjusted (i.e. payments takes into account factors such as age and socioeconomic status) it may encourage providers to avoid high-risk patients such as patients with multiple comorbid conditions, a process known as “cherry picking” (145).

Institutions higher-up in the health system are paid using similar methods to those seen in the primary care setting but in addition include other payment methods, such as per diem payment and case fees. In the per diem method, the provider is paid according to the number of in-patient days. Consequently, there is an incentive to increase the number of hospital days but there is an incentive to reduce resources used per day. In the case fees payment, the

provider is paid a fixed amount per case, based on Diagnostic Related Groupings, and as such it creates an incentive to minimize the input for each case and encourages early discharge (142). For example, introduction of the case fees payment system in the United Stated was associated with reduction in hospital stays (146). However, it may encourage admission and unnecessary readmissions. Additionally, providers may code patients in more expensive groups.

Langenbrunner et al., noted that the impact of the different payment approaches highly depends on other factors such as the context where the policy is being used (e.g. level of resources available, extent of competition), the presence of any information constraints (e.g. technical resources, baseline information on cost and needed care), and the management capacity of the providers (e.g. autonomy of providers) (147). All of the payment methods discussed above have an implicit effect on quality of care and do not fully align with the optimal care of patients, especially those with chronic conditions. As such, new payment methods have been proposed. However, many governments are moving toward the use of blended payment to counterbalance the disadvantages of each. For example, there has been a shift from service-based payment (e.g. fee for service) approaches in tax-financed health system to a combination of payment methods. Although, in social health insurance and mixed funded health systems service based payment is still dominant (e.g. United States) (148). The following table presents some examples of payment approaches to providers in Western Europe.

*Table 4 Examples of provider payment methods in Western Europe*

| Country | Salary | Capitation | Fee for service | Combination |
|---|---|---|---|---|
| Tax-based health system | | | | |
| Denmark | | | | X (capitation + FFS) |
| England | X | X (public) | X (private) | |
| Finland | X | | | |
| Ireland | | X (public) | X (private) | |
| Norway | | | X | |
| Sweden | X (public) | | X (private) | |
| Italy | | X | | |
| Portugal | X | | | |
| Spain | | | | X (salary + capitation) |
| Social Health Insurance based system | | | | |
| Germany | | | X (private) | |
| Belgium | | | X | |
| France | | | X | |

Source: Langenbrunner et al. (141).

## 2.2 Pay for performance as a quality improvement lever

Many countries recognized the need to develop more innovative ways to pay providers. The use of explicit financial incentives to improve the quality of health care is increasing in many countries, through "pay for performance" schemes. In the literature, there are many terms used for pay for performance, such as results-based financing, performance-based financing, and conditional cash transfers. Pay for performance is one of the approaches of value based purchasing. Other approaches include selective contracting and public reporting of provider performance (149).

Various factors contributed to the increase use of pay for performance schemes in different health systems and specifically in the United States and UK. First, evidence from sectors that resembles health care sector, such as education, showed that employees do respond to explicit incentives (150). Second, there is

a sponsorship from high-profile organisations for the use of explicit financial incentives. For example, in 2000, the WHO encouraged purchasers of health care services to move from passive purchasing of health care services to more strategic purchasing (151). In their report "Crossing the Quality Chasm", the IOM recommended the alignment of financial incentives with quality improvement (106), and recently the Institute explicitly stated that monetary incentives can be a powerful stimulus to derive change in the health care provider behavior (152). Third, there is a shift in cultural beliefs where in the past providers faced limited accountability; however, with the advances in evidence based medicine and performance measurement (153), coupled with growing recognition that the views of patients, the public, and other key players are relevant (118, 154), resulted in a greater pressure on providers to deliver better care. Fourth, a number of research findings suggest that patients are not receiving optimal care. For instance, McGlynn et al., found that adult patients in the United States received evidence based care only 54.9% of the time (95% CI: 54.3–55.5) (155). Similarly, a systematic review of studies evaluating the quality of care delivered in primary care from 1995-99 concluded that care did not reach acceptable standards in the UK, Australia, and New Zealand (156). Five, paying for performance is seen as a way to overcome the barriers to tailor care to individual patients brought by the current reimbursement strategies (157). Finally, policy commentators have argued that provider payment methods, such as fee-for-service and capitation, are limited in their impact on quality improvement (140, 158).

The instinctive appeal of pay for performance, along with the factors mentioned above, prompted many countries to use pay for performance schemes in their providers' contract including the United States (159), UK (160), Australia (161), New Zealand (162), Canada (163), Germany (164), the Netherlands (165), and in developing countries (166).

## 2.3 Description of selected pay for performance programmes

United States:

The first generation of pay for performance schemes in the United States were small in scale and mainly focused on preventive measures such as immunizations and were mainly implemented by private health plans. Many of the systematic reviews that examined the impact of financial incentives on quality of care (167-170) drew much of their conclusions using similar studies (171-174). However, this has changed in recent years with several private and public payers engaging in pay for performance schemes in the United States. For example, in a survey of commercial Health Maintenance Organizations (HMO) published in 2006, Rosenthal et al., found that 53% use pay for performance schemes (175) and a recent survey found an overall increase of pay for performance schemes from 11% in 2008 to 55% in 2010 (176). Medicare has several pay for performance demonstration projects. The most important is the Premier Hospital Quality Incentive Demonstration, which covers about 250 hospitals. The scheme collects data on 34 measures relating to five clinical conditions: acute myocardial infarction, heart failure, community-acquired pneumonia, coronary-artery bypass graft, and hip and knee replacement.

Hospitals in the top 10 percent were given a 2% bonus payment and those in the next decile were given 1% bonus payment (177). Evaluation of the first two years of the programme found an improvement in the composite process measures ranging from 2.6% to 4.1% compared to the control group (178). Conversely, Glickman et al., found smaller improvements in process measures for acute myocardial of 1.6% over 3 years and no association were found between pay for performance and mortality (179).

Another demonstration is the Physician Group Practice demonstration, which was initiated in 2005 and directed towards physicians groups. The scheme uses 32 performance measures covering diabetes, heart failure, coronary artery disease and preventive care. Physicians may earn up to 80% of the savings generated (180). No empirical evaluation of the program is yet available; however, a case study reported encouraging efforts in identifying high-cost patients and improving the care delivered to them, hence avoiding hospital stays (181).

Australia:

The Australian government introduced the Enhanced Primary Care Practice incentive in 1998 to increase the engagement of general practitioners in structured and coordinated care. Measures identified include: information systems; after-hours care; teaching of medical students; participation in national prescribing service; care for patients with diabetes, asthma, cervical screening or mental health; and rural location. Practices receive various payment structures according to the service provided (182). For example, in the case of the diabetes incentive programme, the practice will receive a sign on payment in

the amount of AUD $1.00 (£0.64) per Standard Whole Patients Equivalent (a measure of practice size and adjusted for the age and gender of patients), when the practice register for the programme and uses a register and a recall system for patients with diabetes. Further, a payment of AUD $20 (£12.8) per Standard Whole Patients Equivalent if 2% of the practice patients are diagnosed with diabetes and have a completed a set of clinical activity (183).

A study published in 2008, assessed if this scheme had positive effect on the proportion of consultation in which HbA1c been measured. Data were collected from 2001-2006 from 1,000 general practitioners. Practices that joined the scheme were 15% more likely to order HbA1c than practices that did not join (184).

Taiwan:

The Taiwanese government implemented a pay for performance scheme in late 2001. Initially the program covered four diseases: diabetes, tuberculosis, breast cancer, and asthma. In 2006, hypertension and depression were added. The scheme is voluntary and any provider can participate given they meet specific quality measures, such as having the required certification for participating providers and follow established treatment guidelines. Payment structure varies according to the disease. For instance, in the case of breast cancer, providers are paid 1% of regular case payment at 1$^{st}$ year survival and 2% at 2$^{nd}$ year survival. For diabetes, a more complex process-based bonus scheme that includes a number of points for every process with each point translates to TWD $1.00 (£0.02) (185). For example, a provider would receive 1845 points for initial visit for new patient. Of note, the scheme does not incorporate any risk

adjustment method in providers' payment. Evaluation of the diabetes scheme found an increase in diabetes-specific test post-intervention (3.8% vs. 6.4%, $p<0.001$) compared to the control group who did not enroll in the scheme (3.5% vs. 3.6, $p<0.001$) (186).

## 2.4 Pay for performance in the UK

The Quality and Outcomes Framework (QOF) was introduced as part of a new General Practitioner contract in April 2004 (Table 5). The scheme is unique in its size and scope. It has been described as "the boldest quality improvement initiative ever attempted anywhere in the world" (187). The scheme links up to 25% of provider income to their performance. This is considerably higher than the percentage of income incentivised in schemes in the United States, which typically range from 2–10% (188). The framework covered eleven conditions when it was introduced. However, this was not the first time the UK tried to introduce financial incentives. In 1986, the government attempted to introduce a "Good Practice Allowance" to reward practices that provided high-quality care but the British Medical Association (BMA), which negotiates on behalf of general practices, dismissed it (189). The first experience of pay for performance was in 1990 when the government introduced incentives to achieve targets for cervical cytology and childhood immunization, which lead to improvement in coverage in these areas. This also resulted in many general practices to invest in information technology in order to achieve these targets effectively (160).

*Table 5 Component of the general practitioner contract*

| Services | Funding |
|---|---|
| Essential Services: Treatment of any registered patient who is ill or thinks he is ill | Global sum: practices received an average payment of £56 per patient per annum |
| Enhanced services: Services that are not included in the essential or additional services and are optional. They can be Directed, or Local | Payment rate is set national for the Directed services and negotiated locally for local services. |
| QOF: pre-specified quality and activity targets | Payment according to total points achieved |

Source: http://www.bma.org.uk/images/FundingGeneralPractice_tcm41-179188.pdf

The aim of QOF is to financially reward practices for the delivery of evidence-based standards of care. Up to one quarter of general practice income is dependent on achieving a detailed set of quality indicator targets. Practices can earn up to 1000 points across clinical (655 points), organizational (167.5 points), patient experience (146.5 points) and additional services (36 points) domains where each point triggers an average payment of £124 (revised to £130 in 2011-12) (190) (Table 6).

*Table 6 QOF domains*

| **Clinical** | | **Organisational** | **Additional services** | **Patient experience** | **Holistic care** |
|---|---|---|---|---|---|
| **2004/05** | Added in 2006/07 | | | | |
| **Coronary Heart Disease*** | Heart failure* | Education and training | Cervical screening | Length of consultation | Holistic care |
| **Stroke/transient ischemic attack** | Palliative care | Medicines Management | Child health surveillance | Patient survey | |
| **Hypertension** | Dementia | Patient communication | Contraceptive services* | | |
| **Diabetes*** | Depression* | Practice management | Maternity services | | |
| **Chronic obstructive pulmonary disease** | Chronic kidney Disease* | Records and information about patients | | | |
| **Epilepsy** | Atrial fibrillation | | | | |
| **Hypothyroidism** | Obesity | | | | |
| **Cancer** | Learning disabilities | | | | |
| **Mental health** | Cardiovascular disease*‡ | | | | |
| **Asthma** | | | | | |
| **Smoking** | | | | | |

*Points and indicators changed in 2008/09.
‡Added in 2008/09 revision.

Diabetes is one of the twenty conditions included in the clinical domain of QOF and accounts for nearly 15% of QOF clinical domain points. Quality indicators cover structural, process and outcome dimensions of care. The majority of points (more than 50%) are directed to intermediate outcome measures. The total points assigned for intermediate outcome measures for HbA1c, blood pressure and cholesterol are 35, 18 and 6 points respectively. One criticism is that the treatment targets set within QOF are less stringent than those set out in national clinical guidelines (Table 7).

Points are awarded to a practice according to their measured achievement on a sliding scale with a minimum and maximum threshold. For example, the minimum and maximum threshold for the cholesterol target is 40% to 70%. If 55% of patients reached the desired target the practice will earn 3 points out of the possible 6 points. Beyond the 70% threshold the practice will not be rewarded more than 6 points.

*Table 7 Examples of the indicators used in QOF for diabetes care*

| Quality domain | Indicator | Points | Threshold |
|---|---|---|---|
| Structural | The practice can produce a register of all patients aged 17 years and over with diabetes mellitus, which specifies whether the patient has type 1 or type 2 diabetes | 6 | NA |
| Process | The percentage of patients with diabetes who have a record of HbA1c or equivalent in the previous 15 months | 3 | 40-90% |
| Process | The percentage of patients with diabetes whose notes record BMI in the previous 15 months | 3 | 40-90% |
| Process | The percentage of patients with diabetes who have a record of the blood pressure in the previous 15 months | 3 | 40-90% |
| Outcome | The percentage of patients with diabetes in whom the last HbA1c is 7 or less in the previous 15 months | 17 | 40-90% |
| Outcome | The percentage of patients with diabetes in whom the last blood pressure is 145/85 mm Hg or less | 18 | 40-60% |
| Outcome | The percentage of patients with diabetes whose last measured total cholesterol within the previous 15 months is 5 mmol/l or less | 6 | 40-70% |

Source: http://www.nhsemployers.org

Quality indicators can be revised in QOF but any changes require agreement between the government and the British Medical Association. Since its introduction, QOF has undergone two revisions. In 2006, new clinical conditions were added to the clinical domain (atrial fibrillation, depression, chronic kidney disease, obesity, palliative care, dementia, and palliative care) and the clinical domain points were increased to 655 from 550. In addition, the overall maximum points to be reached were slightly reduced to 1000. In 2009, more points were added for a new area of primary prevention of heart disease, which brought the clinical indicators to 697 points (nearly 70% of the framework). Revisions can include the removal or addition of indicators. For example, the 2009/10 revision of QOF included additional points for HbA1c control. For example, practices achieve 17 points if 50% of their diabetes patients achieve HbA1c level of ≤7% (191). This has now been removed in the latest revision of QOF. The QOF is a voluntary scheme, yet more than 99% of practices participate in this scheme and achievement in the first year exceeded the expectation of the government making it a very expensive scheme (192).

Exception reporting in QOF:

An important concept in the QOF is exception reporting which allows practices to remove patients from the denominator calculations in order not to penalize practices for underachieving for reasons outside their control, such as a patient not attending a review, and ensure that they are not incentivised to deliver clinically inappropriate care (Box 3). A disadvantage of allowing for exception reporting is that providers might exclude patients solely to boost their

performance; at its most severe, simply excluding patients not meeting the targets. For example, qualitative work in 27 practices found that practitioners considered exception reporting as a gaming tool (193). Regardless of whether exception reporting is being willfully misused it will mean information about the quality of health care delivered to these patients is left unknown. Furthermore, levels of exception reporting might be used to judge if an indicator in the scheme should be removed (194).

*Box 3 Reasons of exception reporting under QOF*

Family practitioners are able to exception report patients if a patient:

- Refuses to attend review having been invited on at least three occasions during the preceding twelve months
- Is inappropriate for review of the chronic disease parameters due to particular circumstances e.g. terminal illness, extreme frailty
- Is on maximum tolerated doses of medication and whose levels remain sub-optimal
- Is not clinically appropriate to prescribe a medication e.g. those who have an allergy, another contraindication or have experienced an adverse reaction
- Has not tolerated medication
- Does not agree to investigation or treatment (informed dissent), and this has been recorded in their medical records
- Has a supervening condition which makes treatment of their condition inappropriate e.g. cholesterol reduction where the patient has liver disease

According to the Department of Health Information Centre, exception-reporting rates for England in 2008/09 for HbA1c (≤7.5%), total cholesterol (≤5mmol/l), and blood pressure target (≤145/85 mm Hg) were 10%, 9% and 6%, respectively with considerable variation between practices. Little is known about the characteristics of diabetes patients who are exception reported or the reasons for this. Ecological analysis of the exception rate during the second year

of the QOF found an overall median rate of exception reporting in intermediate outcomes of 7.1 and more specifically a median of 8.4 for diabetes intermediate outcomes (195). Obtaining further information about exception reporting is important because there is the potential for practices to game the system to maximize income from QOF and because patients who are exception reporting may receive poorer quality care.

In a serial cross sectional analysis, using individual level data from 23 practices in North London, of exception reporting that I was involved in, older patients (blood pressure control, AOR: 2.52, p<0.01; cholesterol control, AOR: 2.79, P<0.01), black and south Asian groups (HbA1c control, AOR: 1.55 and AOR: 1.64, p<0.01, respectively), and patient with co-morbid conditions (blood pressure control, AOR: 1.68, p<0.01; cholesterol control, AOR: 1.59, p<0.01) were more likely to be exception reported. Those patients were less likely to achieve the intermediate treatment target. However, we did not have reasons for exception reporting (196).

## 2.5 Has QOF improved the management of diabetes in the UK?

Studies seeking to evaluate the impact of QOF on patient care face a number of methodological challenges. Firstly, the General Practitioner contract was implemented nationally. This means that there is no comparison group that can be used as a concurrent control. Secondly, as mentioned earlier, quality was already improving before the introduction of QOF. Finally, the Quality Management and Analysis System (QMAS), the main reporting tool for QOF and most commonly used dataset for QOF evaluation research, contains no pre-QOF data or patient level information, such as age, gender and ethnicity. This

has meant that few studies evaluating the impact of QOF have taken into account underlying trends in quality improvement or undertaken subgroup analyses.

### 2.5.1 Studies examining trends after the introduction of QOF

A recent study of QMAS data obtained from the 98% of general practices participated in England illustrates overall improvements in intermediate outcome targets for diabetes patients over the first 4 years of QOF. The median practice proportion for the HbA1c target of ≤7.5% increased from 59.1% in the first year to 66.7% (IQR: 60.6–72.7) in the fourth year. The median achievements for the blood pressure target of ≤145/85 mmHg increased from 70.9% in the first year to 80.2% in the fourth year. Achievements were also apparent for the cholesterol target of ≤5.0mmol/l reaching 83.6% in the fourth year compared to 72.6% in the first year. Further, the percentage of low-performing practices, measured as practices that achieved less than the 25$^{th}$ centile for HbA1c target, dropped from 57% to 26% (197).

### 2.5.2 Studies examining quality before and after the introduction of QOF

Achievements of diabetes clinical indicators were collected before and after the introduction of QOF from 66 practices in Shropshire, England. Significant improvement on process and intermediate outcome were noted between April 2004 and March 2006. For example the percentage of patients achieving blood pressure control targets was 47% in 2004 compared to 65% in 2006 (198). Another study found similar improvements in south London, where clinical data

were extracted from 26 practices. Median practice achievement increased from 2003 to 2005: for recording of HbA1c from 78% to 95%; for a target of HbA1c ≤7.4% from 38% to 57%; for a target of HbA1c ≤10% from 72% to 89%; for recording of blood pressure from 89% to 98%; for a target of blood pressure ≤145/85 mmHg from 50% to 70%; for recording of cholesterol from 77% to 93%; and for a target of cholesterol ≤5.0 mmol/l from 47% to 72% (199). A longitudinal study involving 32 practices in southwest London examined the impact of QOF on smoking cessation support among 4284 patients with diabetes. The proportion of patients whose smoking status recorded was greater in 2005 than 2003 (86.7% vs. 67.6%, P<0.001); the proportion of patients with a documented smoking cessation advice was also greater in 2005 than 2003 (83.5% vs. 48.0%, P<0.001) (200). Further, the prevalence of smoking decreased from 20% to 16% (P<0.001) over this period. These findings are consistent with those from a systematic review of studies published between 1999 and 2006, which compared achievement of process and outcome indicators for diabetes before QOF to those reported nationally in the first year of QOF. The study found that achievement of quality indicators for diabetes was considerably higher after QOF than that seen in prior published studies (201). Although these studies identified improvements in quality associated with the introduction of QOF, none adjusted for underlying trends.

### 2.5.3 Studies adjusting for underlying trends

A longitudinal study of 42 volunteer general practices in England, comparing actual quality of diabetes care in 2005 with that predicted by the underlying

trend (between 1998 and 2003), found that the introduction of QOF was associated with accelerated improvements in care (P=0.002) (202). The authors updated their analysis in 2009 by collecting performance measures for the same practices in 2007. They then employed a segmented time series analysis to examine the impact of QOF on diabetes care and if this effect was maintained. There was a significant change in the level of improvement in diabetes care (7.5%; 95% CI: 4.1–11.0), but these improvement were not maintained after 2005 (-0.6%; 95% CI: -1.4–0.1) (203). However, both of these analyses used only two pre-QOF measurement points and hence there is some uncertainty about the robustness of the projections made in the two studies.

Using data from the doctors' independent network database, Calvert et al., examined data from 147 general practices from 2002 to 2007 to evaluate if QOF had an effect on HbA1c control. Introduction of QOF was associated with small improvements in the HbA1c target level of ≤7.5% (AOR: 1.05; 95% CI: 1.01–1.09) for patients with type 2 diabetes, but similar associations were not seen for HbA1c level of ≤10% in patients with type 2 diabetes and HbA1c levels of ≤7.5% or ≤10% for patients with type 1 diabetes (204). However, the effect of QOF on blood pressure and cholesterol was not modeled in this study. Further, the authors did not use a segmented time series analysis instead of estimating an overall effect of QOF.

Studies that have examined the relationship between practice characteristics, such as list size; diabetes case volume; and number of practitioners, have identified little variation in the quality of diabetes management after the

introduction of QOF. For example, a study of 9,411 practices in England and Scotland in the first year of QOF found broadly similar achievements on intermediate outcome indicators in small and large practices (205). Smaller practices had lower achievement on process quality indicators than larger practices, but the differences tended to be small (<5%). These findings were confirmed by a more recent longitudinal study, which found that achievements on the majority of diabetes indicators were similar before and after QOF. The only exception was glycaemic control, where there were significant differences in the mean proportion of patients achieving HbA1c ≤7.4% and HbA1c ≤10% between large and small practices before the introduction of QOF (64% vs. 36%, P=0.02 and 73% vs. 64%, P=0.003 for HbA1c ≤7.4% and ≤10%, respectively). Nevertheless, these differences were attenuated in 2005 (49% vs. 47%, P=0.39 and 85% vs. 84%, P=0.48 for HbA1c ≤7.4% and ≤10%, respectively) and 2006 (62% vs. 61%, P=0.67 and 88% vs. 88%, P=0.72 for HbA1c ≤7.4% and ≤10%, respectively) (206).

Research into whether the improved QOF scores will translate into measurable improvement in population health, such as unplanned admission to hospitals because of complications, is limited. In an ecological cross-sectional study conducted during the first year of QOF, Bottle et al examined associations between the achievement of QOF targets, for 303 primary care trusts in England, and hospital admissions. After allowing for area deprivation and diabetes prevalence, the study found a significant negative association between glycaemic control and hospital admissions among patients aged 65 and older,

but there was no significant association for younger patients (207). In contrast, Downing et al., did not find significant association between increases in the clinical domain scores for diabetes and hospital admission in 94 practices across two primary care trusts (208). Dusheiko et al., expanded these findings by using a longitudinal analysis and accounting for more covariates in the first three years after QOF introduction. Improvements in HbA1c control were associated with lower hospital admission (209).

Srirangalingam et al., used cross sectional study conducted to assess the impact of QOF on referral patterns for diabetes care before and after six months of implementation. The authors did not find any significant increase in the total number of referral to specialty clinic, however increases were evident for poor glycemic control (210).

## 2.6 Does QOF provide value for money?

Despite increases in the number of pay for performance schemes, the evidence on the efficiency of these schemes is scarce. For example, the 2006 systematic review by Peterson et al (167), found only one study (211) that assessed the cost effectiveness of pay for performance in the United States. The study examined the impact of pay for performance on access and Medicaid expenditure in nursing homes. Cost in the intervention group was 20% lower than that of the control group over a period of 12 months. Furthermore, a recent systematic review on the economic evaluation of pay for performance schemes found only nine studies, all from the United States except one, with mixed

results. The authors concluded that the evidence is “scarce and inconclusive” (212).

A recent report by the Health Foundation assessed whether better management in primary care reduces hospital cost. None of the QOF clinical areas were statistically associated with hospital cost except Stroke. One-point increase in stroke QOF rate was associated with a decrease of £0.44 per person (213).

## 2.7 Potential unintended consequences of pay for performance

Several authors have raised concerns about the perverse consequences of using financial incentives to improve quality. For example, Salisbury et al., found that the incentive introduced by the UK government to reduce waiting times to see general practitioners made it difficult for people to book appointments in advance (214). Financial incentives could lead the provider to be concerned with those clinical measures that are incentivised only. Evidence from the QOF reveals that care for non-incentivized indicators for conditions in the QOF improved at a lower rate (11%; 95% CI: 6–15%) compared to incentivized indicators (16%; 95% CI: 10–22%) (215). Pay for performance might affect the internal motivation of providers and crowd-out some of the caring aspects of consultation. However, analysis from two general practices in England suggest that QOF did not have any effect on internal motivation but some concerns were raised by the nurses (216). Analysis from 12 practices in east of England found that some doctors and nurses raised their concern with loss of holistic care and continuity of care (217).

Structured, systematic interventions to improve quality in chronic disease management, such as the use of financial incentives, can lead to reductions in inequalities if they improve the monitoring of risk factors which might benefit minorities the most (218). However, it may also have a potential negative consequence on its impact on inequalities. Concerns that pay for performance might erode equity in the provision of health care have been raised in the United States. For example, Casliano et al., noted that providers serving minorities may receive less income, pay for performance schemes might provoke providers to introduce interventions to improve quality and minority patient may not benefit from them, such as using patient leaflet in a specific language and providers may engage in "cherry picking" to avoid costly patients (219). For example, in the United States, based on 9 Heath Plan Employer and Data Information Data Set found that patients who received care from providers in the top performance tertile had fewer minority patients, and non-English speaking patients, when compared to patients of providers in the bottom performance tertile (220). One example of "cherry picking" is illustrated in the Taiwanese experiment of pay for performance to improve diabetes care. Providers in this scheme are allowed to choose which patient to be included in the scheme. Not surprisingly, patients with comorbidity and older patients were more likely to be excluded from the scheme (221). Another example, is the adverse selection of most severe substance abuse patients in the United States between 1991 and 1995 (222). Similar concerns have been raised with the introduction of QOF (160, 223). For instance, a number of studies suggest that QOF may not address inequalities in diabetes management previously evident between age, gender and ethnic

groups (135, 224). However, the government and the BMA have stated that the scheme is likely to reduce inequalities in health care (225, 226). Others have stated that "QOF is a truly equitable public health intervention" (227). Furthermore, indicators used in pay for performance schemes are designed using evidence from clinical trials (228). These trials may exclude older patients and patients with comorbidities. Hence, they tend to focus on patients with only a single condition (44).

## 2.8 Contribution to the literature

In recent years, financial incentives have gained momentum and were seen as a way to change providers' behaviour towards the delivery of better care (as discussed in the start of this section). The impact of pay for performance on diabetes care and on care delivered to ethnic minorities is still unclear and how such impact is disseminated to minorities. In addition, the important primary care role in reducing inequalities has been reaffirmed by the WHO and the recent Marmot review (229, 230). Furthermore, the WHO has recently recommended that all government policies and programmes be assessed for their impact on health and health equity (231). Despite this recommendation, research into the impact of pay for performance programmes on health care inequalities is limited. For example, a recent systematic review did not identify any study evaluating the impact of pay for performance on inequalities in health care (232). However, the review was confined to United States studies that examined impacts on ethnic and racial inequalities only. Assessing the impact of

pay for performance on other known inequalities in health care, including those related to age, sex and socioeconomic status is important.

My work contributes to the literature in three ways. First, synthesis of the available evidence on the impact of pay for performance on health care inequalities is lacking. Second, studies that assessed the impact of QOF on ethnic inequalities in diabetes management have mainly used a pre-post design (200, 233), which meant underlying trends in improvement where not adjusted for. Further, one study that adjusted for underlying trend (234), used one measurement point after QOF had been implemented and examined only HbA1c and blood pressure only, in addition the authors did not adjust for other patients' covariates such as, the number of comorbidities and duration of diabetes. I extend on this work by conducting a longitudinal analysis by using multiple measurement points before and after QOF introduction. This should allow me to examine the "inverse equity hypothesis" (88), which is based on findings from child health inequities studies in Brazil and remains largely untested in populations with chronic illnesses in developed countries. The authors explored this by examining trends for inequality ratio for morbidity and mortality within Brazil. Examining whether universal quality improvement programs, such as the QOF, address inequalities in health care over time has important implications for policy makers and health planners. This is because it will inform decisions about whether additional resources are required for targeted interventions to improve care in vulnerable populations. While the QOF was not explicitly designed to narrow inequalities, associated systematic improvement and standardization in the quality of care maybe expected to lead

to reductions in inequalities (235), and the UK department of health has stated that the QOF is likely to reduce inequalities (226). Third, ethnic minorities with diabetes are more likely to have comorbid conditions and clinical guidelines are geared to the management of single medical condition (236, 237). Previous studies suggest that patients with multiple conditions may receive similar or higher quality of care than those with a single condition and may have benefited more from quality improvement strategies (238). The impact of QOF on diabetes management among patients with diabetes from different ethnic groups with and without comorbid medical conditions is limited. For example, Previous research has found white-black group disparities in blood pressure control were greater among hypertensive patients with multiple cardiovascular conditions (239).

## 3.0 Aims and Objectives

Research question:

What is the impact of the quality and outcomes framework on ethnic inequalities in diabetes management?

Aim:

To assess the impact of QOF on ethnic inequalities in delivered quality of diabetes care.

Objectives:

1. To carry out a systematic review on the impact of pay for performance on inequalities in health care quality.
2. To examine longer-term impact of the quality and outcome framework on ethnic inequalities in diabetes management.
3. To examine the impact of the quality and outcome framework on ethnic inequalities in patients with and without comorbidities in diabetes management.

# 4.0 Impact of pay for performance on inequalities in health care: a systematic review

The evidence on the use of explicit financial incentives to improve quality, albeit mixed, prompted wide implementations of pay for performance schemes. Despite this, there remains limited evaluation of their impact, particularly in relation to possible unintended consequences, such as their impact on inequalities. Reducing health inequalities, is a key policy objective in many countries (240, 241), which requires a multifaceted approach including achieving greater equity in health care delivery (230). In this chapter I aim to undertake a systematic review of published articles that assessed the impact of pay for performance programmes on the quality of health care in relation to age, sex, ethnicity and socioeconomic status (SES).

## 4.1 Methods

### 4.1.1 Search strategy

Papers published between 1 January 1980 and 1 November 2008, were identified through a systematic search of published English language literature in MEDLINE, EMBASE, PsycINFO and the Cochrane Library. The search was periodically updated to include the most recent publications with the last update ended on February 2011. I examined papers that assessed quantitatively the impact of pay for performance on health care inequalities. In MEDLINE, my search included Medical Subject Heading (MeSH) terms and text words. MeSH terms used were: physician incentive plans; reimbursement, incentive; reimbursement mechanisms; insurance, health, reimbursement; quality

indicators, health care; ethnic groups; minority groups; minority health; healthcare disparities; health care inequalities, health status disparities; and socioeconomic factors. Text words used were: pay for performance and P4P. In EMBASE I used the following EMTREE heading terms: reimbursement, health care quality, prospective payment, performance measurement system, minority group, ethnic group, ethnic difference, race difference, and social status. Text word included pay for performance, P4P, pay for quality, physician incentive and deprivation. In PsycINFO terms used includes: incentive, monetary incentive, quality of care, racial and ethnic groups, minority groups, racial and ethnic differences, social deprivation, social justice, socioeconomic status, and health disparities. The following text words were also used: pay for performance, physician incentive, incentive payment, and performance measurement. Where the title or abstract of the paper were not clear, the full text of the article was retrieved and reviewed. In addition, the grey literature was consulted.

### 4.1.2 Study selection

Pay for performance incentives were defined as the use of monetary incentives to reward health care providers' achievements in predetermined quality standards. Quantitative studies were included if they examined the relationship between the use of an explicit financial incentive and healthcare inequalities. Dimensions of health care inequality examined included: age, sex, ethnicity, and SES status. I included both experimental and observational studies. I excluded papers that examined the use of non-monetary rewards, such as public report cards. Along with a colleague we independently used the Downs and Black critical appraisal tool to assess the methodological quality of the retrieved

studies (242). I used a similar approach used by Peterson et al. (167) to assign studies into a quality scale from 1 to 4. Studies considered to be of poor methodological quality were scored as '1+' and studies considered to be of excellent methodological quality were scored as '4+'. Whenever there was conflict in the score of the retrieved articles, a third scorer was consulted.

## 4.2 Results

Our search yielded 4396 articles (Figure 2). Based on the title of the articles, I identified 85 papers for further review; out of which, 23 relevant articles were identified. One additional article was retrieved through the reference list search of the retrieved articles. A summary of the retrieved studies is in Appendix 2. Most of the studies retrieved were observational studies conducted in the UK assessing the impact of the introduction of the QOF in April 2004. Some studies examined more than one aspect of inequality.

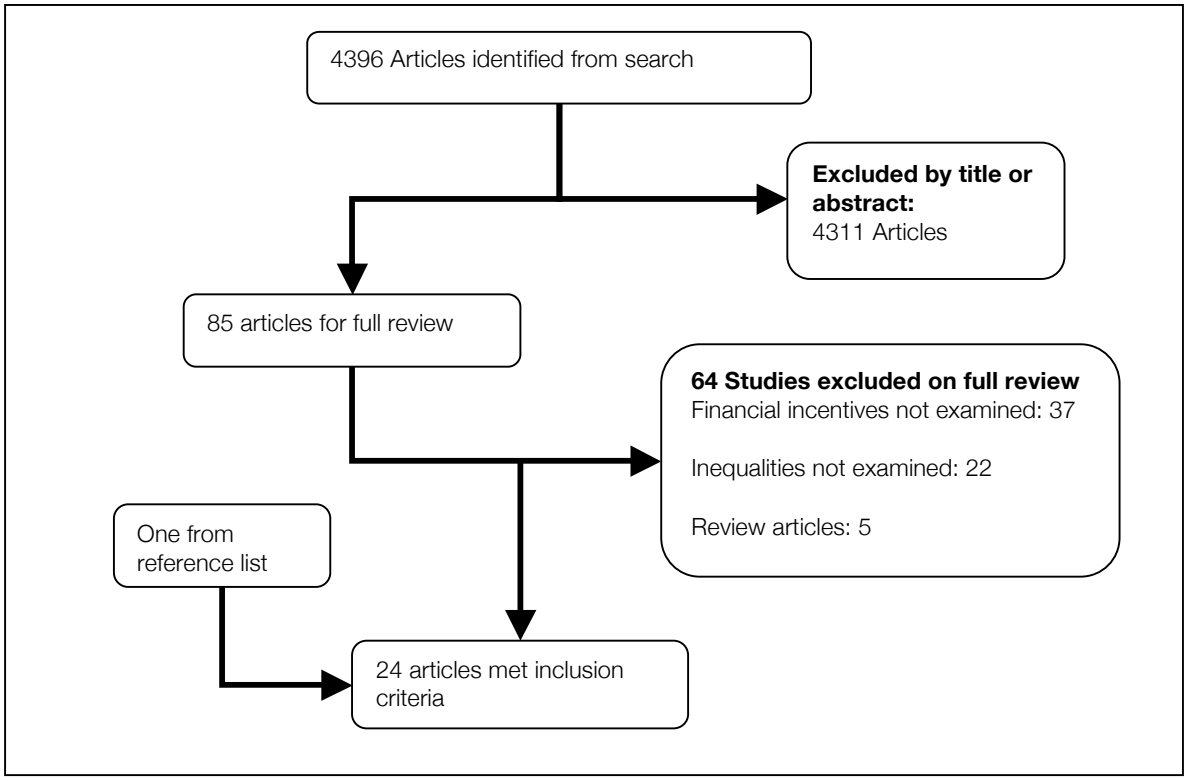


*Figure 2 Flow chart of study selection*

### 4.2.1 Socioeconomic inequality

SES was the most frequently examined variable (199, 200, 205, 243-259). Most studies used a cross-sectional design and examined associations between quality of care and an area deprivation score after the implementation of the QOF. Only one study, which was conducted in a largely rural and relatively deprived part of Scotland, found that deprivation was positively associated with higher quality in the first year of the QOF (254). The remaining studies identified significantly lower quality of care in deprived areas compared with affluent areas. However, the magnitudes of the differences were generally small and appear to have been attenuated in the second and third year of this pay for performance programme. For example, Ashworth et al. (243) found a difference in the achievements between least and most deprived practices of 64.5 QOF points (a difference of 6.1%) in the first year of the QOF, but this figure decreased to 30.4 QOF points (a difference of 2.9%) in the second year. Doran and colleagues (249), undertook a similar analysis and found a further narrowing of quality during the third year of QOF. Median achievement increased by 4.4% in the least deprived quintile of practices and by 7.6% in the most deprived quintile of practices. Consequently, the gap in median achievement narrowed from 4.0% to 0.8% during this period and was no longer associated with deprivation (P=0.062). Furthermore, the authors found a significant association between scores in the previous year and increases in achievement. The lower the score in the previous year, the better were the achievements in the following year ($p<0.01$).

In a methodologically similar paper (244), data were collected from over 97% of practices in England to examine the values of blood pressure monitoring and control in five chronic diseases in relation to deprivation over a period of three years after QOF introduction. Differences between affluent and deprived areas seen in the first year after the QOF had almost disappeared by the third year. For example, 79.2% of diabetes patients attending practices in affluent areas achieved the desired blood pressure targets compared to 78.6% of diabetes patients attending practices in deprived areas. By the third year deprivation had a weak positive effect on blood pressure monitoring ($P<0.001$).

A study by Ashworth et al. (246), found higher levels of statin prescribing in deprived areas when compared to affluent areas in the first year of the QOF after adjusting for differences in cardiovascular disease prevalence. Saxena et al. (251), examined associations between deprivation and quality of care for coronary heart disease, hypertension and stroke in the first year of this pay for performance programme. Achievements were very similar in practices working in deprived and affluent areas. However, affluent practices achieved better scores for some indicators associated with initial diagnosis and management, such as referral for exercise testing ($p<0.001$). Using a comparable study design, Millett et al. (205), found broadly similar achievement of quality indicators for diabetes in practices working in deprived and affluent areas. Sigfrid and colleagues (252), examined associations between deprivation and 'exception reporting' for 15 diabetes indicators in the QOF, whereby patients can be excluded from the data used to calculate the achievement of a target. They found that practices working in deprived areas were more likely to report

'exceptions' for process of care indicators ($p<0.05$), although the relationship appeared to be reversed for intermediate clinical outcome indicators, which raised the concern that reported achievements in the QOF could mask wider inequalities.

Three studies evaluated the impact of this pay for performance programme using a before and after study design. McGovern et al. (256), found that patients with coronary heart disease living in deprived areas were less likely than patients living in affluent areas to have their smoking status recorded (Pre-QOF: Adjusted Odds Ratio [AOR] 1.04; 95% CI: 0.86–1.26, Post-QOF: AOR 0.78; 95% CI: 0.62 – 0.99), blood pressure recorded (Pre-QOF: AOR 0.95; 95% CI: 0.74–1.20, Post-QOF: AOR 0.59; 95% CI: 0.45–0.78), or have beta blocker therapy (Pre-QOF: AOR 0.87; 95% CI: 0.77–0.97, Post-QOF: AOR 0.84; 95% CI: 0.76–0.92) after the implementation of the QOF. These differences were not evident before the introduction of the QOF. However, deprived Coronary Heart Disease (CHD) patients were more likely than affluent CHD patients to have antiplatelet or anticoagulant therapy (Pre-QOF: AOR 1.11; 95% CI: 0.95–1.28, Post-QOF: AOR 1.14; 95% CI: 1.00–1.22). Using a similar study design, Simpson and colleagues (257), found significant difference between stroke patients living in most and least deprived areas after QOF introduction. Stroke patients in the highest deprivation group were less likely to have a recording of blood pressure (Pre-QOF: AOR 0.98; 95% CI: 0.88–1.09, Post-QOF: AOR 0.66; 95% CI: 0.54–0.80) and a record of smoking status (Pre-QOF: AOR 1.16; 95% CI: 1.05–1.29, Post-QOF: AOR 0.81; 95% CI: 0.71–0.94) after the implementation of the QOF. Millett et al (200), found no significant variation in

ascertainment of smoking status and provision of smoking cessation advice in patients with diabetes living in deprived and affluent areas before and after the introduction of QOF. Using data from the GPRD Hamilton et al. (259), found no differences between patients living in affluent and deprived areas in the achievement of intermediate outcomes.

### 4.2.2 Age and sex inequalities

Four studies explored the impact of the QOF on age and sex inequalities. In Scotland, a serial cross sectional study found large improvements in quality indicators for stroke patients. However, inequalities present before the introduction of QOF did not narrow. For instance, stroke patients aged more than 75 years were less likely than young stroke patients to have their smoking status recorded (AOR: 0.69; 95%CI: 0.62–0.76), have a smoking advice given (Pre-QOF: AOR 0.92; 95% CI: 0.76–1.12, Post-QOF: AOR 0.75; 95% CI: 0.60 –0.93) and have their cholesterol level recorded (Pre-QOF: AOR 0.35; 95% CI: 0.32–0.38, Post-QOF: AOR 0.71; 95% CI: 0.66–0.77). Older stroke patients were more likely to receive antiplatelet or anticoagulant therapy after the QOF introduction (Pre-QOF: AOR 0.68; 95% CI: 0.64–0.74, Post-QOF: AOR 1.75; 95% CI: 1.60–1.91). Women who had a stroke were less likely than men to be current smokers (Pre-QOF: AOR 0.92; 95% CI: 0.76–0.98, Post-QOF: AOR 0.87; 95% CI: 0.81–0.95), or receive antiplatelet or anticoagulant therapy (Pre-QOF: AOR 0.95; 95% CI: 0.89–1.00, Post-QOF: AOR 0.93; 95% CI: 0.86–0.99). Further, women with stroke were less likely to have a controlled blood pressure (Pre-QOF: AOR 0.90; 95% CI: 0.84–0.98, Post-QOF: AOR 0.86;

95% CI: 0.81–0.91) or controlled cholesterol levels (Pre-QOF: AOR 0.59; 95% CI: 0.51–0.68, Post-QOF: AOR 0.56; 95% CI: 0.52–0.60) after QOF compared to men (257). In a similar study, pay for performance did not improve the age and sex inequalities for CHD patients seen before introduction of the QOF. For example, women were less likely than men to have a recording of blood pressure (Pre-QOF: AOR 0.92; 95% CI: 0.87–0.97, Post-QOF: AOR 0.89; 95% CI: 0.82–0.97) or having their blood pressure controlled (Pre-QOF: AOR 0.84; 95% CI: 0.79–0.89, Post-QOF: AOR 0.84; 95% CI: 0.80–0.87), or have a recording of beta blocker therapy (Pre-QOF: AOR 0.85; 95% CI: 0.81 –0.88, Post-QOF: AOR 0.81; 95% CI: 0.79–0.84). Older patients were less likely than younger patients to have a recording of beta-blocker therapy (Pre-QOF: AOR 0.39; 95% CI: 0.36–0.42, Post-QOF: AOR 0.53; 95% CI: 0.51–0.56) (256). Using a serial cross sectional study, Millett et al. found that the introduction of QOF was associated with an attenuation of differences in ascertainment of smoking status and provision of cessation advice in people with diabetes from different age groups. For instance, patients aged 75 years had an AOR of 0.92 (95% CI: 0.26–3.31). Ascertainment of smoking status remained significantly higher in women with diabetes than in men (AOR: 2.01; 95% CI: 1.59–2.54) after introduction of the QOF, however reduction in smoking prevalence was lower in women than men (AOR: 0.71; 95% CI: 0.53–0.95) (200). Using data from GPRD, differences in diabetes care seen between men and women before the QOF narrowed after QOF introduction. Further, older patients (>45 years) appear to have benefited more than younger patients after QOF have been introduced (259).

### 4.2.3 Ethnic inequalities

In an analysis undertaken during the first year of pay for performance, Ashworth et al. found lower statin prescribing in areas with high proportions of residents with African-Caribbean or South Asian ethnicity (246). A cross-sectional survey of 32 general practices in London, identified significant ethnic group inequalities in diabetes management, with black and South Asian patients less likely to achieve all three intermediate clinical outcome targets when compared to the white group (258). Using a serial cross sectional design, Millett et al. (233), examined inequalities in prescribing and intermediate outcomes for diabetes management before and after the introduction of the QOF. The study found that percentage achievement of treatment targets for blood pressure, HbA1c and total cholesterol increased in all ethnic groups after the implementation of pay for performance. However, the magnitude of the improvement in HbA1c control (AOR: 0.75; 95% CI: 0.57–0.97) and blood pressure control (AOR: 0.65; 95% CI: 0.53 – 0.81) was lower in the black Caribbean group than the White British group which meant that inequalities in HbA1c and blood pressure control persisted. Variations in prescribing were also documented in the study, with lower prescribing of insulin in the Black African group (AOR: 0.69; 95% CI: 0.51–0.93), Indian group (AOR: 0.51; 95% CI: 0.38–0.70), Pakistani group (AOR: 0.56; 95% CI: 0.40–0.78) and Bangladeshi group (AOR: 0.49; 95% CI: 0.25–0.98) relative to the white British group, differences which persisted after introduction of the QOF. Furthermore, prescribing of oral hypoglycaemic agents increased significantly after QOF introduction, however these changes were largely seen in the black African and South Asian groups rather than the white

British (P<0.001). A more recent longitudinal study assessed the impact of QOF on mean blood pressure and HbA1c values among white, black and South Asian patients with diabetes living in South-West London. The introduction of QOF was associated with reduction in mean values for systolic and diastolic blood pressures and HbA1c; these reductions were significantly greater than the predicted values using the underlying trends in all ethnic groups. However, the magnitude of improvement varied between ethnic groups. For example, reduction in mean HbA1c was significantly greater than the predicted trend in the white group (-0.5%, P<0.05) but similar significant reductions were not seen in the black (-0.3%) or the south Asians (-0.4%) groups (234).

In another study Millett et al., found no variations between different ethnic groups in the recording of smoking status and smoking cessation advice (200). In a study evaluating QOF, (260) achievements of incentivised quality indicators were evaluated before and after the QOF introduction. Overall attainment of CHD management and intermediate clinical outcome improved significantly after the QOF introduction and were similar across ethnic groups.

### 4.2.4 Longer term impact of pay for performance on inequalities

I identified an additional UK study which examined the impact of a more limited pay for performance scheme introduced as part of the 1990 General Practitioner contract (247). This scheme provided financial incentives for reaching fixed targets for cervical cancer screening coverage. The study findings suggest that while these incentives were initially associated with widening of inequalities in cervical screening coverage between deprived and affluent areas, these were largely attenuated at five years follow up. The inequality ratio (equality

represented as a ratio of 1) in 1991 was 0.46 however it increased towards equality when the affluent areas maintained maximum levels and by 1999 the inequality ratio was 0.77.

### 4.2.5 Pay for performance impact on inequalities in the United States

Karve et al. (261), used data from 3449 hospitals to examine the impact of pay for performance on process measures for acute myocardial infarction, community acquired pneumonia and heart failure. The study shows that hospitals with more than 20% of African American patients were less likely to improve on the scores for acute myocardial infarction and pneumonia compared to hospitals that served a lower proportion of non-minority patients. In contrast, Jha et al. (262), found that hospitals with more poor patients had greater improvements in performance for acute myocardial infarction and pneumonia when compared to hospitals that did not participate in the Medicare demonstration project. However, these improvements were not evident for congestive heart failure.

## 4.3 Comment

The introduction of QOF was associated with reductions in inequalities in chronic disease management between affluent and deprived areas. However, it is unclear if these reductions are attributable to QOF or part of underlying trend that pre-dates QOF such as the NSFs. Other Important inequalities in quality of care between age, sex and ethnic groups present before the introduction of this programme appear to have persisted. Specifically women, older patients and those from some minority ethnic groups continued to receive lower quality of

care after the introduction of QOF. The studies included in this review have a number of important limitations. This partly reflects the way that pay for performance programmes have been introduced into health care systems, generally precluding evaluation using an experimental design or a non-intervention comparison group. The data for most studies included in this review was derived from the financial administration system for QOF, the QMAS, and its usefulness for evaluating impacts on inequalities in health care is limited for a number of reasons. Firstly, the system does not hold patient level information on characteristics such as age, sex, ethnicity and SES. Hence, most of the QOF evaluations reported here used practice level data and may underestimate the relationship between deprivation and quality of care. This has been further compounded by poor recording of patient based measures of ethnicity and of SES within primary care information systems in the UK. Secondly, the ability of practices to exclude patients from performance reporting for the contract means that this data may underestimate the extent of inequalities in care. Finally, studies that use data from the system are unable to examine underlying trends in quality, making it difficult to attribute reductions in socioeconomic inequalities to QOF. This is an important limitation given that the UK government has instituted a policy agenda to reduce health inequalities since the late 1990s (240) and the important role primary care plays in achieving such objectives (229). Most of the studies identified in this review examined the impact of the QOF on health care inequalities. Conclusions drawn from these studies may not be applicable to other settings, particularly to low and middle-income countries, or to market-based health care systems in countries without universal access to

healthcare, such as the United States. Pay for performance programmes vary considerably within the United States, in terms of the type of incentives being offered (bonuses, penalties), the type of achievement being rewarded (percentage achievement or improvement), the recipient of incentives (provider organizations or individual physicians) and their overall financial cost, and as such may have differential impacts on health care inequalities (144). In contrast, the UK system is much more standardised and is applied uniformly across the country. This may change if purchasers are given more local flexibility in the implementation of pay for performance schemes. The lack of studies undertaken in the United States may be due to a number of factors, including lack of funding from payers to evaluate pay for performance programmes and the low adoption of electronic medical records (263, 264). This also likely reflects the fact that the impact of pay for performance programmes on health care inequalities is a relatively new area of research enquiry.

# 5.0 Pay for performance and ethnic disparities: an interrupted time series analysis

## 5.1 Methods

### 5.1.1 Study setting

The study was conducted in Wandsworth in South West London (Figure 3), where the population is younger than that of England as a whole, with 74% aged less than 45 years (compared with a national average of 60%); and with a high proportion of residents from ethnic minorities groups. According to the 2001 census, the proportion of Wandsworth population who refer to themselves, as white is 65% and 22% consider themselves as non-white. The proportion of residents who describe themselves as black Caribbean, black African, Indian, Pakistani, Bangladeshi, and Chinese was 4.9%, 3.9%, 2.9%, 2.1%, 0.4% and 2.2% in 2001, respectively. Wandsworth has a relatively high level of deprivation. According to the 2000 Index of Multiple Deprivation Wandsworth is ranked at 148 of all local authorities and in 2007 it was ranked 128 (rank is out of 357 local authorities in England, the higher the rank the more deprived the area).

<u>The CONDUIT quality improvement programme:</u>

The Wandsworth Primary Care Trust initiated a programme to establish a comprehensive disease register in September 2000. The Cutting Out Needless Deaths Using Information Technology (CONDUIT) programme was initially

piloted in Battersea, Wandsworth South and Putney localities in 63 practices covering a registered population of 382,188 and targeted individuals with

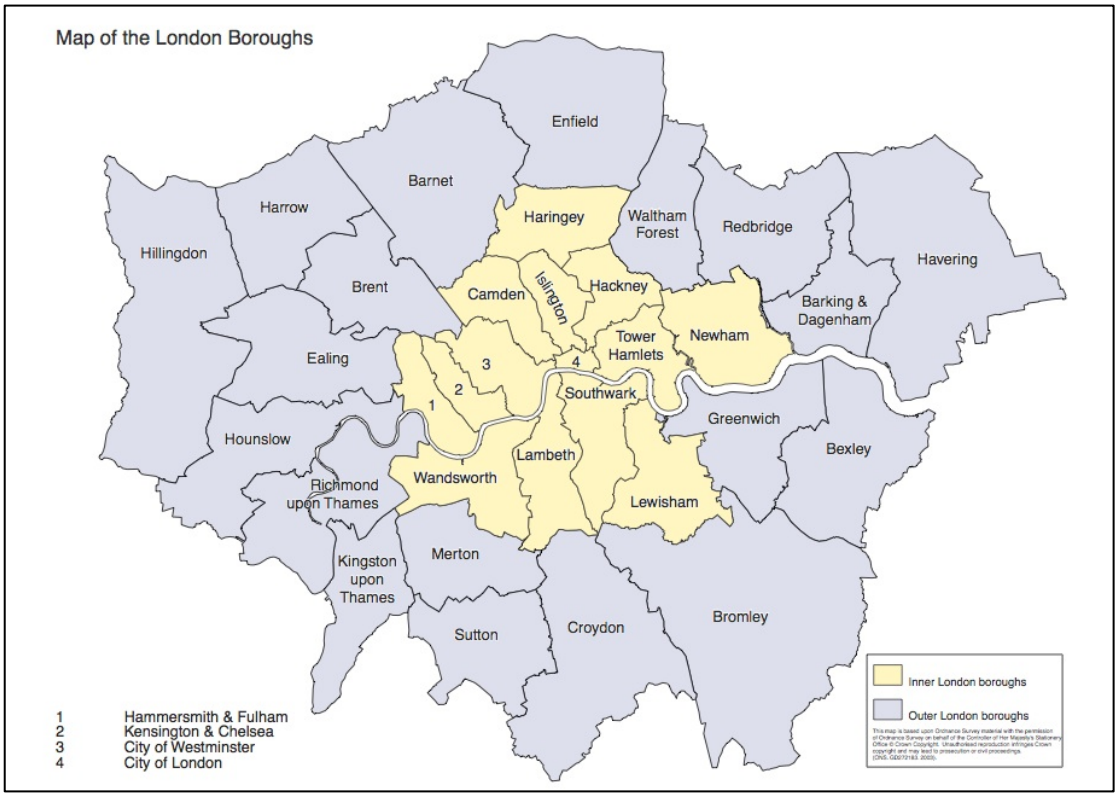


*Figure 3 London Boroughs*

Source: www.ons.gov.uk

hypertension and ischemic heart disease. In 2003, due to changes in the practices computers, the practices in Putney locality were dropped from CONDUIT 2 and from subsequent CONDUIT collections. CONDUIT 2 involved 34 practices and included patients with hypertension, ischemic heart disease and diabetes. CONDUIT 3 involved 32 practices in 2005 and included patients with hypertension, ischemic heart disease, diabetes and asthma.

The output from this programme resulted in a standardised method of identifying patients with cardiovascular disease and diabetes, and facilitated the

establishment of accurate chronic disease registers. In addition, the findings of the CONDUIT programme have been published in leading international journals. My work builds on the early CONDUIT efforts and involved analysis of data from practices that participated in this programme. Practices that participated in the study serve a more ethnically diverse and deprived population than Putney.

The study area covered 32 practices. Of these 29 practices agreed to take part in this study. The practices had a median list size of 7,451 patients. Ten practices had more than 10,000 patients; ten practices had between 5,000 and 9,000 patients and nine practices had less than 4,000 patients.

Identification of diabetes cases:

The method used to identify patients in Wandsworth was piloted in 2002 (265). The study concluded it is essential to search beyond diagnostic Read codes, such as C10, and include diabetes management codes from computerised medical records. The inclusion criteria used in my study are:

- Diagnostic Read code for diabetes (C10 or sub-codes).
- Diabetes management Read code (66A).
- Patient age is more or equal to 18 years.

Data was collected on all patients, identified in December 2007, retrospectively for the years 2000–2007 from computerised patient records at each of the 29 participating practices by staff of the Wandsworth primary care trust research centre. The data subsequently was stored in a secure location at the research centre. I was not able to link patient registered in 2007 to previous CONDUIT

because the ethics committee did not approve the extraction of a unique patient identifier.

### 5.1.2 Study variables

The process and outcome indicators collected were according to the indicators used in the QOF (Box 4). The main outcome variables were HbA1c, total cholesterol, and blood pressure levels based on patients' last recorded measurement in each year. Further, I constructed three outcome variables corresponding to the control targets used in QOF: HbA1c≤7.5%, cholesterol≤5.0 mmol/l, and blood pressure ≤145/85 mm Hg.

Process indicators included were recording of HbA1c, cholesterol, and blood pressure, visual examination of feet, retinal screening, recording of peripheral pulses or ability to feel vibration, recording of serum creatinine, recording of BMI, and recording of micro-albuminuria.

*Box 4 List of indicators used in QOF*

- The percentage of patients with diabetes whose notes record BMI the previous 15 months.
- The percentage of patients with diabetes whose notes record of HbA1c or equivalent in the previous 15 months.
- The percentage of patients with diabetes whose notes record of retinal screening in the previous 15 months.
- The percentage of patients with diabetes whose notes record of the presence or absence of peripheral pulses in the previous 15 months.
- The percentage of patients with diabetes whose notes record of neuropathy testing in the previous 15 months.

- The percentage of patients with diabetes whose notes record of blood pressure in the previous 15 months.
- The percentage of patients with diabetes in whom the last blood pressure is 145/85 or less.
- The percentage of patients with diabetes who have a record of micro-albuminuria testing in the previous 15 months.
- The percentage of patients with diabetes who have a record of estimated glomerular filtration rate (eGFR) or serum creatinine testing in the previous 15 months.
- The percentage of patients with diabetes who have a record of total cholesterol in the previous 15 months.
- The percentage of patients with diabetes whose last measured total cholesterol within previous 15 months is 5.0 mmol/l or less.
- The percentage of patients with diabetes whose last measured HbA1c within previous 15 months is 7.5 mmol/l or less.
- The percentage of patients with diabetes whose notes record smoking status in the previous 15 months.
- The percentage of patients with diabetes whose notes contain a record that smoking cessation advice has been offered within the previous 15 months.

My main predictor variable was ethnicity. In the UK, ethnicity recording has historically been low. In October 2000, the UK government required the recording of ethnic group in patient records (mainly in NHS trusts) in similar fashion to the ethnic categories used in the 2001 census (266). Recently, two main incentives were introduced to improve ethnicity coding nationally: the QOF and the Directly Enhanced Services. Despite this, ethnicity coding in primary care remains low in general practice for meaningful use in health services research and epidemiological research (267). For example, practices participating in the national diabetes audit in 2004-05 had only 17% of their registered patients with ethnicity coding and slightly improved in the following

year to 36% (268). Similarly, in 2006/7 the level of ethnicity coding in 530 practices contributing to the QRESEARCH database was 10.2% (269).

The Wandsworth Primary Care Trust implemented a financial scheme in 2002 to improve the level of ethnicity coding for patients with chronic conditions through the use of templates with limited list of ethnicity codes. Information on ethnic background is collected from the patient during consultation or upon registration and is entered in the patients' electronic record using the 2001 census classification. Due to the small numbers in some of the ethnic groups, I had to group them into one. For example, I combined Indian, Pakistanis and Bangladeshis into one south Asian group (See appendix 3 for breakdown of the main ethnicity groups and cross sectional analysis). Additional patient level information collected includes age, sex, BMI, and SES. I used practice postcode to assign a SES score to each patient using the index of multiple deprivation as I could not use patient post code (270) because the ethnical committee did not agree for this information to be extracted. The index is used to measure area level SES in the UK and is composed of several dimensions including income, employment, health and disability, education skills and training, barriers to housing and services, living environment, and crime.

To adjust for the severity of diabetes, I further collected information on the duration of diabetes and the number of comorbid medical conditions, Duration of diabetes was calculated in years using the date of diagnosis entered in the electronic medical record. Comorbid conditions included hypertension, stroke, atrial fibrillation, heart failure, coronary heart disease (CHD), asthma, chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), and

depression. I chose these as they are most commonly observed and commonly managed in primary care.

Further, I collected data on whether a patient was prescribed any oral hypoglycemic agent (Sulfonylurease, Metformin, Glitazone), Insulin, any antihypertensive medication (Angiotension-converting enzyme, Beta blocker, Calcium channel blocker, Diuretics), and any lipid lowering medication.

### 5.1.3 Analysis

Interrupted time series analysis:

I estimated unadjusted annual mean values and 95% confidence interval for HbA1c, cholesterol, and systolic and diastolic blood pressure for each ethnic group and for all the population. These variables were approximately normally distributed. For binary outcomes, I present annual percentage achievement with 95% confidence interval for each ethnic group and for all the population.

The QOF was implemented nationally, meaning using a gold standard method, similar to a control trial, is not an option. Further, limiting my analysis to a pre-post study design may over-estimate the impact of QOF as quality of care was improving before the introduction of QOF. To estimate changes in risk factor control associated with QOF while controlling for secular trend, I fitted a segmented regression model of the time series for all the population and individually in the three ethnic groups for each of the outcome variables (271, 272). In addition, to accommodate the multilevel nature of the data (multiple measurements per patients, and patients clustered within practices), I treated patients and practices as random effects in a multilevel model to adjust for the

correlation in error term within both individual level and practice level. Ignoring such data structure might lead to biased estimate (i.e standard error of model coefficients might be underestimated leading to narrower confidence interval) (273). The model estimates three main parameters:

$$y_{ijt} = \beta_{0ijt} + \beta_1 x\ time_{ijt} + \beta_2 x\ policy_{ijt} + \beta_3 x\ years\ after\ policy_{ijt} + \beta_4\ X_{ijt} + V_t + U_{jt} + e_{ijt}$$

$\beta_1$ estimates the change in the outcome associated with each year before QOF was introduced in April 2004 where time is a continuous variable ranging from 1 to 8 to represent time in years, $\beta_2$ estimates the immediate change associated with QOF where policy is coded as zero before the intervention and coded as 1 for the years after the intervention, and $\beta_3$ estimates the change in the outcome associated with each year after QOF had been introduced where years after policy is a continuous variable representing the number of years after the intervention and coded as zero for the years before the intervention. $\beta_4$ are estimates of covariates adjusted for in the model, these include age, gender, duration of diabetes, number of co-morbid medical conditions, and SES. $V_t$ and $U_{jt}$ are the variances of the intercept for practice level and patient level and $e_{ijt}$ is the residual error. For the continuous variables (HbA1c, cholesterol, and systolic and diastolic blood pressure) I use a linear regression model (using the *xtmixed* syntax) and present change in mean values with 95% confidence interval. For the binary outcome, I used a logistic regression (using the *xtmelogit* syntax) and present the change in odds ratios with 95% confidence interval.

For the key indicators (HbA1c, cholesterol, systolic, and diastolic blood pressure) I present the models unadjusted in Appendix 5.

As part of my sensitivity analysis I ran the models on patients with complete records over the study period to investigate whether change in the case mix in the post-QOF years had an effect on my original estimates. Further, I tested for attrition bias using Heckman selection model (274). Details of the sensitivity analysis are in Appendix 4.

Further, I estimated the overall trend for each indicator using a simpler linear model ( $y = \beta_0 + \beta_1$ x time), where y is the percentage of patients achievement in a given indicator in each year; time is a chronological index of the eight year extracted ranging from 1 (2000) to 8 (2007).

Cross sectional analysis:

For each binary indicator, e.g. HbA1c measured, I used a logistic regression with ethnicity as a dummy variable and the White group as the reference group to examine if inequalities present at the start of study were addressed at the end of the study period. I fitted the model for each indicator separately for the year 2000 and for the year 2007. All analyses were adjusted for age, gender, duration of diabetes, number of comorbidities, SES, and practice level clustering.

I performed all analysis using the statistical software Stata version 10.

Ethical approval:

The study was approved by the Wandsworth Local Research Ethics Committee.

## 5.2 Results

I identified 7,542 patients with diabetes registered with practices in 2007. I excluded 108 with implausible or missing values. The mean age of patients was 59.1 years and 49.6% were female. Overall, 90.0% of patients had their ethnicity coded. White patients comprised 42.7% of the sample, 24.3% were Black, and 22.2% were South Asian (Table 8).

*Table 8 Sample characteristics*

| | | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | | 2005 | | 2006 | | 2007 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Numbers | % | Numbers | % | Numbers | % | Numbers | % | Numbers | % | Numbers | % | Numbers | % | Numbers | % |
| Gender | Male | 1,448 | 52.6 | 1,760 | 52.6 | 2,047 | 52.4 | 2,300 | 51.7 | 2,623 | 51.5 | 2,947 | 51.3 | 3,284 | 50.8 | 3,749 | 50.4 |
| | Female | 1,303 | 47.4 | 1,589 | 47.4 | 1,861 | 47.6 | 2,147 | 48.3 | 2,465 | 48.5 | 2,802 | 48.7 | 3,183 | 49.2 | 3,685 | 49.6 |
| Age group | 18-44 | 507 | 18.4 | 591 | 17.6 | 668 | 17.1 | 763 | 17.2 | 843 | 16.7 | 966 | 16.8 | 1,126 | 17.4 | 1,329 | 17.9 |
| | 45-54 | 510 | 18.5 | 605 | 18.1 | 688 | 17.6 | 741 | 16.7 | 845 | 16.6 | 928 | 16.1 | 1,025 | 15.8 | 1,151 | 15.5 |
| | 55-64 | 832 | 30.2 | 976 | 29.1 | 1,094 | 28.0 | 1,172 | 26.4 | 1,303 | 25.6 | 1,410 | 24.5 | 1,514 | 23.4 | 1,645 | 22.1 |
| | 65-74 | 665 | 24.2 | 846 | 25.3 | 997 | 25.5 | 1,207 | 27.1 | 1,355 | 26.6 | 1,525 | 26.5 | 1,691 | 26.1 | 1,945 | 26.2 |
| | >=75 | 237 | 8.6 | 331 | 9.9 | 461 | 11.8 | 564 | 12.7 | 742 | 14.6 | 920 | 16.0 | 1,111 | 17.2 | 1,364 | 18.3 |
| Ethnicity | White | 1,104 | 40.1 | 1,354 | 44.5 | 1,614 | 45.5 | 1,847 | 45.7 | 2,139 | 42.0 | 2,410 | 46.5 | 2,751 | 47.1 | 3,181 | 42.7 |
| | Black | 682 | 24.8 | 836 | 27.5 | 963 | 27.1 | 1,103 | 27.3 | 1,255 | 24.7 | 1,416 | 27.3 | 1,584 | 27.1 | 1,811 | 24.3 |
| | South Asian | 697 | 25.3 | 832 | 27.4 | 948 | 26.7 | 1,066 | 26.3 | 1,198 | 23.6 | 1,321 | 25.5 | 1,465 | 25.1 | 1,653 | 22.2 |
| | Other | 12 | 0.4 | 17 | 0.6 | 19 | 0.5 | 26 | 0.6 | 35 | 0.69 | 32 | 0.6 | 35 | 0.6 | 45 | 0.6 |
| | Missing | 256 | 9.3 | 310 | 9.2 | 364 | 9.3 | 405 | 9.1 | 461 | 9.06 | 570 | 9.9 | 632 | 9.7 | 739 | 9.9 |
| Comorbidity | 0 | 691 | 25.1 | 863 | 25.8 | 1,038 | 26.6 | 1,202 | 27.0 | 1,434 | 28.2 | 1,679 | 29.2 | 1,952 | 30.2 | 2,368 | 31.8 |
| | 1 | 985 | 35.8 | 1,229 | 36.7 | 1,437 | 36.8 | 1,649 | 37.1 | 1,886 | 37.1 | 2,146 | 37.3 | 2,399 | 37.1 | 2,727 | 36.7 |
| | ≥2 | 1,075 | 39.1 | 1,257 | 37.5 | 1,433 | 36.6 | 1,596 | 35.9 | 1,768 | 34.7 | 1,924 | 33.5 | 2,116 | 32.7 | 2,339 | 31.5 |
| Total | | 2,751 | | 3,349 | | 3,908 | | 4,447 | | 5,088 | | 5,749 | | 6,467 | | 7,434 | |

### 5.2.1 Process measures

HbA1c recording:

Recording of HbA1c increased substantially during the study period from 33.2% (95% CI: 31.5–35.0) in 2000 to 79.8% (95% CI: 78.9–80.8) in 2007 at an average rate of 6.9%, p<0.01. HbA1c recording increased from 33.9%, 37.8%, and 24.1% in 2000 to 78.4%, 84.3%, and 81.6% for white, black, and South Asian patients in 2007, respectively (Figure 4 and table 9).

In the pre-QOF period, the proportion of people having their HbA1c recorded increased annually (AOR: 1.81; 95% CI: 1.74–1.89, p<0.01). The introduction of QOF was associated with an additional immediate improvement in the proportion of people having their HbA1c recorded (AOR: 1.73; 95% CI: 1.49–2.02, p<0.01). In the post-QOF years, annual improvements in the proportion of people to have HbA1c recorded were significantly lower than that during the pre-QOF period (AOR: 0.63; 95% CI: 0.58–0.67, p<0.01). These findings were similar for the three ethnic groups (Table 10).

Inequalities were not abolished in 2000 for south Asian patients (AOR: 0.83; 95% CI: 0.63–1.09). However, at the end of the study period south Asian and black patients were more likely to have their HbA1c measured when compared to white group (AOR: 1.42; 95% CI: 1.26–1.80 and AOR: 1.54; 95% CI: 1.30–1.81, respectively).

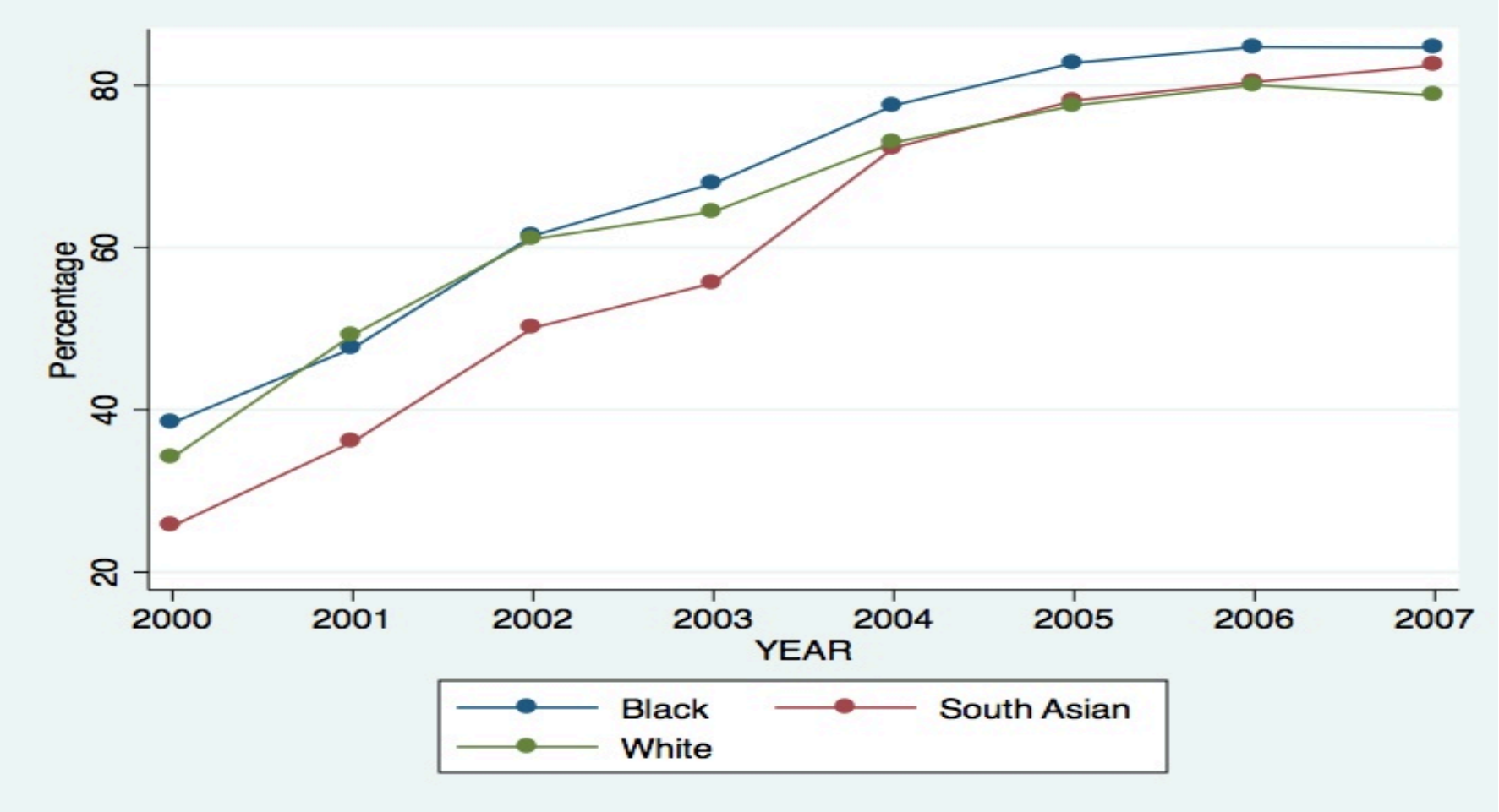


*Figure 4 Annual percentages of patients with HbA1c recorded*

*Table 9 Percentage of patients with HbA1c measured*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 33.9 (31.1-36.7) | 48.6 (46.0-51.3) | 60.7 (58.3-63.1) | 60.9 (58.6-63.1) | 72.1 (70.2-74.0) | 76.8 (75.1-78.4) | 79.7 (78.2-81.2) | 78.4 (77.0-79.9) |
| Black | 37.8 (34.1-41.4) | 46.1 (42.7-49.5) | 60.0 (56.9-63.1) | 65.0 (62.1-67.8) | 76.6 (74.3-78.9) | 81.8 (79.8-83.8) | 84.3 (82.5-86.1) | 84.3 (82.6-86.0) |
| South Asian | 24.1 (20.9-27.2) | 33.2 (30.0-36.5) | 46.9 (43.7-50.1) | 54.2 (51.2-57.2) | 71.5 (68.9-74.0) | 76.9 (74.7-79.2) | 79.4 (77.3-81.5) | 81.6 (79.8-83.5) |
| ALL | 33.2 (31.5-35.0) | 44.8 (43.1-46.5) | 57.3 (55.7-58.8) | 62.1 (60.7-63.6) | 72.5 (71.3-73.7) | 77.9 (76.8-78.9) | 80.0 (79.1-81.0) | 79.8 (78.9-80.8) |

Values in brackets are 95% Confidence Interval

*Table 10 Interrupted time series for HbA1c measured*

| | HbA1c, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 1.81 (1.74-1.89)** | 1.78 (1.67-1.90)** | 1.84 (1.70-2.00)** | 1.90 (1.76-2.06)** |
| Level change with QOF | 1.73 (1.49-2.02)** | 1.51 (1.18-1.92)** | 1.85 (1.34-2.56)** | 1.89 (1.40-2.57)** |
| Post-QOF trend | 0.63 (0.58-0.67)** | 0.63 (0.57-0.70)** | 0.63 (0.55-0.73)** | 0.64 (0.56-0.73)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Cholesterol recording:

Cholesterol recording increased at an average rate of 7.5%, p<0.01 between 2000 and 2007. Recording increased from 30.7% (95% CI: 28.9–32.4) in 2000 to 80.6% (95% CI: 79.7–81.5) in 2007. Cholesterol recording increased from 32.1%, 36.9%, and 21.8% in 2000 to 78.5%, 84.4%, and 83.9% for white, black, and South Asian patients in 2007, respectively (Figure 5 and table 11). In the pre-QOF period, the proportion of people having their cholesterol recorded increased on annual basis (AOR: 1.82; 95% CI: 1.75–1.90, p<0.01). The introduction of QOF was associated with an additional immediate improvement in the proportion of people having their cholesterol recorded (AOR: 1.74; 95% CI: 1.50–2.02, p<0.01). In the post-QOF years the proportion of people having their cholesterol recorded was significantly lower than that during the pre-QOF period (AOR: 0.63; 95% CI: 0.59–0.68, p<0.01). These findings were similar for black and south Asian patients. However, QOF introduction had no additional immediate improvements in the proportion of white patients having their cholesterol recorded (AOR: 1.16; 95% CI: 0.92–1.48, p>0.05) (Table 12). The South Asian group was less likely to have cholesterol measured when compared to the white group in 2000 (AOR: 0.74; 95% CI: 0.56-0.98). By the end of the study period South Asian were more likely to have a cholesterol measurement when compared to the white group (AOR: 1.55; 95% CI: 1.28-1.87). Similarly, black patients were more likely to have cholesterol measured when compared to white patients (AOR: 1.40; 95% CI: 1.18-1.66).

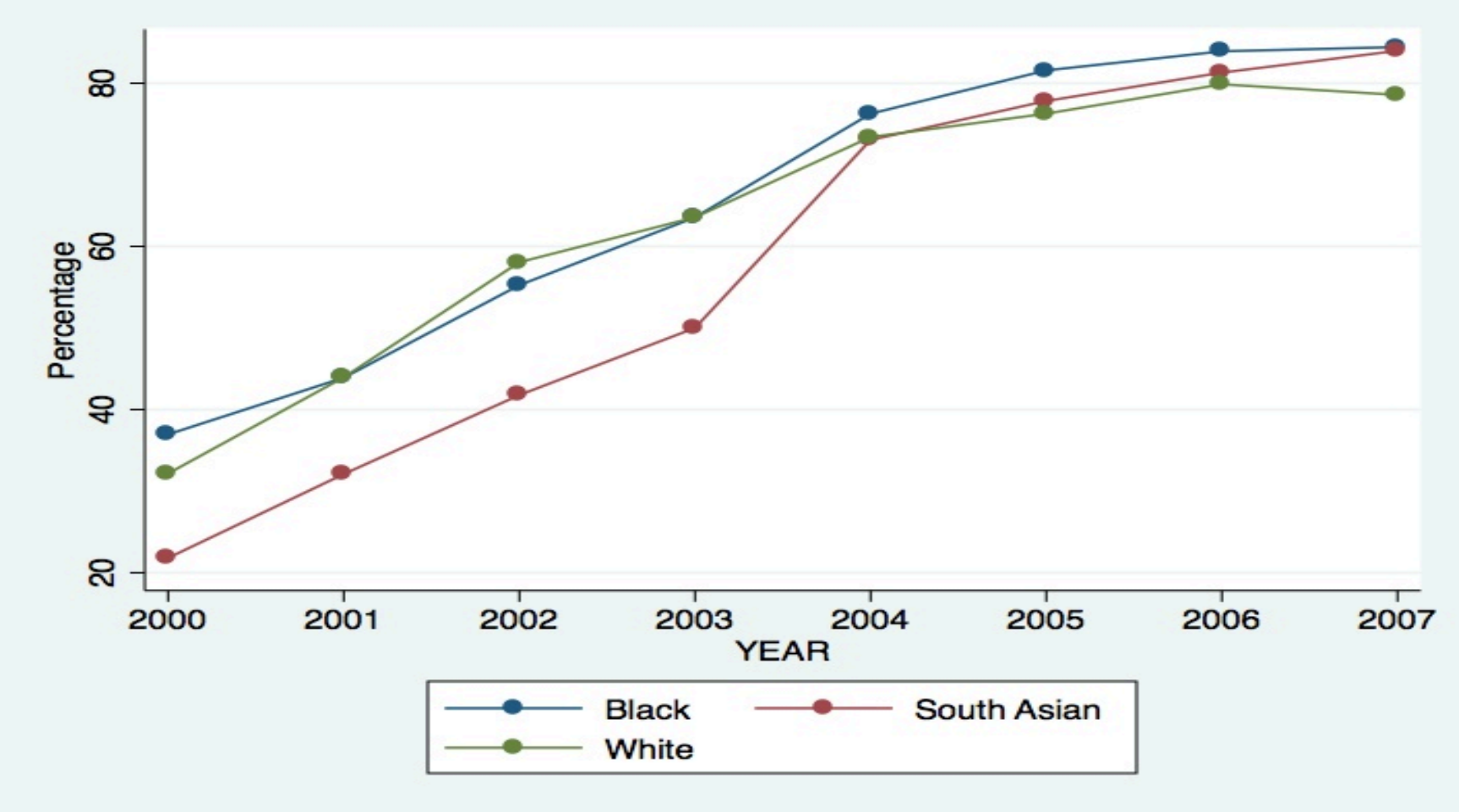


*Figure 5 Annual percentages of patients with cholesterol measured*

*Table 11 Percentage of patients with cholesterol measured*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 32.1 (29.3-34.9) | 43.9 (41.2-46.5) | 58.0 (55.6-60.4) | 63.5 (61.3-65.7) | 73.3 (71.5-75.2) | 76.2 (74.5-77.9) | 79.8 (78.3-81.3) | 78.5 (77.1-79.9) |
| Black | 36.9 (33.3-40.5) | 43.8 (40.5-47.2) | 55.2 (52.0-58.3) | 63.5 (60.7-66.3) | 76.2 (73.8-78.6) | 81.5 (79.5-83.5) | 83.9 (82.0-85.7) | 84.4 (82.7-86.1) |
| South Asian | 21.8 (18.7-24.8) | 32.0 (28.9-35.2) | 41.7 (38.6-44.9) | 50.0 (46.9-53.0) | 73.0 (70.5-75.5) | 77.8 (75.5-80.0) | 81.2 (79.2-83.2) | 83.9 (82.1-85.7) |
| ALL | 30.7 (28.9-32.4) | 41.8 (40.1-43.5) | 52.2 (50.6-53.8) | 59.5 (58.1-61.0) | 72.9 (71.7-74.1) | 77.2 (76.1-78.3) | 80.4 (79.4-81.3) | 80.6 (79.7-81.5) |

Values in brackets are 95% Confidence Interval

*Table 12 Interrupted time series for cholesterol measured*

| | Cholesterol, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 1.82 (1.75-1.90)** | 1.94 (1.82-2.07)** | 1.72 (1.59-1.86)** | 1.55 (1.45-1.66)** |
| Level change with QOF | 1.74 (1.50-2.02)** | 1.16 (0.92-1.48) | 2.07 (1.51-2.83)** | 1.87 (1.44-2.43)** |
| Post-QOF trend | 0.63 (0.59-068)** | 0.58 (0.52-0.64)** | 0.67 (0.59-0.77)** | 0.79 (0.70-0.89)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Blood pressure recording:

The recording of blood pressure increased from 55.3% (95% CI: 55.3–57.2) in 2000 to 90.1% (95% CI: 89.4–90.8) in 2007 at an average rate of 5.6%, p<0.01. Blood pressure recording increased from 52.1%, 61.7%, and 49.6% in 2000 to 90.8%, 92.2%, and 89.5% for white, black, and South Asian patients in 2007, respectively (Figure 6 and table 13).

In the pre-QOF period, the proportion of people having their blood pressure recorded increased annually (AOR: 1.35; 95% CI: 1.31–1.39, p<0.01). The introduction of QOF was associated with an additional immediate improvement in the proportion of people having their blood pressure recorded (AOR: 1.38; 95% CI: 1.19–1.59, p<0.01). In the post-QOF years, annual improvements in the proportion of people having their blood pressure measured was significantly lower than that during pre-QOF period (AOR: 0.92; 95% CI: 0.87–0.98, p<0.01). These findings were similar for black and south Asian patients. However, QOF introduction was not associated with additional improvement in the proportion of white patients having their blood pressure measured (AOR: 1.21; 95%: 0.91–1.61, p>0.05) (Table 14).

The south Asian group was less likely to have blood pressure measured when compared to the white group in 2000 (AOR: 0.78; 95% CI: 0.61–0.99). By the end of the study period no inequalities were evident for South Asian or black groups when compared to the white group (AOR: 1.16; 95% CI: 0.90–1.48 and AOR: 1.25; 95% CI: 0.99–1.58, respectively).

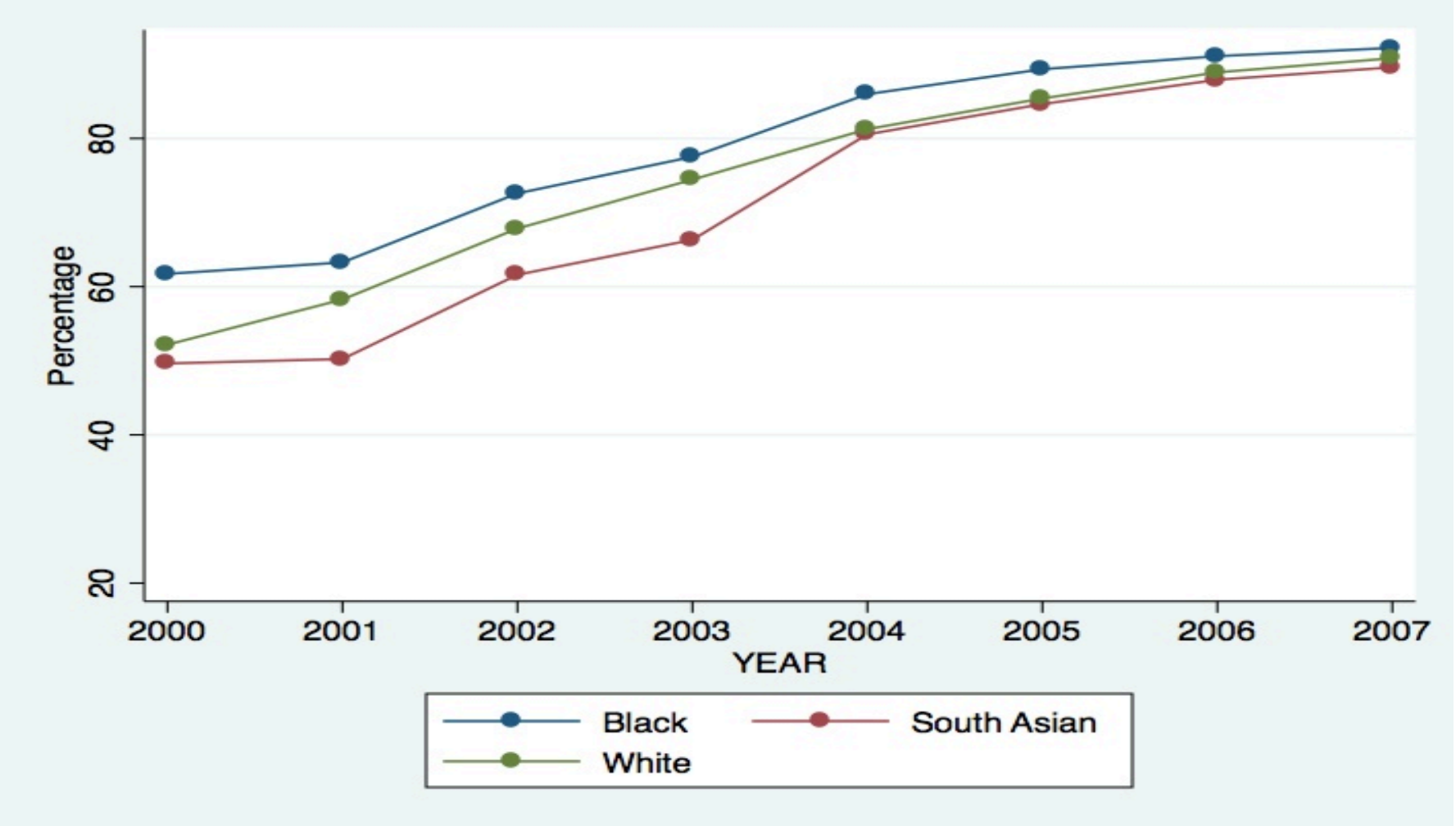


*Figure 6 Annual percentages of patients with blood pressure recorded*

*Table 13 Percentage of patients with blood pressure measured*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 52.1 (49.2-55.1) | 58.2 (55.6-60.9) | 67.8 (65.5-70.1) | 74.4 (72.4-76.4) | 81.2 (79.5-82.9) | 85.3 (83.9-86.8) | 88.9 (87.7-90.0) | 90.8 (89.8-91.8) |
| Black | 61.7 (58.0-65.3) | 63.2 (60.0-66.5) | 72.5 (69.7-75.4) | 77.5 (75.0-79.9) | 85.9 (84.0-87.8) | 89.3 (87.7-90.9) | 91.0 (89.6-92.5) | 92.2 (90.9-93.4) |
| South Asian | 49.6 (45.9-53.3) | 50.2 (46.8-53.6) | 61.6 (58.5-64.7) | 66.3 (63.4-69.1) | 80.5 (78.3-82.7) | 84.6 (82.6-86.5) | 87.9 (86.2-89.5) | 89.5 (88.1-91.0) |
| ALL | 55.3 (53.5-57.2) | 58.7 (57.0-60.4) | 67.0 (65.5-68.5) | 72.4 (71.1-73.7) | 81.8 (80.7-82.8) | 85.5 (84.6-86.5) | 88.2 (87.4-89.0) | 90.1 (89.4-90.8) |

Values in brackets are 95% Confidence Interval

*Table 14 Interrupted time series for blood pressure measurement*

| | Blood pressure, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 1.35 (1.31-1.39)** | 1.82 (1.70- 1.96)** | 1.60 (1.46-1.76)** | 1.25 (1.40-1.66)** |
| Level change with QOF | 1.38 (1.19-1.59)** | 1.21 (0 .91-1.61) | 2.13 (1.43-3.18)** | 2.61 (1.83-3.73)** |
| Post-QOF trend | 0.92 (0.87-0.98)** | 0.81 (0.72-0.92)** | 0.80 (0.67-0.96)** | 0.90 (0.77-1.05) |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

BMI recording:

The recording of BMI increased from 39.2% (95% CI: 37.4–41.4) in 2000 to 76.5% (95% CI: 75.6–77.5) in 2007 at an average rate of 6.1%, p<0.01. BMI recording increased from 38.3%, 46.7%, and 36.4% in 2000 to 77.3%, 78.9%, and 78.1% for white, black, and South Asian patients in 2007, respectively (Figure 7 and table 15).

In the pre-QOF period, the proportion of people having their BMI recorded increased annually (AOR: 1.54; 95% CI: 1.48–1.60, p<0.01). The introduction of QOF was associated with an additional improvement in the proportion of people having their BMI recorded (AOR: 1.88; 95% CI: 1.62–1.18, p<0.01). In the post-QOF years, annual improvements in the proportion of people having their BMI recorded were significantly lower than that during the pre-QOF years (AOR: 0.70; 95% CI: 0.66–0.75, p<0.01). These findings were similar for black and South Asian patients (Table 16).

No inequalities were evident between ethnic groups in 2000. However, at the end of the study period black patients were more likely to have their BMI measured when compared to white group (AOR: 1.22; 95% CI: 1.04–1.43).

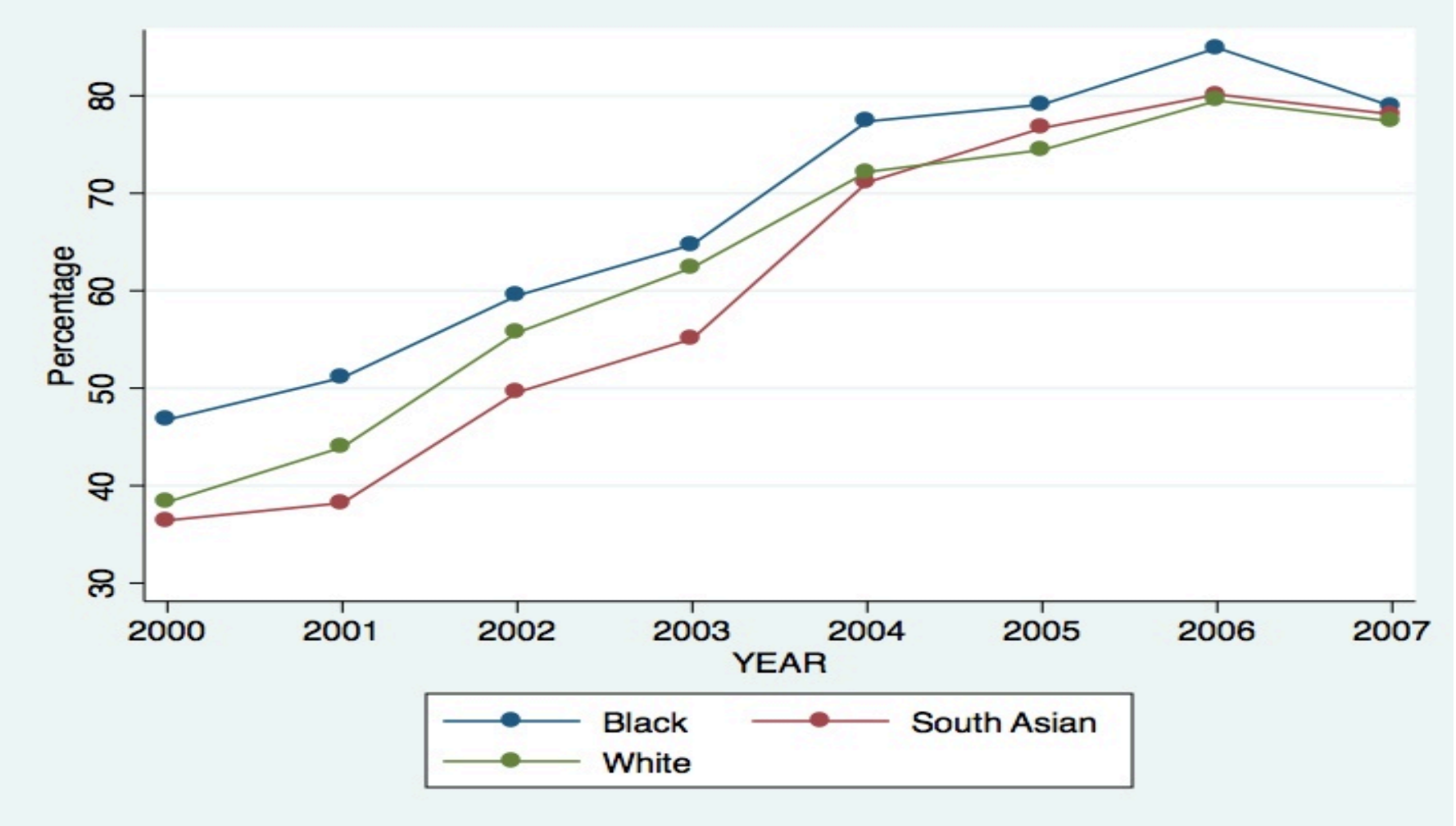


*Figure 7 Annual percentages of patients with BMI measured*

*Table 15 Percentage of patients with BMI measured*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 38.3 (35.4-41.1) | 43.9 (41.2-46.5) | 55.7 (53.2-58.1) | 62.3 (60.1-64.5) | 72.1 (70.2-74.0) | 74.4 (72.6-76.1) | 79.4 (77.9-81.0) | 77.3 (75.9-78.2) |
| Black | 46.7 (43.0-50.5) | 51.0 (47.6-54.4) | 59.5 (56.3-62.6) | 64.7 (61.9-67.5) | 77.3 (75.0-79.6) | 79.0 (76.9-81.2) | 84.9 (83.1-86.6) | 78.9 (77.0-80.7) |
| South Asian | 36.4 (32.8-40.0) | 38.2 (34.9-41.5) | 49.5 (46.3-52.7) | 55.0 (52.0-58.0) | 71.1 (68.5-73.6) | 76.6 (74.4-78.9) | 80.1 (78.0-82.1) | 78.1 (76.1-80.0) |
| ALL | 39.2 (37.4-41.1) | 43.4 (41.7-45.1) | 53.7 (52.1-55.2) | 59.2 (57.8-60.6) | 71.5 (70.3-72.8) | 74.0 (72.9-75.1) | 79.5 (78.5-80.5) | 76.5 (75.6-77.5) |

Values in brackets are 95% Confidence Interval

*Table 16 Interrupted time series for BMI measurement*

| | BMI measured, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 1.54 (1.48-1.60)** | 1.66 (1.56-1.77)** | 1.46 (1.35-1.57)** | 1.49 (1.38-1.61)** |
| Level change with QOF | 1.88 (1.62-2.18)** | 1.39 (1.10-1.74)** | 2.37 (1.75-3.20)** | 2.96 (2.19-3.99)** |
| Post-QOF trend | 0.70 (0.66-0.75)** | 0.66 (0.59-0.72)** | 0.66 (0.58-0.75)** | 0.70 (0.61-0.80)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Retinal screening:

The percentage of patients having retinal screening increased from 4.9% (95% CI: 4.1–5.7) in 2000 to 56.6% (95% CI: 55.5–57.8) in 2007 at an average rate of 9.0%, $p<0.01$. Patients who had their retinal screening increased from 2.2%, 5.1%, and 8.3% in 2000 to 58.0%, 58.7%, and 58.6% for white, black, and South Asian patients in 2007, respectively (Figure 8 and table 17).

In the pre-QOF period the proportion of people having their retinal screening recorded increased annually (AOR: 3.43; 95% CI: 3.23–3.63, $p<0.01$). The introduction of QOF was not associated with additional immediate improvement in the proportion of people having their retinal screening recorded (AOR: 1.06; 95% CI: 0.92–1.23, $p>0.05$). In the post-QOF years, annual improvements in the proportion of people having their retinal screening were significantly lower than that during the pre-QOF years (AOR: 0.27; 95% CI: 0.25–0.29, $p<0.01$). These findings were similar for white, black and south Asian patients (Table 18). No inequalities were evident for black and south Asian patients when compared with white patients in 2000 or 2007.

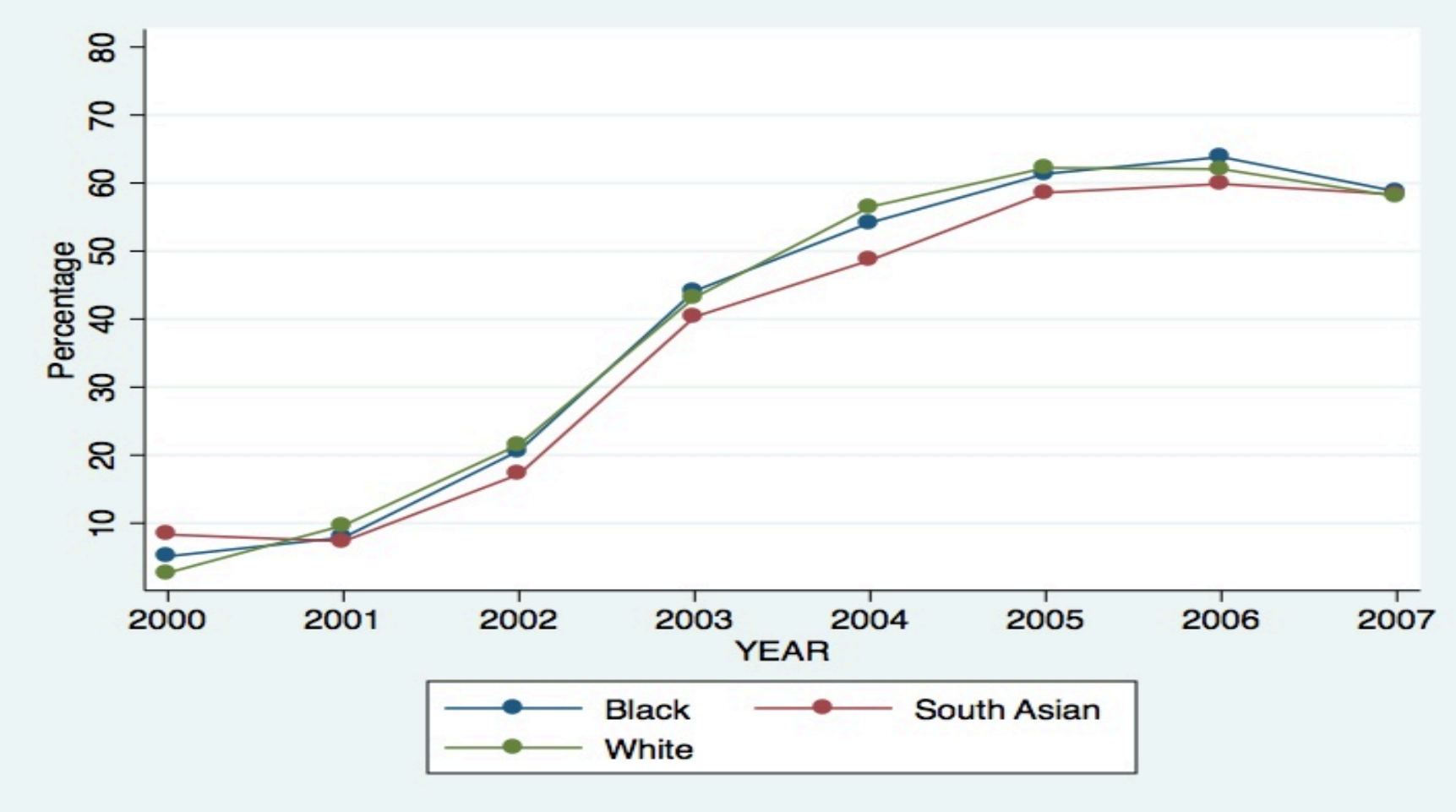


*Figure 8 Annual percentages of patients with retinal screening*

*Table 17 Percentage of patients with retinal screening*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 2.71 (1.75-3.67) | 9.67 (8.09-11.2) | 21.5 (19.5-23.5) | 43.2 (40.9-45.4) | 56.5 (54.4-58.6) | 62.2 (60.3-64.1) | 62.0 (60.2-63.8) | 58.0 (56.3-59.7) |
| Black | 5.13 (3.47-6.79) | 7.89 (6.06-9.72) | 20.6 (18.1-23.2) | 44.1 (41.2-47.0) | 54.1 (51.4-56.9) | 61.3 (58.8-63.9) | 63.8 (61.4-66.1) | 58.7 (56.4-61.0) |
| South Asian | 8.32 (6.26-10.3) | 7.33 (5.55-9.10) | 17.1 (14.7-19.6) | 40.3 (37.3-43.2) | 48.6 (45.8-51.4) | 58.5 (55.9-61.2) | 59.8 (57.3-62.3) | 58.3 (55.9-60.6) |
| ALL | 4.87 (4.06-5.67) | 8.36 (7.42-9.29) | 19.3 (18.1-20.5) | 41.6 (40.2-43.1) | 52.8 (51.4-54.2) | 60.0 (58.8-61.3) | 60.6 (59.4-61.8) | 56.6 (55.5-57.8) |

Values in brackets are 95% Confidence Interval

*Table 18 Interrupted time series for retinal screening*

| | Retinal screening, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 3.43 (3.23-3.63)** | 3.76 (3.42-4.13)** | 3.39 (3.02-3.79)** | 2.99 (2.67-3.34)** |
| Level change with QOF | 1.06 (0.92-1.23) | 0.96 (0.77-1.21) | 0.92 (0.69-1.22) | 1.21 (0.89-1.63) |
| Post-QOF trend | 0.27 (0.25-0.29)** | 0.24 (0.21-0.27)** | 0.27 (0.24-0.32)** | 0.34 (0.30-040)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Smoking status:

The percentage of patients having their smoking status recorded increased from 30.3% (95% CI: 28.5–32.0) in 2000 to 76.4% (95% CI: 75.5–77.4) in 2007 at an average rate of 5.7%, $p<0.01$. Patients who had their smoking status recorded increased from 30.0%, 36.3%, and 26.1% in 2000 to 79.1%, 78.4%, and 76.2% for white, black, and South Asian patients in 2007, respectively (Figure 9 and table 19).

In the pre-QOF period the proportion of people having their smoking status recorded increased annually (AOR: 1.58; 95% CI: 1.52–1.64, $p<0.01$). The introduction of QOF was associated an additional improvements in the proportion of people having their smoking status recorded (AOR: 3.25; 95% CI: 2.77–3.81, $p<0.01$). In the post-QOF years, annual improvements in the proportion of people having their smoking status recorded were significantly lower than that during the pre-QOF years (AOR: 0.65; 95% CI: 0.61–0.69, $p<0.01$). These findings were similar for white, black and South Asian patients (Table 20).

No inequalities were evident for black and South Asian patients when compared with white patients in 2000 or 2007.

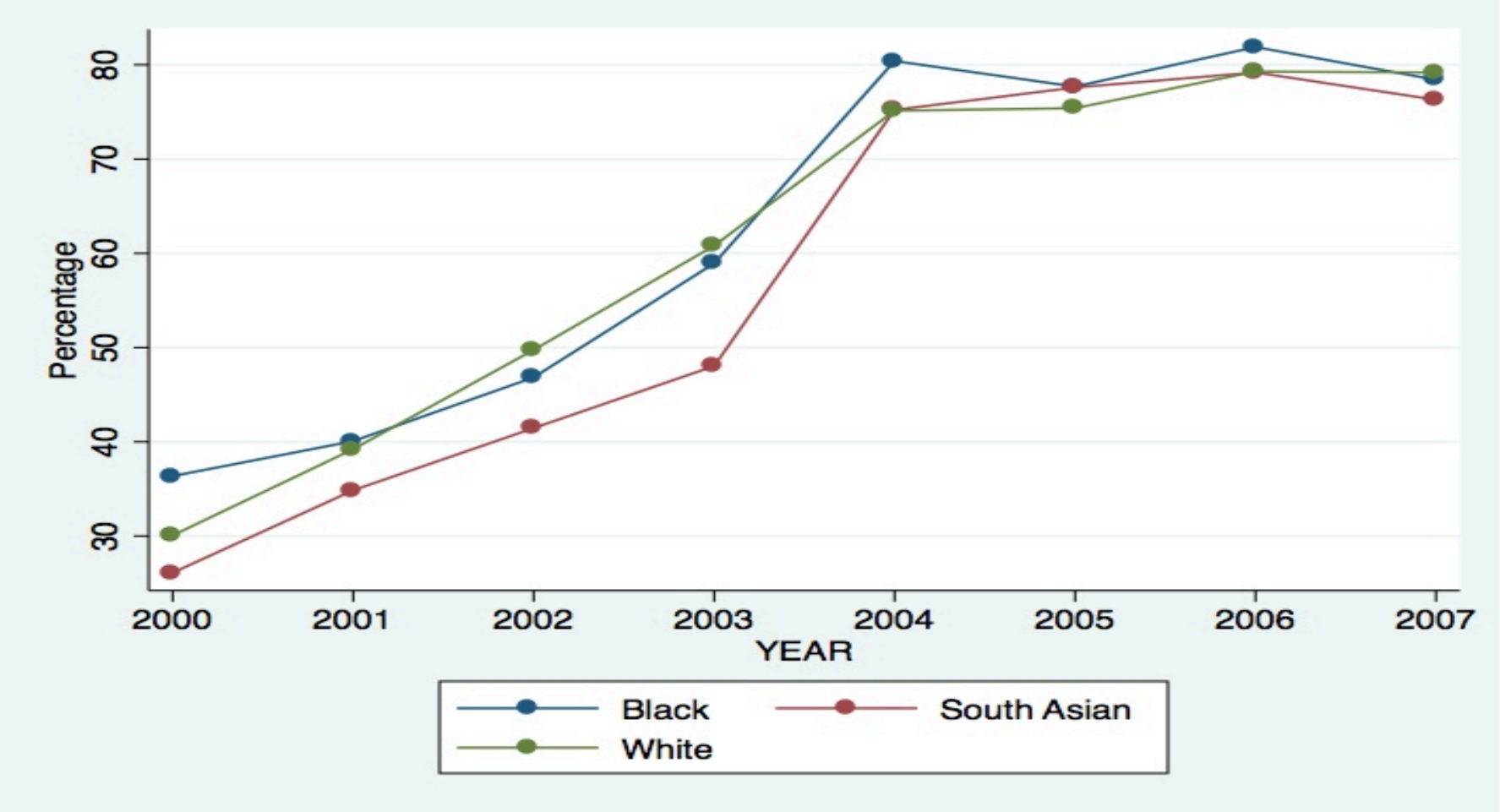


*Figure 9 Annual percentages of patients with smoking status recorded*

*Table 19 Percentage of patients having their smoking status recorded*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 30.0 (27.3-32.7) | 39.2 (36.6-41.8) | 49.7 (47.3-52.1) | 60.8 (58.5-63.0) | 75.1 (73.2-76.9) | 75.3 (73.6-77.1) | 79.2 (77.7-80.7) | 79.1 (77.7-80.6) |
| Black | 36.3 (32.7-39.9) | 40.0 (36.7-43.4) | 46.8 (43.6-49.9) | 58.9 (56.0-61.8) | 80.3 (78.1-82.5) | 77.6 (77.5-79.8) | 81.8 (79.9-83.7) | 78.4 (76.5-80.3) |
| South Asian | 26.1 (22.8-29.3) | 34.8 (31.6-38.1) | 41.4 (38.3-44.5) | 48.0 (45.0-51.0) | 75.2 (72.7-77.6) | 77.5 (75.3-79.8) | 79.1 (77.0-81.2) | 76.2 (74.2-78.3) |
| ALL | 30.3 (28.5-32.0) | 37.4 (35.8-39.0) | 45.6 (44.1-47.2) | 55.5 (54.1-57.0) | 74.9 (73.7-76.1) | 74.9 (73.8-76.1) | 78.5 (77.5-79.5) | 76.4 (75.5-77.4) |

Values in brackets are 95% Confidence Interval

*Table 20 Interrupted time series for smoking status*

| | Smoking status, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 1.58 (1.52-1.64)** | 1.76 (1.65-1.86)** | 1.48 (1.38-1.58)** | 1.47 (1.37-1.58)** |
| Level change with QOF | 3.25 (2.77-3.81)** | 2.07 (1.61-2.66)** | 3.57 (2.58-4.93)** | 6.17 (4.42-8.62)** |
| Post-QOF trend | 0.65 (0.61-0.69)** | 0.64 (0.58-0.70)** | 0.68 (0.60-0.77)** | 0.64 (0.56-0.72)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Smoking advice:

The percentage of patients having their smoking status recorded increased from 2.25% (95% CI: 1.69–2.28) in 2000 to 42.6% (95% CI: 41.5–43.7) in 2007 at an average rate of 5.0%, p<0.01. Patients who had a smoking advice offered increased from 2.08%, 2.78%, and 2.58% in 2000 to 48.0%, 41.5%, and 38.5% for white, black, and South Asian patients in 2007, respectively (Figure 10 and table 21).

In the pre-QOF period the proportion of people having a smoking advice offered increased annually (AOR: 2.26; 95% CI: 2.12–2.42, p<0.01). The introduction of QOF was associated with an additional immediate improvement in the proportion of people having a smoking advice offered to them (AOR: 1.49; 95% CI: 1.26–1.76, p<0.01). In the post-QOF years, annual improvements in the proportion of people being offered a smoking advice was less significantly lower than that during the pre-QOF years (AOR: 0.60; 95% CI: 0.55–0.65, p<0.01). These findings were similar for white, black and South Asian patients (Table 22). By the end of the study period black and south Asian were less likely to be offered a smoking advice when compared to white (AOR: 0.70; 95% CI: 0.61–0.81 and AOR: 0.71; 95% CI: 0.61–0.84, respectively).

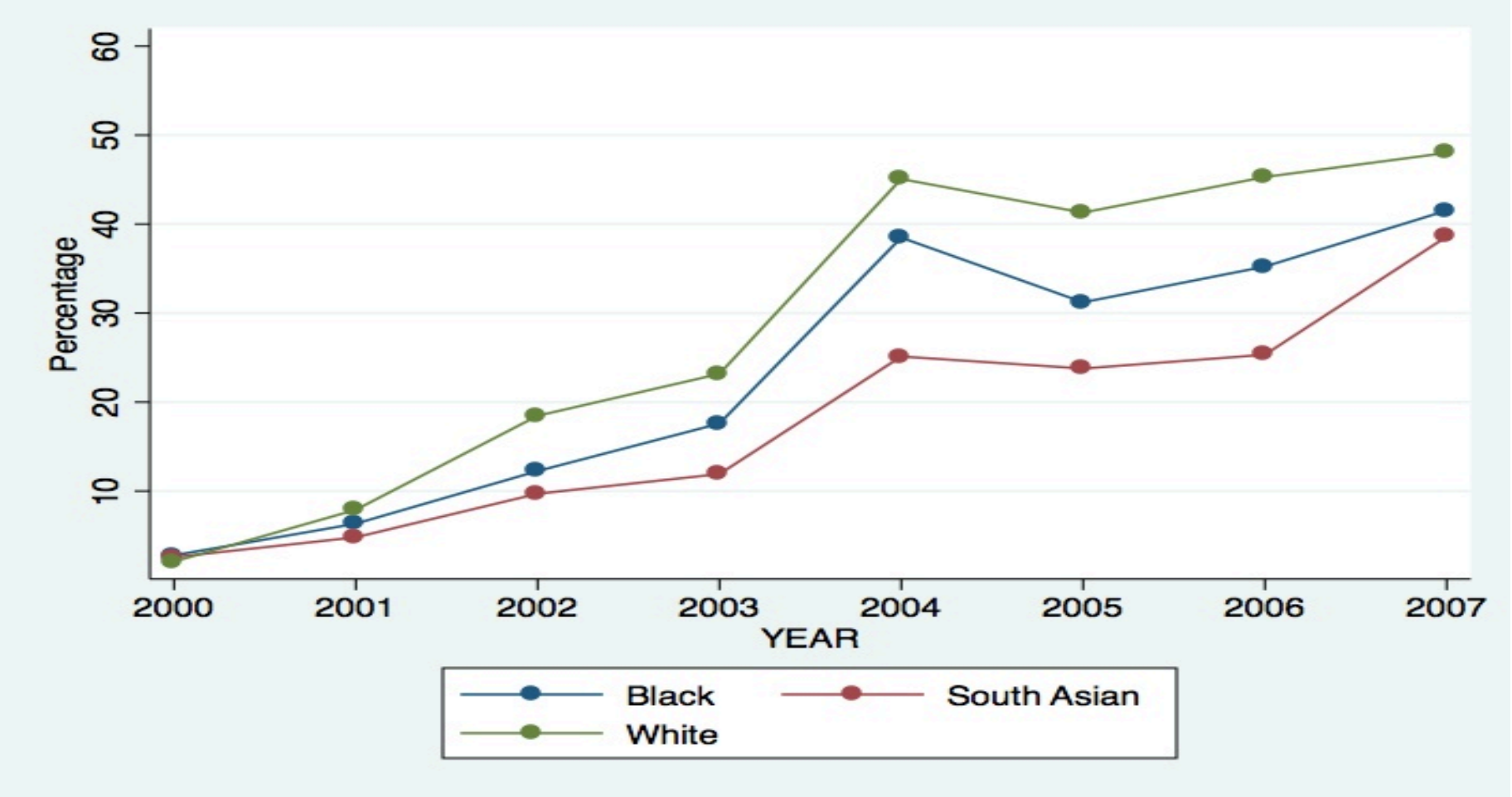


*Figure 10 Annual percentages of patients having a smoking advice offered*

*Table 21 Percentages of patients having smoking advice*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 2.08 (1.23-2.92) | 7.90 (6.46-9.34) | 18.4 (16.5-20.3) | 23.1 (21.2-25.0) | 45.0 (42.9-47.1) | 41.2 (39.3-43.2) | 45.2 (43.4-47.1) | 48.0 (46.2-49.7) |
| Black | 2.78 (1.54-4.02) | 6.33 (4.68-7.99) | 12.2 (10.1-14.3) | 17.5 (15.3-19.8) | 38.4 (35.7-41.1) | 31.2 (28.7-33.6) | 35.2 (32.8-37.5) | 41.5 (39.2-43.7) |
| South Asian | 2.58 (1.40-3.76) | 4.80 (3.35-6.26) | 9.70 (7.81-11.5) | 11.9 (9.96-13.8) | 25.1 (22.6-27.5) | 23.7 (21.4-26.0) | 25.3 (23.0-27.5) | 38.5 (36.2-40.9) |
| ALL | 2.25 (1.69-2.28) | 6.53 (5.70-7.37) | 14.0 (13.0-15.1) | 18.0 (16.9-19.2) | 37.1 (35.8-38.4) | 33.2 (31.9-34.4) | 36.5 (35.3-37.7) | 42.6 (41.5-43.7) |

Values in brackets are 95% Confidence Interval

*Table 22 Interrupted time series for smoking advice*

| | Smoking advice, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 2.26 (2.12-2.42)** | 2.46 (2.24-2.71)** | 2.21 (1.94-2.52)** | 1.89 (1.63-2.18)** |
| Level change with QOF | 1.49 (1.26-1.76)** | 2.02 (1.58-2.58)** | 1.35 (0.97-1.88) | 0.78 (0.53-1.15) |
| Post-QOF trend | 0.60 (0.55-0.65)** | 0.49 (0.44-0.55)** | 0.63 (0.54-0.74)** | 0.93 (0.78-1.11)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Peripheral pulse screening:

The percentage of patients having their peripheral pulses examined increased from 12.2% (95% CI: 11.0–13.4) in 2000 to 68.6% (95% CI: 67.5–69.6) in 2007 at an average rate of 9.0%, p<0.01. Patients who had their peripheral pulse exam recorded increased from 15.5%, 13.3%, and 5.8% in 2000 to 67.3%, 73.8%, and 71.3% for white, black, and South Asian patients in 2007, respectively (Figure 11 and table 23).

In the pre-QOF period the proportion of people having their peripheral pulse exam recorded increased annually (AOR: 2.26; 95% CI: 2.16–2.36, p<0.01). The introduction of QOF was associated with an additional immediate improvement in the proportion of people having their peripheral pulse exam recorded (AOR: 1.79; 95% CI: 1.56–2.07, p<0.01). In the post-QOF years, annual improvements in the proportion of people having their peripheral pulse exam recorded were significantly lower than that during the pre-QOF (AOR: 0.46; 95% CI: 0.43–0.49, p<0.01). These findings were similar for white, black and South Asian patients (Table 24).

Inequalities were not abolished in 2000 for South Asian patients (AOR: 0.69; 95% CI: 0.44–1.08). However, at the end of the study period black and South Asian patients were more likely to have their peripheral pulse examined when compared to white group (AOR: 1.29; 95% CI: 1.12–1.49 and AOR: 1.20; 95% CI: 1.03–1.41, respectively).

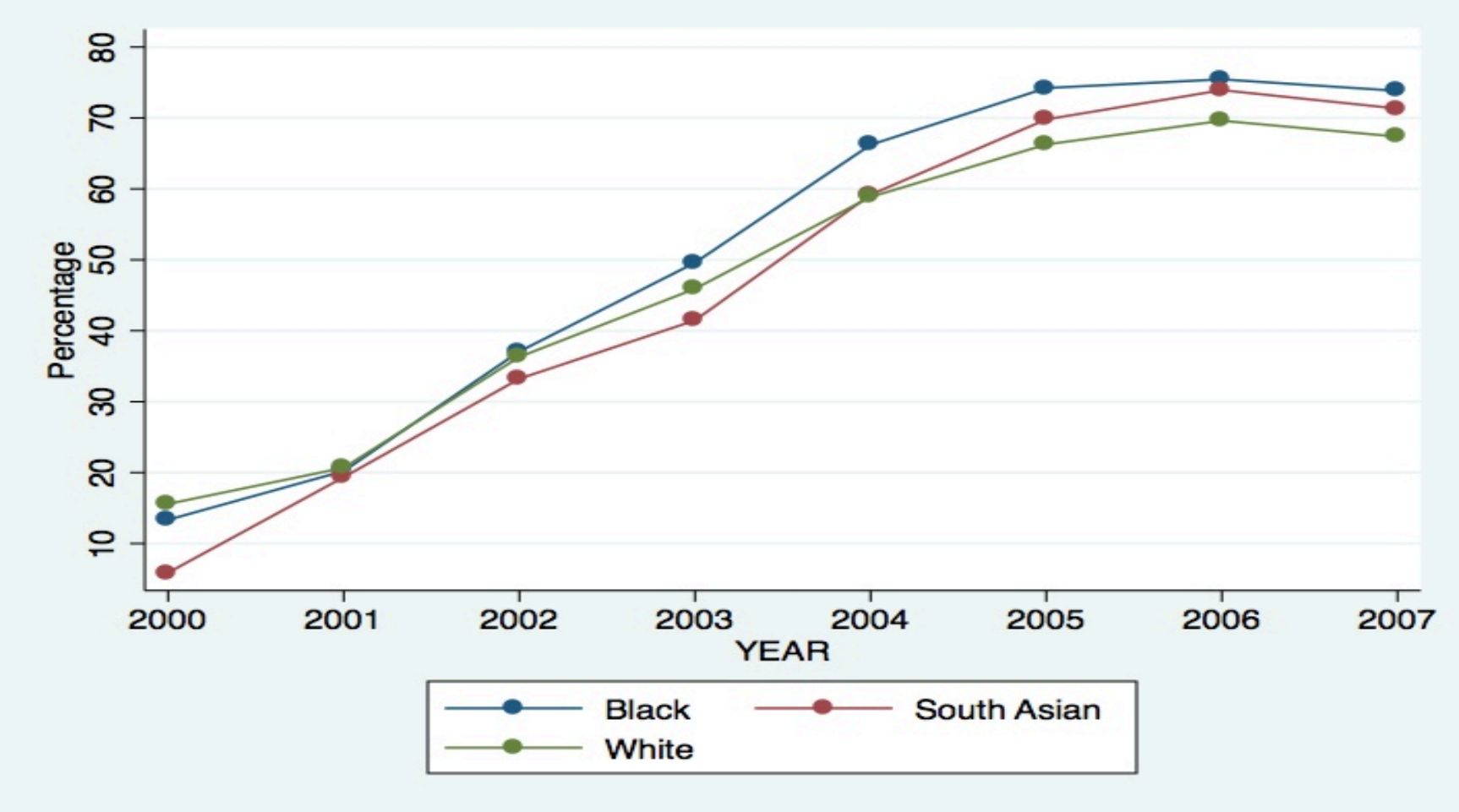


*Figure 11 Annual percentages of patients with peripheral pulse screened*

*Table 23 Percentages of patients with peripheral pulse screening*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 15.5 (13.4-17.7) | 20.6 (18.5-22.8) | 36.3 (33.9-38.6) | 45.9 (43.6-48.1) | 58.8 (56.7-60.9) | 66.2 (64.3-68.1) | 69.6 (67.8-71.3) | 67.3 (65.7-68.9) |
| Black | 13.3 (10.7-15.9) | 20.2 (17.4-22.9) | 37.0 (34.0-40.1) | 49.5 (46.6-52.5) | 66.2 (63.5-68.8) | 74.2 (71.9-76.5) | 75.4 (73.3-77.5) | 73.8 (71.8-75.8) |
| South Asian | 5.88 (4.13-7.63) | 19.3 (16.6-22.0) | 33.2 (30.2-36.2) | 41.4 (38.5-44.4) | 59.1 (56.3-61.9) | 69.7 (67.3-72.2) | 73.9 (71.6-76.1) | 71.3 (69.1-73.5) |
| ALL | 12.2 (11.0-13.4) | 19.7 (18.4-21.1) | 34.6 (33.1-36.1) | 44.4 (42.9-45.8) | 59.3 (57.9-60.6) | 67.8 (66.6-69.0) | 70.7 (69.6-71.8) | 68.6 (67.5-69.6) |

Values in brackets are 95% Confidence Interval

*Table 24 Interrupted time series for peripheral pulse screening*

| | Peripheral pulse screening, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 2.26 (2.16-2.36)** | 2.13 (1.99-2.28)** | 2.40 (2.19-2.62)** | 2.42 (2.21-2.66)** |
| Level change with QOF | 1.79 (1.56-2.07)** | 1.62 (1.30-2.01)** | 1.84 (1.38-2.44)** | 1.94 (1.45-2.60)** |
| Post-QOF trend | 0.46 (0.43-0.49)** | 0.49 (0.45-0.55)** | 0.42 (0.37-0.47)** | 0.43 (0.38-0.49)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Serum creatinine:

The percentage of patients having their serum creatinine measured increased from 24.4% (95% CI: 22.8–26.0) in 2000 to 81.6% (95% CI: 80.7–82.5) in 2007 at an average rate of 8.4%, p<0.01. Patients who had their serum creatinine recorded increased from 27.7%, 28.7%, and 15.4% in 2000 to 80.4%, 86.1%, and 84.2% for white, black, and South Asian patients in 2007, respectively (Figure 12 and table 25).

In the pre-QOF period the proportion of people having their serum creatinine recorded increased annually (AOR: 2.13; 95% CI: 2.04–2.23, p<0.01). The introduction of QOF was associated with an additional immediate improvement in the proportion of people having their serum creatinine recorded (AOR: 1.39; 95% CI: 1.20–1.63, p<0.01). In the post-QOF years, annual improvements in the proportion of people having their serum creatinine recorded were significantly lower than that during pre-QOF years (AOR: 0.56; 95% CI: 0.52–0.60, p<0.01). These findings were similar for black and South Asian patients. However, QOF did not have any positive effect on the proportion of white patients having their serum creatinine recorded (AOR: 0.92; 95% CI: 0.72–1.17) (Table 26).

No inequalities were evident between ethnic groups in 2000. However, at the end of the study period black and South Asian patients were more likely to have their creatinine measured when compared to white group (AOR: 1.44; 95% CI: 1.20–1.72 and AOR: 1.47; 95% CI: 1.21–1.78, respectively).

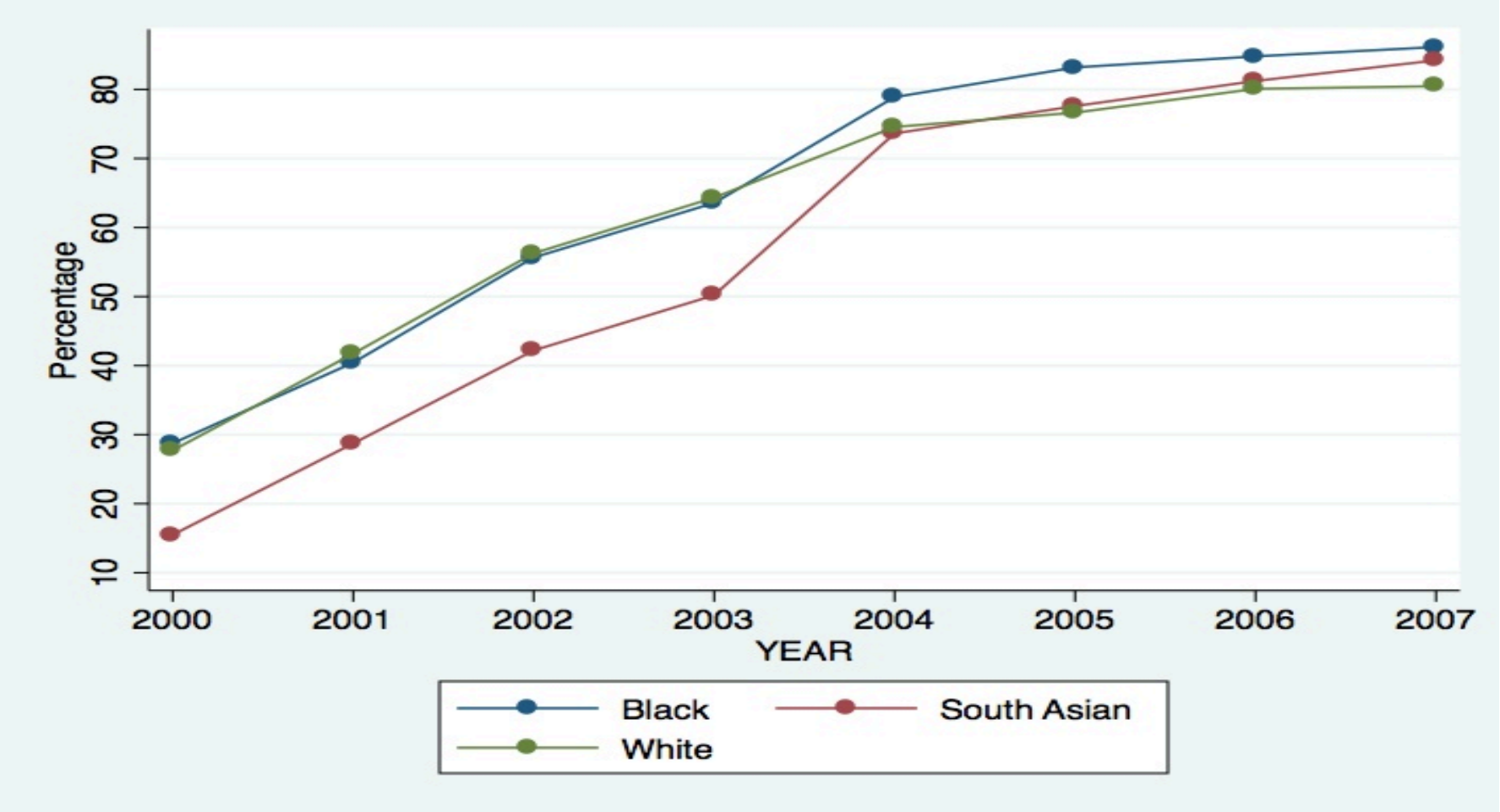


*Figure 12 Annual percentages of patients with serum creatinine measured*

*Table 25 Percentage of patients with serum creatinine measured*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 27.7 (25.0-30.3) | 41.7 (39.0-44.3) | 56.2 (53.8-58.6) | 64.3 (62.1-66.5) | 74.5 (72.7-76.4) | 76.6 (74.9-78.3) | 80.0 (78.5-81.5) | 80.4 (79.0-81.8) |
| Black | 28.7 (25.3-32.1) | 40.4 (37.0-43.7) | 55.6 (52.5-58.8) | 63.5 (60.7-66.3) | 78.8 (76.6-81.1) | 83.1 (81.2-85.1) | 84.7 (83.0-86.5) | 86.1 (84.5-87.7) |
| South Asian | 15.4 (12.8-18.1) | 28.7 (25.6-31.8) | 42.1 (39.0-45.3) | 50.1 (47.1-53.1) | 73.6 (71.1-76.1) | 77.5 (75.3-79.8) | 81.2 (79.2-83.2) | 84.2 (82.4-85.9) |
| ALL | 24.4 (22.8-26.0) | 37.3 (35.6-38.9) | 51.3 (49.7-52.8) | 59.4 (58.0-60.8) | 74.2 (73.0-75.4) | 77.6 (76.5-78.7) | 80.6 (79.6-81.5) | 81.6 (80.7-82.5) |

Values in brackets are 95% Confidence Interval

*Table 26 Interrupted time series for serum creatinine*

| | Serum creatinine, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 2.13 (2.04-2.23)** | 2.20 (2.05-2.35)** | 2.10 (1.93-2.28)** | 2.14 (1.96-2.33)** |
| Level change with QOF | 1.39 (1.20-1.63)** | 0.92 (0.72-1.17) | 1.75 (1.27-2.42)** | 1.89 (1.39-2.57)** |
| Post-QOF trend | 0.56 (0.52-0.60)** | 0.54 (0.49-0.61)** | 0.56 (0.48-0.64)** | 0.62 (0.54-0.71)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Urine micro-albuminuria:

The percentage of patients having their micro-albuminuria measured increased from 0.65% (95% CI: 0.38–0.95) in 2000 to 44.9% (95% CI: 43.8–46.1) in 2007 at an average rate of 8.6%, p<0.01. Patients who had their micro-albuminuria recorded increased from 0.36%, 1.31%, and 0.28% in 2000 to 43.4%, 51.8%, and 45.4% for white, black, and South Asian patients in 2007, respectively (Figure 13 and table 27).

In the pre-QOF period the proportion of people having their micro-albuminuria recorded increased annually (AOR: 4.46; 95% CI: 3.80–5.24, p<0.01). The introduction of QOF was associated with an additional immediate improvement in the proportion of people having their micro-albuminuria recorded (AOR: 3.92; 95% CI: 3.05–5.02, p<0.01). In the post-QOF years, annual improvements in the proportion of people having their micro-albuminuria recorded were less significantly lower than that during the pre-QOF years (AOR: 0.20; 95% CI: 0.17–0.24, p<0.01). These findings were similar for white, black and south Asian patients (Table 28).

At the end of the study period black patients were more likely to have micro-albuminuria recorded when compared to the white group (AOR: 1.37; 95% CI: 1.20–1.55) and South Asian had similar care to the white group (AOR: 1.14; 95% CI: 0.99–1.31). No inequalities were evident in 2000.

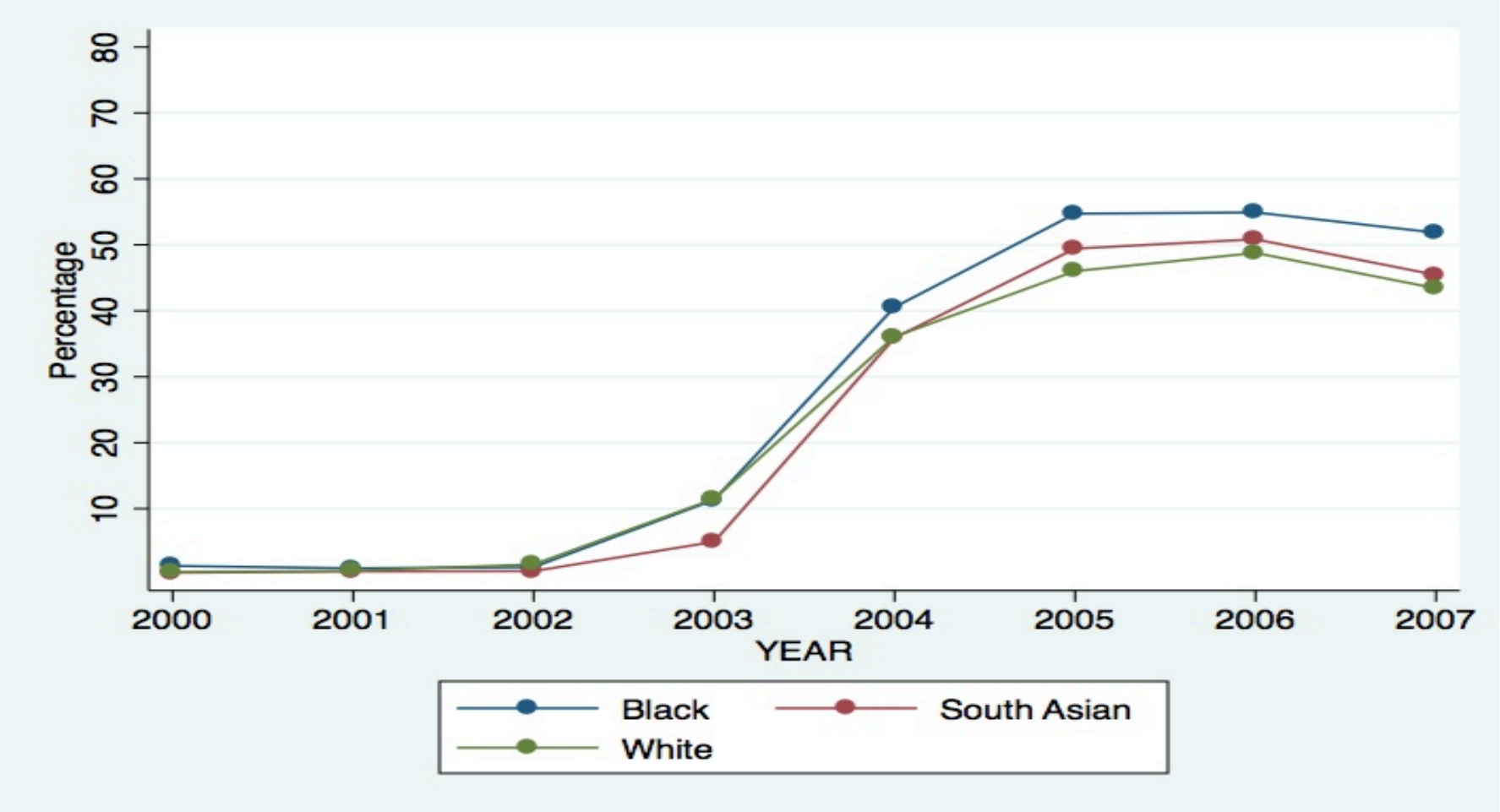


*Figure 13 Annual percentages of patients with urine micro-albuminuria measured*

*Table 27 Percentage of patients with urine micro-albuminuria measured*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 0.36 (0.01-0.71) | 0.59 (0.18-0.99) | 1.54 (0.94-2.15) | 11.4 (10.0-12.9) | 36.0 (34.0-38.1) | 46.0 (44.0-48.0) | 48.7 (46.9-50.6) | 43.4 (41.6-45.1) |
| Black | 1.31 (0.46-2.17) | 0.95 (0.29-1.61) | 1.14 (0.46-1.18) | 11.3 (9.45-13.2) | 40.5 (37.8-43.2) | 54.7 (52.1-57.3) | 54.9 (52.4-57.3) | 51.8 (49.5-54.1) |
| South Asian | 0.28 (-0.11-0.68) | 0.48 (0.00-0.95) | 0.52 (0.00-0.98) | 4.97 (3.66-6.27) | 35.8 (33.1-38.6) | 49.4 (46.7-52.1) | 50.8 (48.2-53.4) | 45.4 (43.0-47.8) |
| ALL | 0.65 (0.35-0.95) | 0.65 (0.38-0.93) | 1.15 (0.81-1.48) | 9.57 (8.71-10.4) | 35.8 (34.5-37.1) | 47.7 (46.4-49.0) | 49.8 (48.6-51.0) | 44.9 (43.8-46.1) |

Values in brackets are 95% Confidence Interval

*Table 28 Interrupted time series for urine micro-albuminuria*

| | Urine micro, OR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 4.46 (3.80-5.24)** | 5.90 (4.50-7.73)** | 3.63 (2.80-4.72)** | 3.99 (2.61-6.10)** |
| Level change with QOF | 3.92 (3.05-5.02)** | 2.14 (1.45-3.16)** | 5.32 (3.42-8.29)** | 9.27 (4.86-17.6)** |
| Post-QOF trend | 0.20 (0.17-0.24)** | 0.15 (0.12-0.20)** | 0.25 (0.19-0.33)** | 0.22 (0.14-0.35)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Foot screening:

The percentage of patients having their feet examined increased from 4.68% (95% CI: 3.89–5.47) in 2000 to 59.9% (95% CI: 58.8–61.0) in 2007 at an average rate of 8.6%, $p<0.01$. Patients who had their feet examined recorded increased from 2.62%, 4.54%, and 7.74% in 2000 to 62.1%, 63.8%, and 60.3% for white, black, and South Asian patients in 2007, respectively (Figure 14 and table 29).

In the pre-QOF period the proportion of people having their foot screening recorded increased annually (AOR: 2.64; 95% CI: 2.52–2.78, $p<0.01$). The introduction of QOF was associated with an additional immediate improvement in the proportion of people having their foot exam recorded (AOR: 1.32; 95% CI: 1.15–1.53, $p<0.01$). In the post-QOF years, annual improvements in the proportion of people having their foot exam were significantly lower than that during the pre-QOF years (AOR: 0.35; 95% CI: 0.33–0.38, $p<0.01$). These findings were similar for white, black and South Asian patients (Table 30).

No inequalities were evident between ethnic groups in 2000. However, at the end of the study period black and South Asian patients were more likely to have their foot examined when compared to white group (AOR: 1.31; 95% CI: 1.08–1.59 and AOR: 1.46; 95% CI: 1.18–1.82, respectively).

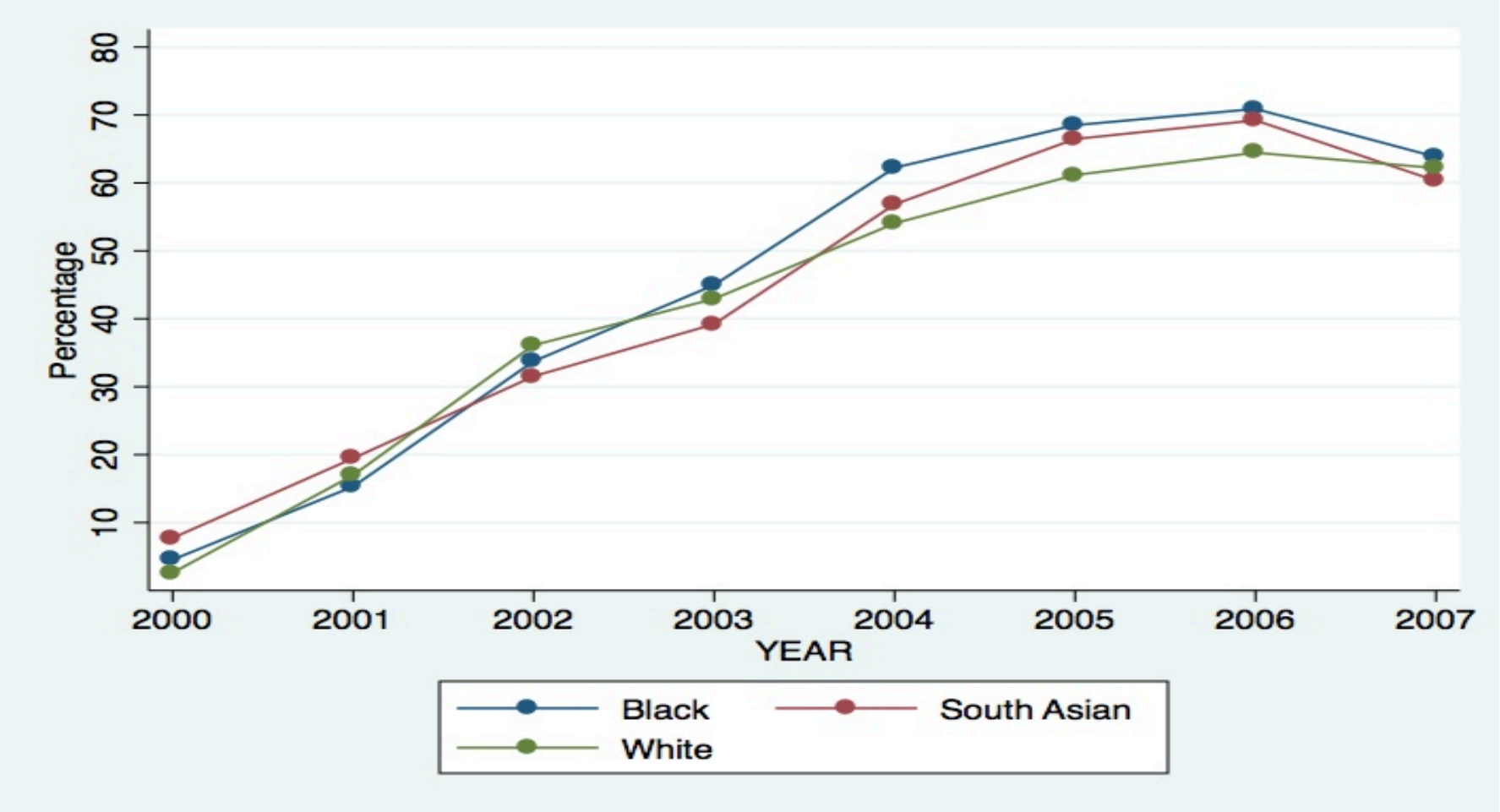


*Figure 14 Annual percentages of patients with foot screening*

*Table 29 Percentage of patients with foot screening*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 2.62 (1.68-3.57) | 16.9 (14.9-18.9) | 36.1 (33.7-38.4) | 42.9 (40.6-45.1) | 54.0 (51.9-56.1) | 61.1 (59.2-63.1) | 64.4 (62.6-66.2) | 62.1 (60.4-63.8) |
| Black | 4.54 (2.97-6.11) | 15.3 (12.8-17.7) | 33.7 (30.7-36.7) | 44.9 (42.0-47.9) | 62.2 (59.5-64.9) | 68.5 (66.0-70.9) | 70.8 (68.6-73.1) | 63.8 (61.6-66.0) |
| South Asian | 7.74 (5.75-9.73) | 19.4 (16.7-22.1) | 31.5 (28.5-34.5) | 39.2 (36.2-42.1) | 56.8 (54.0-59.6) | 66.4 (63.9-69.0) | 69.2 (66.8-71.5) | 60.3 (57.9-62.6) |
| ALL | 4.68 (3.89-5.47) | 16.7 (15.5-18.0) | 32.9 (31.5-34.4) | 40.9 (39.5-42.4) | 54.9 (53.6-56.3) | 62.1 (60.8-63.3) | 64.9 (63.7-66.0) | 59.9 (58.8-61.0) |

Values in brackets are 95% Confidence Interval

*Table 30 Interrupted time series for foot screening*

| | Foot screen prescribed, OR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 2.64 (2.52-2.78)** | 2.89 (2.67-3.13)** | 2.86 (2.59-3.15)** | 2.15 (1.97-2.36)** |
| Level change with QOF | 1.32 (1.15-1.53)** | 0.83 (0.67-1.04) | 1.47 (1.11-1.95)** | 2.74 (2.06-3.65)** |
| Post-QOF trend | 0.35 (0.33-0.38)** | 0.36 (0.32-0.40)** | 0.30 (0.26-0.34)** | 0.38 (0.33-0.43)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

### 5.2.2 Intermediate outcomes measures

HbA1c control:

The percentage of patients' achieving the HbA1c target of ≤7.5%, increased from 41.0% (95% CI: 37.7–44.2) in 2000 to 58.2% (56.9–59.5) in 2007, at an average rate of 2.7%, p<0.01. Patients who had their HbA1c controlled increased from 44.8%, 41.8%, and 34.5% in 2000 to 59.1%, 57.4%, and 54.5% in 2007 for white, black and south Asian in 2007, respectively (Figure 15 and table 31).

In the pre-QOF period the proportion of people having their HbA1c controlled increased annually (AOR: 1.31; 95% CI: 1.23–1.39, p<0.01). The introduction of QOF was not associated with an additional immediate improvement in the proportion of people having their HbA1c controlled (AOR: 1.00; 95% CI: 0.83–1.21, p>0.05). In the post-QOF years, annual improvement in the proportion of people having HbA1c controlled was significantly lower than that during the pre-QOF years (AOR: 0.76; 95% CI: 0.70–0.83, p<0.01). These findings were similar for white, black and South Asian patients (Table 32).

A trend of significant reductions in mean HbA1c was evident in all three ethnic groups before QOF introduction (p<0.01). There was no significant step change in HbA1c levels associated with the initial introduction of QOF in white and black patients and HbA1c levels increased significantly relative to the pre-QOF trend in South Asian patients (0.18%; 95% CI: 0.02–0.34). There was a significant sustained annual increase in mean HbA1c in each ethnic group (P<0.01) in the post-QOF period relative to the pre-QOF trend (Table 33 and 34).

In 2000 south Asian patients were less likely to achieve the QOF target of ≤7.5% when compared to white patients (AOR: 0.66; 95%: 0.60–0.96) and the black group had an AOR of 0.82; 95% CI: 0.56–1.19. These inequalities were not corrected for in 2007. Black patient and south Asian were less likely to achieve the QOF target ≤7.5% when compare to white patients (AOR: 0.82; 95% CI: 0.71–0.94 and AOR: 0.72; 95% CI: 0.61–0.85).

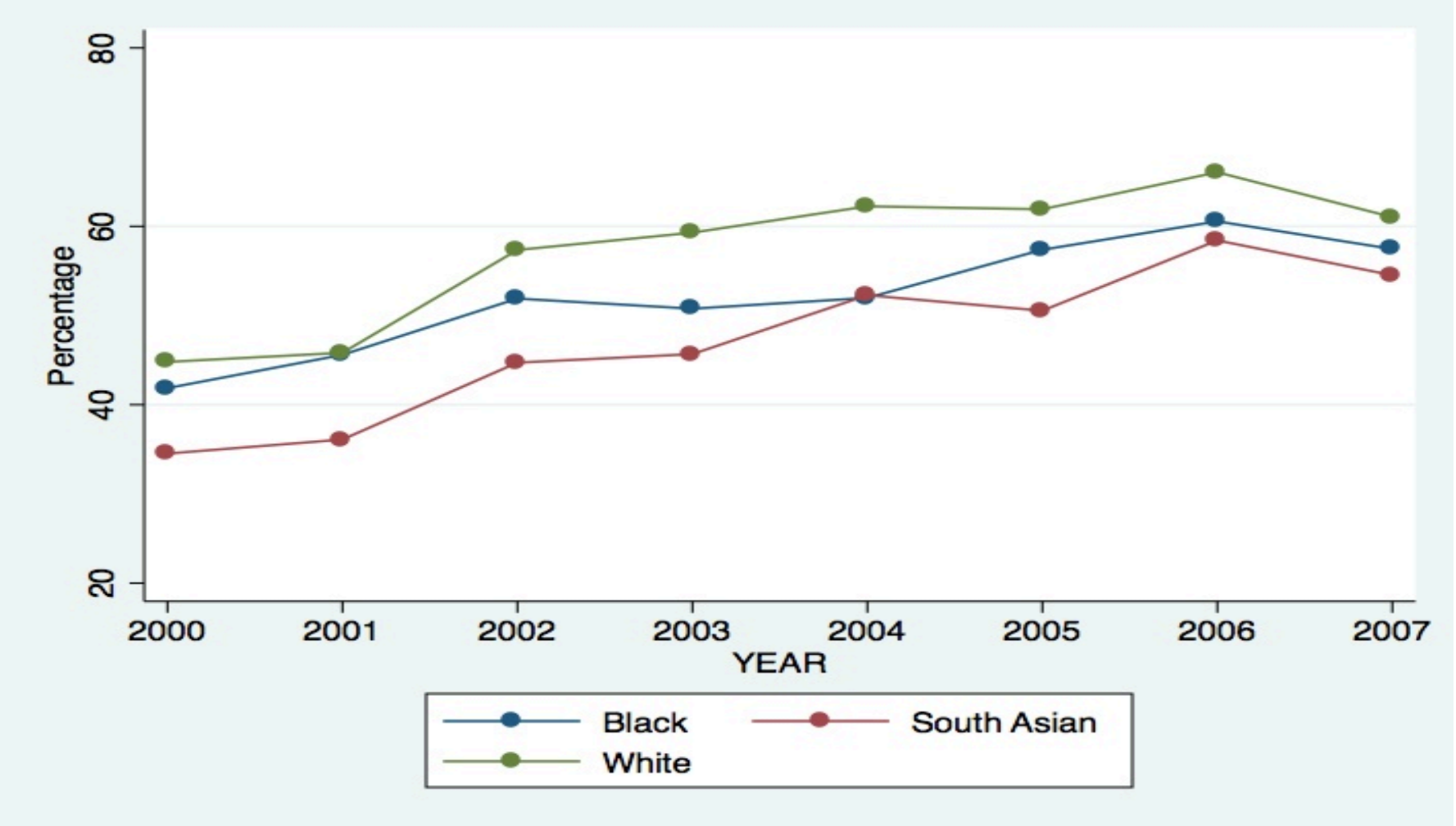


*Figure 15 Annual percentages of patients with HbA1c ≤7.5%*

*Table 31 Percentage of patients with HbA1c ≤7.5%*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 44.8 (39.7-49.8) | 45.8 (42.0-49.6) | 57.3 (53.2-60.4) | 59.2 (56.4-62.1) | 62.2 (59.8-64.6) | 61.9 (59.6-64.1) | 66.0 (64.0-68.0) | 59.1 (62.9-62.9) |
| Black | 41.8 (35.8-47.9) | 45.5 (40.6-50.5) | 51.9 (47.8-55.9) | 50.7 (47.0-54.4) | 51.9 (48.8-55.1) | 57.3 (54.5-60.2) | 60.5 (57.9-63.1) | 57.4 (54.9-59.9) |
| South Asian | 34.5 (27.2-41.7) | 36.1 (30.4-41.7) | 44.7 (40.0-49.3) | 45.6 (41.6-49.7) | 52.2 (48.9-55.6) | 50.5 (47.4-53.6) | 58.4 (55.5-61.2) | 54.5 (51.8-57.1) |
| ALL | 41.0 (37.8-44.2) | 43.5 (40.9-46.0) | 52.8 (50.7-54.9) | 53.2 (51.3-55.1) | 56.5 (54.9-58.1) | 57.7 (56.2-59.1) | 62.4 (61.0-63.7) | 58.2 (56.9-59.5) |

Values in brackets are 95% Confidence Interval

*Table 32 Interrupted time series for controlled HbA1c*

| | HbA1c <=7.5%, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 1.31 (1.23-1.39)** | 1.41 (1.28-1.55)** | 1.20 (1.07-1.35)** | 1.21 (1.05-1.40)** |
| Level change with QOF | 1.00 (0.83-1.21) | 0.89 (0.66-1.2) | 1.19 (0.84-1.69) | 1.05 (0.70-1.58) |
| Post-QOF trend | 0.76 (0.70-083)** | 0.65 (0.57-0.75)** | 0.84 (0.72-0.98)* | 0.93 (0.78-1.12) |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

*Table 33 Annual mean value of HbA1c*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 8.1 (7.9-8.3) | 8.0 (7.9-8.2) | 7.6 (7.5-7.7) | 7.5 (7.4-7.6) | 7.5 (7.4-7.6) | 7.4 (7.4-7.5) | 7.3 (7.2-7.4) | 7.5 (7.4-7.5) |
| Black | 8.5 (8.2-8.8) | 8.2 (8.0-8.4) | 7.9 (7.7-8.0) | 8.0 (7.8-8.1) | 7.9 (7.8-8.0) | 7.7 (7.6-7.8) | 7.6 (7.5-7.7) | 7.8 (7.7-7.9) |
| South Asian | 8.6 (8.3-8.9) | 8.3 (8.1-8.5) | 8.0 (7.8-8.2) | 7.9 (7.8-8.1) | 7.9 (7.8-8.0) | 7.9 (7.8-8.0) | 7.7 (7.6-7.8) | 7.8 (7.7-7.8) |
| ALL | 8.3 (8.2-8.5) | 8.2 (8.1-8.3) | 7.8 (7.7-7.8) | 7.8 (7.7-7.8) | 7.7 (7.6-7.8) | 7.7 (7.6-7.7) | 7.5 (7.4-7.5) | 7.7 (7.6-7.7) |

Values in brackets are 95% Confidence Interval

*Table 34 Interrupted time series analysis for HbA1c levels*

| | HbA1c, %, (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | -0.21 (-0.23, -0.18)** | -0.20 (-0.24, -0.17)** | -0.21 (-0.27, -0.15)** | -0.20 (-0.26, -0.15)** |
| Level change with QOF | 0.04 (-0.04, 0.12) | 0.07 (-0.04, 0.18) | -0.12 (-0.29, 0.04) | 0.18 (0.02, 0.34)* |
| Post-QOF trend | 0.19 (0.15, 0.22)** | 0.21 (0.16, 0.26)** | 0.21 (0.14, 0.29)** | 0.11 (0.04, 0.18)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Cholesterol control:

The percentage of patients' achieving the cholesterol target of ≤5.0 mmol/l, increased from 46.8% (95% CI: 43.5–50.2) in 2000 to 77.5% (95% CI: 76.4–78.5) in 2007, at an average rate of 4.8%, p<0.01. Patients who had their cholesterol controlled increased from 42.2%, 44.8%, and 59.2% in 2000 to 76.9%, 76.4%, and 80.4% in 2007 for white, black and south Asian, respectively (Figure 16 and table 35).

In the pre-QOF period the proportion of people having their cholesterol controlled increased annually (AOR: 1.41; 95% CI: 1.33–1.51, p<0.01). The introduction of QOF was associated with an additional immediate improvement in the proportion of people having their cholesterol controlled (AOR: 1.42; 95% CI: 1.17–1.72, p<0.01). This was true for white (AOR: 1.69; 95% CI: 1.26–2.26) but not for black or South Asian patients. In the post-QOF years, annual improvements in the proportion of people having their cholesterol controlled were significantly lower than that during the pre-QOF years (AOR: 0.96; 95% CI: 0.88–1.85, p<0.01). These findings were similar for white, black and South Asian patients (Table 36).

A trend of significant reductions in mean total cholesterol was evident in all three ethnic groups before QOF introduction (p<0.01). The introduction of QOF was associated with significant additional reductions in cholesterol levels in white and black patients but not in South Asian patients (-0.07 mmol/l; 95% CI: -0.20–0.04). There was no significant sustained annual reduction in cholesterol levels in black and South Asian patients in the post-QOF period relative to the pre-QOF trend. White patients experienced a significant increase in mean

cholesterol trend in the post-QOF period relative to the pre-QOF trend (0.04 mmol/l; 95% CI: 0.01–0.08) (Table 37 and 38).

In 2000, South Asian patients were more likely to achieve the QOF target of ≤5.0 mmol/l when compared to white patients (AOR: 2.03; 95%: 1.36–3.01) and the black group had an AOR: 1.18 (95% CI: 0.85–1.65). However in 2007 this picture did not change. South Asian patients were more likely to achieve the QOF target ≤5.0 mmol/l when compare to white patients (AOR: 1.36; 95% CI: 1.11–1.66) and black patients had an AOR: 1.14 (95% CI: 0.95–1.37).

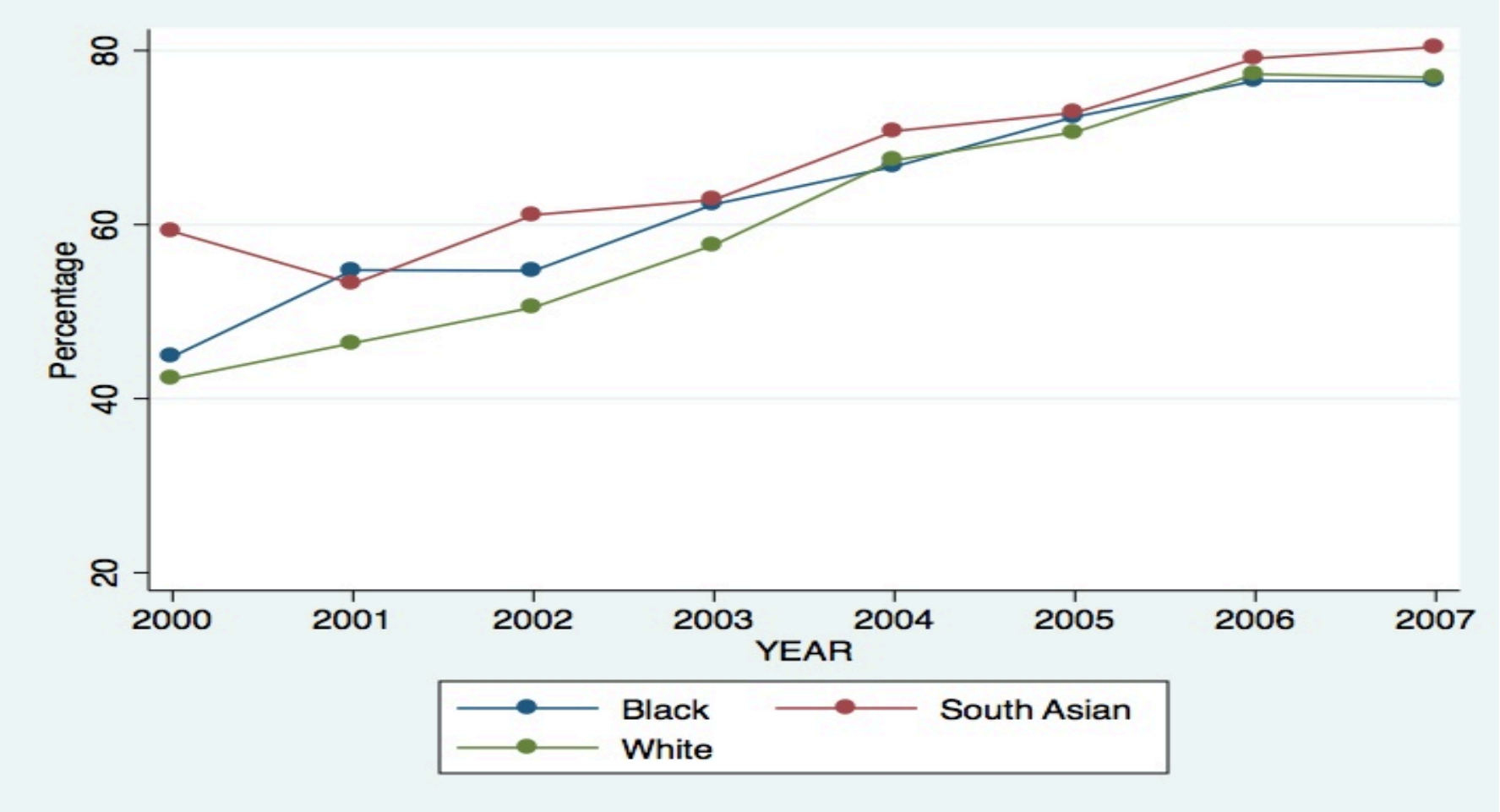


*Figure 16 Annual percentages of patients with cholesterol ≤5.0 mmol/l*

*Table 35 Percentage of patients with cholesterol ≤5.0 mmol/l*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 42.2 (37.0-47.4) | 46.3 (42.3-50.4) | 50.4 (47.2-53.6) | 57.6 (54.8-60.4) | 67.3 (65.0-69.7) | 70.6 (68.5-72.7) | 77.2 (75.5-79.0) | 76.9 (75.2-78.5) |
| Black | 44.8 (38.6-51.0) | 54.7 (49.6-59.8) | 54.6 (50.4-58.9) | 62.3 (58.7-65.9) | 66.6 (63.6-69.6) | 72.3 (69.7-74.9) | 76.5 (74.2-78.8) | 76.4 (74.3-78.5) |
| South Asian | 59.2 (51.3-67.1) | 53.1 (47.1-59.2) | 61.1 (56.2-65.9) | 62.8 (58.7-66.9) | 70.7 (67.7-73.7) | 72.8 (70.1-75.5) | 79.0 (76.7-81.4) | 80.4 (78.3-82.4) |
| ALL | 46.8 (43.5-50.2) | 50.9 (48.2-53.6) | 53.8 (51.6-55.9) | 60.0 (58.1-61.8) | 67.4 (65.9-68.9) | 71.2 (69.9-72.6) | 77.2 (76.1-78.3) | 77.5 (76.4-78.5) |

Values in brackets are 95% Confidence Interval

*Table 36 Interrupted time series for controlled cholesterol*

| | Cholesterol <=5.0 mmol/l, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 1.41 (1.33-1.51)** | 1.47 (1.34-1.62)** | 1.46 (1.30-1.65)** | 1.37 (1.18-1.58)** |
| Level change with QOF | 1.42 (1.17-1.72)** | 1.69 (1.26-2.26)** | 1.28 (0.88-1.85) | 1.14 (0.75-1.75) |
| Post-QOF trend | 0.96 (0.88-1.05) | 0.92 (0.80-1.05) | 0.85 (0.72-1.01) | 1.08 (0.89-1.31) |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

*Table 37 Annual mean value of cholesterol (mmol/l)*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 5.2 (5.1-5.3) | 5.2 (5.1-5.3) | 5.0 (5.0-5.1) | 4.9 (4.8-4.9) | 4.6 (4.6-4.7) | 4.6 (4.5-4.6) | 4.4 (4.3-4.4) | 4.4 (4.3-4.4) |
| Black | 5.1 (5.0-5.3) | 4.9 (4.8-5.0) | 4.9 (4.9-5.0) | 4.8 (4.7-5.0) | 4.6 (4.5-4.7) | 4.6 (4.5-4.6) | 4.4 (4.3-4.5) | 4.4 (4.3-4.5) |
| South Asian | 5.0 (4.8-5.2) | 4.9 (4.8-5.0) | 4.8 (4.7-4.9) | 4.7 (4.6-4.8) | 4.4 (4.3-4.5) | 4.4 (4.4-4.5) | 4.2 (4.2-4.3) | 4.2 (4.2-4.3) |
| ALL | 5.1 (5.1-5.2) | 5.0 (5.0-5.1) | 5.0 (4.9-5.0) | 4.9 (4.8-4.9) | 4.6 (4.5-4.6) | 4.5 (4.5-4.6) | 4.4 (4.3-4.4) | 4.4 (4.3-4.4) |

Values in brackets are 95% Confidence Interval

*Table 38 Interrupted time series for controlled cholesterol levels*

| | Cholesterol, mmol/l (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | -0.13 (-0.15, -0.11)** | -0.15, (-0.17, -0.12)** | -0.11 (-0.14, -0.08)** | -0.13 (-0.17, -0.08)** |
| Level change with QOF | -0.12 (-0.18, -0.06)** | -0.13 (-0.21, -0.05)** | -0.10 (-0.20, -0.01)* | -0.07 (-0.20, 0.04) |
| Post-QOF trend | 0.03 (0.01, 0.05)* | 0.04 (0.01, 0.08)* | 0.03 (-0.01, 0.07) | 0.02 (-0.03, 0.07) |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Blood pressure control:

The percentage of patients' achieving the blood pressure target of ≤145/85 mm Hg, increased from 65.7% (95% CI: 63.7–68.1) in 2000 to 83.0% (95% CI: 82.1–83.9) in 2007, at an average rate of 2.7%, p<0.01. Patients who had their blood pressure controlled increased from 63.3%, 61.5%, and 72.5% in 2000 to 83.2%, 80.7%, and 84.8% in 2007 for white, black and south Asian, respectively (Figure 17 and table 39).

In the pre-QOF period the proportion of people having their blood pressure controlled increased annually (AOR: 1.05; 95% CI: 1.00–1.10, p<0.05), however this was not true for black and South Asian patients. The introduction of QOF was associated with an additional immediate improvement in the proportion of people having their blood pressure controlled (AOR: 1.40; 95% CI: 1.19–1.65, p<0.01) but black patients did not enjoy such benefits (AOR: 1.28; 95% CI: 0.94–1.75). In the post-QOF years, annual improvements in the proportion of people having their blood pressure controlled were significantly more likely to achieve the blood pressure target when compared with the pre-QOF years (AOR: 1.18; 95% CI: 1.10–1.27, p<0.01) (Table 40).

A trend of a significant reduction in mean systolic blood pressure was evident in white patients (-0.50 mm Hg; 95% CI: -0.93 to -0.08, p<0.01) but not in black (0.31 mm Hg; 95% CI: -0.20–0.83) or South Asian patients (0.42 mm Hg; 95% CI: -0.16–1.01) before QOF introduction. The introduction of QOF was associated with initial accelerated reductions in systolic blood pressure control in white (-2.12 mm Hg; 95% CI: -3.48 to -0.77, p<0.01) and black (-2.32 mm Hg; 95% CI: -4.03 to -0.61, p<0.01) patients but not in South Asian patients (-1.08

mm Hg; 95% CI: -2.97–0.08). There was a significant sustained annual decrease in mean systolic blood pressure in black (-1.68 mm Hg; 95% CI: -2.41 to -0.95) and South Asian patients (-1.79 mm Hg; 95% CI: -2.60 to -0.98), but not in White patients, in the post-QOF period relative to the pre-QOF trend (Table 41 and 43).

A trend of significant reductions in mean diastolic blood pressure was evident in all three ethnic groups before QOF ($p<0.01$). The introduction of QOF was associated with an accelerated reduction in systolic blood pressure levels in white patients (-1.01 mm Hg; 95% CI: -1.79 to -0.24) but not in black or South Asian patients. There was no significant sustained annual reduction in mean diastolic blood pressure in any group in the post-QOF period relative to the pre-QOF trend (Table 42 and 44).

In 2000 no inequalities were evident for black and south Asian patients (AOR: 0.89; 95% CI: 0.67–1.19 and 1.37; 95% CI: 0.96–1.95, respectively). However, at the end of the study period black patients were less likely to achieve the QOF target (AOR: 0.84%; 95% CI: 0.73–0.97) when compared to white patients. South Asian patients were more likely to achieve the QOF target when compared to white patients (AOR: 1.25; 95% CI: 1.07–1.46).

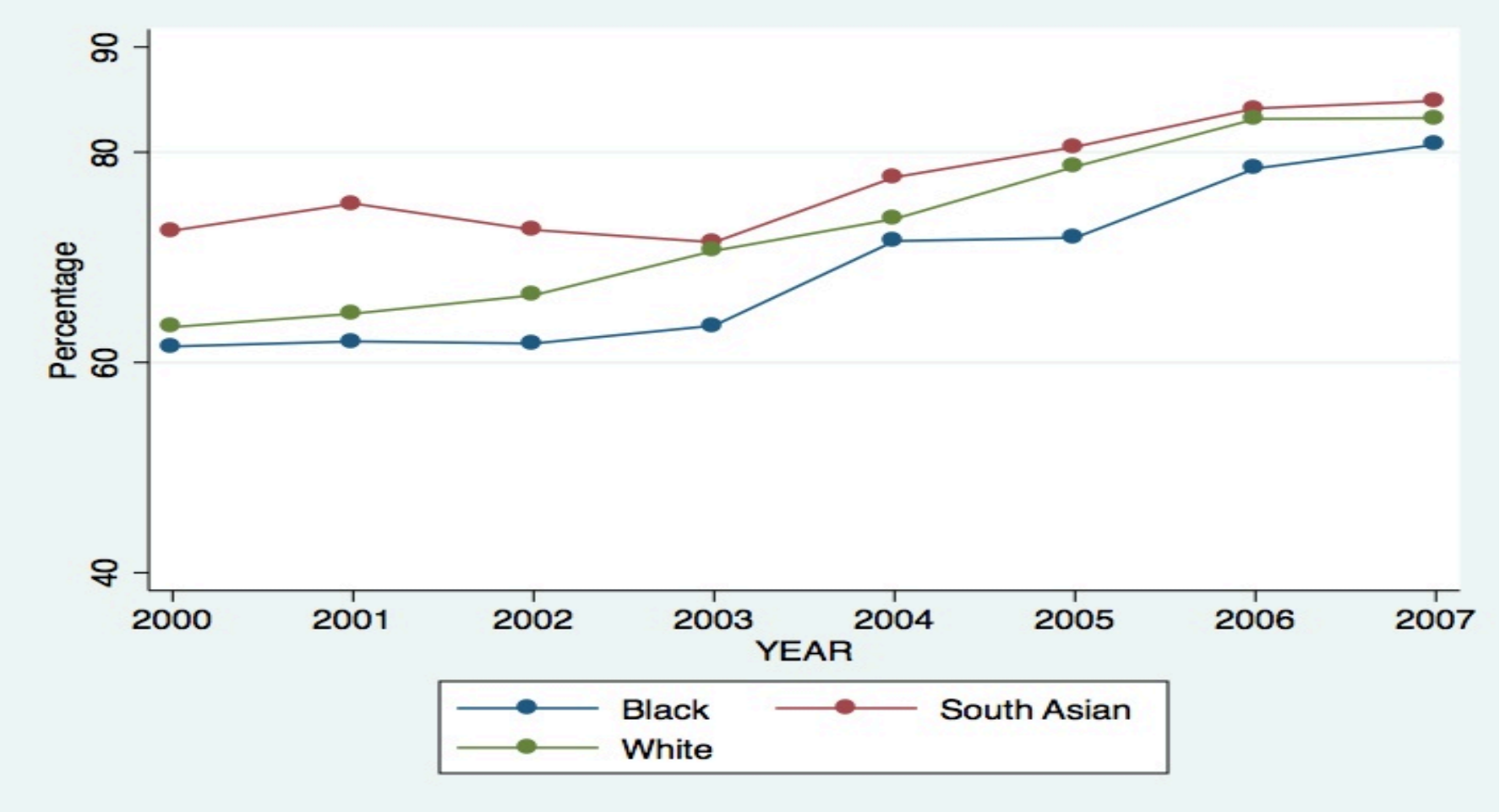


*Figure 17 Annual percentages of patients with blood pressure ≤145/85 mm Hg*

*Table 39 Percentage of patients with blood pressure ≤145/85 mm Hg*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 63.3 (59.4-67.3) | 64.6 (61.2-67.9) | 66.3 (63.5-69.1) | 70.6 (68.2-73.0) | 73.6 (71.5-75.7) | 78.6 (76.8-80.3) | 83.1 (81.6-84.6) | 83.2 (81.8-84.6) |
| Black | 61.5 (56.8-66.1) | 62.0 (57.8-66.1) | 61.8 (58.1-65.4) | 63.5 (60.2-66.7) | 71.5 (68.8-74.2) | 71.8 (69.3-74.3) | 78.4 (76.3-80.5) | 80.7 (78.8-82.6) |
| South Asian | 72.5 (67.8-77.2) | 75.1 (70.9-79.2) | 72.6 (68.9-76.2) | 71.4 (68.0-74.7) | 77.6 (74.9-80.2) | 80.5 (78.1-82.8) | 84.1 (82.1-86.1) | 84.8 (83.0-86.7) |
| ALL | 65.7 (63.3-68.1) | 66.7 (64.6-68.9) | 67.1 (65.3-68.9) | 69.1 (67.5-70.7) | 74.1 (72.8-75.5) | 77.3 (76.1-78.5) | 82.2 (81.2-83.2) | 83.0 (82.1-83.9) |

Values in brackets are 95% Confidence Interval

*Table 40 Interrupted time series of controlled blood pressure*

| | Blood pressure <=145/85, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 1.05 (1.00-1.10)* | 1.14 (1.06-1.23)** | 1.02 (0.93-1.12) | 0.93 (0.84-1.04) |
| Level change with QOF | 1.40 (1.19-1.65)** | 1.37 (1.06-1.77)* | 1.28 (0.94-1.75) | 1.68 (1.17-2.41)** |
| Post-QOF trend | 1.18 (1.10-1.27)** | 1.04 (0.93-1.16) | 1.32 (1.16-1.52)** | 1.29 (1.10-1.51)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

*Table 41 Annual mean value of systolic blood pressure*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 140.5 (139.0-142.1) | 139.8 (138.4-141.1) | 140.3 (139.2-141.4) | 138.3 (137.3-139.3) | 136.7 (135.9-137.5) | 135.1 (134.3-135.8) | 133.3 (132.6-134.0) | 132.9 (132.3-133.5) |
| Black | 141.1 (139.3-142.8) | 141.4 (139.7-143.0) | 142.7 (141.3-144.1) | 141.4 (140.0-142.7) | 138.3 (137.2-139.3) | 138.2 (137.2-139.2) | 135.8 (134.9-136.6) | 135.0 (134.2-135.8) |
| South Asian | 135.6 (133.5-137.6) | 135.8 (134.0-137.6) | 137.4 (135.9-139.0) | 136.3 (134.9-137.6) | 135.2 (134.0-136.4) | 134.2 (133.2-135.2) | 132.2 (131.2-133.1) | 131.0 (130.1-131.9) |
| ALL | 139.3 (138.3-140.2) | 139.1 (138.3-140.0) | 139.9 (139.2-140.7) | 138.5 (137.9-139.2) | 136.7 (136.2-137.2) | 135.6 (135.2-136.1) | 133.6 (133.2-134.0) | 132.9 (132.5-133.3) |

Values in brackets are 95% Confidence Interval

*Table 42 Annual mean value of diastolic blood pressure*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 80.2 (79.4-81.0) | 79.9 (79.2-80.6) | 79.2 (78.6-79.7) | 78.6 (78.0-79.1) | 77.6 (77.1-78.1) | 76.9 (76.5-77.3) | 75.8 (75.4-76.2) | 76.0 (75.6-76.4) |
| Black | 82.6 (81.7-83.6) | 81.8 (81.0-82.7) | 81.7 (81.0-82.5) | 80.4 (79.7-81.1) | 79.2 (78.6-79.8) | 79.1 (78.6-79.7) | 78.0 (77.5-78.5) | 77.7 (77.2-78.2) |
| South Asian | 81.4 (80.3-82.4) | 80.3 (79.3-81.2) | 78.6 (77.8-79.5) | 78.5 (77.6-79.3) | 77.4 (76.6-78.0) | 76.6 (76.0-77.2) | 76.1 (75.6-76.6) | 75.6 (75.0-76.1) |
| ALL | 81.2 (80.7-81.7) | 80.7 (80.2-81.2) | 79.7 (79.4-80.1) | 79.1 (78.8-79.5) | 78.1 (77.8-78.4) | 77.5 (77.2-77.8) | 76.6 (76.3-76.8) | 76.5 (76.3-76.8) |

Values in brackets are 95% Confidence Interval

*Table 43 Interrupted time series for systolic blood pressure levels*

| | Systolic blood pressure, mm Hg (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | -0.03 (-0.31, 0.25) | -0.50 (-0.93, -0.08)* | 0.31 (-0.20, 0.83) | 0.42 (-0.16, 1.01) |
| Level change with QOF | -1.95 (-2.87, -1.02)** | -2.12 (-3.48, -0.77)** | -2.32 (-4.03, -0.61)** | -1.08 (-2.97, 0.08) |
| Post-QOF trend | -1.04 (-1.42, -0.64)** | -0.21 (-0.80, 0.37) | -1.68 (-2.41, -0.95)** | -1.79 (-2.60, -0.98)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

*Table 44 Interrupted time series for diastolic blood pressure levels*

| | Diastolic blood pressure, mm Hg (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | -0.84 (-1.00, -0.67)** | -0.69 (-0.93, -0.44)** | -0.84 (-1.14, -0.54)** | -1.06 (-1.41, -0.72)** |
| Level change with QOF | -0.51 (-1.05, 0.01) | -1.01 (-1.79, -0.24)* | -0.33 (-1.32, 0.65) | 0.20 (-0.90, 1.30) |
| Post-QOF trend | 0.19 (-0.03, 0.41) | 0.10 (-0.23, 0.43) | 0.12 (-0.30, 0.54) | 0.40 (-0.07, 0.87) |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Achievement of all of three intermediate outcome targets:

The percentage of patients' achieving all the three intermediate outcome indicators, increased from 1.4% (95% CI: 0.9–1.8) in 2000 to 15.6% (14.8–16.4) in 2007, at an average rate of 2.8%, $p<0.01$. Patients who achieved the target for the three intermediate outcomes increased from 1.2%, 1.6%, and 0.8% in 2000 to 17.5%, 15.6%, and 15.6% in 2007 for white, black and South Asian, respectively (Figure 18 and table 45).

In the pre-QOF period, the proportion of people having all the three intermediate outcomes controlled increased annually (AOR: 1.80; 95% CI: 1.64–1.97, $p<0.01$). The introduction of QOF was not associated with an additional immediate improvement in the proportion of people having all the three intermediate outcome indicators controlled (AOR: 1.17; 95% CI: 0.93–1.46). In the post-QOF years, patients were less likely to achieve all the three intermediate outcome indicators when compared with the pre-QOF years (AOR: 0.63; 95% CI: 0.56–0.70, $p<0.01$) (Table 46). This was true for white and black but not South Asian patients (AOR: 0.80; 95% CI: 0.64–1.00).

There were no inequalities evident in 2000 in the achievement of all three intermediate outcome targets; however, in 2007 South Asian patients were less likely to have all three intermediate outcome targets controlled when compared to the white group (AOR: 0.79; 95% CI: 0.65–0.95).

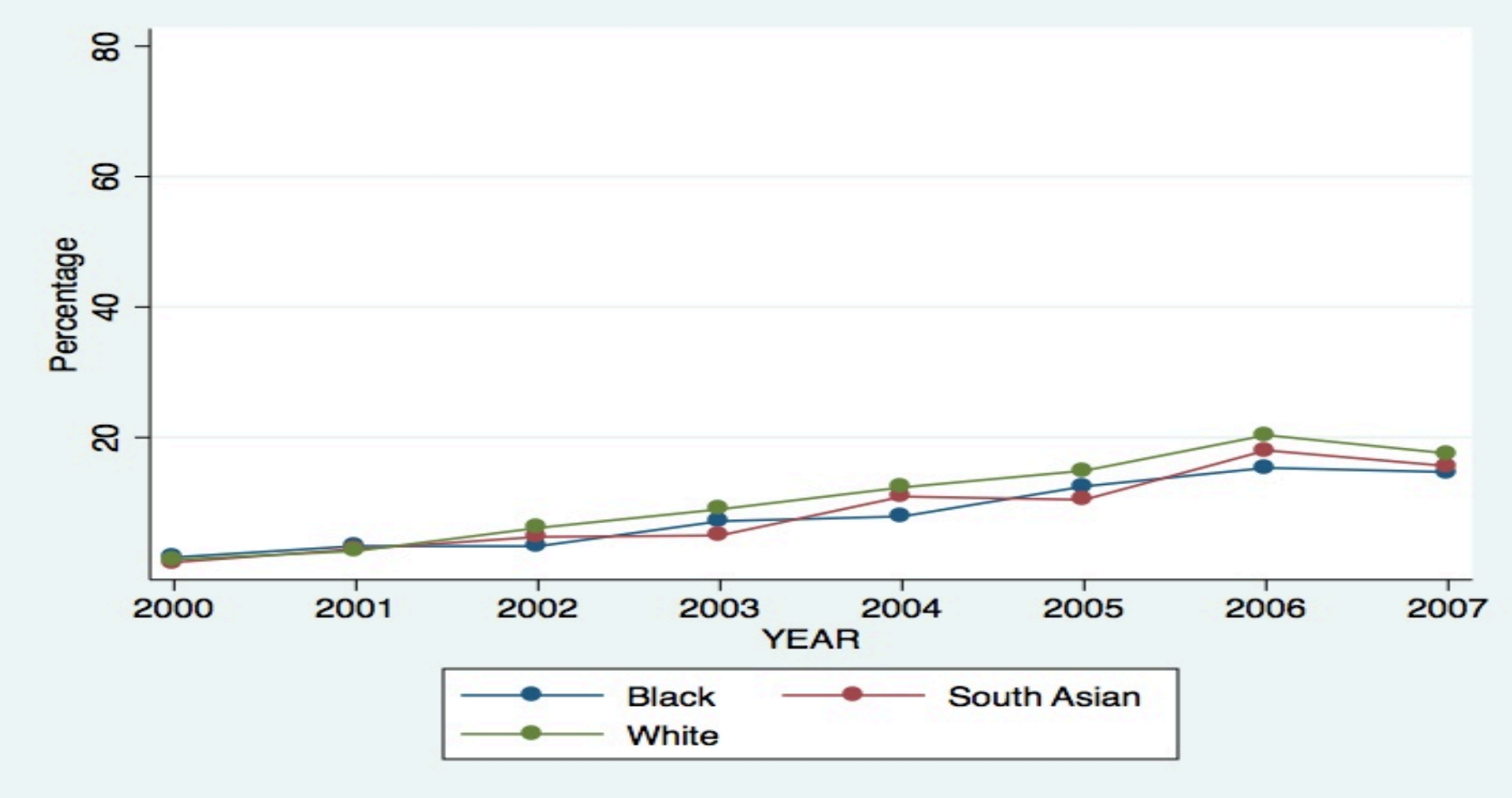


*Figure 18 Annual percentages of patents that achieved all the three intermediate outcomes*

*Table 45 Annual percentages of patients achieving all three intermediate outcomes*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 1.2 (0.6–1.9) | 2.5 (1.7–3.4) | 6.1 (4.9–7.3) | 8.9 (7.6–10.2) | 12.3 (10.9–13.7) | 14.8 (13.4–16.3) | 20.3 (18.8–21.8) | 17.5 (16.2–18.8) |
| Black | 1.6 (0.6–2.5) | 3.3 (2.1–4.5) | 3.3 (2.1–4.4) | 7.1 (5.6–8.6) | 7.8 (6.3–9.3) | 12.5 (10.7–14.2) | 15.3 (13.5–17.1) | 14.6 (13.0–16.3) |
| South Asian | 0.8 (0.1–1.5) | 2.8 (1.7–4.0) | 4.7 (3.3–6.1) | 4.9 (3.6–6.2) | 10.9 (9.1–12.7) | 10.4 (8.7–12.1) | 18.0 (16.0–19.9) | 15.6 (13.8–17.3) |
| ALL | 1.4 (0.9–1.8) | 2.7 (2.1–3.3) | 4.7 (4.0–5.3) | 7.2 (6.5–8.0) | 10.5 (9.6–11.3) | 12.8 (11.9–13.6) | 17.9 (16.9–18.8) | 15.6 (14.8–16.4) |

Values in brackets are 95% Confidence Interval

*Table 46 Interrupted time series for the achievement of all three intermediate outcomes*

| | All three intermediate outcomes, OR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 1.80 (1.64–1.97)** | 2.02 (1.76–2.33)** | 1.70 (1.42–2.04)** | 1.57 (1.30–1.90)** |
| Level change with QOF | 1.17 (0.93–1.46) | 0.95 (0.68–1.31) | 1.25 (0.79–1.97) | 1.41 (0.86–2.29) |
| Post-QOF trend | 0.63 (0.56–0.70)** | 0.55 (0.47–0.65)** | 0.65 (0.53–0.81)** | 0.80 (0.64–1.00) |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

### 5.2.3 Prescribing data

Oral Hypoglycemic Agents (OHAs):

The percentage of patients' prescribed OHAs increased from 30.1% (95% CI: 28.4–31.8) in 2000 to 58.9% (95% CI: 57.8–60.0) in 2007, at an average rate of 4.6%, p<0.01. Patients who had OHAs prescribed increased from 26.8%, 37.5%, and 29.2% in 2000 to 52.3%, 65.8%, and 67.5% in 2007 for white, black and South Asian, respectively (Figure 19 and table 47).

In the pre-QOF period, the proportion of people having OHAs prescribed in their record increased annually (AOR: 1.76; 95% CI: 1.67–1.86, p<0.01). The introduction of QOF was associated with an immediate additional improvement in the proportion of people having OHAs prescribed (AOR: 1.42; 95% CI: 1.18–1.70, p<0.01) but South Asian patients did not enjoy similar shift (AOR: 1.23; 95% CI: 0.86–1.76). In the post-QOF years, annual improvements in the proportion of patients being prescribed OHAs were significantly lower than the pre-QOF years (AOR: 0.74; 95% CI: 0.68–0.80, p<0.01) (Table 48).

Black patients were more likely to be prescribed OHAs in 2000 (AOR: 1.60; 95% CI: 1.29–1.98) when compared to white group and the south Asian group had similar prescribing rates (AOR: 1.06; 95% CI: 0.84–1.35). However, in 2007 black and South Asian groups were more likely to be prescribed OHAs (AOR: 1.71; 95% CI: 1.51–1.94 and AOR: 1.83; 95% CI: 1.59–2.09, respectively), when compared to the white group.

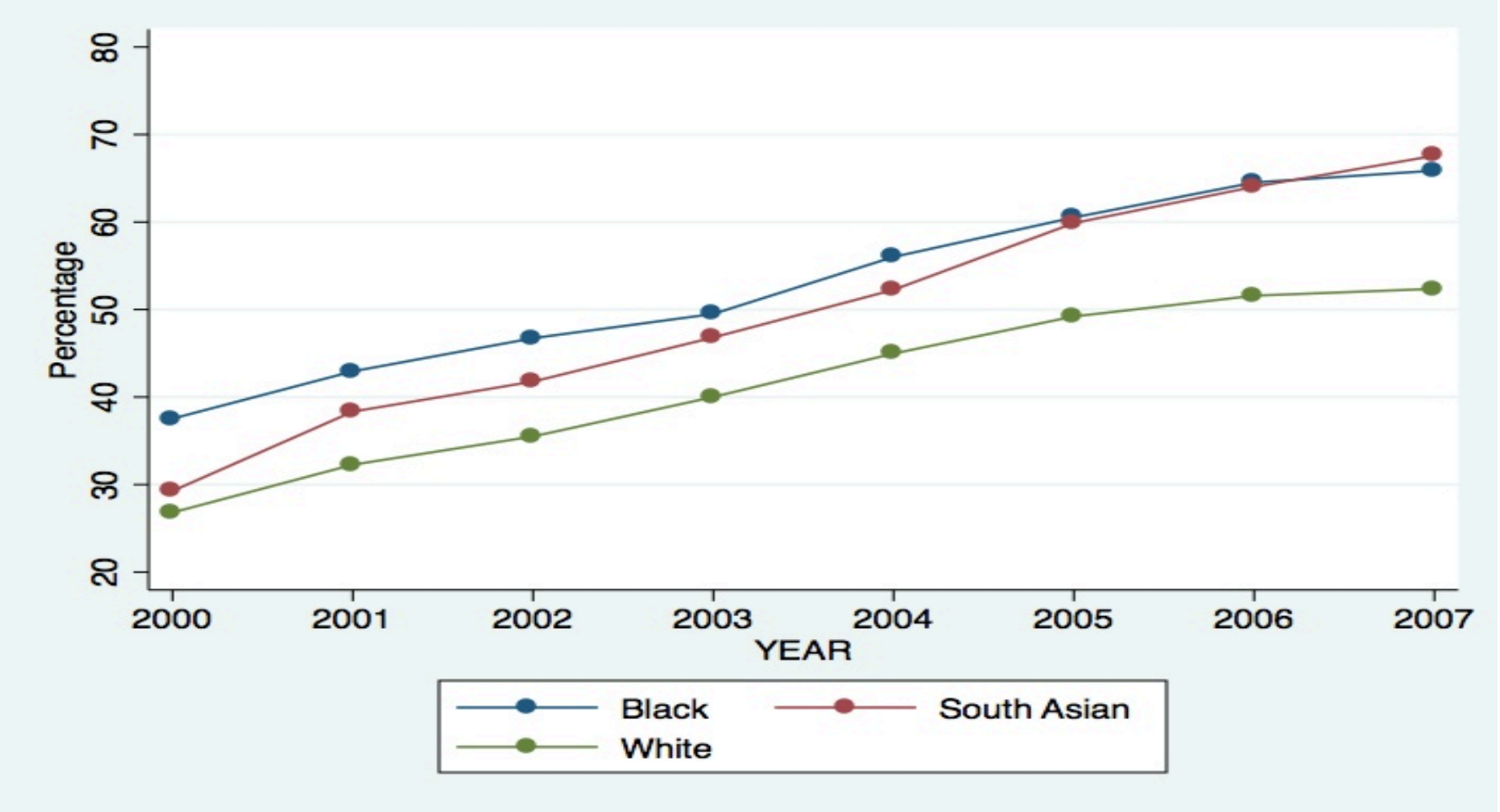


*Figure 19 Annual percentage of patients prescribed OHAs*

*Table 47 Percentage of patients prescribed OHAs*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 26.8 (24.1-29.4) | 32.2 (29.7-34.7) | 35.5 (33.1-37.8) | 40.0 (37.7-42.2) | 44.9 (42.8-47.0) | 49.2 (47.2-51.2) | 51.5 (49.7-53.4) | 52.3 (50.6-54.1) |
| Black | 37.5 (33.8-41.1) | 42.9 (39.5-46.4) | 46.7 (43.5-49.8) | 49.5 (46.5-52.4) | 56.0 (53.2-58.7) | 60.5 (57.9-63.0) | 64.5 (62.1-66.8) | 65.8 (63.6-68.0) |
| South Asian | 29.2 (25.8-32.6) | 38.3 (35.0-41.6) | 41.7 (38.6-44.9) | 46.8 (43.8-49.8) | 52.2 (49.4-55.0) | 59.8 (57.2-62.5) | 64.0 (61.5-66.4) | 67.5 (65.3-69.8) |
| ALL | 30.1 (28.4-31.8) | 36.7 (35.1-38.4) | 39.7 (38.2-41.3) | 43.8 (42.3-45.3) | 49.3 (48.0-50.7) | 54.3 (53.0-55.6) | 57.4 (56.2-58.6) | 58.9 (57.8-60.0) |

Values in brackets are 95% Confidence Interval

*Table 48 Interrupted time series for prescribed OHAs*

| | OHA prescribed, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 1.76 (1.67-1.86)** | 1.81 (1.65-1.98)** | 1.61 (1.45-1.78)** | 1.94 (1.75-2.16)** |
| Level change with QOF | 1.42 (1.18-1.70)** | 1.38 (1.03-1.85)* | 1.54 (1.08-2.19)* | 1.23 (0.86-1.76) |
| Post-QOF trend | 0.74 (0.68-080)** | 0.67 (0.59-0.77)** | 0.87 (0.74-1.01) | 0.77 (0.66-0.90)** |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Insulin:

The percentage of patients' prescribed Insulin increased from 15.4% (95% CI: 14.0–16.7) in 2000 to 19.9% (95% CI: 19.0–20.8) in 2007, at an average rate of 0.5%, $p<0.01$. Patients who had Insulin prescribed increased from 18.7%, 16.1%, and 10.3% in 2000 to 22.5%, 22.1%, and 16.2% in 2007 for white, black and South Asian, respectively (Figure 20 and table 49).

In the pre-QOF period the proportion of people having Insulin prescribed in their record increased annually (AOR: 2.40; 95% CI: 2.16–2.67, $p<0.01$). The introduction of QOF was not associated with an additional immediate improvement in the proportion of people having Insulin prescribed (AOR: 0.83; 95% CI: 0.58–1.19). In the post-QOF years, annual improvements in the proportion of patients having an insulin prescription was significantly lower than that during pre-QOF years (AOR: 1.10; 95% CI: 0.93–1.20) except for white patients (AOR: 1.67; 95% CI: 1.28–2.17) (Table 50).

South Asian patients were less likely to be prescribed insulin in 2000 (AOR: 0.47; 95% CI: 0.34–0.65) when compared to the white group. These inequalities were not abolished at the end of the study period (AOR: 0.70; 95% CI: 0.59–0.83). Black patients had a similar rate of insulin prescribing in 2000 and 2007, when compared to the white group (AOR: 0.80; 95% CI: 0.61–1.05 and AOR: 0.87; 95% CI: 0.75–1.01).

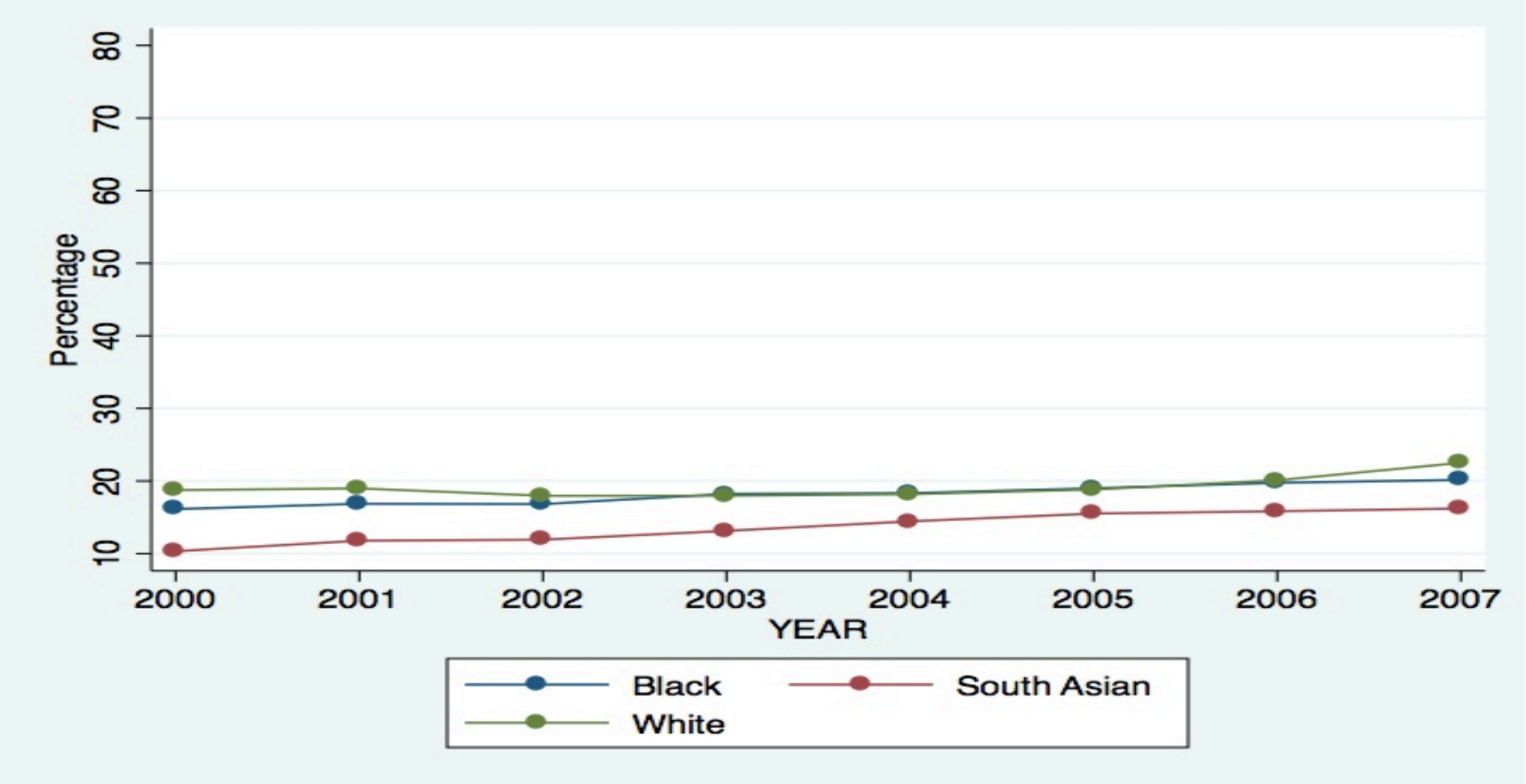


*Figure 20 Annual percentage of patients prescribed insulin*

*Table 49 Percentage of patients prescribed insulin*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 18.7 (16.4-21.0) | 18.9 (16.8-21.0) | 17.9 (16.0-19.8) | 17.9 (16.2-19.7) | 18.1 (16.5-19.8) | 18.8 (17.2-20.4) | 20.1 (18.6-21.6) | 22.5 (21.0-23.9) |
| Black | 16.1 (13.3-18.8) | 16.8 (14.3-19.4) | 16.8 (14.4-19.1) | 18.2 (15.9-20.5) | 18.3 (16.1-20.4) | 18.9 (16.9-21.0) | 19.7 (17.7-21.7) | 20.1 (18.3-22.0) |
| South Asian | 10.3 (8.0-12.5) | 11.7 (9.5-13.9) | 11.9 (9.8-13.9) | 13.1 (11.1-15.1) | 14.4 (12.4-16.4) | 15.5 (13.5-17.4) | 15.8 (13.9-17.7) | 16.2 (14.4-17.9) |
| ALL | 15.4 (14.0-16.7) | 16.3 (15.0-17.5) | 15.8 (14.7-17.0) | 16.7 (15.6-17.8) | 17.1 (16.1-18.2) | 17.5 (16.5-18.5) | 18.5 (17.6-19.5) | 19.9 (19.0-20.8) |

Values in brackets are 95% Confidence Interval

*Table 50 Interrupted time series for prescribed insulin*

| | Insulin prescribed, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 2.40 (2.16-2.67)** | 2.38 (2.02-2.80)** | 2.77 (2.23-3.45)** | 2.15 (1.68-2.73)** |
| Level change with QOF | 0.83 (0.58-1.19) | 0.64 (0.36-1.14) | 1.28 (0.62-2.66) | 1.45 (0.70-3.01) |
| Post-QOF trend | 1.10 (0.93-1.30) | 1.67 (1.28-2.17)** | 0.70 (0.51-0.98)* | 0.80 (0.58-1.10) |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Antihypertensive medications:

The percentage of patients' prescribed antihypertensive medication (AHT) increased from 43.5% (95% CI: 41.6–45.3) in 2000 to 68.8% (95% CI: 67.7–69.8) in 2007, at an average rate of 4.1%, p<0.01. Patients who had AHT medication prescribed to them increased from 44.5%, 51.3%, and 36.1% in 2000 to 69.3%, 73.5%, and 70.2% in 2007 for white, black and South Asian, respectively (Figure 21 and table 51).

In the pre-QOF period the proportion of people having antihypertensive medications prescribed in their record increased annually (AOR: 2.40; 95% CI: 2.25–2.60, p<0.01). The introduction of QOF was not associated with an additional immediate improvement in the proportion of people having any AHT medication prescription (AOR: 1.26; 95% CI: 0.98–1.61). In the post-QOF years, annual improvements in the proportion of people having any AHT medication prescribed was significantly lower than that during the pre-QOF (AOR: 0.98; 95% CI: 0.98–1.10), this was true for white, black and South Asian patients (Table 52).

South Asian patients were less likely to be prescribed AHT medication in 2000 (AOR: 0.61; 95% CI: 0.49 –0.76) when compared to the white group. However, these inequalities were abolished at the end of the study period (AOR: 1.00; 95% CI: 0.87–1.16). Black patients were more likely to be prescribed AHT medication in 2000 and 2007, when compared to the white group (AOR: 1.25; 95% CI: 1.03–1.53 and AOR: 1.24; 95% CI: 1.08–1.42, respectively).

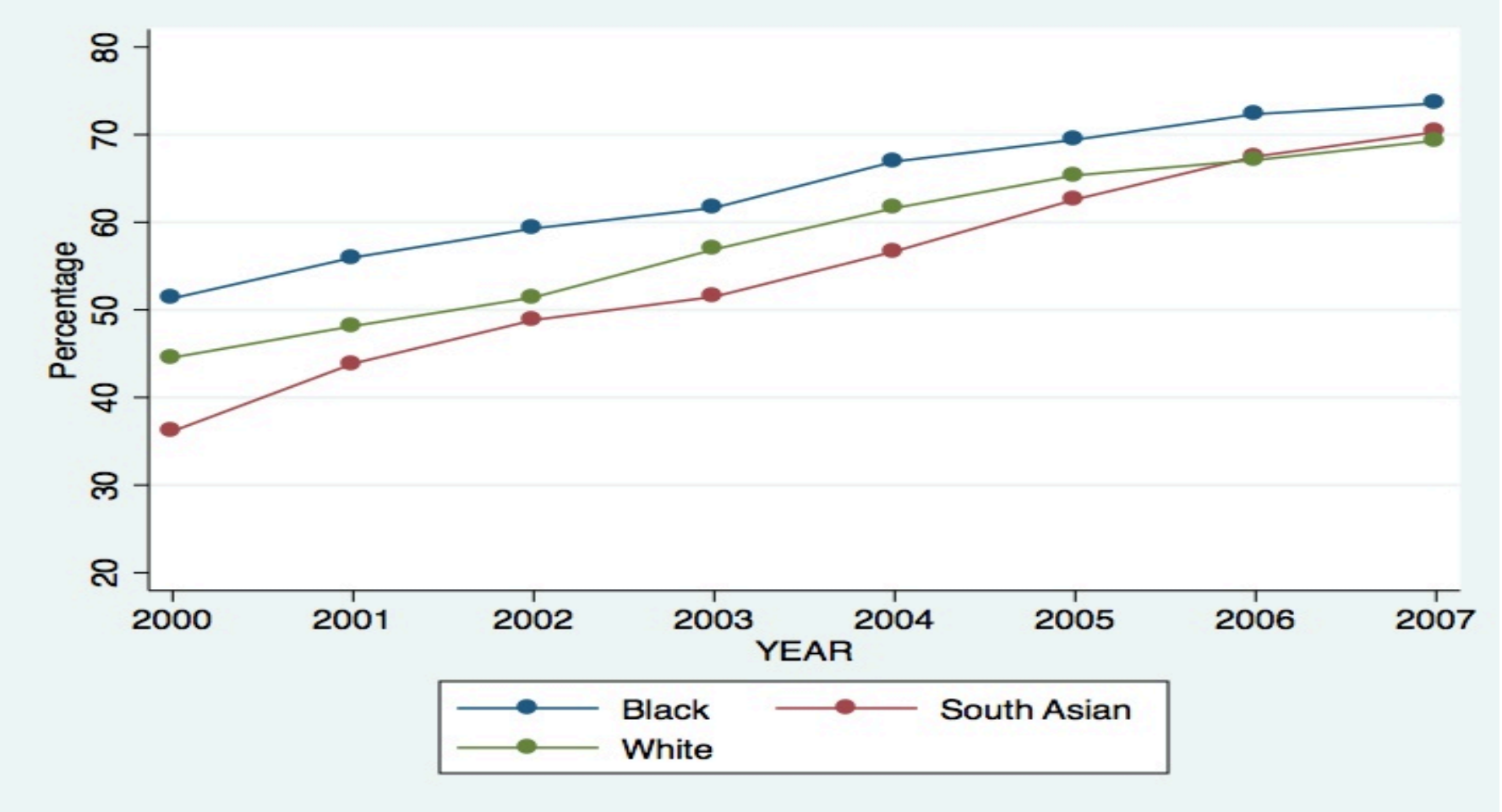


*Figure 21 Annual percentages of patients prescribed AHT medications*

*Table 51 Percentage of patients prescribed AHT medications*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 44.5 (41.6-47.5) | 48.1 (45.4-50.8) | 51.4 (48.9-53.8) | 56.9 (54.6-59.1) | 61.6 (59.5-63.6) | 65.3 (63.4-67.2) | 67.1 (65.3-68.8) | 69.3 (67.7-70.9) |
| Black | 51.3 (47.5-55.0) | 55.9 (52.6-59.3) | 59.2 (56.1-62.4) | 61.6 (58.7-64.5) | 66.9 (64.3-69.5) | 69.4 (67.0-71.8) | 72.3 (70.1-74.5) | 73.5 (71.5-75.5) |
| South Asian | 36.1 (32.5-39.7) | 43.8 (40.4-47.2) | 48.8 (45.6-52.0) | 51.5 (48.4-54.5) | 56.6 (53.8-59.4) | 62.6 (59.9-65.2) | 67.5 (65.1-69.9) | 70.2 (68.0-72.5) |
| ALL | 43.5 (41.6-45.3) | 48.4 (46.7-50.1) | 52.0 (50.4-53.5) | 55.7 (54.2-57.1) | 60.3 (58.9-61.6) | 64.1 (62.9-65.3) | 67.1 (66.0-68.3) | 68.8 (67.7-69.8) |

Values in brackets are 95% Confidence Interval

*Table 52 Interrupted time series for prescribed AHT medications*

| | AHT prescribed, AOR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 2.40 (2.25-2.60)** | 2.59 (2.29-2.93)** | 2.32 (2.01-2.68)** | 2.46 (2.12-2.85)** |
| Level change with QOF | 1.26 (0.98-1.61) | 1.30 (0.86-1.97) | 1.28 (0.76-2.15) | 1.13 (0.72-1.80) |
| Post-QOF trend | 0.98 (0.88-1.10) | 0.96 (0.79-1.17) | 1.07 (0.85-1.36) | 1.00 (0.81-1.24) |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

Lipid-lowering medications:

The percentage of patients' prescribed any lipid-lowering agent increased from 15.3% (95% CI: 14.0–16.7) in 2000 to 67.4% (95% CI: 66.4–68.5) in 2007, at an average rate of 8.0%, p<0.01. Patients who had lipid-lowering medication prescribed increased from 18.1%, 11.2%, and 16.2% in 2000 to 68.6%, 66.7%, and 71.3% in 2007 for white, black and South Asian, respectively (Figure 22 and table 53).

In the pre-QOF period the proportion of people having lipid-lowering medications prescribed in their record increased annually (AOR: 3.93; 95% CI: 3.59–4.31, p<0.01). The introduction of QOF was not associated with an additional immediate improvement in the proportion of people having any lipid-lowering medication prescribed (AOR: 2.32; 95% CI: 1.84–2.92). In the post-QOF years, annual improvements in the proportion of people having any lipid-lowering medication prescribed was significantly lower than that during pre-QOF years (AOR: 0.66; 95% CI: 0.59–0.74, p<0.01), this was true for white, black and South Asian patients (Table 54).

Black patients were less likely to be prescribed a lipid lowering medication in 2000 (AOR: 0.56; 95% CI: 0.42 –0.75) when compared to the white group. However, these inequalities were attenuated at the end of the study period but not abolished (AOR: 0.96; 95% CI: 0.84–1.10). Relative to white patients, south Asian patients had similar prescribing record of lipid lowering medication in 2000 (AOR: 0.82; 95%: 0.62–1.09) that were abolished in 2007 but did not reach significant levels (AOR: 1.12; 95% CI: 0.97–1.30).

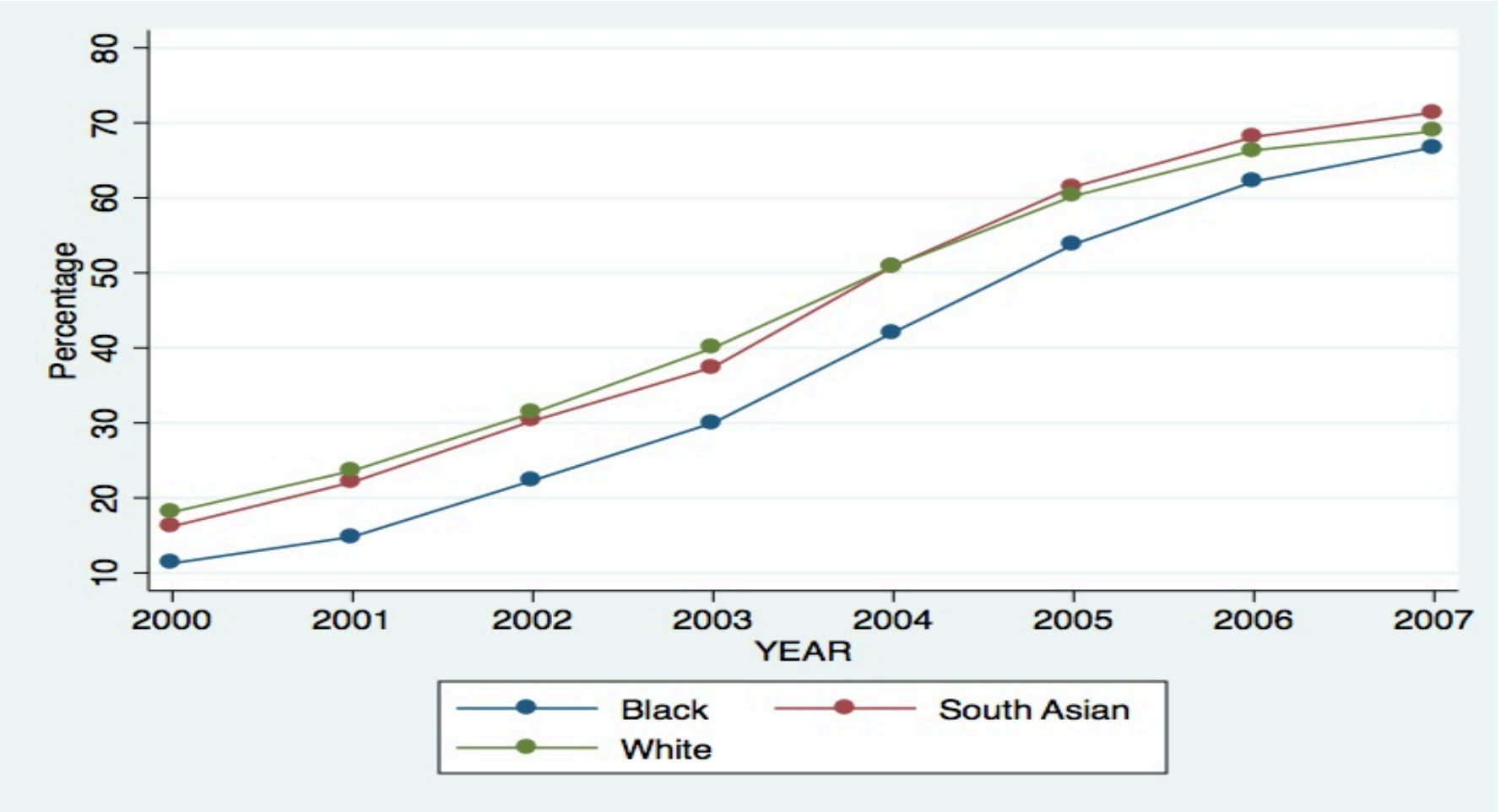


*Figure 22 Annual percentages of patients prescribed any lipid lowering medication*

*Table 53 Percentage of patients prescribed any lipid lowering medications*

| Ethnicity | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|
| White | 18.1 (15.8-20.3) | 23.6 (21.3-25.8) | 31.3 (29.0-33.6) | 40.0 (37.7-42.2) | 50.9 (48.7-53.0) | 60.2 (58.2-62.2) | 66.3 (64.5-68.1) | 68.8 (67.2-70.4) |
| Black | 11.2 (8.9-13.6) | 14.8 (12.4-17.2) | 22.3 (19.6-24.9) | 30.0 (27.3-32.7) | 42.0 (39.3-44.8) | 53.8 (51.2-56.4) | 62.1 (59.7-64.5) | 66.7 (59.7-64.5) |
| South Asian | 16.2 (13.4-18.9) | 22.1 (19.2-24.9) | 30.2 (27.3-33.2) | 37.4 (34.5-40.3) | 50.9 (48.0-53.7) | 61.4 (58.8-64.0) | 68.1 (65.7-70.5) | 71.3 (69.2-73.5) |
| ALL | 15.3 (14.0-16.7) | 20.8 (19.4-22.1) | 27.9 (26.5-29.3) | 35.9 (34.5-37.3) | 47.6 (46.3-49.0) | 57.5 (56.2-58.8) | 64.3 (63.2-65.5) | 67.4 (66.4-68.5) |

Values in brackets are 95% Confidence Interval

*Table 54 Interrupted time series for any lipid lowering prescribed*

| | Lipid lowering prescribed, OR (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | 3.93 (3.59-4.31)** | 4.46 (3.79-5.26)** | 4.23 (3.50-5.12)** | 3.39 (2.89-3.99)** |
| Level change with QOF | 2.32 (1.84-2.92)** | 2.04 (1.40-2.98)** | 2.15 (1.36-3.38)** | 2.87 (1.84-4.49)** |
| Post-QOF trend | 0.66 (0.59-0.74)** | 0.61 (0.51-0.74)** | 0.67 (0.54-0.84)** | 0.71 (058-0.88) |

Note: Values are adjusted for age, sex, SES, duration of diabetes, and number of comorbidities, and clustering.
*p<0.05, **p<0.01

# 6.0 Impact of pay for performance on diabetes intermediate outcomes in ethnic minority patients with and without comorbid medical conditions: cross sectional study

A key objective of my study is to assess the impact of the quality and outcome framework on ethnic minority patients with and without comorbid medical conditions. Because of the sample size, I had to limit my analysis to 2007, however acknowledging the limitation of this in the discussion section of my thesis.

## 6.1 Data analysis

I divided comorbid conditions into cardiovascular conditions with concordant management goals (hypertension, heart failure, stroke, atrial fibrillation, CHD, CKD) and other conditions with discordant management goals (COPD, asthma, depression) and calculated the number of comorbidities for each patient.
I calculated mean HbA1c, systolic and diastolic blood pressure and total cholesterol and the percentage of patients achieving the quality and outcome framework intermediate outcome target (HbA1c≤7.5%, blood pressure ≤145/85 mm Hg, cholesterol ≤5.2 mmol/l) by ethnic group and comorbidity status. Regression analyses were undertaken to examine associations between ethnicity, number of comorbidities and each of the outcome measures while controlling for age, sex, duration of illness, BMI and neighbourhood SES score. To adjust for clustering of patients within practices, I fitted a random effects model for all the regression analysis. I included an interaction terms in each

model to examine whether association between comorbidity and the outcome measures varied between ethnic groups.

## 6.2 Results

Overall 52.2% had hypertension, 14.3% had depression, 12.9% had CHD, 12.1% had COPD, 10.4% had asthma, 6.4% had experienced a stroke, 4.6% had CKD, 3.4% had atrial fibrillation, and 2.7% had heart failure. Men comprised a larger proportion of patients than women to have concordant comorbid medical conditions (60.1% vs. 57.8%), but this was reversed in discordant comorbid medical conditions (7.1% vs. 11.3%). Black patients were more likely to have at least one concordant comorbid condition than white or south Asian patients (65.5% vs. 59.4% vs. 57.6%). White patients were more likely to have at least one discordant comorbid condition compared to South Asian or black patients (11.0% vs. 7.7% vs. 6.0%).

*Table 55 Sample characteristics (2007)*

| | White | Black | South Asian |
|---|---|---|---|
| N | 3,181 | 1,811 | 1,653 |
| Age: median (IQR) | 64 (50-72) | 64 (51-72) | 60 (51-69) |
| Female: % | 47.4 | 54.1 | 46.5 |
| BMI: median (IQR) | 29.2 (25.6-33.7) | 29.1 (26.1-33.1) | 27.0 (24.3-30.4) |
| Diabetes duration: median (IQR) | 5 (2-8) | 5 (2-9) | 6 (2-9) |
| Comorbidity: n (%) | | | |
| No of comorbidity | 940 (29.6) | 518 (28.6) | 574 (34.7) |
| 1 concordant condition | 1,271 (40.0) | 914 (50.5) | 647 (39.2) |
| ≥2 concordant condition | 617 (19.4) | 271 (15.0) | 304 (18.4) |
| ≥1 discordant condition | 351 (11.0) | 108 (6.0) | 127 (7.7) |

HbA1c management:

Black and south Asian patients were significantly less likely than white patients to achieve the HbA1c target of ≤7.5% (AOR, 0.82; 95% CI 0.71-0.94 and AOR, 0.72; 95% CI 0.61-0.85, respectively) (Tables 56 and 59). Compared to white patients, mean HbA1c was significantly higher among black (0.3%, p<0.01) and south Asian patients (0.2%, p<0.01) (Table 60).

Patients with concordant comorbid conditions had significantly lower mean HbA1c and were significantly more likely to achieve the HbA1c target compared to those without (AOR, 1.20; 95% CI 1.03-1.39 for patients with 1 concordant comorbid condition). Patients with discordant conditions had similar HbA1c control as those without co-morbidity (AOR, 1.18; 95% CI 0.93-1.49). No significant interaction between ethnicity and comorbidity was found.

*Table 56 HbA1c control by ethnicity and number of comorbidities*

| | No comorbidity | 1 concordant condition | ≥2 concordant conditions | ≥1 discordant conditions |
|---|---|---|---|---|
| HbA1c, Mean (SE), % | | | | |
| White | 7.8 (0.07) | 7.4 (0.04) | 7.3 (0.06) | 7.7 (0.12) |
| Black | 8.3 (0.11) | 7.7 (0.06) | 7.5 (0.09) | 7.6 (0.18) |
| South Asian | 7.9 (0.08) | 7.7 (0.06) | 7.6 (0.07) | 8.1 (0.18) |
| HbA1c≤7.5% | | | | |
| White | 37.5 | 49.5 | 52.5 | 41.6 |
| Black | 33.8 | 40.5 | 45.8 | 48.1 |
| South Asian | 34.8 | 36.0 | 35.6 | 31.0 |

Blood pressure:

Black patients were significantly less likely to achieve the blood pressure treatment target (AOR, 0.84; 95% CI: 0.73-0.97) than white patients. However, South Asian patients were more likely to reach the management target for blood pressure control (AOR, 1.25; 95% CI: 1.07-1.46) (Table 57 and 59).

Patients with concordant comorbid conditions were significantly less likely to achieve the blood pressure target compared to patients without any comorbidity (AOR, 0.62; 95% CI: 0.53-0.71 for patients with 1 concordant comorbid condition). Patients with discordant conditions had similar blood pressure control to those without any comorbidity (AOR, 1.19; 95% CI: 0.96-1.48) (Table 57 and 59).

When white patients with no comorbidities were the reference group, mean systolic blood pressure was higher in white patients with one concordant comorbidity (4.6 mm Hg, $p<0.01$) but similar in those with two or more concordant comorbidities. Relative to white patients without comorbidity, mean systolic blood pressure was similar among black patients without comorbidity but was significantly higher among black patients with 1 (5.9 mm Hg, $p<0.01$) and $\geq 2$ concordant comorbid conditions (6.2 mm Hg, $p < 0.01$). Relative to white patients without comorbidity, mean systolic blood pressure was significantly lower among south Asian patients without comorbidity but was similar among south Asian patients with concordant comorbid conditions. No interaction effect was found for achievement of blood pressure target or diastolic blood pressure ($p>0.05$) (Table 60).

*Table 57 Blood pressure control by ethnicity and number of comorbidities*

| | No comorbidity | 1 concordant condition | ≥2 concordant conditions | ≥1 discordant conditions |
|---|---|---|---|---|
| Systolic, mean (SE),mm Hg | | | | |
| White | 128.3 (0.5) | 136.4 (0.4) | 134.4 (0.7) | 127.3 (0.9) |
| Black | 129.8 (0.7) | 137.4 (0.5) | 138.6 (1.1) | 126.5 (1.4) |
| South Asian | 126.9 (0.7) | 133.9 (0.7) | 133.6 (1.1) | 125.5 (1.5) |
| Diastolic, mean (SE),mm Hg | | | | |
| White | 76.7 (0.3) | 76.7 (0.3) | 73.4 (0.4) | 76.4 (0.5) |
| Black | 77.8 (0.4) | 78.4 (0.3) | 75.6 (0.7) | 76.5 (0.9) |
| South Asian | 76.2 (0.4) | 76.7 (0.4) | 72.4 (0.6) | 74.6 (0.8) |
| BP≤145/85 mmHg, % | | | | |
| White | 45.9 | 30.4 | 36.8 | 49.2 |
| Black | 44.6 | 26.5 | 33.0 | 48.9 |
| South Asian | 53.0 | 40.7 | 42.6 | 56.5 |

Cholesterol:

South Asian patients had significantly lower mean cholesterol levels and were significantly more likely to achieve the cholesterol treatment target than white patients (AOR, 1.36; 95% CI 1.11-1.66). No significant difference was found between black and white patients in achievement of cholesterol target (Table 58, 59 and 60).

Patients with concordant comorbid conditions had significantly lower mean cholesterol levels and were significantly more likely to achieve the cholesterol target compared to patients without comorbidity (AOR, 1.40; 95% CI 1.17-1.68 for patients with 1 concordant comorbid condition). Patients with discordant conditions had similar achievements in cholesterol target compared to those without comorbidities (AOR, 1.01; 95% CI 0.77-1.32). No significant interaction was found between ethnicity and comorbidities (Table 58, 59 and 60).

*Table 58 Cholesterol control by ethnicity and number of comorbidities*

| | No comorbidity | 1 concordant condition | ≥2 concordant conditions | ≥1 discordant conditions |
|---|---|---|---|---|
| Cholesterol, mean (SE), mmol/L | | | | |
| White | 4.6 (0.04) | 4.4 (0.03) | 4.1 (0.04) | 4.5 (0.06) |
| Black | 4.5 (0.05) | 4.4 (0.03) | 4.2 (0.06) | 4.6 (0.11) |
| South Asian | 4.5 (0.06) | 4.1 (0.03) | 3.9 (0.06) | 4.6 (0.11) |
| Cholesterol≤5.0 mmol/L, % | | | | |
| White | 75.9 | 82.2 | 87.9 | 77.1 |
| Black | 77.4 | 83.5 | 86.5 | 76.9 |
| South Asian | 79.0 | 87.3 | 90.7 | 75.0 |

*Table 59 Odds of achieving intermediate outcome targets by ethnicity and number of comorbidities*

| Measure | HbA1c ≤7.5 | Cholesterol≤5.0 | BP≤145/85 | All targets |
|---|---|---|---|---|
| Ethnic group: | AOR (95% CI) | AOR (95% CI) | AOR (95% CI) | AOR (95% CI) |
| White (ref) | 1.00 | 1.00 | 1.00 | 1.00 |
| Black | 0.82 (0.71-0.94) | 1.14 (0.95-1.37) | 0.84 (0.73-0.97) | 0.79 (0.65–0.95) |
| South Asian | 0.72 (0.61-0.85) | 1.36 (1.11-1.66) | 1.25 (1.07-1.46) | 1.07 (0.85-1.33) |
| Number of comorbidites: | | | | |
| No comorbidity (ref) | 1.00 | 1.00 | 1.00 | 1.00 |
| 1 concordant condition | 1.20 (1.03-1.39) | 1.40 (1.17-1.68) | 0.62 (0.53-0.71) | 0.97 (0.79-1.20) |
| ≥2 concordant condition | 1.28 (1.06-1.55) | 1.81 (1.40-2.33) | 0.78 (0.65-0.94) | 1.24 (0.96-1.60) |
| ≥1 discordant condition | 1.18 (0.93-1.49) | 1.01 (0.77-1.32) | 1.19 (0.96-1.48) | 1.25 (0.92-1.70) |

ref = reference group; BP = blood pressure

Note: Values are adjusted for age, sex, diabetes duration, BMI, socioeconomic status and practice level clustering.

Note: All interactions between ethnicity and comorbidity were not significant (p>0.05)

*Table 60 Mean differences in intermediate outcomes by ethnicity and number of comorbidites*

| Measure | Systolic† | Diastolic‡ | Cholesterol‡ | HbA1c‡ |
|---|---|---|---|---|
| Ethnic group (comorbidity) | Mean difference | | | |
| White (0) | 0 | | | |
| White (1 concordant) | 4.6 (3.0,6.1)** | | | |
| White (≥2 concordant) | 1.5 (-0.3,3.3) | | | |
| White (≥1 discordant) | -1.4 (-3.5,0.8) | | | |
| Black (0) | 0.9 (-0.9,2.9) | | | |
| Black (1 concordant) | 5.9 (4.3,7.6)** | | | |
| Black (≥2 concordant) | 6.2 (3.8,8.5)** | | | |
| Black (≥1 discordant) | -3.1 (-6.7,0.3) | | | |
| SA (0) | -2.3 (-4.2,-0.3)* | | | |
| SA (1 concordant) | 2.6 (-0.5,5.3) | | | |
| SA (≥2 concordant) | 1.4 (-0.8,3.6) | | | |
| SA (≥1 discordant) | -4.2 (-7.5,-0.9)* | | | |
| Ethnic group: | | | | |
| White (ref) | | 0 | 0 | 0 |
| Black | | 1.3 (0.7,1.9)** | -0.04 (-0.1,0.02) | 0.3 (0.1,0.4)** |
| South Asian | | -0.5 (-1.2,0.2) | -0.2 (-0.2,-0.1)** | 0.2 (0.04,0.3)** |
| Number of comorbidites: | | | | |
| No comorbidity (ref) | | 0 | 0 | 0 |
| 1 concordant condition | | 1.5 (0.9,2.1)** | -0.1 (-0.2,-0.1)** | -0.2 (-0.3,-0.1)** |
| ≥2 concordant condition | | -0.1 (-0.9,0.6) | -0.3 (-0.4,-0.2)** | -0.2 (-0.4,-0.1)** |
| ≥1 discordant condition | | -1.0 (-2.0,-0.6)* | -0.01 (-0.1,0.01) | -0.1 (-0.3,0.1) |

ref = reference group

Note: Values are adjusted for age, sex, diabetes duration, BMI, socioeconomic status and practice level clustering.

†Interaction between ethnicity and comorbidity significant (p=0.03).

‡ Interaction between ethnicity and comorbidity not significant (p>0.05).

*P<0.05, **P<0.01

# 7.0 Discussion

## 7.1 Main findings

The quality of diabetes care, as measured by the QOF indicators, has improved substantially throughout the study period; however, QOF had a different impact on process and intermediate outcomes. The introduction of QOF was associated with an accelerated improvement in the recording of nearly all of the process indicators but annual improvements in the proportion of patients having a recording in some of the process indicators were significantly lower than that during the pre-QOF years. However, inequalities that were present before QOF in some of the process indicators have largely disappeared at the end of the study period. For example, South Asian patients were less likely to have a blood pressure recording, when compared to white patients, before QOF introduction but at the end of the study period these differences had disappeared. One exception is the smoking advice indicator where black and South Asian patients were less likely to have a smoking advice compared to the white group at the end of the study period.

There was a trend of increasing prescribing of OHAs, insulin, AHT medications, and lipid lowering agents in the years before QOF. The introduction of QOF was not associated with additional increases in the level of prescribing. Inequalities in the prescribing levels of insulin seen before QOF remained present at the end of the study period.

My analysis indicates an underlying trend of general improvements in HbA1c, cholesterol and blood pressure control predating QOF. The introduction of QOF

was associated with initial accelerated improvements in systolic blood pressure in white and black patients but this was only sustained in black patients. Initial improvements in diastolic blood pressure in white patients and in cholesterol in black and white patients were not sustained in the post-QOF period. There was no beneficial impact of QOF on HbA1c in any ethnic group. Existing inequalities in risk factor control remained largely intact at the end of the study period. Further, the QOF had no significant impact on the achievement of a composite of all the three outcome indicators. At the end of the study period, South Asian patients were less likely to achieve a composite of all the three outcome indicators when compared to the white group, a situation that was not evident before QOF.

Findings from the cross sectional study suggest that patients with concordant comorbid conditions are more likely to reach the treatment targets for HbA1c and cholesterol, but less likely to reach the blood pressure target, compared to patients with no comorbidity. Ethnic inequalities in blood pressure management were more pronounced among patients with cardiovascular comorbidities. For instance, black patients with one, two or more concordant medical conditions had higher systolic blood pressure when compared to white patients without comorbidity. People with discordant conditions, such as asthma and depression, were not better managed than those without comorbidity.

## 7.2 Previous research

The improvements I found in diabetes care before the introduction of QOF is similar to findings published elsewhere (133). Few studies have examined the impact of pay for performance on health care inequalities especially on ethnic

inequalities. A recent systematic review in the United States found one study that assessed the impact of public reporting of Coronary Artery Bypass Graft (CABG) on ethnic inequalities but no studies relevant to the impact of pay for performance were found (232). The study found that the release of CABG report card widened the white versus black differences by 2.3 percentage points and 2.5 percentage points in white versus Hispanic differences in receiving CABG. In the comparison group no significant differences were found between white, black and Hispanic patients in CABG use (275). Findings from my systematic review suggest that the impact of pay for performance on inequalities in chronic disease management is limited. I found only one study that used an interrupted time series design to estimate the effect of QOF on ethnic inequalities, which found initial widening in inequalities in HbA1c and blood management control (234). However, process indicators and cholesterol outcome were not examined in this study. Furthermore, only one measurement point was examined after QOF. My work examines the longer-term impact of QOF on diabetes care management using a segmented time-series methodology. I found that QOF had no significant effect on HbA1c levels; these actually reversed slightly during the post-QOF years, which is in keeping with previous findings. For example, Vamos et al, found that the annual increase seen in HbA1c before QOF reversed to a decline of 0.2% in the year after QOF (42, 276).

Campbell et al (203), found significant additional improvements in the level of performance for diabetes care associated with the introduction of QOF; however, it is difficult to compare it with my findings as they performed their analysis using a summary indicator and not on individual indicators.

Furthermore, their analysis used practice level data and did not adjust for various patient level covariates. Calvert et al., found a small improvement in HbA1c target level of ≤7.5% and no improvement was evident for a target level of ≤10%. However, the authors did not use a segmented time series analysis (204). Serumaga et al (277), did not find any significant impact of QOF among hypertensive patients in the UK. Furthermore, the authors did not find significant decline in blood pressure control over time (from 2000 to 2007). This is in contrast to findings from national (278) and international studies (129).
The decrease in the proportion of patients meeting the targets seen in the post-QOF years can be attributable to ceiling effect or the lack of financial incentives. Practices that reached a certain threshold may not be inclined to take on additional work (279). This conclusion has also been reached by others (203).

Few studies have examined the interaction between ethnicity and comorbidity in inequalities in diabetes care and to my knowledge no study has previously been undertaken in the UK. My finding that patients with comorbidity were less likely to have a controlled blood pressure is consistent with a previous study in the UK (42). This finding was unanticipated given that blood pressure control is incentivised for four of the six cardiovascular conditions examined in this study (stroke, CHD, hypertension, CKD) in the QOF. This finding may be partly explained by the much poorer blood pressure control among black patients with comorbidity. This suggests that there is an important additional inequality in care between ethnic groups with cardiovascular comorbidity that has not been addressed by the QOF.

Patients with discordant comorbid conditions did not have better care than patients without comorbidity; this finding suggest that more frequent contact with health services by itself does not improve the management of diabetes unless these conditions have concordant treatment goals. Data from the United States suggests that the number of patients' encounters with health care providers did not have an effect on the achievement of hypertension treatment goals with discordant or concordant conditions (280). I was not able to adjust for the number of patient visits in my cross sectional analysis.

Previous work in Wandsworth found that the presence of cardiovascular comorbidity was associated with better blood pressure control among white hypertensive patient when compared to white patients without comorbidity. However, similar association was not evident in black patients with cardiovascular comorbidities (239). In Italy, patients with low level of comorbidity benefited more from glycaemic control compared to those with high level of comorbidity (51).

My study is in keeping with other studies that have evaluated ethnic inequalities in diabetes care in the UK. For example, a previous analysis in the Wandsworth area, found poor HbA1c control in south Asian and black patients compared to white (258) and analysis of the HSE found poor glycaemic control in Pakistani patients but not in the Indian group or the black group, this findings might be explained by the sample size of the study (136).

Ethnic inequalities in diabetes care are a persistent feature in developed countries. Analysis of the National Health and Nutrition Examination Survey (NHANES) in the United States found that non-Hispanic black patients with

diabetes were less likely to have a controlled glycaemic levels (AOR: 0.57; 95% CI: 0.39–0.84, p<0.05) when compared to non-Hispanic Whites (281). Similarly, over a period of eight years (from 1999–2006) black patients had lower rate of glycaemic control (-16.5%, p<0.001) when compared to white patients (282). A longitudinal study of blood pressure control from 1996 to 2006 in the Veterans Affairs Health System in the United States found non-Hispanic black and Hispanic patients to be more likely to have a poor control of blood pressure when compared to white patients (AOR: 1.5; 95% CI: 1.3–1.7 and AOR: 1.5; 95% CI: 1.4–1.9, respectively) (283). A systematic review conducted in the United States found higher levels of HbA1c of 0.5% in Hispanic patients than non-Hispanic whites (284). In Norway, South Asian patients were less likely to have a controlled HbA1c compared to Norwegian patients (AOR: 0.6; 95% CI: 05–0.9) (285).

There were significant increases in the levels of prescribing. However, QOF generally had no significant impact on the proportion of patients prescribed medication for secondary prevention; the only exception to this was for lipid lowering medication. The variations I found in prescribing are consistent with previous findings in the UK. For example, analysis from 26 practices in Brent, North London, found that South Asian patients were less likely to be prescribed insulin in 1997 and 2006 when compared to the white group (286). Similarly, previous work in Wandsworth found that South Asian patients were less likely to be prescribed insulin in 2005 (233). This may be explained by a host of barriers, such as providers' reluctance to tackle patients' barriers to initiate insulin therapy (e.g. sense of loss of control and personal failure) (287).

## 7.3 Strengths and limitations

My study has a number of strengths and limitations. The QOF was implemented nationally, which meant I did not have control over the intervention and as such I could not use a gold standard method such as a randomised controlled trial to evaluate its impact. Nevertheless, the interrupted time series employed is a robust quasi-experimental method that can withstand many biases and is superior to pre-post study designs that do not take underlying trends into account (288). Further, as QOF was the only major quality improvement initiative introduced in primary care during 2004, it is reasonable to attribute any additional improvements in diabetes management seen to this policy.

My study is based on retrospective data from patients registered with practices in 2007, which means that I did not have information on patients that died or changed their practice during the study period. However, my sensitivity analyses, accounting for attrition bias, yielded results substantiating the robustness of findings from my main analysis.

I was not able to assess the interaction between ethnicity and comorbidity using an interrupted time series method. The inequalities findings between patients with comorbid conditions are limited by the cross sectional design of the study and as such I am limited in my conclusions. Due to small numbers in some of the ethnic groups, I had to combine patients into three main groups (for example, I combined patients from Indian, Pakistani and Bangladesh ethnic background into south Asian group). I accept that this might mask differences in diabetes management (289). I was not able to distinguish between patients with type-1 and type-2 diabetes.

29 out of 32 practices participated in this study; hence my findings present a comprehensive snapshot of the care delivered in this ethnically diverse location. However, my findings were derived from one primary care organisation in the UK, which may not translate to other areas in the UK. Further, the UK health system is different in the way it is financed, organised and governed compared to the more market based health systems such as that in the United States. Hence, my findings may not be applicable to other systems, particularly those that do not offer universal health coverage. Nonetheless, my findings suggest that minority groups with diabetes may not be receiving optimal care even in a health system that offers universal coverage.

Improvements seen in process indicators may be due to improvements in recording and not necessarily improvement in care provided. The differences I found in the intermediate indicators may be attributable to variations in recording. However, this is likely to be minimised because data for cholesterol and HbA1c are downloaded electronically to the patient's electronic record from the local hospital laboratory. I used practice postcode to assign deprivation score to each patient, patients attending the same practice may be from different socioeconomic background. However, practice derived deprivation score are generally accepted as a reasonable proxy measure for patient deprivation (290).

### 7.4 Policy implications

The rising epidemic of diabetes presents a major challenge to the NHS in the coming years. This challenge underlines the importance of ongoing efforts to improve the quality of diabetes management in primary care, especially given

that diabetes is a major contributor to inequalities in mortality (291). The introduction of QOF appears to have accelerated improvements in diabetes management for the quality indicators included in the QOF, particularly, in the process aspect of quality. Nonetheless, not all groups appear to have benefited equally from this policy, people from certain ethnic minority groups, and many people with diabetes are still not meeting established treatment targets. For example, only half of the patients in this study achieved HbA1c≤7.5%.

The use of QOF to improve the management of diabetes and reduce variations in care further will be a challenge. Greater emphasis on outcome measures might be more appropriate since process measures have been largely met. This is visible in the retirement of the recording of HbA1c, cholesterol and blood pressure indictors in the 2011-12 revision of QOF. However, retirement of such indicators does not mean it should not be monitored. Experience from the United States shows that rate in the level of screening for diabetic retinopathy decreased by 3% per year after removing the financial incentive attached to it (292). Similarly, financial incentives linked to a diabetes clinical decision support system improved HbA1c control, however use of the system lowered when the incentives were discontinued (293). An increase in the threshold for achievement of existing targets may be more appropriate, as it may lead to greater overall net benefits to patients, especially that practices are offered exception reporting. The presence of exception reporting and threshold target may limit the public health impact of QOF (294). This has also been recently suggested by the Marmot review (230), which proposed setting higher thresholds to provoke active case finding of patients with undiagnosed or untreated disease.

Inclusion of an inequality-reducing element in pay for performance schemes may be warranted. Strategies, among others, include rewarding improvement as well as absolute achievements, inclusion of disease areas and quality indicators that are more important in minority patients or directly rewarding reductions in inequalities. For example, the Massachusetts Medicaid programme has recently developed a pay for performance programme aimed at reducing inequalities in the quality of hospital care between ethnic groups (295). However, evaluation of the programme demonstrated the complexity of designing a pay for performance scheme directed at reducing inequalities. For example, lack of sufficient numbers of patients may present difficulties to payers in identifying high performers. In addition, it demonstrated the importance of choosing measures that are relevant to inequalities reduction (296). However, It is important to note that ignoring the context that people are in and focusing on health services alone cannot solve inequalities.

As discussed earlier, ethnicity-coding levels are low in the UK. It is essential to identify people from ethnic minorities to evaluate service use by such patients and investigate differences between patients. Further, spoken language and communication can influence many aspects of care. For example, a qualitative study in England found that providers face uncertainty when dealing with ethnically diverse population, which may lead to reluctance in providing care (297). Having a financial incentive can help in improving the levels of ethnicity coding and recording of first language. For example, the QOF+ scheme offers financial rewards to practices in Hammersmith and Fulham in London to reach

ethnicity levels between 60% to 90% (298).

The current diagnostic case definition for diabetes used in QOF should be revisited as some patients might be overlooked, for example patients with a diabetic treatment Read code. Further, the impact of exception reporting on diabetes management requires further and ongoing evaluation. The framework does not capture other aspects of diabetes management. Patients' communication, engagement and empowerment are not adequately incentivised by QOF and evidence suggests that QOF had no positive effect on improvements in physicians-communications (203). This is one of the quality measures where the UK compares less favourably to other nations (299). Additionally, meeting these challenges will require better coordination between primary and secondary care with investment in both sectors. This requires improvements in providing patients with continued, personal and coordinated care, elements that may need to be reflected in QOF in the future. Furthermore, the amount of money attached to QOF may need to be reconsidered. For instance, such resources could be used to go beyond simply monitoring intermediate outcome target but to develop new innovative performance measures indicators, such as to measure the support of shared decision-making (300), or indicators that measures response to poor intermediate outcome (301, 302). Such innovations in performance measurement could focus the attention of providers to patient's most likely benefit from appropriate treatment.

The national implementation of QOF limits the ability to conduct cost-effectiveness studies, however, the involvement of NICE in reviewing and developing indicators for QOF could help in the selection of cost effective

indicators. Under the new process there will be a chance to pilot new indicators to test their validity and monitor any unintended consequences although the six-month piloting period may not be sufficient to evaluate the effect of new indicators (303).

The QMAS may need to be modified to include patient level variables such as age, sex, and ethnicity. Not only to allow for the continuous equity audit of health care but also to monitor any potential indicators based on personalised risk quality measures in the future.

Longer-term follow up of the impact of QOF is essential to assess whether some of the persisting inequalities in diabetes management that have been identified are reduced over time. Indicators used in pay for performance schemes, such as QOF, are mostly driven from trials that exclude patients with comorbidity. Research on the impact of QOF on such patients is limited.

The research presented in this thesis, and other work carried out in the Department of Primary Care & Public Health at Imperial College London, helped in the planning of the QOF+ programme in NHS Hammersmith & Fulham. The QOF+ programme offers additional incentives for achieving quality targets and for recording of ethnicity status in primary care. An evaluation to assess the impact of the programme on quality of care and intermediate health outcomes is currently underway.

## 7.5 Future research

The introduction of QOF in the UK has attracted international interest; however many unanswered question remains in regards to the QOF and to pay for

performance in general. First, we know little about which incentive structure may be better suited to reducing health care inequity. For example, whether rewarding absolute achievement is more effective than rewarding improvements in care in tackling inequalities is unclear. Two, understanding which practice characteristics explain the variations between practices is essential. Some practice characteristic has been examined in the QOF context such as practice size. The use of multi-level modeling can assist in exploring these factors. Third, QOF was used to complement capitation payment in primary care. Understanding how effective pay for performance within other payment methods (e.g. fee for service) compared to capitation is essential and whether any unintended consequences may surface. Fourth, even though exception-reporting rates have been low and there was no evidence of gaming, nevertheless, long term monitoring on patients whom are exception reported is important since ethnic minorities and patient with comorbidities are more likely to be exception reported and might be at risk of receiving less attention relative to those not exception reported. Fifth, there is an interest in designing local incentive schemes. For example, the NHS review in 2008 encouraged devolving part of QOF budget to local primary care organizations to design locally led incentive schemes (304). Evaluating such schemes in terms of their effectiveness and if they can be used to tackle inequalities is needed. Evidence from the Massachusetts scheme discussed earlier demonstrates how the use of financial incentives to tackle inequalities needs careful design. Sixth, my work was confined to quantitative analysis. However, recent qualitative work by the Kings fund to review the impact of QOF on inequalities found that few practices

thought they had a role in reducing health inequalities and there was no evidence of proactive case finding (305). In addition, qualitative research on the effect of QOF, or any pay for performance scheme, on the culture of primary care is warranted as such schemes may lead to a financially driven model of primary care or the fragmentation of general practice (306).

## 7.6 Conclusion

My findings suggest that universal quality improvement schemes, such as QOF, have not addressed important inequalities in diabetes management over time, i.e. are not consistent with the inverse equity hypothesis. They provide support for the view that targeted interventions at the level of the patient that focuses on the interaction between the patient and the provider may be needed to meet the needs of minorities with poor risk factor control. Targets that are driven by guidelines and embedded in public reporting or in pay for performance schemes may present a challenge to providers caring for patients from a specific ethnic background, or patients presenting with comorbid conditions. Designers of pay for performance should weigh the effect of such schemes on ethnic minorities and patients suffering from complex conditions and consider incorporating targeted incentives to address the persistence of such disparities. Local efforts in the UK to reduce inequalities by using financial incentives to improve care in minority groups and monitor progress through better recording of ethnicity and first language may represent a promising step forward.

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# Appendix 1 Publication and presentation outputs from this work

Publication in peer reviewed journals:

**Alshamsan R**, Lee J, Netuveli G, Majeed A, Millett C. Pay for performance and ethnic disparities in diabetes care over time: interrupted time series analysis. Annals of Family Medicine. (In press 2011).

**Alshamsan R**, Majeed A, Vamos EP, Khunti K, Curcin V, Rawaf S, Millett C. Ethnic diffrences in diabetes management in patients with and without comorbid medical conditions: a cross-sectional study. Diabetes Care. 2011 Mar; 34(3): 655-7.

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**Alshamsan R**, Millett C, Majeed A, Khunti K. has pay for performance improved the management of diabetes in the UK? Primary Care Diabetes. 2010 Jul; 15(3): 178-84.

Dalton AR, **Alshamsan R**, Majeed A, Millett C. Exclusion of patients from quality measurement of diabetes care in the UK pay for performance programme. Diabetic Medicine. 2011 May; 28(5): 525-31.

Presentation in Conferences:

**Alshamsan R**; Majeed A; Curcin V; Khunti K; Millett C. Ethnic disparities in management of intermediate outcome indicators among diabetes patients with and without comorbidities. The Society for Academic Primary Care - Annual meeting, Jul 2010.

**Alshamsan R**; Majeed A; Ashworth M; Car J; Millett C. Impact of pay for performance on inequalities. The Society for Academic Primary Care - Annual meeting, Jul 2009.

# Appendix 2 Summary of systematic review studies

| A. Studies without pre-intervention data | | | | | |
|---|---|---|---|---|---|
| **First Author, Year (reference)** | **Study Design<br>Target population<br>Data level** | **Disease/indicator** | **Disparity dimension** | **Key analysis and findings** | **Study quality*** |
| Ashworth, M., 2007 (241) | Serial cross sectional study for 2004-5 & 2005-06 after QOF introduction.<br>n=8264 GP practices in England.<br>Practice level data. | Multiple indicators for 10 clinical conditions | Socioeconomic | Multivariate regression.<br><br>The first year difference in total QOF scores between most and least deprived practices was 64.5 points (95% CI = 57.6 to 71.3), in the second year this difference decreased to 30.4 (95% CI = 26.4 to 34.4).<br><br>Practices located in the highest deprivation quintile were less likely to achieve a threshold of 1040 QOF points (OR: 0.47). | 2+ |
| Ashworth, M., 2008 (242) | Serial cross sectional study for 2004-05 & 2005-06 & 2006-07 after QOF introduction.<br>n=8192 GP practices in England.<br>Practice level data. | Blood pressure monitoring & control for five chronic conditions | Socioeconomic | Multivariate analysis of differences of proportion of patient with up to date blood pressure monitoring in the least and most deprived areas.<br><br>By the third year deprivation had a weak positive effect on blood pressure monitoring (p<0.001). | 2+ |

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|---|---|---|---|---|---|
| Ashworth, M., 2006 (243) | Cross sectional survey for 2004-05 after QOF introduction.<br>n=8480 GP practices in England.<br>Practice level data. | Multiple indicators for 10 clinical conditions | Socioeconomic | Multivariate analysis of QOF scores, deprivation and various confounders.<br><br>Social deprivation was inversely related to total QOF scores (P < 0.001). | 1+ |
| Ashworth, M., 2007 (244) | Cross sectional survey for 2004-05 after QOF introduction.<br>n=8430 GP practices in England<br>Practice level data.<br>. | Statin prescribing | Age, gender, ethnicity and Socioeconomic | Multivariate analysis of statin prescribing and nine predictor variables using forward stepwise selection.<br><br>Higher volume of statin prescribing was associated with deprivation (p<0.001).<br><br>Practices with a higher proportion of patients aged >75 years prescribed less statins (p<0.001).<br><br>Practices with Proportion of patients from an Afro-Caribbean or south Asians ethnic group prescribed less statins (p<0.001). | 1+ |
| Baker, D., 2003 (245) | Serial cross sectional study from 1991 to 1999 after the 1990 GP contract.<br>n=60 District Health Authority.<br>Practice Level data. | Cervical screening | Socioeconomic | Ratio of the mean value of target achievement for the deprived group to the affluent group was calculated.<br><br>t test to test for the significance of differences between the two groups.<br>Disparity ratio decreased over the nine years from 0.46 in 1991 to 0.77 in 1999.<br><br>Mean rate of change for the affluent group was 1.27% per year and 4.04% for the deprived group (t=6.1, p<0.001). | 2+ |

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|---|---|---|---|---|---|
| Doran, T., 2006 (246) | Cross sectional survey for 2004-05 after QOF introduction.<br>n=8105 GP practices in England.<br>Practice level data. | Multiple indicators for 10 clinical conditions | Socioeconomic | Multiple linear regressions for the association of area, patient and practice with overall reported achievements.<br><br>Practices with high proportion of population living in income deprived household had lower achievements ($p<0.01$). | 1+ |
| Doran, T., 2008 (247) | Serial cross sectional study for 2004-05 & 2005-06 & 2006-07 after QOF.<br>N=7637 GP practices in England.<br>Practice level data. | 48 clinical activity indicators covering 11 chronic conditions | Socioeconomic | Logistic regression to calculate the odds of a practice from each deprivation quintile being in the top and bottom performing 5% of practices in regards to achievements.<br><br>Multiple linear regressions to analyze the association of practice level characteristics with practice achievements, exclusion of patients and changes in outcome.<br><br>The gap between deprived and affluent areas in mean achievement narrowed from 4% in the first year to 0.8% in the third year. Deprivation was no longer associated with achievements ($p=0.062$). | 2+ |
| Gulliford, M., 2007 (197) | Serial cross sectional survey for 2004-05 after QOF introduction.<br>N=8484 GP practices in England, n=26 GP practices south London<br>Practice level data. | Three intermediate outcome indicators for Diabetes | Socioeconomic | Multivariate regression to analyze the association of HbA1c target with practice and population characteristic.<br><br>Practice in located in highest deprivation tertile had lower proportion of patients achieving HbA1C target (57.1%) compared to practices located in the lowest deprivation tertile (60.2%) $p<0.001$. | 1+ |

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|---|---|---|---|---|---|
| Mclean, G., 2006 (248) | Cross sectional survey for 2004-05 after QOF introduction.<br>n=1024 GP practices in Scotland<br>Practice level data. | 33 clinical indicators for CHD, Stroke, Hypertension, Diabetes and COPD | Socioeconomic | Linear regression analysis to estimate the trend across deprivation for paid and delivered quality.<br><br>For 17 out of 33 indicators delivered quality falls with increased deprivation ($p<0.05$). | 1+ |
| Millett, C., 2007 (203) | Cross sectional survey for 2004-05 after QOF introduction.<br>n=8970 GP practices in England & Scotland<br>Practice level data. | 17 process & intermediate indicators for Diabetes | Socioeconomic | Comparison of achievement between practices in affluent and deprived areas.<br><br>In general, practices in deprived areas performed worse than practices in affluent areas. | 1+ |
| Saxena S., 2007 (249) | Cross sectional survey for 2004-05 after QOF introduction.<br>n=8970 GP practices in England & Scotland<br>Practice level data. | 26 indicators for CHD, Hypertension and Stroke | Socioeconomic | Comparison of achievement between practices in affluent and deprived areas using Kruskal–Wallis test.<br><br>Affluent practices had better achievements in some of the QOF scores ($p<0.0001$). | 1+ |
| Sigfrid, L., 2006 (250) | Cross sectional survey for 2004-05 after QOF introduction.<br>n=49 GP practices in Brighton and Hove, England.<br>Practice level data. | Exception reporting and achievement for 15 indicators for Diabetes | Socioeconomic | Spearman's correlation coefficients to calculate the correlation between exception reporting, achievements and deprivation.<br><br>Correlation between exception reporting and deprivation for 10 indicators but no correlation seen for achievements indicators ($p<0.05$). | 1+ |

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|---|---|---|---|---|---|
| Strong, M., 2006 (251) | Cross sectional survey for 2004-05 after QOF introduction.<br>n=38 GP practices in South Yorkshire, England<br>Practice level data | 11 process and outcome indicators for CHD | Socioeconomic | Spearman rank correlation coefficients for achievements against deprivation.<br><br>Only one indicator showed positive association with deprivation: recording of smoking status (r=0.34, p=0.04). | 1+ |
| Sutton, M., 2006 (252) | Cross sectional survey for 2004-05 after QOF introduction. n=60 GP practices in Scotland.<br>Practice level data. | Multiple indicators for 10 clinical conditions | Socioeconomic | Multivariate analysis using forward stepwise selection.<br><br>Deprivation was positively associated with achievements (P=0.038.). | 1+ |
| Wright, J., 2006 (253) | Cross sectional survey for 2004-05 after QOF introduction. N=8569 GP practices in England.<br>Practice level data. | Overall quality points achieved | Socioeconomic | Multivariate regression of overall QOF points in relation to deprivation.<br><br>Negative association between deprivation and achievements (p<0.001). | 1+ |
| Gray, J., 2007 (256) | Cross sectional survey for 2005-06<br>n=32 GP practices in south west London, England.<br>Patient level data | 13 process and outcome indicators for Diabetes | Ethnicity | Adjusted odds ratio and 95% CI interval were calculated for each ethnic group and compared to a reference group.<br><br>Black and south Asians were less likely to achieve all three intermediate outcomes AOR: 0.76 (95% CI 0.67–0.87) for the black group and AOR: 0.76 (95% CI 0.59–0.98) for the south Asians group. | 1+ |

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|---|---|---|---|---|---|
| Karve, A., 2008 (259) | Cross sectional survey for 2006-07 Medicare P4P n=3449 Hospitals in USA. Hospital level data. | AMI, CAP & HF/process measures | Ethnicity | Multiple logistic regression to calculate adjusted odds ratio of ranking in accordance to performance of hospitals treating >20% African American relative to hospital treating <20% African American.<br><br>Hospital with >20% African American were more likely to be ranked in the lowest quintile of performance. AOR for AMI and CAP were 1.8 (95% CI 1.4-2.4) and 2.3 (95% CI 1.8-2.9) respectively.<br><br>For HF hospitals with>20% African American were as likely as hospital with >20% African American to be ranked in the highest or lowest quintile. | 1+ |
| Jha, A., 2010 (260) | Cross sectional study for baseline year (2003) and three years after P4P in 2006-07<br>n=251 P4P hospital compared with n=3017 as control | AMI, CHF & Pneumonia/process measures | SES | Measure the association between the disproportionate-share index (a marker for caring for poor people) and change in performance while controlling for various hospital characteristics.<br><br>In the P4P group higher disproportionate-share index was associated with improved performance for AMI (0.6%, 95% CI 0.2-1.1), pneumonia (1.2%, 95% CI: 0.5-1.8), but not CHF (0.3%, 95% CI: –0.3-1.0).<br><br>In the control group higher disproportionate-share index was associated with improved performance only for pneumonia (0.3%, 95% CI: 0.1-0.5).<br><br>Interaction term was used to determine if the association between the index and change in performance varied between the two groups. It was negative and significant for AMI (-0.6, p=0.045) and pneumonia (-0.9, p=0.009) but not for CHF (-0.2, p=0.65). | 3+ |

| B. Studies with pre-intervention data | | | | | |
|---|---|---|---|---|---|
| McGovern, M., 2008 (254) | Serial cross sectional study before (March 2004) & after (March 2005).<br>n=310 GP practices in Scotland.<br>58406 patients included before QOF.<br>75495 patients included after QOF.<br>Patient level data. | 11 process and outcome indicators for CHD | Age, gender and socioeconomic | Chi-square test for the difference between groups.<br>Multiple logistic regressions to determine odds ratio and 95% CI for the achievements of quality indicators with relation to age, gender and deprivation.<br><br>Overall increase in recording of all indicators ($p<0.05$).<br><br>Post QOF, women were less likely than men to be recorded in 9 indicators. Older patient were less likely than the young to have a recording in 7 indicators and the most deprived patients were less likely to be recorded in 4 indicators. | 2+ |
| Millett, C., 2007 (198) | Longitudinal survey before (June-October 2003) & after (November 2005-January 2006).<br>n=32 GP practices in south west London, England.<br>4284 patients included before & after QOF.<br>Patient Level Data. | Recording of smoking status and smoking cessation advice for Diabetes | Age, gender, ethnicity and socioeconomic | McNemar test to test for the differences between the two measurement points.<br>Multiple logistic regression specifying for the clustering of patients within practices to analyze the association of the achievements with age, sex, ethnic background and deprivation group.<br><br>Increase of the proportion of patient offered the advice from 48% to 83.5% ($p<0.001$), the variation in the provision of smoking advice was attenuated in 2005.<br><br>Smoking prevalence decreased from 20% to 16.2% ($p<0.001$), these reductions were largely equitable between the different groups. | 2+ |

| | | | | | |
|---|---|---|---|---|---|
| Simpson, C., 2006 (255) | Serial cross sectional study before (March 2004) & after (March 2005).<br>n=310 GP practices in Scotland.<br>21901 patients included before QOF.<br>32401 patients included in after QOF.<br>Patient level data. | 10 process and outcome indicators for Stroke | Age, gender, and socioeconomic | Chi-square test for the difference between groups.<br>Multivariate logistic regressions to determine odds ratio and 95% CI for the achievements of quality indicators with relation to age, gender and deprivations.<br><br>Increases were larger for affluent and older patient. Women were less likely than men to have a smoking status recorded (AOR: 0.87; 95% CI 0.81-0.95) or receive antiplatelet or anticoagulant therapy (AOR: 0.93; 95% CI 0.86-0.99). | 2+ |
| Millett, C., 2007 (231) | Longitudinal survey before (June-October 2003) & after (November 2005-January 2006).<br>n=32 GP practices in south west London England.<br>4284 patients included before & after.<br>Patient Level Data. | 3 treatment targets for diabetes | Ethnicity | McNemar test to test for the differences between the two measurement points.<br>Multivariate logistic regressions specifying for the clustering of patients within practices to analyze the association of the achievements with ethnicity.<br><br>More patients reached the treatment target in 2005 than 2003 ($p=0.005$ for HbA1c, $p<0.001$ for blood pressure and cholesterol targets).<br><br>Black Caribbean group were less likely than the white group to reach HbA1c target (AOR: 0.75; 95% CI: 0.57-0.97) or the blood pressure target (AOR: 0.65; 95% CI 0.53-0.81). | 2+ |

| | | | | | |
|---|---|---|---|---|---|
| Millett, C., 2008 (258) | Serial cross sectional study before (June-October 2003) & after (November 2005-January 2006).<br>n=32 GP practices in south west London England.<br>2891 patients included before QOF.<br>3101 patients included after QOF.<br>Patient Level Data. | 8 process of care and intermediate outcome for CHD | Ethnicity | Multivariate logistic regressions to analyze the association of the achievements with ethnicity.<br>Improvements in blood pressure control target were better in the black group compared to the white (54.8% vs. 58.3%).<br><br>Variations in blood pressure recording between south Asians and white groups seen before the contract were attenuated after QOF (96.9% south Asians vs. 97.3% white in 2005). | 2+ |
| Millett, C., 2009 (232) | Longitudinal survey between 2000 and 2005.<br>n=16 GP practices in south west London.<br>1968 patients included | HbA1c, systolic and diastolic levels for diabetes | Ethnicity | Multilevel model were used to assess the effect of QOF. White Introduction of QOF was associated with improvement in systolic and diastolic blood pressure (-5.3 & -4.4) compared to black group (-2.3 & -1.8) but no significant reductions were evident for the south Asian group.<br><br>HbA1c levels decreased in the white group by 0.3% but no benefit were seen for the black & south Asian group. | 2+ |

| | | | | | |
|---|---|---|---|---|---|
| Hamilton, F, 2010 (257) | Longitudinal survey between 1997 and 2005. n=422 GP practices in UK. 154,945 patients included Patient Level Data | 6 process & intermediate control targets for diabetes | Age, sex, and socioeconomic | GEE models to predict post-QOF using underling trends from 1997 to 2003. t-test was used to compare actual target achievements with predicted ones.<br><br>All groups did not benefit in terms of HbA1c control.<br><br>Younger patients (18-44 years) benefited less from QOF in terms of blood pressure and cholesterol targets and existing inequalities in 1997 were not addressed specially for blood pressure control.<br><br>Females benefited more from QOF in terms of blood pressure and cholesterol but existing inequalities in 1997 were not addressed for blood pressure and cholesterol control.<br><br>Patients attending practices in deprived or affluent areas benefited similarly from QOF. | 2+ |

AMI: Acute Myocardial Infarction, AOR: Adjusted Odds Ratio, OR: Odds Ratio, CAP: Community Acquired Pneumonia, CHD: Chronic Heart Disease, CI: Confidence Interval, COPD: Chronic Obstructive Pulmonary Disease, GP: General Practitioner, HF: Heart Failure, P4P: Pay for Performance, QOF: Quality and Outcome Framework, SES: Socioeconomic status
Note: Studies were graded on a scale from 1+ (poor) to 4+ (excellent).

# Appendix 3 Analysis with expanded ethnicity

Appendix table 1: Sample characteristics in 2007 with expanded ethnicity

| Ethnicity | | Number | % | Age: Median (IQR), years | Female: % | BMI: median (IQR) | Diabetes duration: median (IQR) |
|---|---|---|---|---|---|---|---|
| White | British | 2,464 | 33.2 | 63 (50-74) | 47.1 | 29 (26-34) | 5 (2-8) |
| | Irish | 157 | 2.1 | 68 (60-75) | 42.7 | 29 (26-33) | 5 (2-8) |
| | Other | 534 | 7.2 | 63 (45-73) | 49.9 | 29 (26-33) | 4 (1-8) |
| Black | African | 649 | 8.7 | 56 (46-65) | 45.4 | 28 (25-32) | 4 (1-7) |
| | Caribbean | 1,062 | 14.3 | 68 (57-74) | 59.6 | 29 (26-33) | 6 (2-10) |
| | Other | 100 | 1.3 | 66 (51-74) | 52.7 | 29 (27-33) | 5 (2-9) |
| South Asian | Indian | 723 | 9.7 | 63 (52-71) | 46.7 | 27 (24-30) | 6 (2-10) |
| | Pakistani | 467 | 6.3 | 58 (49-68) | 44.7 | 28 (25-31) | 5 (2-9) |
| | Bangladeshi | 99 | 1.3 | 59 (49-68) | 41.4 | 26 (23-28) | 5 (1-10) |
| | Other | 364 | 4.8 | 59 (51-67) | 50.3 | 27 (24-30) | 5 (2-7) |

Appendix table 2: Inequalities in HbA1c management in 2007

| Ethnicity | | % Measured | HbA1c controlled | | OHA prescribed | | Insulin prescribed | |
|---|---|---|---|---|---|---|---|---|
| | | | % | AOR | % | AOR | % | AOR |
| White | British | 79.1 | 60.0 | 1.0 | 51.3 | 1.0 | 23.7 | 1.0 |
| | Irish | 83.4 | 71.0 | 1.54 (1.02-2.32) | 57.3 | 1.22 (0.87-1.72) | 19.1 | 0.78 (0.49-1.25) |
| | Other | 75.3 | 63.1 | 1.15 (0.91-1.45) | 56.3 | 1.31 (1.07-1.60) | 18.3 | 0.62 (0.47-0.82) |
| Black | African | 82.4 | 54.8 | 0.94 (0.76-1.17) | 62.6 | 1.58 (1.30-1.93) | 18.8 | 0.71 (0.55-0.92) |
| | Caribbean | 86.3 | 59.4 | 0.93 (0.78-1.11) | 67.6 | 1.83 (1.55-2.16) | 20.8 | 0.87 (0.71-1.07) |
| | Other | 79.1 | 52.8 | 0.78 (0.47-1.29) | 71.4 | 2.25 (1.38-3.65) | 24.2 | 1.05 (0.61-1.83) |
| South Asian | Indian | 82.6 | 55.3 | 0.88 (0.71-1.09) | 69.6 | 2.31 (1.89-2.83) | 14.7 | 0.43 (0.33-0.57) |
| | Pakistani | 81.2 | 49.1 | 0.76 (0.59-0.97) | 68.1 | 2.36 (1.87-3.00) | 18.4 | 0.64 (0.48-0.87) |
| | Bangladeshi | 87.9 | 65.5 | 1.66 (1.02-2.70) | 64.6 | 1.88 (1.20-2.94) | 16.2 | 0.47 (0.25-0.87) |
| | Other | 82.0 | 56.0 | 0.92 (0.70-1.21) | 65.7 | 1.90 (1.47-2.46) | 17.2 | 0.67 (0.48-0.94) |

AOR; adjusted odss ratio; adjusted for age, gender, diabetes duration, BMI, comorbidity, and practice level deprivation
OHA; oral hypoglycemic agents
Controlled: HbA1c levels ≤7.5%

Appendix table 3: Inequalities in Cholesterol management in 2007

| Ethnicity | | % Measured | Cholesterol controlled | | Lipid lowering prescribed | |
|---|---|---|---|---|---|---|
| | | | % | AOR | % | AOR |
| White | British | 79.2 | 80.9 | 1.0 | 69.4 | 1.0 |
| | Irish | 83.4 | 87.0 | 1.40 (0.82-2.38) | 79.6 | 1.16 (0.75-1.79) |
| | Other | 75.9 | 81.7 | 1.04 (0.79-1.38) | 64.7 | 0.94 (0.74-1.19) |
| Black | African | 83.8 | 81.1 | 1.23 (0.95-1.60) | 63.8 | 0.93 (0.74-1.16) |
| | Caribbean | 85.7 | 82.6 | 1.12 (0.90-1.39) | 68.4 | 0.76 (0.64-0.92) |
| | Other | 79.1 | 83.3 | 1.50 (0.75-2.98) | 73.6 | 1.41 (0.81-2.44) |
| South Asian | Indian | 85.5 | 84.5 | 1.36 (1.04-1.79) | 71.1 | 0.92 (0.74-1.16) |
| | Pakistani | 82.0 | 85.6 | 1.61 (1.02-1.52) | 70.2 | 1.14 (0.87-1.49) |
| | Bangladeshi | 86.9 | 89.5 | 2.10 (1.02-4.28) | 80.8 | 2.09 (1.15-3.77) |
| | Other | 85.5 | 81.0 | 1.09 (0.78-1.52) | 73.3 | 1.20 (0.89-1.62) |

AOR; adjusted odss ratio; adjusted for age, gender, diabetes duration, BMI, comorbidity, and practice level deprivation
Controlled: Cholesterol ≤5.0 mmol/l

Appendix table 4: Inequalities in blood pressure management in 2007

| Ethnicity | | % Measured | Blood pressure controlled | | >=2 antihypertensive prescribed | |
|---|---|---|---|---|---|---|
| | | | % | AOR | % | AOR |
| White | British | 91.8 | 75.3 | 1.0 | 45.4 | 1.0 |
| | Irish | 92.4 | 73.8 | 0.82 (0.55-1.22) | 49.7 | 1.22 (0.87-1.72) |
| | Other | 87.6 | 78.1 | 1.10 (0.86-1.41) | 42 | 1.31 (1.07-1.60) |
| Black | African | 90.6 | 69.4 | 0.69 (0.55-0.78) | 42.7 | 1.58 (1.30-1.93) |
| | Caribbean | 94.2 | 72.9 | 0.85 (0.70-1.02) | 58.8 | 1.83 (1.55-2.16) |
| | Other | 85.7 | 70.5 | 0.78 (0.46-1.32) | 52.7 | 2.25 (1.38-3.65) |
| South Asian | Indian | 91.3 | 76.8 | 1.04 (0.82-1.32) | 48.1 | 2.31 (1.89-2.83) |
| | Pakistani | 87.2 | 76.9 | 1.10 (0.83-1.45) | 38.8 | 2.36 (1.87-3.00) |
| | Bangladeshi | 91.9 | 89 | 2.02 (1.02-3.99) | 41.4 | 1.88 (1.20-2.94) |
| | Other | 90.7 | 79.2 | 1.1 (0.85-1.60) | 43.3 | 1.90 (1.47-2.46) |

AOR; adjusted odss ratio; adjusted for age, gender, diabetes duration, BMI, comorbidity, and practice level deprivation
Controlled: blood pressure levels ≤145/85 mm Hg

## Appendix 4 Sensitivity analysis

The dataset consists of the historical records (2000-2007) of patients registered with practices in 2007. Some patients might not have complete records throughout each year and I did not capture information on patients with diabetes conditions registered with practices during the study period who moved away or died before 2007. If there were systematic differences between the type of individuals who have complete records and those who do not, analysis would suffer and inferences about the effect of the policy may be inaccurate.

For example, HbA1c missing values ranged from 56% to 19%, cholesterol ranged from 59% to 18%, systolic and diastolic blood pressure ranged from 42% to 9.1% for 2000 and 2007, respectively.

To test if these missing values had any effect on my estimates I used Heckman sample selection model. The Heckman selection model consists of two parts. The first is the outcome equation $y_{ijt} = X_{ijt} B + u_{ijt1}$. The second is a selection equation is used to predict whether or not somebody responds $Z_{ijt} = W_{ijt} r + u_{ijt2}$. The dependent variable is observed if $Z>0$. Where $y$ are the outcome measure, $X$ are the covariates in the outcome equation, $W$ are the covariates in the selection equation. In these equations, rho (ρ) is the correlation between two error terms, i.e. corr($u_{ijt1}$, $u_{ijt2}$)=ρ. I did not use any exclusion restriction to estimate the model; therefore the same regressors were used in both equations.

I used the Likelihood-ratio (LR) test as a test of $H_0$: ρ = 0. Under the $H_0$ there is no selection problem. Selection bias would not be a problem if the estimated

correlation coefficient, rho (ρ), is not statistically significant and LR test does not reject independence of the two error terms.

My findings from the Heckman model indicate that attrition bias was not an issue except for systolic and diastolic blood pressure. However, the magnitudes of the coefficient are still consistent with the original findings.

Appendix table 5: Results of the sensitivity analysis

| | Systolic | | Diastolic | |
|---|---|---|---|---|
| | Heckman Coefficient | Selection Coefficient | Heckman Coefficient | Selection Coefficient |
| Baseline trend | -0.320 | 0.208** | -1.044** | 0.208** |
| Level change | -2.133** | 0.192** | -0.640** | 0.192** |
| Trend change | -0.838** | -0.0493** | 0.331* | -0.0503** |
| rho (standard error) | | -0.220 (0.033) | | -0.261 (0.036) |
| P value for LR test | | 0.001 | | 0.001 |

*Indicates significance at the 5% level and ** at the 1% level

The change in patient mix might introduce bias in my estimates (i.e more patients were included in later years compared to earlier years). To assess if this is introduces bias I repeated the analysis on patients who were followed in all years (i.e same patient in every year). The results are similar to my initial findings and my conclusion is the same (Appendix table 6).

Appendix table 6: Interrupted time series analysis on patients with a measurement in every year

| | Hba1c, % (n= 1775) | Systolic BP, mm Hg (n=1950) | Systolic BP, mm Hg (n=1950) | Cholesterol, mmol/l (n=1600) |
|---|---|---|---|---|
| Pre-QOF | -0.17 (-0.20, -0.14) | -0.16 (-0.47, 0.14) | -1.0 (-1.2, -0.87) | -0.16 (-0.18, -0.13) |
| QOF introduction | 0.11 (0.01, 0.22) | -1.6 (-2.8, -5.1) | -0.42 (-1.1, 0.23) | -0.14 (-0.22, -0.07) |
| Post-QOF | 0.16 (0.11, 0.20) | -1.3 (-1.6, -0.62) | 0.83 (-0.20, 0.37) | 0.06 (0.02, 0.09) |

# Appendix 5 Model output unadjusted

For the intermediate indicators, I repeated the analysis without any adjustment. The findings were similar. For example, the impact of QOF on HbA1c was 0.04 (-0.04, 0.12) for the adjusted model and 0.05 (-0.02, 0.13) for the unadjusted model. One exception to this was the impact of QOF on diastolic blood pressure, which was -0.51 (-1.05, 0.01) in the adjusted model compared to -0.63 (-1.14, -1.11) in the unadjusted model. However, the result for each of the ethnic groups was similar in the adjusted & unadjusted model.

Appendix table 7: results of the unadjusted interrupted time series for HbA1c

| | HbA1c, % (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | -0.18 (-0.21, -0.15)** | -0.18 (-0.21, -0.14)** | -0.18 (-0.24, -0.12)** | -0.18 (-0.23, -0.12)** |
| QOF | 0.05 (-0.02, 0.13) | 0.07 (-0.04, 0.18) | -0.11 (-0.28, 0.06) | 0.17 (0.01, 0.34)* |
| Post-QOF | 0.19 (0.15, 0.23)** | 0.21 (0.16, 0.26)** | 0.21 (0.14, 0.29)** | 0.11 (0.04, 0.19)** |

*p<0.05, **p<0.01

Appendix table 7: results of the unadjusted interrupted time series for Cholesterol

| | Cholesterol, mmol/l (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | -0.14 (-0.15, -0.11)** | -0.16 (-0.17, -0.12)** | -0.12 (-0.15, -0.09)** | -0.14 (-0.18, -0.10)** |
| QOF | -0.11 (-0.17, -0.06)** | -0.14 (-0.22, -0.05)** | -0.11 (-0.21, -0.01)* | -0.08 (-0.20, 0.04) |
| Post-QOF | 0.03 (0.01, 0.06)* | 0.05 (0.01, 0.08)* | 0.04 (-0.01, 0.08) | 0.02 (-0.03, 0.08) |

*p<0.05, **p<0.01

Appendix table 8: results of the unadjusted interrupted time series for Systolic blood pressure

| | Systolic blood pressure, mm Hg (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | -0.09 (-0.36, 0.18) | -0.56 (-1.08, -1.30)* | 0.23 (-0.28, 0.74) | 0.28 (-0.30, 0.90) |
| QOF | -1.90 (-2.80, -1.10)** | -2.15 (-3.51, -0.78)** | -2.44 (-4.15, -0.73)** | -1.09 (-3.00, 0.80) |
| Post-QOF | -1.16 (-1.55, -0.78)** | -0.40 (-0.99, 0.18) | -1.75 (-2.48, -1.02)** | -1.83 (-2.64, -1.01)** |

*p<0.05, **p<0.01

Appendix table 9: results of the unadjusted interrupted time series for Diastolic blood pressure

| | Diastolic blood pressure, mm Hg (95% CI) | | | |
|---|---|---|---|---|
| | ALL | White | Black | South Asian |
| Pre-QOF | -0.93 (-1.08, -0.77)** | -0.79 (-1.03, -0.55)** | -0.97 (-1.27, -0.67)** | -1.21 (-1.55, -0.86)** |
| QOF | -0.63 (-1.14, -1.11)* | -1.07 (-1.85, -0.30)** | -0.36 (-1.35, 0.63) | 0.16 (-0.94, 1.27) |
| Post-QOF | 0.27 (0.05, 0.49)* | 0.19 (-0.14, 0.52) | 0.15 (-0.27, 0.57) | 0.46 (-0.06, 0.94) |

*p<0.05, **p<0.01

# Appendix 6 Coefficients of adjustment variables for key intermediate variables

Appendix table 10: Result for HbA1c and cholesterol

| | HbA1c, % | | | | Cholesterol, mmol/l | | | |
|---|---|---|---|---|---|---|---|---|
| | ALL | White | Black | South Asian | ALL | White | Black | South Asian |
| Baseline trend | -0.210*** | -0.209*** | -0.214*** | -0.209*** | -0.133*** | -0.151*** | -0.115*** | -0.132*** |
| Level change after QOF | 0.0421 | 0.0716 | -0.124 | 0.185** | -0.122*** | -0.135*** | -0.105** | -0.0794 |
| Trend change after QOF | 0.191*** | 0.213*** | 0.218*** | 0.115*** | 0.0317** | 0.0459** | 0.0342 | 0.0170 |
| Female | -0.0654 | -0.0555 | -0.0400 | -0.113 | 0.269*** | 0.349*** | 0.201*** | 0.200*** |
| Age | -0.0194*** | -0.0183*** | -0.0211*** | -0.0217*** | -0.010*** | -0.010*** | -0.00199 | -0.010*** |
| Duration of illness | 0.0301*** | 0.0308*** | 0.0344*** | 0.0279*** | -0.0116*** | -0.011*** | -0.013*** | -0.0170*** |
| IMD Quintile 2 | 0.125 | 0.182 | 0.0695 | -0.0277 | 0.0396 | 0.0415 | 0.0628 | -0.0829 |
| IMD Quintile 3 | 0.172 | 0.314*** | 0.110 | -0.137 | 0.0884 | 0.0626 | 0.144** | 0.0209 |
| IMD Quintile 4 | 0.0430 | 0.120 | -0.131 | 0.00326 | 0.0488 | 0.0410 | -0.0200 | 0.0313 |
| IMD Quintile 5 | 0.000125 | -0.00685 | -0.188 | 0.374*** | 0.0134 | 0.0904 | -0.0942 | -0.0119 |
| One co-morbidity | -0.144*** | -0.0127 | -0.414*** | -0.0551 | -0.139*** | -0.121*** | -0.0825 | -0.229*** |
| Two co-morbidities or more | -0.184*** | -0.0491 | -0.511*** | -0.117 | -0.205*** | -0.209*** | -0.186*** | -0.209*** |
| Black | 0.289*** | | | | -0.0934*** | | | |
| Others | 0.119 | | | | -0.187 | | | |
| South Asian | 0.241*** | | | | -0.205*** | | | |
| Unknown | -0.516 | | | | 0.145 | | | |
| Constant | 9.654*** | 9.356*** | 10.45*** | 10.08*** | 5.972*** | 6.079*** | 5.512*** | 6.025*** |

**indicates significance at the 5% level, *** at the 1% level

Appendix table 11: Result for HbA1c measured/ HbA1c controlled

| | HbA1c Measured, AOR | | | | HbA1c Controlled, AOR | | | |
|---|---|---|---|---|---|---|---|---|
| | ALL | White | Black | South Asian | ALL | White | Black | South Asian |
| Baseline trend | 1.895*** | 1.775*** | 1.882*** | 1.952*** | 1.404*** | 1.524*** | 1.295*** | 1.325*** |
| Level change after QOF | 1.429*** | 1.478*** | 1.861*** | 1.865*** | 1.035 | 0.911 | 1.232 | 1.034 |
| Trend change after QOF | 0.724*** | 0.657*** | 0.643*** | 0.643*** | 0.767*** | 0.658*** | 0.836** | 0.927 |
| Female | 0.885** | 0.594*** | 1.113 | 0.894 | 1.151** | 1.234** | 1.097 | 1.087 |
| Age | 1.047*** | 1.054*** | 1.044*** | 1.019*** | 1.041*** | 1.042*** | 1.036*** | 1.047*** |
| Duration of illness | 0.990** | 1.006 | 0.992 | 0.987* | 0.919*** | 0.915*** | 0.923*** | 0.921*** |
| IMD Quintile 2 | 1.179 | 1.048 | 1.370 | 1.268 | 0.871 | 0.855 | 0.875 | 1.113 |
| IMD Quintile 3 | 1.230 | 1.172 | 1.360 | 0.945 | 0.754 | 0.545*** | 0.889 | 1.371 |
| IMD Quintile 4 | 1.042 | 1.104 | 1.037 | 0.994 | 0.881 | 0.881 | 1.073 | 0.754 |
| IMD Quintile 5 | 1.991* | 1.699* | 2.304** | 2.090* | 1.005 | 1.055 | 1.290 | 0.557*** |
| One co-morbidity | 1.629*** | 1.610*** | 1.668*** | 1.977*** | 1.172* | 1.105 | 1.516*** | 0.992 |
| Two co-morbidities or more | 1.616*** | 1.605*** | 1.767*** | 1.960*** | 1.279** | 1.086 | 1.992*** | 1.123 |
| Black | 1.359*** | | | | 0.737*** | | | |
| Others | 1.470 | | | | 0.794 | | | |
| South Asian | 1.012 | | | | 0.648*** | | | |
| Unknown | 0.190* | | | | 1.452 | | | |

**indicates significance at the 5% level, *** at the 1% level

Appendix table 12: Result for cholesterol measured/ cholesterol controlled

| | Cholesterol Measured, AOR | | | | Cholesterol Controlled, AOR | | | |
|---|---|---|---|---|---|---|---|---|
| | ALL | White | Black | South Asian | ALL | White | Black | South Asian |
| Baseline trend | 1.874*** | 1.958*** | 1.770*** | 1.838*** | 1.413*** | 1.461*** | 1.435*** | 1.332*** |
| Level change after QOF | 1.676*** | 1.150 | 2.094*** | 2.453*** | 1.449*** | 1.686*** | 1.252 | 1.148 |
| Trend change after QOF | 0.659*** | 0.605*** | 0.685*** | 0.732*** | 0.957 | 0.925 | 0.866* | 1.109 |
| Female | 0.762*** | 0.609*** | 1.032 | 0.782** | 0.520*** | 0.422*** | 0.588*** | 0.662*** |
| Age | 1.047*** | 1.056*** | 1.039*** | 1.024*** | 1.016*** | 1.018*** | 1.007 | 1.021*** |
| Duration of illness | 0.982*** | 0.988*** | 0.977*** | 0.978*** | 1.034*** | 1.029*** | 1.043*** | 1.048*** |
| IMD Quintile 2 | 1.390 | 1.315 | 1.557 | 1.587 | 0.854 | 0.806 | 0.812 | 1.112 |
| IMD Quintile 3 | 1.295 | 1.167 | 1.389 | 1.014 | 0.768* | 0.795 | 0.676 | 0.906 |
| IMD Quintile 4 | 1.114 | 1.062 | 1.000 | 0.899 | 0.798 | 0.830 | 1.033 | 0.651** |
| IMD Quintile 5 | 2.147** | 1.929** | 2.322** | 1.988* | 1.029 | 0.905 | 1.276 | 1.048 |
| One co-morbidity | 1.729*** | 1.574*** | 1.822*** | 1.998*** | 1.442*** | 1.307** | 1.266 | 1.944*** |
| Two co-morbidities or more | 1.921*** | 1.746*** | 2.158*** | 2.171*** | 1.949*** | 2.053*** | 1.655*** | 1.988*** |
| Black | 1.357*** | | | | 1.332*** | | | |
| Others | 1.466 | | | | 1.523 | | | |
| South Asian | 1.167** | | | | 1.556*** | | | |
| Unknown | 0.339 | | | | 0.755 | | | |

**indicates significance at 5% level, *** at the 1% level

Appendix table 13: Result for systolic and diastolic blood pressure

| | Systolic, mm Hg | | | | Diastolic, mm Hg | | | |
|---|---|---|---|---|---|---|---|---|
| | ALL | White | Black | South Asian | ALL | White | Black | South Asian |
| Baseline trend | -0.0315 | -0.509** | 0.316 | 0.429 | -0.843*** | -0.692*** | -0.847*** | -1.067*** |
| Level change after QOF | -1.950*** | -2.127*** | -2.325*** | -1.081 | -0.519* | -1.017** | -0.334 | 0.201 |
| Trend change after QOF | -1.040*** | -0.215 | -1.686*** | -1.792*** | 0.190 | 0.102 | 0.124 | 0.402 |
| Female | -0.794*** | -1.530*** | -0.812 | 0.503 | -0.741*** | -1.542*** | 0.135 | -0.460 |
| Age | 0.280*** | 0.266*** | 0.295*** | 0.323*** | -0.128*** | -0.115*** | -0.137*** | -0.145*** |
| Duration of illness | -0.00886 | -0.0237 | 0.0168 | -0.0529 | -0.178*** | -0.162*** | -0.208*** | -0.194*** |
| IMD Quintile 2 | -1.862 | -2.538 | -4.060*** | -2.004 | -1.531 | -1.780 | -2.016** | -1.423 |
| IMD Quintile 3 | -0.622 | -0.578 | -2.931*** | -0.368 | 0.155 | 0.102 | -0.122 | -0.173 |
| IMD Quintile 4 | -2.656** | -2.291 | -4.834*** | -2.668 | -1.365 | -1.559 | -1.475* | -1.291 |
| IMD Quintile 5 | -1.913 | -1.671 | -4.419*** | -2.351 | -1.178 | -1.352 | -1.421 | -1.192 |
| One co-morbidity | 5.251*** | 4.351*** | 6.435*** | 5.405*** | 2.440*** | 1.875*** | 3.378*** | 2.426*** |
| Two co-morbidities or more | 4.587*** | 3.476*** | 6.117*** | 4.807*** | 1.521*** | 0.776** | 3.296*** | 1.167** |
| Black | 2.585*** | | | | 1.858*** | | | |
| Others | -1.801 | | | | 0.695 | | | |
| South Asian | -1.460*** | | | | -0.324 | | | |
| Unknown | 2.923 | | | | 3.648 | | | |
| Constant | 118.7*** | 122.4*** | 120.2*** | 112.3*** | 91.16*** | 90.94*** | 92.59*** | 92.52*** |

**indicates significance at 5% level, ***at 1% level

Appendix table 14: Result for blood pressure measured/ blood pressure controlled

| | Blood Pressure Measured, AOR | | | | Blood pressure Controlled, AOR | | | |
|---|---|---|---|---|---|---|---|---|
| | ALL | White | Black | South Asian | ALL | White | Black | South Asian |
| Baseline trend | 1.720*** | 1.844*** | 1.664*** | 1.584*** | 1.044* | 1.133*** | 1.013 | 0.921 |
| Level change after QOF | 1.707*** | 1.207 | 2.160*** | 2.624*** | 1.392*** | 1.358** | 1.251 | 1.665*** |
| Trend change after QOF | 0.871*** | 0.857** | 0.815** | 0.908 | 1.170*** | 1.023 | 1.322*** | 1.291*** |
| Female | 1.019 | 0.908 | 1.259* | 1.014 | 1.037 | 1.088 | 1.093 | 0.884 |
| Age | 1.047*** | 1.055*** | 1.040*** | 1.030*** | 0.966*** | 0.968*** | 0.965*** | 0.965*** |
| Duration of illness | 0.974*** | 0.982*** | 0.970*** | 0.969*** | 0.999 | 1.005 | 0.992 | 1.002 |
| IMD Quintile 2 | 1.010 | 0.975 | 0.972 | 1.474 | 1.388 | 1.360 | 2.136*** | 1.439 |
| IMD Quintile 3 | 1.305 | 1.309 | 1.106 | 0.989 | 1.046 | 1.090 | 1.342** | 0.991 |
| IMD Quintile 4 | 0.961 | 0.954 | 0.609 | 1.007 | 1.324 | 1.314 | 1.726*** | 1.384 |
| IMD Quintile 5 | 1.359 | 1.378 | 0.945 | 1.489 | 1.309 | 1.175 | 1.961*** | 1.335 |
| One co-morbidity | 2.514*** | 2.346*** | 3.210*** | 2.141*** | 0.431*** | 0.521*** | 0.385*** | 0.359*** |
| Two co-morbidities or more | 3.063*** | 2.850*** | 3.698*** | 2.915*** | 0.444*** | 0.534*** | 0.393*** | 0.382*** |
| Black | 1.297*** | | | | 0.720*** | | | |
| Others | 0.726 | | | | 1.339 | | | |
| South Asian | 0.888 | | | | 1.169** | | | |
| Unknown | 0.387 | | | | 1.176 | | | |

**indicates significance at the 5% level, *** at the 1% level