Tom Hennell
Sacha Wyke
Diane Black
Andrea Hutchinson
Karen Tocque
Mark A Bellis

# Forecasting the BURDEN OF DIABETES

## on secondary care within Aintree Hospitals NHS Trust

**The Department of Health**
Government Office North West
City Tower
Piccadilly Plaza
Manchester
M1 4BE

**North West Public Health Observatory**
Centre for Public Health
Faculty of Health and Applied Social Sciences
Liverpool John Moores University
Liverpool
L3 2AY

Department of Health

NorthWest Public Health Observatory

Aintree Hospitals NHS
NHS Trust

Knowsley NHS
Primary Care Trust

North Liverpool NHS
Primary Care Trust

Southport and Formby NHS
Primary Care Trust

South Sefton NHS
Primary Care Trust

ISBN 1-902051-72-6

# Forecasting The Burden Of Diabetes On Secondary Care Within Aintree Hospitals NHS Trust

**Tom Hennell[a], Sacha Wyke[b], Diane Black[c], Andrea Hutchinson[c], Karen Tocque[b,c], Mark A Bellis[b,c]**

[a] Government Office North West, City Tower, Piccadilly Plaza, Manchester, M1 4BE
[b] North West Public Health Observatory, Faculty of Health and Applied Social Sciences, Liverpool John Moores University, Liverpool, L3 2AY
[c] Centre for Public Health, Faculty of Health and Applied Social Sciences, Liverpool John Moores University, Liverpool, L3 2AY

## Executive Summary

**Key Points**

- Diabetes is already a major treatment issue and an increasing public health concern for Aintree Hospitals NHS Trust, which provides acute health care for around 330,000 people living in Liverpool, Sefton, St Helens and Knowsley Local Authorities.
- Based on projected changes in population size and age structure, this study predicted that by 2011 Aintree Hospitals NHS Trust could expect up to 983 additional diabetes cases (over the 2052 seen in 2001), consistent with a rise in obesity and other risk factors.
- Thus a 1% increase in obesity is related to a 1.5% increase in the hospitalised prevalence of diabetes. Although factors other than obesity are playing a significant role in the predicted rise in diabetes cases, it is not currently possible to identify the exact nature of these additional factors. However, the time lag between the onset of obesity and related chronic disease is likely to be an important incalculable factor.
- Given high re-admission rates in Merseyside, and in the worst-case scenario of increasing obesity and increasing other factors, between 2001 and 2011 Aintree Hospitals NHS Trust could expect up to 46.6% higher actual hospital episodes due to diabetes.
- Treatment services in Primary Care and in Hospital Trusts have already expanded to meet current demand. However, tackling both currently undiagnosed existing cases and new cases as predicted by this study will require further massive increases in capacity, unless the underlying causes of diabetes are immediately addressed.

### Background

Aintree Hospitals NHS Trust provides acute health care for a population of 330,000 living in Liverpool, Sefton, St Helens and Knowsley Local Authorities. In order to design and improve future health services for the Aintree catchment population, local public health priorities must be taken into account. Diabetes and the future demands on diabetes related services have been recognised as key public health priorities by the Trust. In response to this, Aintree Hospitals NHS Trust along with South Sefton, North Liverpool and Knowsley PCTs commissioned a research project to establish the current and future hospitalised prevalence of diabetes[1] within the Trust's catchment area to predict the future burden on services. This project placed particular emphasis on the prevalence of obesity as a risk factor for type 2 diabetes.

[1] The hospitalised prevalence of diabetes is the annual number of admissions with a primary diagnosis of diabetes expressed as both a crude rate per 100,000 of the population and as an age-standardised ratio, i.e. the ratio between the observed count of individuals with diabetes and the number expected on the basis of the age structure of the locality population compared with the regional average prevalence.

## Methods

Multiple factors related to local variations in the hospitalised prevalence of diabetes were used to construct a predictive mathematical model. This model was used to estimate future measures of hospitalised prevalence of diabetes, associated with changes in age structure, population obesity and other variable parameters. The following procedure was adopted:

1. The catchment population was identified for adult diabetes services at Aintree Hospital
2. Population size and age structure were projected to 2006 and 2011
3. Measures of diabetes and risk factors in the catchment population were identified
4. An explanatory model was developed for ward-level variations in the hospitalised prevalence of diabetes 1998-2002
5. The explanatory model was applied to the projected ward population in the Aintree Hospitals catchment area
6. Multiple scenarios were used to calculate the potential future burden from diabetes on secondary care.

## Modelling

For all selected wards across the Local Authority areas a two-stage model was developed that used population measures to explain local variations in hospitalised diabetes prevalence. First, the estimated hospitalised prevalence of diabetes was age-adjusted, to generate a standardised illness ratio specific to diabetes and this was used as the dependent variable. Second, a multiple linear regression analysis was undertaken to develop a robust predictive model. This model explained 82% of the variation in diabetes in the selected ward areas and included measures of deprivation, ethnicity and obesity. The model was then used to predict a future trend in diabetes. However, applying the model to regional and local populations could only explain around 50% of the annual observed increase in diabetes of 3% per year (i.e. 1.5% per year). The cause of the remaining increase was unknown. Predicted trends in hospitalised diabetes prevalence were therefore generated with various possible changes in obesity combined with various possible changes in the other unknown factors.

## Trend Projections

Based on projected changes in population size and age structure, this analysis predicted a consistent proportional rise in the hospitalised prevalence of diabetes for the Trust catchment area relative to a rise in obesity and the other factors. If levels of obesity continue to rise within the catchment area at 1% per year, Aintree Hospital can expect a proportional rise in the hospitalised prevalence of diabetes from 10.8% through 22.4% to 35% by 2011 based on low, medium and high increases in the other unknown factors. By 2011, these scenarios suggest that between 438 and 983 extra cases of diabetes will be seen by Aintree Trust by 2011 on top of the 2052 cases seen in 2001. However, if trends in reduced exercise and poor eating habits worsen significantly, these figures are likely to be higher.

By taking higher than average re-admission rates into account, this study was also able to predict the notional hospital episodes that might impinge on relevant services. If obesity increases at 1% per year, Aintree Hospitals NHS Trust can expect between 20.3% and 46.6% rise in the number of hospital episodes due to diabetes depending on the level of the other factors. All the predictions in this study were calculated with local information available at the time and should be treated with caution. However, due to various methodological constraints, the predictions almost certainly underestimate the true prevalence of future diabetes in the hospital catchment population.

# CONTENTS

**List of figures**



**List of tables**



**List of maps**



**List of boxes**

# Forecasting The Burden Of Diabetes On Secondary Care Within Aintree Hospitals NHS Trust

## 1. Introduction

Aintree Hospitals NHS Trust provides acute health care for a population of 330,000 living in Liverpool, Sefton, St Helens and Knowsley Local Authorities (Commission for Health Improvement, 2001). In order to design and improve future health services for the Aintree catchment population, local public health priorities must be taken into account. Diabetes and the future demands on diabetes related services were recognised as key public health priorities by the Trust.

In response to this, Aintree Hospitals NHS Trust along with South Sefton, North Liverpool and Knowsley Primary Care Trusts (PCTs) commissioned a research project to establish the current and future hospitalised prevalence of diabetes within the Trust's catchment area to predict the future burden on services. This project placed particular emphasis on the prevalence of obesity as a risk factor for type 2 diabetes.

### 1.1 What is diabetes?

Diabetes mellitus is a chronic progressive medical condition in which the levels of glucose in the blood are too high. These elevated glucose levels are due to the failure of the pancreas to produce enough of the hormone insulin (which controls the levels of glucose) or the inability of the body to make use of the insulin available. (WHO, 2002a).

There are two main types of diabetes:

Type 1 diabetes also known as insulin dependent diabetes develops if the pancreas is unable to produce insulin. This type of diabetes usually develops before the age of 40 and is commonly treated by insulin injections and a controlled diet.

Type 2 diabetes frequently referred to as non-insulin dependant diabetes develops when the body cannot generate enough insulin or if the body cannot use the insulin generated efficiently. This condition is commonly treated by diet and exercise alone or by diet, exercise and tablets/insulin injections (Diabetes UK, 2004). The life expectancy of individuals with type 2 diabetes may be reduced by up to 15 years, with individuals largely dying due to macro vascular complications including heart disease, stroke and amputations (Davies et al., 2004).

### 1.2 Why is it a problem?

An epidemic of diabetes is occurring as a consequence of numerous factors including an ageing population, changes in demographic composition and the excesses of contemporary lifestyle in particular relating to obesity (Mensah et al., 2004). Current projections estimate that the number of cases of diabetes worldwide may double over the next 20 years (King et al., 1998). The global prevalence of diabetes for all age groups was estimated to be 2.8% in 2000 and predicted to be 4.4% in 2030. In general the prevalence of diabetes is higher in men than women, although there are more women with diabetes (Wild et al., 2004).

The prevalence of type I diabetes in the UK has been estimated from population studies to be between 0.2% and 0.3% of the population (Evans et al., 2000) and the prevalence of diagnosed type 2 diabetes is approximately 2-3% in the general adult population (Stevens & Raftery, 1994). There are currently 1.8 million diagnosed diabetics in the UK with an estimated further one million who have the condition but are unaware of it (Diabetes UK, 2005).

Type 2 diabetes has seen the greatest increase in recent years and is largely driven by lifestyle factors including changes in dietary patterns and habits, declining levels of physical activity and increasing sedentary behaviours (Hale, 2004 and Schulze & Hu, 2004). A study by Hu et al in 2001 concluded that the majority of cases of type 2 diabetes could be prevented by the adoption of a healthier lifestyle. Maintaining a healthy body weight by regular physical activity with a healthy diet, avoidance of behaviours such as a sedentary lifestyles or smoking and moderate alcohol consumption could nearly eliminate type 2 diabetes (Schulze & Hu, 2004 and Van Dam, 2003). This makes type 2 diabetes in particular an issue capable of being addressed through assorted public health interventions. Overall, local estimates for North Liverpool suggest that for every diagnosed diabetic who is recorded in primary/secondary care there is at least one more who is not (Gill et al., 2003).

## 1.3 Risk factors

The major risk factors associated with development of type 2 diabetes include:

**1.3.1 Age**- The risk of developing type 2 diabetes increases with age. The majority of people in developed countries with diabetes are in the age range 45-64 (Kesavadev et al., 2003) with one in twenty people over the age of 65 in the UK diagnosed as diabetic (Joint Health Survey Unit, 1999). The key factor in the causation of diabetes in the elderly is the accumulation of fat in the abdomen as a result of changes in body composition (Kesavadev et al., 2003).

**1.3.2 Ethnicity**- The effect of lifestyle factors on obesity and diabetes has been shown to be particularly prevalent within ethnic groups (Abate & Chandalia, 2003). People from black and ethnic minority communities are six times more likely to develop the disease (DH, 2005). Local ethnic profiling completed in Liverpool (Lee et al., 2000) found that people from ethnic groups (aged 40 years and over) were more likely to self report diabetes compared to white British in the same age group, suggesting a greater prevalence of diabetes within ethnic groups.

A genetic predisposition in some ethnic minorities (Mohan, 2004) along with the trappings of western life (i.e. change in dietary habits, environment and lifestyle) makes black and ethnic minority groups more vulnerable to the development of diabetes (Lee et al., 1998) with the disease's onset estimated to occur five to ten years earlier in this group than in the general population (Thorp, 2005).

Asians, Hispanics and Asian-Indians living in the US appear to have a very high risk for the development of type 2 diabetes that is accelerated by adoption of the US lifestyle and by the process of acculturation (Abate & Chandalia 2003). Asian American's diet in America is higher in calories and fat and lower in fibre than in their countries of origin leading to the onset of obesity and diabetes. Another suggested factor is stress. Belonging to a minority group has been associated with increased levels of stress (Abate & Chandalia, 2003) and the risk of developing type 2 diabetes has been associated with stress (Mooy et al., 2000).

**1.3.3 Deprivation-** The prevalence of type 2 diabetes has been strongly correlated with deprivation (Ismail et al., 1999 and Evans et al., 2000). Risk factors for diabetes have shown a link with socio-economic status (Connolly & Kelly, 1995). Prevalence has been shown to increase with decreasing income and educational attainment in both male and females (Tang et al., 2003). There is an inverse relationship between social position and the incidence of diabetes (Kumari et al., 2004). A strong correlation between prevalence of type 2 diabetes and social deprivation has also been shown in Liverpool (Ismail et al., 1999). This relationship is of most significance for individuals from areas of low socio-economic status between the ages of 40-69 years. Possible explanations have included earlier exposure to lifestyle and environmental risk factors for type 2 diabetes (Connolly et al., 2000).

**1.3.4 Smoking**- Smoking is associated with increased risk of type 2 diabetes among both middle-aged and elderly men and women (Sairenchi et al., 2004). A dose-response relationship between cigarettes smoked per day and the incidence of diabetes mellitus has been found for both men and women (Will et al., 2001).

**1.3.5 Weight and obesity**- Obesity is one of the primary risk factors for the development of type 2 diabetes; diagnosis increased linearly with the duration of obesity. Obesity leads to increased insulin resistance along with defective insulin release (Pontiroli, 2004). An increase in body weight of approximately 1 kg can increase the risk for diabetes by 4.5% (Mobley, 2004). The past 40 years have seen dramatic increases in the prevalence of type 2 diabetes and obesity (Gottesman, 2004) with one in five adults in the UK now classified as obese (Diabetes UK, 2005), leading to an even greater burden of cardiovascular disease, end-stage renal disease, blindness, and occasionally lower extremity amputations (Prisant, 2004). Type 2 diabetes is now appearing at a much earlier age with the onset largely attributed to obesity (WHO, 1998). Since 1982, obesity rates have doubled among British children and tripled in adults (Dyer, 2002) with type 2 diabetes becoming the most common type of diabetes in school children (Pontiroli, 2004).

The international standard used to measure obesity/overweight is body mass index (BMI) calculated by dividing a person's weight in kilograms by the square of their height in metres. Overweight is classified as a BMI greater than 25, obesity as a BMI greater than 30 (WHO, 1997). Estimations have calculated that a BMI above 35 $kg/m^2$ increases the risk of developing diabetes by 93-fold in women and by 42-fold in men relative to individuals with BMI values that are less than 23$Kg/m^2$ (Jung, 1997). In addition, clinical trials have shown that as little as 5% weight loss is sufficient to prevent most obese individuals with impaired glucose tolerance developing type 2 diabetes (Astrup & Finer, 2000).

## 1.4 Diabetes Care

The National Service Framework for Diabetes (DH, 2001), the first national standards for the treatment of diabetes, set out a ten year programme of change to enable more people to live free from diabetes and its related complications. The framework and supporting delivery strategy (DH, 2003a) contains twelve standards with associated key interventions for the prevention and management of diabetes. The aims of the strategy being "to empower people with diabetes through skills, knowledge and access to services to manage their own diabetes and fulfil their potential to live long lives free of the complications that accompany diabetes".

The General Medical Services contract introduced in June 2003 (DH, 2003b) provides support for General Practitioners (GPs) in delivering the National Service Framework by highlighting diabetes as a priority condition. By including diabetes, as one of the 11 clinical areas in the quality framework an increased number of resources will be available to GPs to provide the best possible diabetes care. To support monitoring, a core minimum dataset will be collected on all diabetes patients in primary and secondary care.

### 1.5 Future Demand

Diabetes, due to its chronic nature and many complications, places a great demand on time and resources. It has been projected to become one of the world's main killers/disablers in the next 25 years (WHO, 2002b). If the current obesity trends continue, at least one third of adults, a fifth of boys and a third of girls in the UK will be obese by 2020 and consequently demands on diabetes services and treatments are set to increase dramatically (Diabetes UK, 2005). In addition, the over 65 population in the UK, including the North West, is predicted to rise over the next few decades (Harwood et al., 2004 and Casparie, 1991) adding to the burden. However, despite a clear increasing trajectory in prevalence of diabetes, to date little work has been carried out to measure the scale of increase or resulting health service pressures at a local level.

It is difficult to estimate even the current number of people with diabetes due to it remaining undiagnosed (type 1 and type 2) in up to 1% of the population (Connolly & Kelly, 1995) and many patients not attending for regular health care (Gill et al., 2003). Added to this, most data sources do not distinguish between type 1 and type 2 diabetes in adults and therefore it is not always possible to provide separate estimates (Wild et al., 2004). The prevalence of so-called "hidden diabetes" (type 1 and type 2) for North Liverpool was estimated by Gill et al in 2003 to be 1.6% (crude prevalence 1.5%, adjusted prevalence 3.1%).

In the year 2000, Diabetes UK stated that the NHS spent 9% of the healthcare budget alone on the treatment of diabetes (Dyer, 2002). Diabetes treatments have a great impact on resources and estimates suggest that £5 million a day is spent by the NHS on diabetes treatment alone (DH, 2005).

### 1.6 North West

The number of people in the North West diagnosed with diabetes is predicted to increase to 300,000 by 2010 (Harwood et al., 2004) resulting in high demand for the regions treatment services. However, little information is known about the burden/demand on services related to diabetes with changing risk factors such as obesity within the population. The following study utilises existing sources of data on obesity, population demographics, diabetes and hospital attendance to identify which factors are related to diabetes. It explores how these relate to hospital pressures and investigates how current demographic changes will alter pressures on health services over the next six years.

## 2. Methodological Process and Results

In order to predict the future demand for diabetes related services at Aintree Hospitals NHS Trust a range of future scenarios required quantifying. Consequently, factors associated with local variations in the hospitalised prevalence of diabetes were used to construct a dynamic model. This model can then be used to explore the hospitalised prevalence of diabetes, and its relationship with changes in age structure, population obesity and other variables.

The following approach was adopted:

1. Identify the catchment population for adult diabetes services at Aintree Hospitals NHS Trust
2. Project population numbers and age structures for 2006 and 2011
3. Identify measures of diabetes and risk factors in the catchment population
4. Develop an explanatory model for ward-level variations in the hospitalised prevalence of diabetes 1998-2002
5. Apply the explanatory model to the projected ward population in the Aintree Hospitals NHS Trusts catchment area
6. Calculate multiple scenarios of burden from diabetes on secondary care.

## 2.1 Identifying the catchment population for adult diabetes services at Aintree Hospitals NHS Trust

The study was confined to the Local Authority districts of Southport, Sefton, Liverpool, Knowsley and St Helens. For analytical purposes the study needed to identify a catchment population from combinations of small areas within these Local Authorities. A number of small area geographies were potentially available for this, such as 'lower super output areas', 'middle super output areas' and statistical wards. A scoping study demonstrated that in order to have sufficient numbers of survey respondents to the lifestyle surveys (Box 1) in the chosen geographic areas, the statistical wards (the largest of the geographic units) provided the most effective small area geography and therefore were used as the primary geographic unit within the study.

### Box 1 - Liverpool and Sefton Lifestyle Survey

The Liverpool and Sefton Lifestyle Survey covered the following PCTs: Southport and Formby, South Sefton, South Liverpool, Central Liverpool and North Liverpool. A questionnaire was sent by post to 28,000 residents (chosen at random) living in Liverpool and Sefton between October 2002 and January 2003. The data obtained from the completed questionnaires were analysed by risk factor for age, gender, deprivation, educational background, employment status, BMI and ethnicity for each PCT and for the whole of Liverpool and Sefton. Of most interest to the prevalence of type 2 diabetes, is the BMI of the respondents.

The St Helens and Knowsley Health and Community Survey completed in 2001 covered St Helens and Knowsley PCTs. A postal survey was carried out with 6400 adults aged 18 years and over (selected at random from the lists of GP patients held by NHS Central Operations Agency Mersey) received a questionnaire containing 65 questions covering traditional concerns including smoking, drinking, exercise and long-standing illness. In addition, community involvement, urban problems such as crime, safety and access to services, personal deprivation and the extent of informal care were included.

To establish denominator populations for each statistical ward for the years 1998-2002, the 2001 Census Standard Table ward population totals were compared to the corresponding Local Authority district mid-year estimated populations for those years. After identifying adjustment factors (specific to age band and gender), these were then applied to the 2001 Census Standard Table ward populations.

Hospital Episodes (Box 2) for adults (aged 16+) with a primary admission cause given as diabetes, for the year 2002/3, were extracted and the proportional flow into each local hospital service was calculated. Those statistical wards where the largest proportional flow (>40%) was into Aintree were allocated to the study catchment population (Table 1). In total, 26 wards out of 95 in the five Local Authorities were assigned to the Aintree catchment population (Figure 1).

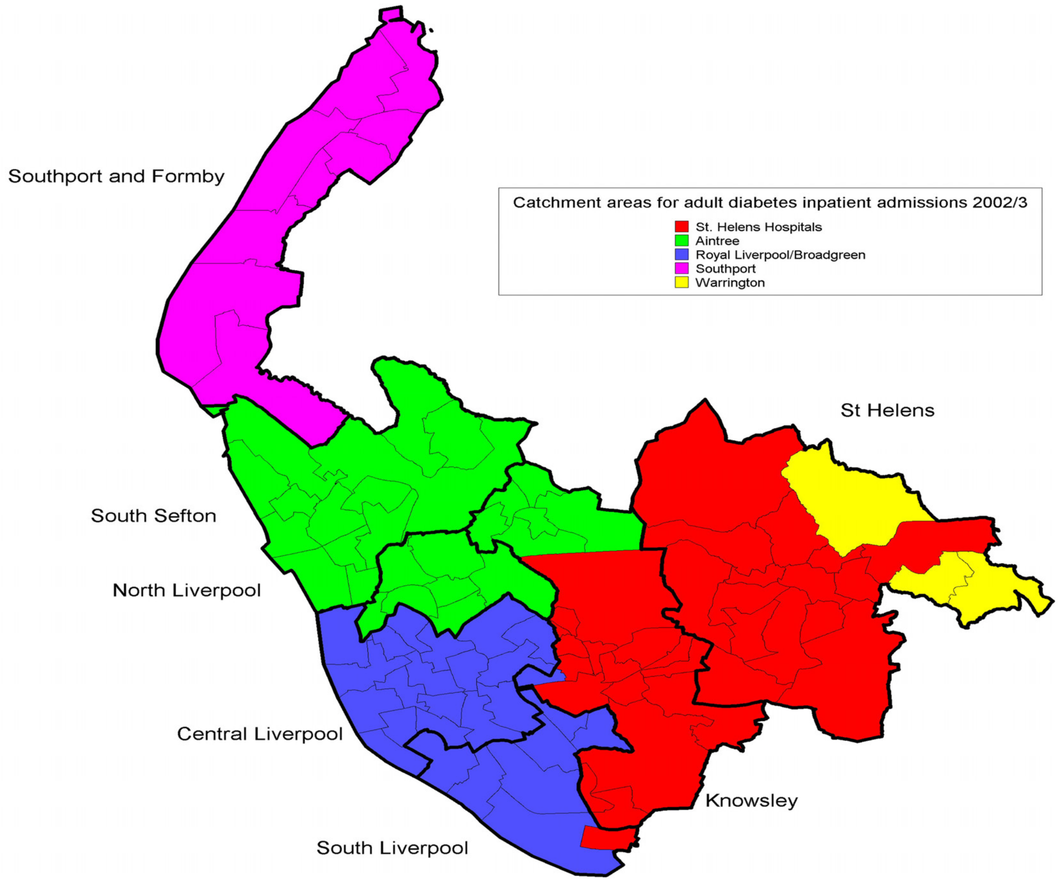
### Box 2 - Hospital Episode Statistics

Hospital Episode Statistics (HES) is a database containing details of all patients admitted to NHS hospitals in England from 1989. For each patient admitted certain details are collected including the patient's age, date of admission and details of any care/operation undertaken and assigned a code. A record is kept separately in the database for each period of care, which is termed an episode. Records are stored according to the financial year in which the treatment finished. HES does not provide information on outpatients, for example those treated in Accident and Emergency.

**Table 1. Percentage inpatients admitted to Aintree Hospitals NHS Trust, from statistical wards within Southport, Sefton, Liverpool, Knowsley and St Helens Local Authorities 2002/3**[2]

| % Inpatients Admitted to Aintree Hospital | >70 | 40-70 | 10-40 | <10 |
|---|---|---|---|---|
| Number of wards | 23 | 3 | 6 | 63 |

**Figure 1. Study catchment areas for adult diabetes hospital admissions 2002/3**[3]




## 2.2 Projection of population numbers and age structures for 2006 and 2011

It was necessary to estimate the population size and age structure of the catchment area for the future years of 2006 and 2011.

This was undertaken in two stages:

[2] Table 1 shows the percentage of inpatients from the catchment area with a primary diagnosis of diabetes admitted to Aintree Hospitals NHS Trust for the year 2002/3. Those statistical wards with admissions greater than 40% were included within the study, the rest were excluded. The data source was Hospital Episode Statistics records for the year 2002/3 (Department of Health Statistics Division).

[3] Figure 1 shows the percentage of inpatients from the catchment area with a primary diagnosis of diabetes admitted to hospitals within the Merseyside study area for the year 2002/3. The data source was Hospital Episode Statistics records for the year 2002/3 (Department of Health Statistics Division).

The projected populations for statistical wards were broken down into the same five year age bands as were calculated for district level population projections. Firstly, by carrying out a local application of a standard methodology, 2001 ward population counts for each age band were aged on. For example, the 2001 population aged 45 to 49 was projected to be the same as the 2006 population aged 50 to 54. This was carried out for all age bands with the exception of 15-19, 20-24 and 25-29, whose population was not aged on because of the high number of students that make up these strata. (Students being a particularly transient group are unlikely to be resident in the same area in 2006 and 2011 as they were in 2001).

Secondly, the projected ward populations were then compared, relative to age and sex differences, with their respective local authority district projections for the year in question. Consequently, a set of age/gender specific adjustment factors were generated.

## 2. 3 Identifying measures of diabetes and risk factors in the catchment population

### 2.3.1 Diabetes Prevalence

Two alternative approaches could have been used to estimate diabetes prevalence. This in effect would either calculate estimates from specialist diabetes outpatient clinics at Aintree Hospitals NHS Trust or from HES for any NHS hospital. However, a high degree of association between the outpatient estimates and inpatient admissions was found (Figure 2), such that approximately 74% of regular diabetes outpatients might expect to be admitted as an inpatient in any one year.

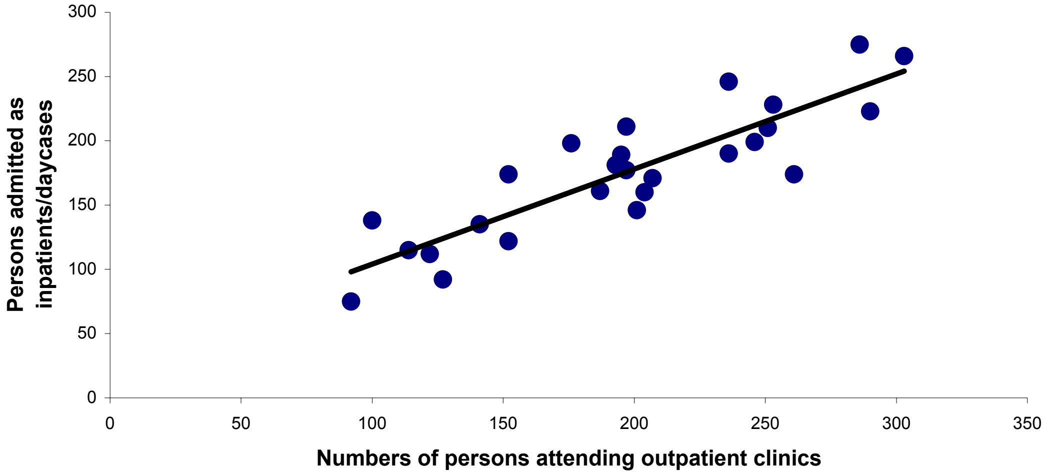



**Figure 2. Comparison of outpatient[4] and inpatient[5] prevalence for wards in the catchment area for Aintree Hospitals NHS Trust 2001/2 – 2002/3 ($R^2$ = 0.762)**

Since local hospital admissions data were available in a consistent format for a series of years for the entire Merseyside study area, it was concluded that the estimates derived from hospital episodes would be used to generate estimates of the hospitalised prevalence of diabetes.

[4] Outpatient register of patients attending diabetes clinics at Aintree Hospitals NHS Trust 2001/2 – 2002/3
[5] Hospital Episode Statistics for the year 2001/2 – 2002/3 (Department of Health Statistics Division)

### 2.3.2 Estimation from hospital admissions to any NHS hospital

Previous studies using hospital episodes to generate estimates of prevalence have had to take into account the high degree of multiple readmission commonly observed for individual patients. Readmission rates vary greatly between hospital units, and hence tend to distort prevalence estimates. Using the data obtained from an exercise undertaken by the Central Department of Health Statistics Division in which an anonymous individual matching code was attached to each episode (derived from the NHS number, date of birth, gender, postcode and other identifying information), it was possible to link episodes of treatment referring to the same individual across any hospital unit in the NHS. The proportion of the population for each statistical ward admitted to hospital in any one year could be calculated and the data for any such episode where a diabetes diagnostic code has shown either as the primary diagnosis, or as any of the subsidiary or contributory recorded diagnoses could be extracted. Thus an annual hospitalised prevalence of diabetes was generated for the population of each statistical ward. This was expressed both as a crude per capita rate, and as an age-standardised ratio, compared with the regional average prevalence. For robustness, the five-year average for 1998-2002 was assumed to be a proxy for the 2001 value of the hospitalised prevalence of diabetes.

### 2.3.3 Risk Factors

The hospitalised prevalence of diabetes was compared with several data sources (listed in Appendix 1) in order to identify statistical relationships with risk factors using data for the whole North West. The following were found to be significant within the region.

#### 2.3.3.1 Ethnicity

Populations in localities with a non-white majority had hospitalised prevalence of diabetes rates as much as three times the regional average (Figure 3).

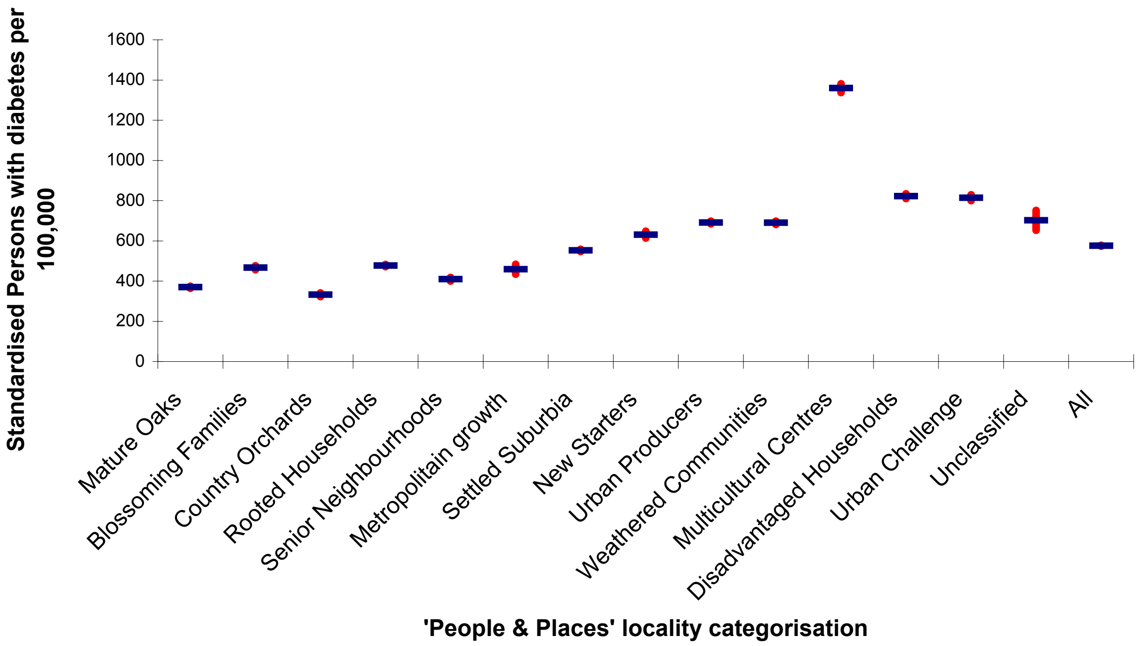



**Figure 3. Hospitalised prevalence of diabetes rate for residents of the North West region 1998-2002 compared to 'People and Places' locality classification**

**Box 3 – 'P² People & Places'**

Using Census 2001 and TGI (Target Group Index) data, P² is a comprehensive classification, using geography to classify people by where they live. Every postcode in the UK has a P² code associated with it. TGI is a fast-growing, global network of single-source market research surveys. TGI was first started in Great Britain in 1969 to provide the advertising and media industries with a means of describing target groups for the broad spectrum of consumer goods and services. By using TGI data, People & Places overcome certain problems associated with census tables.

Unprocessed census data has limitations including:

- The large volumes of data make it hard to see what is relevant
- It's a single snap-shot every ten years
- It contains no data about individuals, only output areas
- No direct data about income or wealth is collected
- Rurality is not well measured
- No information about attitudes and product/brand/media usage is collected.

People and Places classify areas into the following groups (shorthand version):

- **Mature Oak**
  - Older, married, detached housing, rural
- **Blossoming Families**
  - Parents, 25-34, married
- **Country Orchards**
  - Agricultural workers, managerial
- **Rooted Households**
  - Semi-Detached, two plus cars
- **Senior Neighbourhoods**
  - Owner occupied, pensioners
- **Metropolitan Growth**
  - Highly qualified, single
- **Settled Suburbia**
  - Semi detached, terrace, skilled manual
- **New Starters**
  - Students and youth
- **Urban Producers**
  - Terraced without central heating
- **Weathered Communities**
  - Pensioners, single, council
- **Multicultural Centres**
  - Many bed sits, high ethnic
- **Disadvantaged Households**
  - Council, lone parents with children
- **Urban Challenge**
  - Old people, unemployed, single

#### 2.3.3.2 Urban / Rural geography

Populations in more remote rural areas (i.e. 'rural sparse villages') have lower hospitalised prevalence of diabetes rates (Figure 4). Because these locations are not present within the Trust's catchment area, this variable was not included within the final analysis.

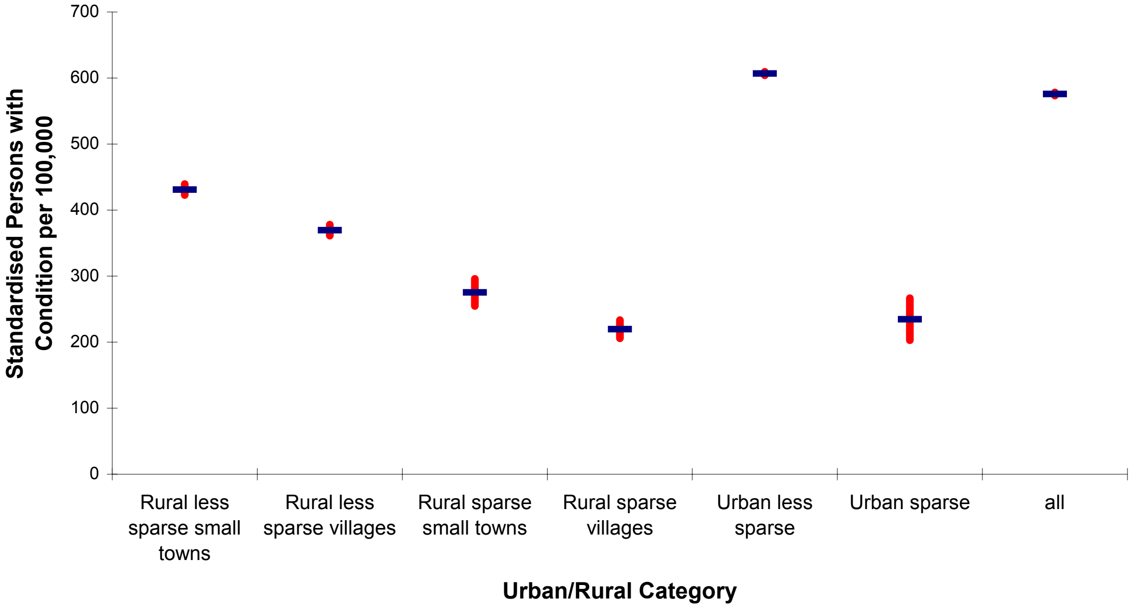



**Figure 4. Hospitalised prevalence of diabetes rate for residents of the North West region 1998-2002 compared to ONS Rural and Urban Classification 2003**

#### 2.3.3.3 Age

Hospitalised prevalence of diabetes rates are observed to increase dramatically with age, particularly for those over 50 years of age (Figure 5).

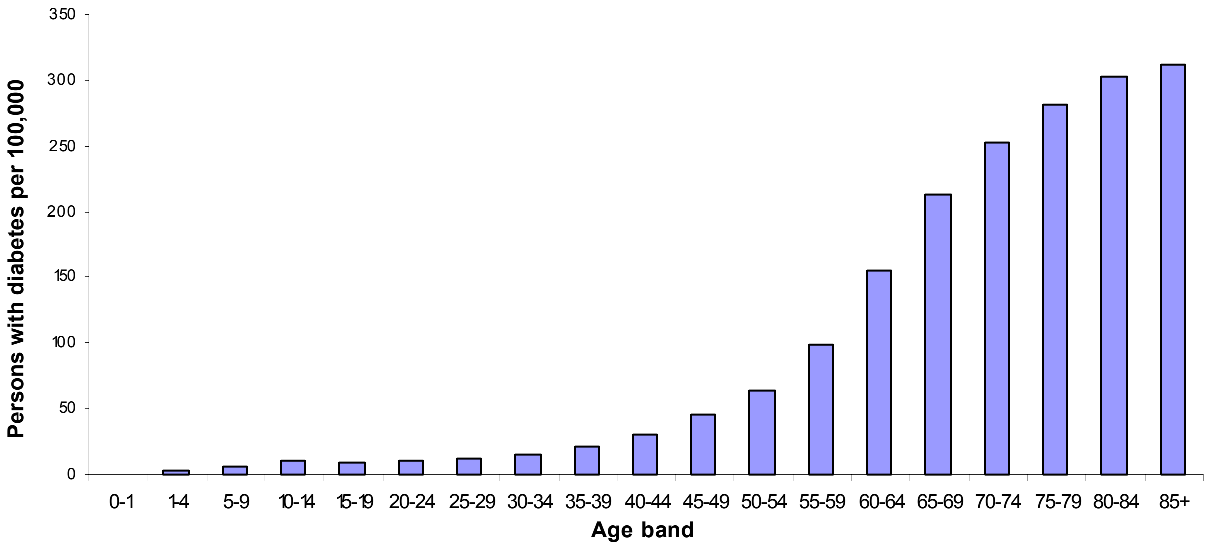



**Figure 5. Hospitalised Prevalence of Diabetes in the North West by five-year age band 1998-2002**

### 2.3.3.4 Obesity (Body Mass Index or BMI > 30 kg/m$^2$)

Two sources of ward-based measures of obesity were investigated in this study, synthetic estimates produced nationally and locally derived data from lifestyle surveys. Synthetic estimates for obesity (Box 4) in a particular ward have been produced based on ward characteristics then related to a national formula which converts these into an estimated prevalence of obesity. The analysis of obesity was undertaken by the National Centre for Social Research (publication forthcoming).

**Box 4 – Synthetic Estimates of Obesity**

Taking records for 25,071 persons aged 16-74 for the Health Survey for England in the year 2000, 2001 & 2002, each individual in the survey was assigned to his or her electoral ward of residence. A logistic regression model was then constructed, in which the dependent variable was a binary measure of individual obesity (0 = Body Mass Index less than 30, 1 = Body Mass Index of 30 or more) and the auxiliary (explanatory) variables were area level population descriptions for each individual's ward of residence derived from the 2001 census, from mortality data, and from administrative datasets. From this a model could be constructed to predict levels of obesity in areas in which the population descriptions are available. Such data are available at ward level and therefore synthetic estimates can be generated.

Within the study area, weak correlation was observed between the ward level synthetic estimates of obesity and the hospitalised prevalence of diabetes (Figure 6).

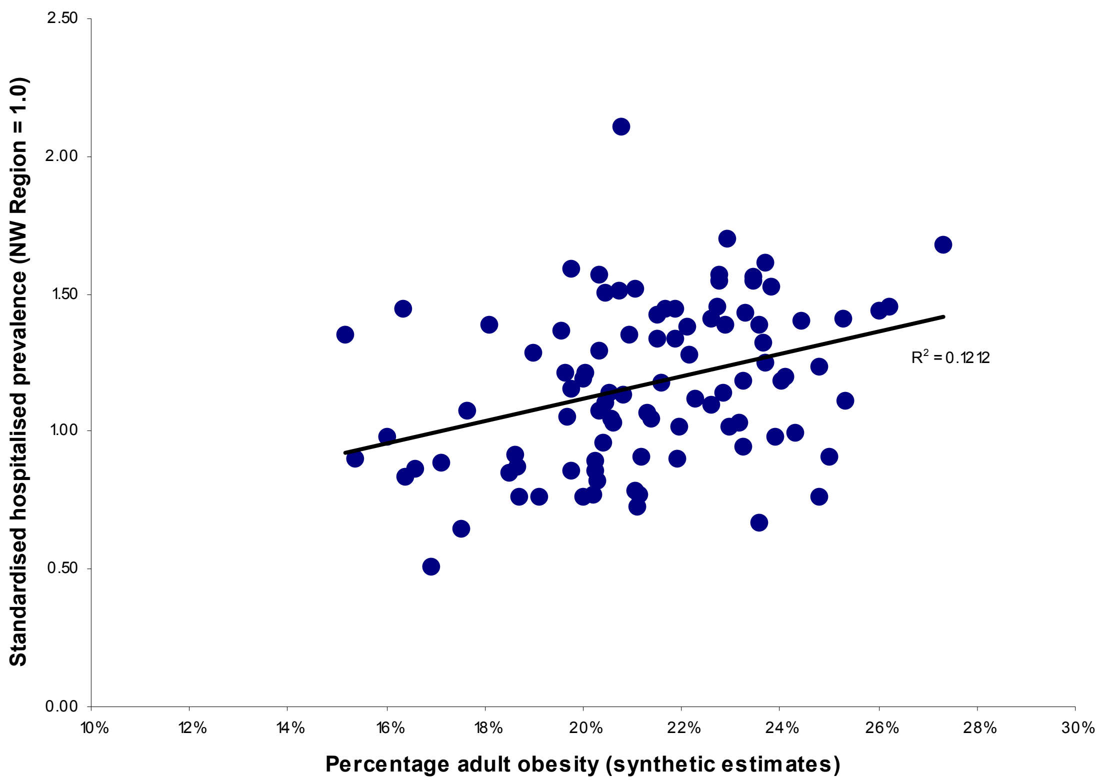



**Figure 6. Hospitalised prevalence of diabetes 1998-2002, compared to synthetic estimate measures of obesity for statistical wards on Merseyside ($R^2$ = 0.121)**

The second source of obesity data from the local lifestyle surveys was limited in its application for many wards (especially in Liverpool) due to a relatively small number of survey respondents. A range of analyses with different cut-off points was undertaken utilising data where the number of respondents per ward exceeded a variety of thresholds. The relationship between obesity and diabetes declined markedly where respondent numbers were below 90. When only areas with greater than 90 respondents were analysed, a significant correlation was observed between obesity and the hospitalised prevalence of diabetes (Figure 7).

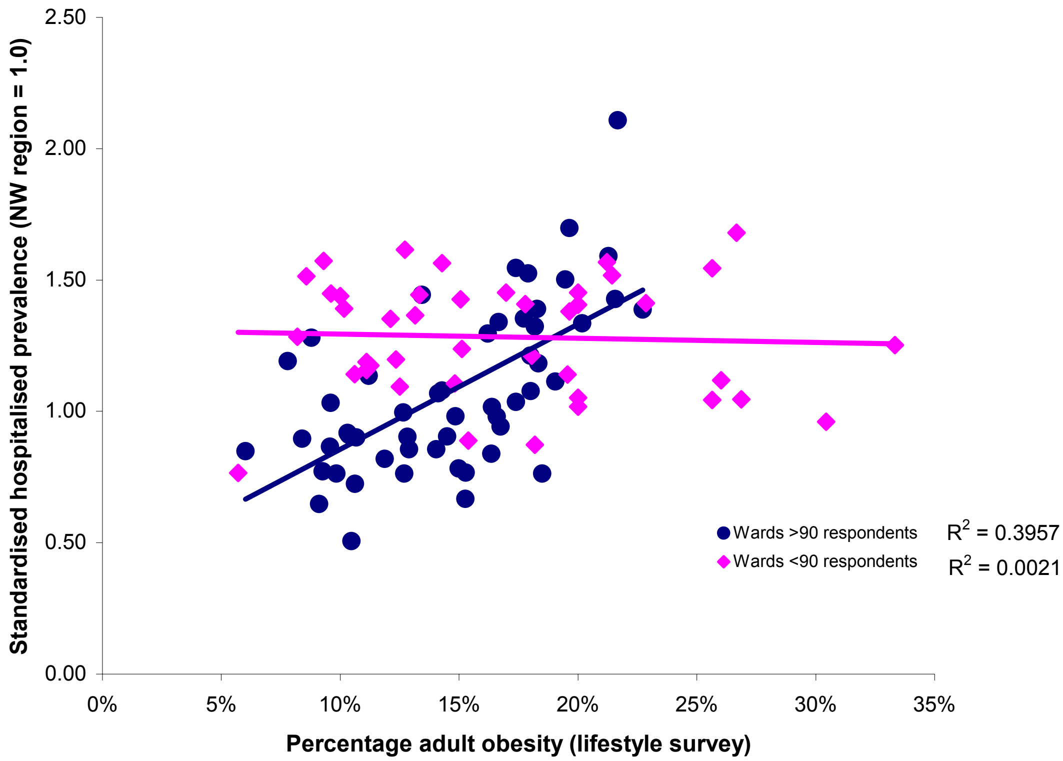



**Figure 7. Hospitalised prevalence of diabetes 1998-2002, compared to lifestyle survey measures of obesity for statistical wards on Merseyside, > 90 respondents ($R^2$ = 0.395), <90 respondents ($R^2$ = 0.002)**

Thus for all wards with 90 or more respondents obesity was estimated directly from the local lifestyle survey. For the 42 wards with less than 90 respondents, estimates of obesity were calculated from a weighted average made up of the survey findings and the synthetic ward estimates of obesity from the National Centre for Social Research (Figure 8).

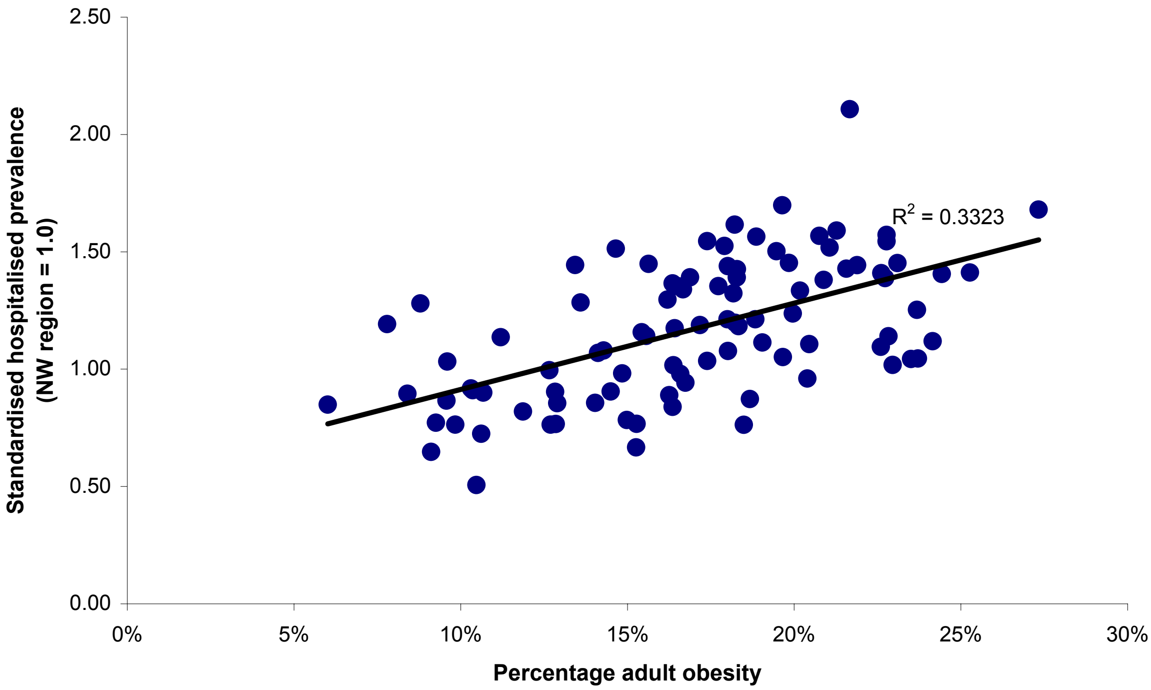



**Figure 8. Hospitalised prevalence of diabetes 1998-2002, compared to lifestyle measures of obesity >=90 respondents integrated with synthetic/lifestyle weighted average measures of obesity (<90) for statistical wards on Merseyside ($R^2$ = 0.332)**

### 2.3.3.5 Deprivation

Deprivation factors in the Index of Deprivation 2004 data set were calculated for lower super output areas, but can be aggregated to statistical wards using population-weighted averages. Populations in the highest quintile for multiple deprivation have higher observed hospitalised prevalence of diabetes rates, between two to three times those of the lowest quintile (Figure 9).

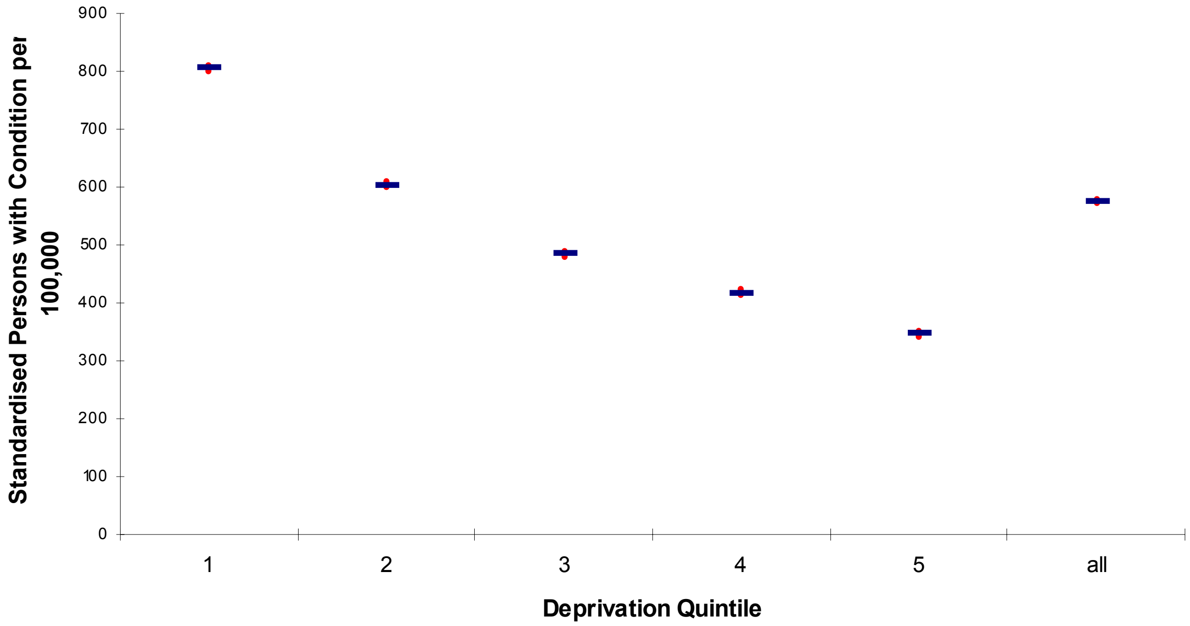



**Figure 9. Hospitalised prevalence rate of diabetes for residents of the North West region 1998-2002 compared to Index of Multiple Deprivation 2004 quintile.**

### 2.3.3.6 Deprivation Component Analysis

Of the components of the Index of Deprivation 2004 (Appendix 1), percentage white was found to be independently significant as an explanatory factor (Granby ward in Liverpool, the only locality with less than two thirds of the population being recorded as white, being by far the ward with the highest observed hospitalised prevalence of diabetes).

A consistent combination of explanatory factors composing the deprivation measure was not possible due to the high degree of correlation between all the various deprivation factors. Inter-correlations were generally much higher than with diabetes. The technique of principal component analysis was therefore applied (at study level i.e. Merseyside) to reduce the deprivation data sets to their common elements. A composite was calculated by this method and the 14 variables were reduced to two principal components.

### 2.3.4 Developing an explanatory model for ward-level variations in the hospitalised prevalence of diabetes 1998-2002

For all wards across the Local Authority areas selected, a two-stage model was developed. The estimated hospitalised prevalence of diabetes was first age-adjusted, to generate a standardised illness ratio specific to diabetes (i.e. the ratio between the observed count of individuals with diabetes and the number expected on the basis of the age structure of the locality population). This standardised ratio was then used as the dependent variable.

Secondly, a multiple linear regression analysis was undertaken specifically for the populations in those wards with more then 90 respondents in the surveys (53 of the 95 wards). Using SPSS, a stepwise linear regression was completed, and the following additive model was found to be robust (Box 5).

**Box 5 – Statistical Model Results**
Constant = 3.172
Deprivation component * 0.134
Proportion white * -2.432
Local Authority factor * 0.319
Proportion obese * 1.542
Where "*" stands for multiplication, $p<0.001$

This model explained 82% of the variation in diabetes in the selected ward areas. A stable model could not be generated without the inclusion of a Local Authority factor (due to higher general hospitalised prevalence of diabetes in St Helens wards, also see Box 6). Since these areas did not coincide with the Aintree catchment populations, this would not generate difficulties in practical application of the above model.

**Box 6 – Standard Diagnostic Tests**
Standard diagnostic tests (plotting unexplained residuals against the dependent variable) still did not indicate a fully specified model. The difficulty related to the Granby Ward, which had very high-standardised hospital diabetes prevalence, and the lowest local level of white population. Having a very extreme outlier tends to distort the linear regression, but excluding this observation would entail losing a high proportion of the explanatory content of the analyses (relating to ethnicity effects). Therefore the model as shown in Box 5 was used to predict future trends.

Thus within the catchment population a 1% increase in obesity is related to a 1.5% increase in the hospitalised prevalence of diabetes. Similarly, increases in the levels of ethnicity will also result in an increase in the hospitalised prevalence of diabetes, as will an increase in deprivation.

### 2.3.5. Applying the explanatory model to the projected ward population in the Aintree Hospitals NHS Trust catchment area

The annual data from the Health Survey for England (Figure 10) indicates a steady increase in adult obesity prevalence by one percentage point each year, from 15% in 1993 to 23% in 2001.

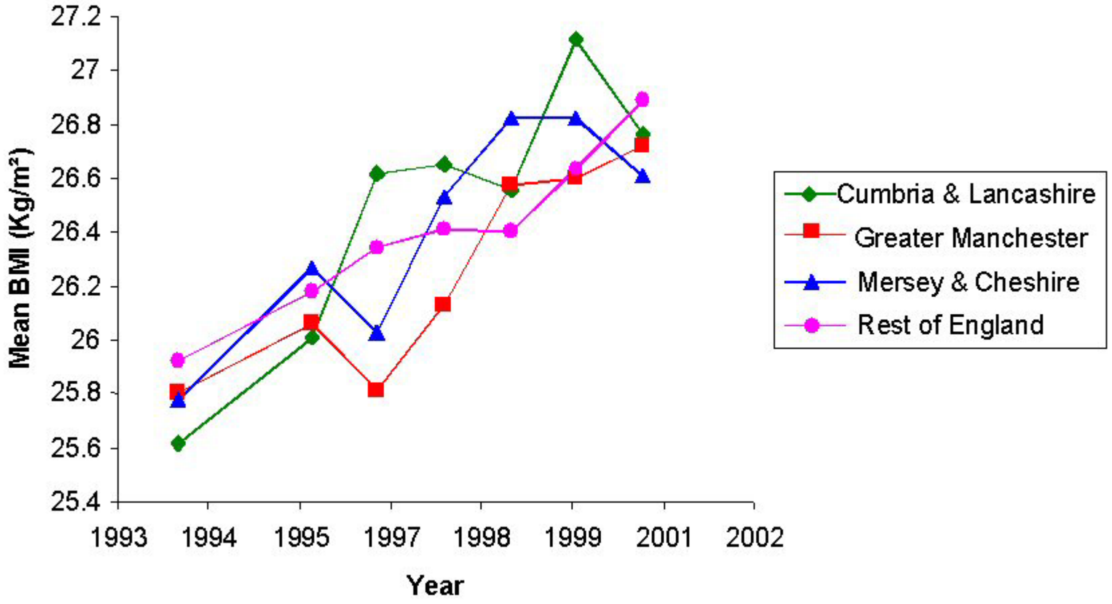
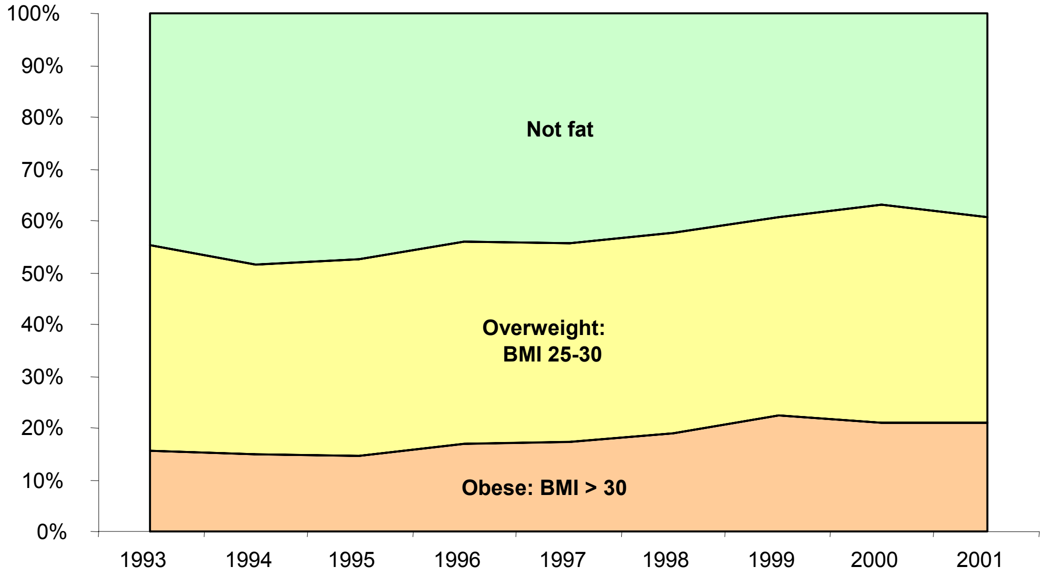



**Figure 10. Mean Body Mass Index (BMI) for Northwest Strategic Health Authorities from the Health Survey for England for the years 1993-2002**

A similar trend seems to be apparent – though less consistently – for the population of the North West Region (Figure 11), which suggests that equivalent trends observed in each of the Strategic Health Authorities in the region (Figure 10) are valid.




| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|
| not fat | 45% | 48% | 48% | 44% | 45% | 42% | 39% | 37% | 39% |
| overweight | 40% | 37% | 38% | 39% | 38% | 39% | 38% | 42% | 40% |
| obese | 15% | 15% | 15% | 17% | 17% | 19% | 22% | 21% | 21% |

**Figure 11. Northwest obesity, overweight-ness from 1993 to 2001, "Fatness in the Northwest" presentation, First Annual Northwest Public Health Conference, March 2004, Windermere**

For the present analysis, we assume that an overall increase in obesity of one percentage point per year would have occurred in the survey area over the period 1998–2002. However over the period 1998 – 2002 the age-standardised prevalence of diabetes (taken from HES) was found to have increased across the region by around 3% per year (Figure 12). A similar level of increase was observed in the Merseyside Conurbation, except in the most recent year 2001/2. Applying the model (Box 5) to regional and conurbation populations suggests that the annual increase in obesity observed in the Health Survey for England could only explain around a half of the annual increase in diabetes (i.e. 1.5% per year).

Hence during the period 1998-2002 another factor (here referred to as extraneous factor), over and above the assumed increase in obesity must also be operating to generate an increase in the hospitalised prevalence of diabetes. It was not possible to determine the nature of this extraneous factor from the current analysis. Therefore different scenarios were generated with a variety of plausible values for this factor over the projected period.

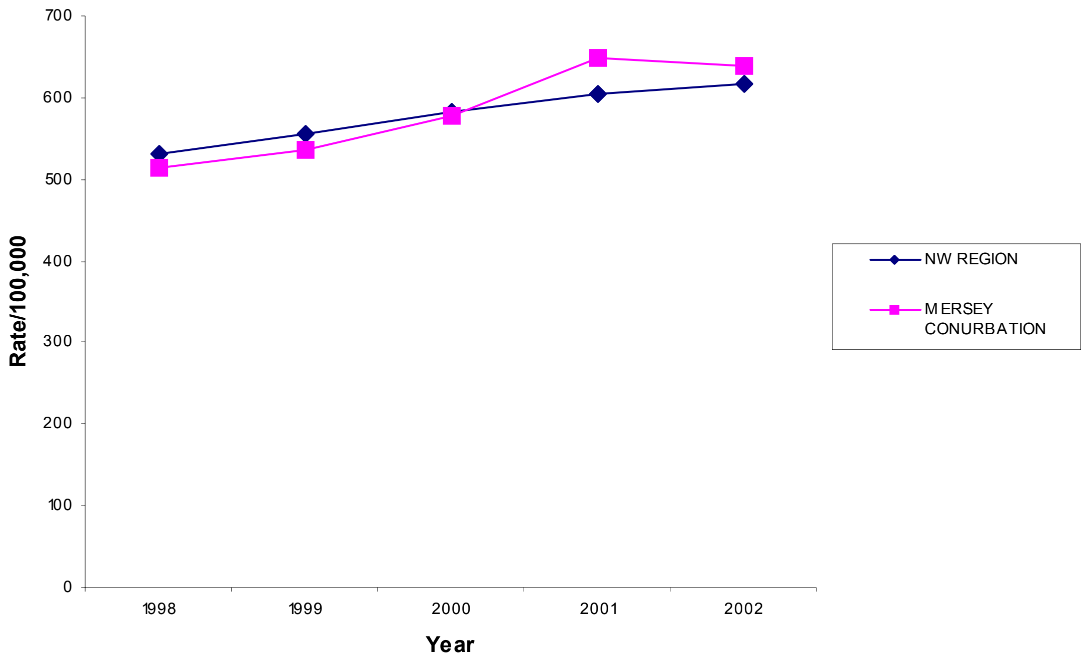



**Figure 12. Hospitalised prevalence of diabetes 1998 – 2002**

### 2.3.6. Calculating multiple scenario measures of diabetes burden on secondary care

For each of these scenarios, the population projections of the statistical wards in the Aintree Catchment population remained constant. Projections were generated for three years: 2001, 2006 and 2011. [6]

#### 2.3.6.1 Obesity

Within the scenario results (Table 2) obesity is varied to generate three possibilities of change:

- No further increase of obesity after 2002;
- An average increase of 0.5 percentage points per year - applied pro rata to ward obesity values (i.e. approximately half the current rate of obesity increase);
- An average increase of 1.0 percentage point per year - applied pro rata to ward obesity values (i.e. approximately the current rate of obesity increase).

#### 2.3.6.2 Extraneous Factor

Within each of the three obesity scenarios a hypothetical extraneous factor is varied with three possibilities of change:

- No further increase;
- An increase of 1% per year;
- An increase of 2% per year.

The projections only relate to diabetes for persons aged 15 years and over.

#### 2.3.6.3 Output Indicators

For each of the resulting nine scenarios, the following projections were generated:

- Total population in the catchment area;
- Total projected hospitalised prevalence of persons with diabetes aged 15 years and over;
- Crude adult hospitalisation rate per 100,000, for persons aged 15 years and over;
- Age standardised hospitalisation rate per 100,000 for person's aged 15 years and over.

#### 2.3.6.4 Notional Episodes

In addition, an expected notional episode[7] count for each scenario was generated by applying average re-admission rates for the whole population of Merseyside to relate the hospitalised prevalence of diabetes to actual hospital episodes (Table 3). This effectively reverse engineers

[6] The hospitalised prevalence of diabetes shown for the baseline year 2001 was the projected value, not the average observed for the years 1998–2002 in our basic data. This was to ensure that the projections calculated for 2006 and 2011 (Table 2) were consistent relative to a baseline at 2001.

[7] The notional episodes consist of (five year age-band) average annual episodes per individual factors (for Merseyside 1998-2002) applied to the counterpart ward projected prevalence for the three modelled years 2001, 2006, 2011. Hence for 2001 it differs from (and is lower than) the actual episode workload in the Aintree catchment, in that Aintree patients tend to be re-admitted with greater frequency than those attending other hospitals.

the methodology used to generate the hospitalised prevalence of diabetes.[8]

These notional episodes relate to the entire population of the Merseyside conurbation in that the proportion of the adult patient flow coming into Aintree is assessed for the whole adult population of each of the 95 statistical wards.

[8] It should be noted as generally projecting fewer episodes than have historically been observed at Aintree because re-admission rates for Aintree are higher than average.

## Table 2. Multiple scenario estimates of diabetes burden on secondary care

### No Increase in Obesity after 2002

| | | 2001 | 2006 | 2011 | % Change 2001 - 2011 |
|---|---|---|---|---|---|
| No extraneous increase | Total Population | 313518 | 312340 | 311783 | -0.6% |
| | Diabetes Population | 2052 | 2160 | 2267 | 10.5% |
| | Prevalence / 100,000 | 654.5 | 691.7 | 727.2 | 11.1% |
| | Standardised Prevalence | 519.9 | 524.8 | 524.3 | 0.8% |
| Extraneous increase of 1% per year | Total Population | 313518 | 312340 | 311783 | -0.6% |
| | Diabetes Population | 2052 | 2271 | 2504 | 22.0% |
| | Prevalence / 100,000 | 654.5 | 727 | 803.3 | 22.7% |
| | Standardised Prevalence | 519.9 | 551.4 | 579.2 | 11.4% |
| Extraneous increase of 2% per year | Total Population | 313518 | 312340 | 311783 | -0.6% |
| | Diabetes Population | 2052 | 2385 | 2764 | 34.7% |
| | Prevalence / 100,000 | 654.5 | 763.7 | 886.4 | 35.4% |
| | Standardised Prevalence | 519.9 | 579.4 | 639.1 | 22.9% |

### Obesity Increasing by 0.5% each year

| | | 2001 | 2006 | 2011 | % Change 2001 - 2011 |
|---|---|---|---|---|---|
| No extraneous increase | Total Population | 313518 | 312340 | 311783 | -0.6% |
| | Diabetes Population | 2052 | 2209 | 2381 | 16.0% |
| | Prevalence / 100,000 | 654.5 | 707.1 | 763.7 | 16.7% |
| | Standardised Prevalence | 519.9 | 536.5 | 550.6 | 5.9% |
| Extraneous increase of 1% per year | Total Population | 313518 | 312340 | 311783 | -0.6% |
| | Diabetes Population | 2052 | 2321 | 2630 | 28.2% |
| | Prevalence / 100,000 | 654.5 | 743.2 | 843.6 | 28.9% |
| | Standardised Prevalence | 519.9 | 563.9 | 608.2 | 17.0% |
| Extraneous increase of 2% per year | Total Population | 313518 | 312340 | 311783 | -0.6% |
| | Diabetes Population | 2052 | 2438 | 2902 | 41.4% |
| | Prevalence / 100,000 | 654.5 | 780.7 | 930.9 | 42.2% |
| | Standardised Prevalence | 519.9 | 592.3 | 671.2 | 29.1% |

### Obesity Increasing by 1% each year

| | | 2001 | 2006 | 2011 | % Change 2001 - 2011 |
|---|---|---|---|---|---|
| No extraneous increase | Total Population | 313518 | 312340 | 311783 | -0.6% |
| | Diabetes Population | 2052 | 2255 | 2490 | 21.3% |
| | Prevalence / 100,000 | 654.5 | 721.9 | 798.6 | 22.0% |
| | Standardised Prevalence | 519.9 | 547.7 | 575.9 | 10.8% |
| Extraneous increase of 1% per year | Total Population | 313518 | 312340 | 311783 | -0.6% |
| | Diabetes Population | 2052 | 2370 | 2750 | 34.0% |
| | Prevalence / 100,000 | 654.5 | 758.7 | 882.2 | 34.8% |
| | Standardised Prevalence | 519.9 | 575.7 | 636.1 | 22.4% |
| Extraneous increase of 2% per year | Total Population | 313518 | 312340 | 311783 | -0.6% |
| | Diabetes Population | 2052 | 2490 | 3035 | 47.9% |
| | Prevalence / 100,000 | 654.5 | 797.1 | 973.5 | 48.7% |
| | Standardised Prevalence | 519.9 | 604.7 | 702 | 35.0% |

## Table 3. Multiple scenario estimates of notional episodes

### No Increase in Obesity after 2002

| | | 2001 | 2006 | 2011 | % Change 2001 - 2011 |
|---|---|---|---|---|---|
| No extraneous increase | | 4328 | 4530 | 4739 | 9.5% |
| Extraneous increase of 1% per year | Notional Episodes | 4328 | 4761 | 5235 | 21.0% |
| Extraneous increase of 2% per year | | 4328 | 5002 | 5776 | 33.5% |

### Obesity Increasing by 0.5% each year

| | | 2001 | 2006 | 2011 | % Change 2001 - 2011 |
|---|---|---|---|---|---|
| No extraneous increase | | 4328 | 4631 | 4977 | 15.0% |
| Extraneous increase of 1% per year | Notional Episodes | 4328 | 4868 | 5497 | 27.0% |
| Extraneous increase of 2% per year | | 4328 | 5113 | 6067 | 40.2% |

### Obesity Increasing by 1% each year

| | | 2001 | 2006 | 2011 | % Change 2001 - 2011 |
|---|---|---|---|---|---|
| No extraneous increase | | 4328 | 4728 | 5205 | 20.3% |
| Extraneous increase of 1% per year | Notional Episodes | 4328 | 4970 | 5750 | 32.9% |
| Extraneous increase of 2% per year | | 4328 | 5221 | 6345 | 46.6% |

## 3. DISCUSSION

On average, individuals with diabetes utilise health services more often than people without the condition (Williams & Farrar, 2000) and consequently a wide range of healthcare staff in primary and secondary services care for people with diabetes for significant periods of time. Staffing levels and facilities are likely to vary between localities and such factors may hide cases of diabetes where access to services is problematic. However, it is also likely that those who do not attend for regular review of their diabetes would become the most frequent users of secondary care services for ensuing complications later on in life.

### 3.1 Estimating diabetes prevalence

Determining the number of people with diabetes in the population is difficult. Studies have generally relied on self-reports of diabetes or on extracting data on diagnoses of diabetes from GP or hospital records. These methods are limited in their accuracy because lay people may not accurately recall a diagnosis correctly, cases of undiagnosed diabetes are not considered, and availability of primary care and hospital data are incomplete and therefore historically have been deemed unreliable. So until primary care diabetes registers are fully established and utilised, direct measures of diabetes (such as incidence and prevalence of the condition) will not be available for areas as small as PCTs or electoral wards. However, progress has been made highlighting diabetes in GPs most recent GMS contract (2004) and in time this should facilitate more reliable primary care data leading to better measures of the condition nationwide.

Here we have limited our analyses of Health Service pressures to those on hospital admissions. However, this current study shows a strong correlation (R=0.762) between outpatient and inpatient records for diabetes care within the Aintree Hospitals NHS Trust catchment area. This supports the use of HES as a proxy for a baseline population prevalence of diabetes. In turn, this study has not established the diabetes prevalence of the resident population, but it has quantified the current and future workload on Aintree Hospitals NHS Trust services.

### 3.2 Identifying measures of risk factors for diabetes

Many risk factors for diabetes have been identified as presented earlier in this report (see Section 2.3.3). The development of a statistical model that could predict current levels of hospitalised prevalence of diabetes involved determining the most robust measures for each of the risk factors identified. Synthetic estimates of obesity alone showed very little predictive power for local diabetes prevalence. However, whilst local lifestyle surveys proved more useful, there were issues with small sample sizes at the ward level. Thus, data from lifestyle surveys were applied where samples size allowed more robust measures and a combination of local survey measures and synthetic estimates were used where local sample sizes were small.

The ethnicity risk factor was identified using the ‘P² People & Places’ classification developed by Beacon Dodsworth (see Section 2.3.3.1, Box 3).

### 3.3 Explaining the current hospitalised prevalence of diabetes

This study examined the inter-relationships between risk factors both regionally and locally in order to untangle major influences on local hospitalised prevalence of diabetes.

After ethnicity, obesity prevalence was the strongest correlate in the statistical model developed to explain the hospitalised prevalence of diabetes within the Aintree catchment area ($R^2$=0.82). However in the period 1998-2002 an extraneous factor was also identified which generated an increase in the hospitalised prevalence of diabetes, over and above the assumed increase due to obesity.

This extraneous influence could be related to many different factors. Increasing population risk of diabetes associated with deprivation or a lagged effect due to increases in obesity in previous periods only now registering at services. It is known that there is a time lag of several years between the onset of obesity and related health problems, highlighting that the rise in obesity over the past two decades may mean that health problems (and healthcare costs) are still being stored for the future (Sturm, 2002). Other factors, such as how individuals manage their condition once diagnosed or hospital treatment regimes that lead to a higher probability of hospital admission for persons with diabetes may also influence trends but these factors could not be measured for the current analysis.

The level of detail possible in this study allowed prediction of a trend towards increasing numbers of diabetes cases which will substantially impinge on the hospital services at Aintree.

### 3.4 Increased burden on health services due to diabetes

Based on projected changes in population size and age structure, the analysis in this study (Table 2) predicted a consistent rise in the hospitalised prevalence of diabetes for the catchment area proportional to a rise in obesity. The unknown extraneous factor that emerged resulted in additional predicted cases. If levels of obesity continue to rise within the catchment area at 1% per year, Aintree Hospitals NHS Trust can expect a proportional rise in diabetes from 10.8% through 22.4% to 35% of current levels by 2011 depending on whether other extraneous factors increase at a low, medium or high rate. By 2011, these scenarios suggest that between 438 and 983 extra cases of diabetes will be seen by Aintree Hospitals NHS Trust on top of the 2052 cases seen in 2001. Even if obesity prevalence does not increase any further in the catchment population, the analysis shows a potential increase in hospitalised diabetes cases of between 215 and 712 based on changes in the population numbers and age. However, if trends in reduced exercise and poor eating habits worsen significantly, these figures are likely to be significantly higher. Nevertheless, these figures should be considered as a sizeable underestimate since:

- They do not include patients diagnosed and managed within primary care, who may go on to be admitted to hospital between 2003 and 2011;
- They do not include admissions for diabetes related conditions or procedures, i.e. a growing burden of type 2 diabetes may require increasing treatment for kidney dialysis, damaged eyesight, neuropathy and resulting amputation surgery;
- They do not reflect the growing trend in childhood obesity, i.e. ten years ago type 2 diabetes was unheard of among children, but it has begun to emerge as the obesity epidemic has exploded;
- The figures cannot take into account the lag time that may occur between the current changes in lifestyle and increase in obesity and the onset of an increase in numbers of type 2 diabetes.

### 3.5 Economic costs of diabetes in Merseyside

For the UK, the Audit Commission note an estimate of 9% of hospital costs (£1.9 billion) attributed to diabetes, with additional costs in primary care. Provisional results of the

T2ARDIS survey estimate £2.0 billion NHS costs for caring for type 2 diabetes alone (4.7% NHS spend in 1998). Although 2-3% of the population have diabetes, people with diabetes account for 10% of hospital admissions (Hine, 2002).

Information on the costs of diabetes, in particular its healthcare costs, is available for many countries, including the UK. The economic aspects of diabetes are currently of considerable interest internationally. As long ago as 1989 at least 4-5% of total healthcare expenditure, including primary, secondary and community care, was estimated to be devoted to the care of people with diabetes (Laing & Williams, 1989). This amounted to around £1 billion in the UK in that year. Of this, an estimated 3.2% (£32 million in 1986-87) was estimated to have been spent in primary care. More recently, it has been estimated that 8.7% of acute sector costs is spent on care for patients with diabetes (Currie et al.,1997a). This was calculated to be an average of £2101 per year per resident with diabetes compared with £308 per year per resident without diabetes. In one district people with diabetes accounted for 5.5% of hospital admissions and 6.4% of outpatient attendances (Currie et al., 1996). The relative risk of hospital admission for diabetes-related complications in this district was around 12 for coronary heart disease and cerebrovascular disease, 16 for neuropathy and peripheral vascular disease, 10 for eye complications and 15 for renal disease (Currie et al., 1996). Patients with diabetes have around a fourfold increased probability of undergoing a cardiac procedure and the total cost of the hospital treatment for coronary heart disease in people with diabetes was estimated (at 1994-95 prices) to be £1.1 billion (Currie et al., 1997b).

The overall cost of hospital care for people with diabetes in one district was predicted to increase by 15% by the year 2011. This is greater than the predicted overall increase of 9.4% for all inpatient care (Currie et al.,1997a). Of significant financial interest to those commissioning services for Aintree Hospitals NHS Trust this study was also able to predict the number of 'notional' episodes that may be expected to impinge on the relevant services, taking into account the higher than average re-admission rates. If levels of obesity rise yearly following the identified national and regional trend of 1%, Aintree Hospitals NHS Trust can expect an episodic rise of between 20.3% and 46.6% by 2011, depending on the level of the extraneous factor (Table 2). Potentially, over 2000 extra episodes would occur in the worst-case scenario, resulting in major consequences for diabetic services by 2011. While these figures should be treated with caution methodological constraints for approximating the hospitalised prevalence of diabetes indicate that the predictions in the study are almost certainly an underestimate of the true prevalence of the condition.

### 3.6 Public Health Perspectives

Current trends in obesity and lifestyle are driving an increasing epidemic of diabetes. Treatment services in Primary Care and in Hospital Trusts have already expanded to meet necessary need in existing cases (currently undiagnosed). New cases (as identified by this study) will require further massive increases in capacity unless the underlying causes of diabetes are addressed. While national work is underway to examine the evidence base for clinical and Public Health interventions to reduce obesity (Health Development Agency, 2004a-b) acute and PCTs need to act now to tackle the causes of this epidemic. A review of possible interventions is beyond this study, however investment in services to reduce the weight of these older, obese individuals contacting services for reasons other than diabetes, and to improve the eating habits of young children (as well as encourage exercise) are likely to prove cost effective in both the short term and long term respectively.

# 4. APPENDICES

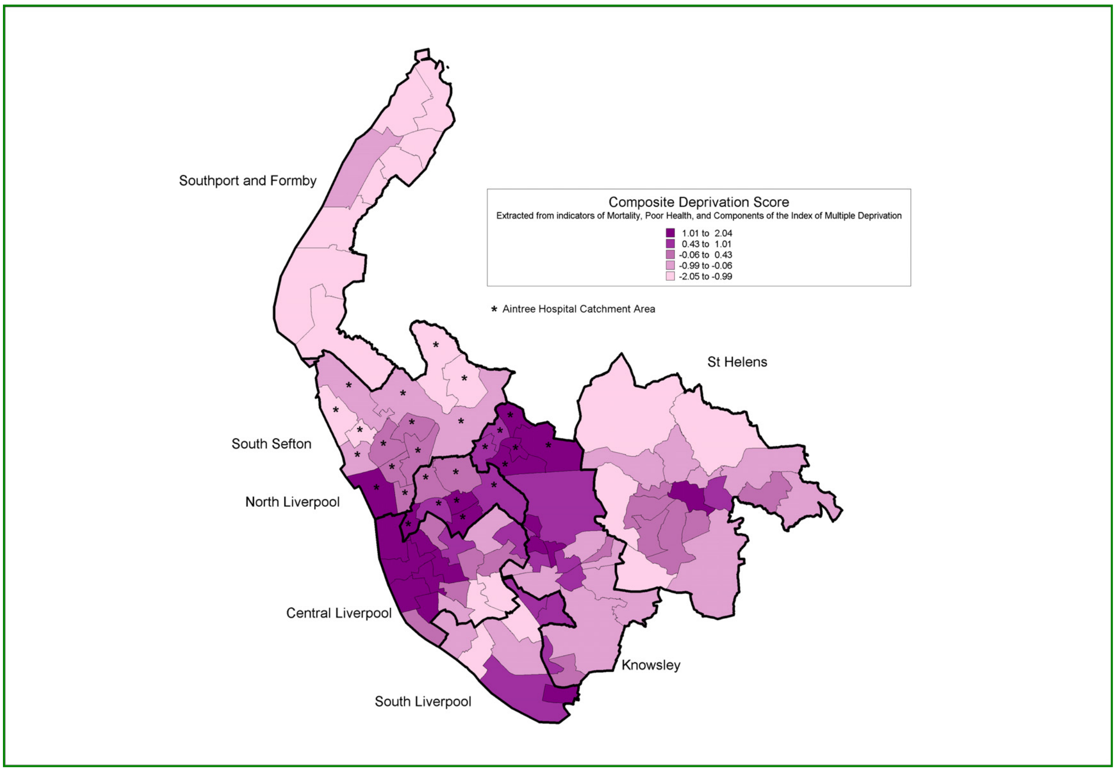
## 4.1 Appendix 1 Datasets

- Mid-year population estimates for Local Authority Districts: 1998-2003 (Office for National Statistics);
- Population projections for Local Authority Districts: 2006 and 2011 (Office for National Statistics);
- Electoral Ward populations (2001 Census);
- Ethnicity for Ward Populations (2001 Census);
- Poor Health, Long-term illness, Permanent sickness for Ward Populations (2001 Census);
- Overcrowding (2001 Census);
- Indicators of Deprivation in 2001: aggregated to Wards (2004 Deprivation Indices);
- Mortality 1998–2002 for wards (Registrar General);
- Obesity and BMI from Local Lifestyle Surveys for St Helens & Knowsley, and for Liverpool & Sefton;
- Obesity and BMI Health Survey for England 1993–2001(National Data Archive);
- Outpatient registers of patients attending diabetes clinics at Aintree Hospitals 2001-2004;
- Hospital Episode Statistics for the years 1998/9-2002/3 (Department of Health Statistics Division);
- Synthetic Estimates of Obesity for Local Authority Wards (National Centre for Social Research);
- $P^2$ People and Places (Beacon Dodsworth G-Commerce Solutions);
- Rural and Urban Area Classification of 2003 Statistical wards (Office for National Statistics).

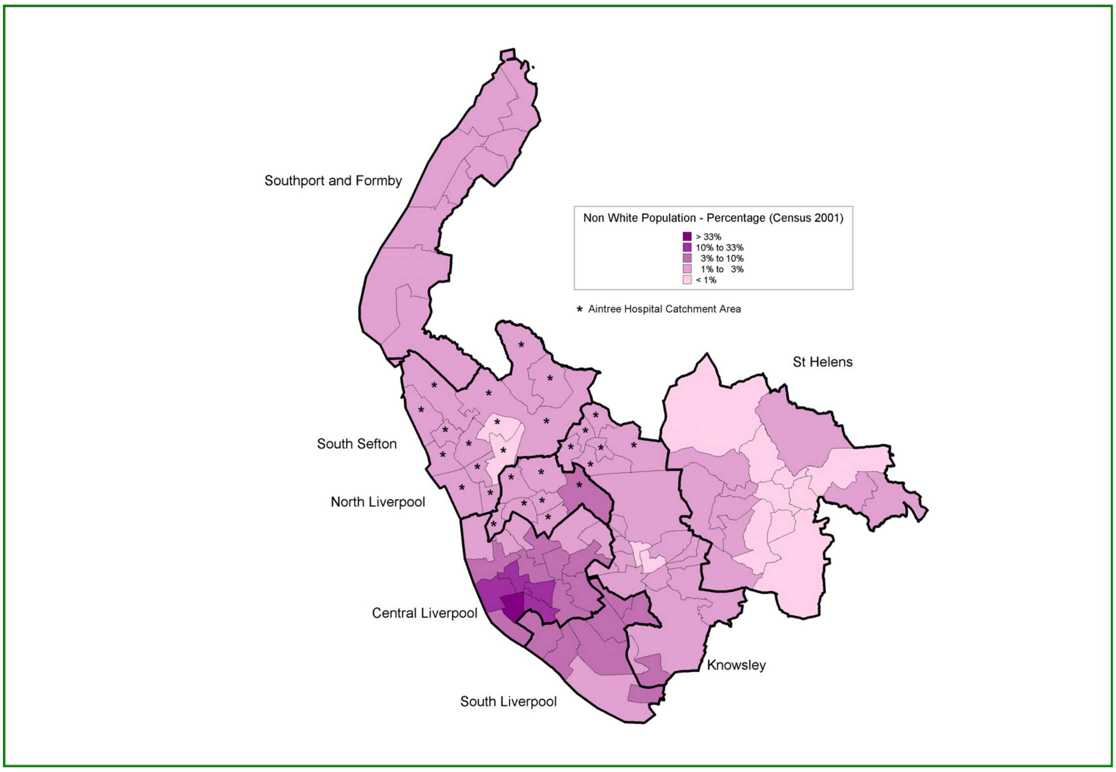
**Index of Deprivation 2004 component data sets:**

- Income deprivation (% of population in household < two thirds national median income);
- Employment deprivation (% of working age population unemployed or claiming incapacity benefits);
- Health deprivation (composite of hospital emergency admissions, early mortality, incapacity and mental health prescription rates);
- Crime (crime rates per capita);
- Environment;
- Poor levels of adult skills;
- Poor levels of child educational attainment;
- Geographical inaccessibility;
- All causes Standardised Mortality Rate;
- <75 Standardised Mortality for circulatory diseases;
- Census standardised illness ratio for “not good health”;
- Census standardised illness ratio for “long term illness”;
- Census standardised illness ratio for “permanent sickness”;
- % living in overcrowded accommodation.

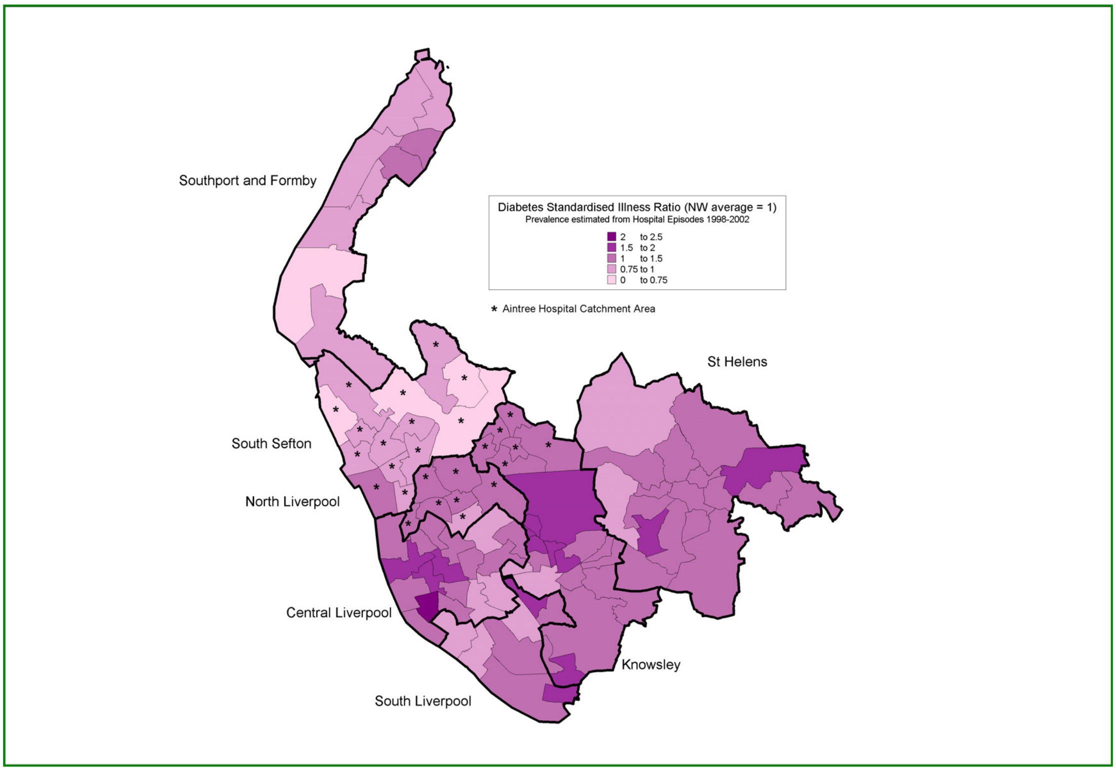
## 4.2 Appendix 2 Thematically mapped risk factors



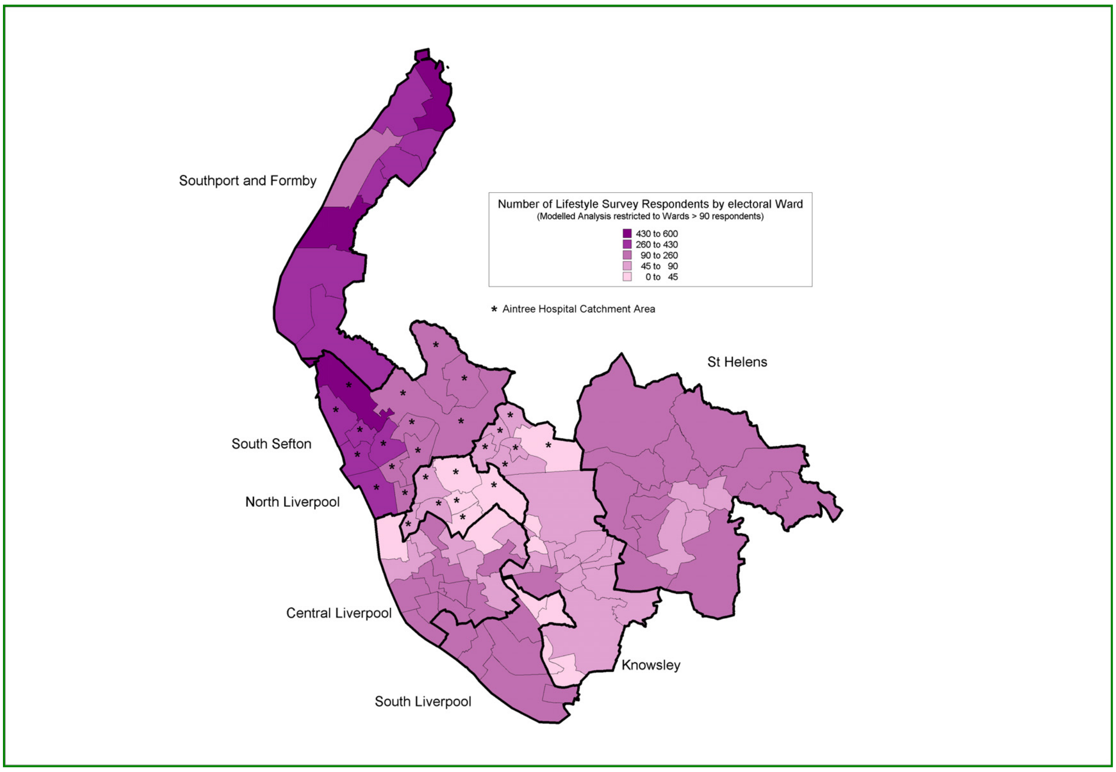

**Map 1** Composite deprivation score by electoral ward and PCT boundary




**Map 2** Percentage non-white population by ward and PCT boundary




**Map 3** Diabetes Standardised Illness Ratio by ward and PCT boundary




**Map 4** Number of Lifestyle Survey respondents by ward and PCT boundary

## 5. REFERENCES

Abate, N. & Chandalia, M. (2003) The impact of ethnicity on type 2 diabetes. *Journal of Diabetes Complications* 17, 39-58.

Astrup, A. & Finer, N. (2000) Redefining type 2 diabetes: 'diabesity' or 'obesity dependent diabetes mellitus'. *Obesity Reviews* 1(2), 57.

Buchan, I. (2004) Northwest obesity, overweight-ness from 1993 to 2001, "Fatness in the Northwest" presentation, First Annual Northwest Public Health Conference, March 2004, Windermere.

Casparie, A. (1991) Epidemiology of type II diabetes mellitus and the aging of the population: health policy implications and recommendations for epidemiological research. *International Journal of Epidemiology* 20(1), 25-29.

Commission for Health Improvement (2001) *Report of a Clinical Governance Review at Aintree NHS Hospitals Trust*. London, Commission For Health Improvement.
http://www.healthcarecommission.org.uk/assetRoot/04/00/29/60/04002960.pdf

Connolly, V. & Kelly, W. (1995) Risk factors for diabetes in men. *British Medical Journal* 311, 188.

Connolly, V. Unwin, N. Sherriff, P. Bilous, R. & Kelly, W. (2000) Diabetes prevalence and socio-economic status: a population based study showing increases prevalence of type 2 diabetes mellitus in deprived areas. *Journal of Epidemiology and Community Health* 54, 173-177.

Currie, C.J. Williams, D.R. Peters, J.R. (1996) Patterns of in and out-patient activity for diabetes: a district survey. *Diabetic Medicine* 13, 273-80.

Currie, C.J. Kraus, D. Morgan, C.L. Gill, L. Stott, N.C.H. Peters, J.R. (1997a) NHS acute sector expenditure for diabetes: the present, future, and excess in-patient cost of care. *Diabetic Medicine* 14, 686-92.

Currie, C.J. Morgan, C.L. Peters, J.R. (1997b) Patterns and costs of diabetes and no diabetes related coronary heart disease hospital care. *Heart* 78, 544-9.

Davies, M.J. Tringham, J.R. Troughton, J. & Khunti, K.K. (2004) Prevention of type 2 diabetes mellitus. A review of the evidence and its application to a UK setting. *Diabetic Medicine* 21(5), 403-414.

Department of Health (2001) *National Service Framework for Diabetes : standards*. London, Department of Health.
http://www.dh.gov.uk/PublicationsAndStatistics/Publications/PublicationsPolicyAndGuidance/PublicationsPolicyAndGuidanceArticle/fs/en?CONTENT_ID=4002951&chk=09Kkz1

Department of Health (2003a) *National Service Framework for Diabetes: delivery strategy*. London, Department of Health.
http://www.dh.gov.uk/PublicationsAndStatistics/Publications/PublicationsPolicyAndGuidance/PublicationsPolicyAndGuidanceArticle/fs/en?CONTENT_ID=4003246&chk=lKNg9r

Department of Health (2003b) *General Medical Services (GMS) Contract*. London, Department of Health.
http://www.dh.gov.uk/PolicyAndGuidance/HumanResourcesAndTraining/ModernisingPay/GPContracts/fs/en

Department of Health (2005) *Improving Diabetes Services-the NSF two years on*. London, Department of Health.
http://www.dh.gov.uk/assetRoot/04/10/67/20/04106720.pdf

Diabetes UK (2004) *Understanding Diabetes*. London, Diabetes UK.
www.diabetes.org.uk/diabetes/under.htm.

Diabetes UK (2005) *Type 2 diabetes and obesity: a heavy burden*. London, Diabetes UK.

Dyer, O. (2002) First case of type 2 diabetes found in white UK teenagers. *British Medical Journal* 324, 506.

Evans, J.M.M. Newton, R.W. Ruta, D.A. MacDonald T.M. & Morris, A.D. (2000) Socio-economic status, obesity and prevalence of type 1 and type 2 diabetes mellitus. *Diabetic Medicine* 17(6), 478.

Gill, G.V. Ismail, A.A. Beeching, N.J. Macfarlane, S.B.J. & Bellis, M.A. (2003) Hidden diabetes in the UK: use of capture-recapture methods to estimate total prevalence of diabetes mellitus in an urban population. *Journal of the Royal Society of Medicine* 96, 328-332.

Gottesman, I. (2004) Managing obesity and glycemic control in insulin-using patients:clinical relevance and practice recommendations. *Diabetes Research and Clinical Practice* 65, S17-S22.

Gray, A. Fenn, P. & McGuire, A. (1995) The cost of insulin-dependent diabetes mellitus (IDDM) in England and Wales. *Diabetic Medicine* 12, 1068-76.

Harwood, C. Mytton, J. & Watkins, F. (2004) *Diabetes and inequalities in the North West of England*, North West Public Health Observatory, Merseyside and Cheshire Zone.

Health Development Agency (2004a) Health Development Agency Briefing No. 3- Interventions on obesity. London, Health Development Agency.
http://www.hda-online.org.uk/Documents/CHB3-obesity-14-7.pdf

Health Development Agency (2004b) Health Development Agency briefing No. 16- Care pathways for the prevention and management of obesity. London, Health Development agency.
http://www.hda-online.org.uk/Documents/CHB16-obesity-prevention.pdf

Hine, C. (2002) *Spotlight on Diabetes: Update*. Avon, National Health Service.
http://www.avon.nhs.uk/phnet/Publications/diabetes_spotlight2.doc

Hu, F.B. Manson, J.E. Stampfer, M.J. Colditz, G. Liu, S. Solomon, C.G. & Willett, W.C. (2001) Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *The New England Journal of Medicine* 345, 790-797.

Ismail, A.A. Beeching, N.J. Gill, G.V. & Bellis, M.A. (1999) Capture-recapture-adjusted prevalence rates of type 2 diabetes are related to social deprivation. *Quarterly Journal of Medicine* 92, 707-710.

Joint Health Surveys Unit (1999) *Health Survey for England 1998: cardiovascular disease, Volume 1*: findings, London, HMSO.

Jung, R.T (1997) Obesity as a disease. *British Medical Bulletin* 53(2), 307-321.

Kesavadev, J.D. Short, K.R. & Nair, K.S. (2003) Diabetes in old age: an emerging epidemic. *Journal of Association of Physicians of India* 51, 1083-94.

Khunti, K. Baker, R. Rumsey, M & Lakham, M. (1999) Quality of care of patients with diabetes: collection of data from multi-practice audits of diabetes in primary care. *Family Practice* 16, 54-59.

King, H. Aubert, R.E. & Herman, W.H (1998) Global burden of diabetes, 1995-2025. *Diabetes Care* 21, 1414-1431.

Kumari, M. Head, J. & Marmot, M. (2004) Prospective study of social and other risk factors for incidence of type 2 diabetes in the Whitehall II study. *Archives of Internal Medicine* 164(17), 1873-1880.

Laing, W. & Williams, R.(1989) *Diabetes: a model for health care management*. London, Office of Health Economics.

Lee, B. Syed, Q. & Bellis, M.A. (1998) *Improving the health of black and ethnic minority communities: a north of England perspective*. Department of Public Health, University of Liverpool & School of Health, Liverpool John Moores University.

Lee, B. Gardner, K. Jones, B. Qassim, T.A Syed, Q. & Bellis, M.A (2000) Ethnicity profiling in primary care: a Princess Park model. Public Health Sector, Liverpool John Moores University.

Mensah, G.A. Mokdad, A.H. Ford, E. Narayan, K.M. Giles, W.H. Vinicor, F.& Deedwania, P.C. (2004) Obesity, metabolic syndrome, and type 2 diabetes: emerging epidemics and their cardiovascular implications. *Journal of Clinical Cardiology* 22(4), 485-504.

Mobley, C.C. (2004) Lifestyle interventions for 'diabesity' : the state of the science. Compend Contin Educ Dent 25(3), 207-8.

Mohan, V. (2004). Why are Indians more prone to diabetes? *Journal of Association of Physicians of India* 52, 468-474.

Mooy, J.M. De Vries, H. Grootenhuis, P.A. Bouter, L.M. & Heine, R.J. (2000) Major stressful life events in relation to prevalence of undetected type 2 diabetes. *Diabetes Care* 23(2): 197-201.

Morrish, N.J. Stevens, L.K. Fuller, J.H. Jarrett, R.J. & Keen, H. (1991) Risk factors for macrovascular disease in diabetes mellitus: the London follow-up to the WHO Multinational Study of Vascular Disease in Diabetics. *Diabetologia* 34, 590-4.

Pontiroli, A.E. (2004) Type 2 diabetes mellitus is becoming the most common type of diabetes in school children. *Acta Diabetol* 41(3), 85-90.

Prisant, L.M (2004) Preventing type II diabetes Mellitus. *Journal of Clinical Pharmacology* 44(4), 406-13.

Sairenchi, T. Iso, H. Nishimura, A. Hosoda, T. Irie, F. Saito, Y. Murakami, A. & Fukutomi, H. (2004) Cigarette smoking and risk of type 2 diabetes mellitus among middle-aged and elderly Japanese men and women. *American Journal of Epidemiology* 160(2), 158-162.

Sandys, M. (2002) Health and Community Survey 2001. Public Health Department, St Helens and Knowsley Health Authority.

Schulze, M.B. & Hu, F.B. (2004). Primary prevention of diabetes: what can be done and how much can be prevented? *Annual Reviews of Public Health*, 26.

Stevens, A. & Raftery, J. (1994) Health care needs assessments. *Radcliffe Medical* 1, 31-56.

Sturm, R. (2002) The Effects of Obesity, Smoking, and Drinking on Medical Problems and Costs. *Health Affairs*, 21, Number 2, March/April 2002.

Tang, M. Chen, Y. & Krewski, D. (2003) Gender-related differences in the association between socioeconomic status and self-reported diabetes. *International Journal of Epidemiology* 32, 381-385.

Thorp, S. (2005) Blind Spot. *Public Health News*, 14 March, pp.12-14.

Van Dam, R.M. (2003) The epidemiology of lifestyle and risk for type 2 diabetes. *European Journal of Epidemiology* 18(12), 1115-1125.

Wild, S. Roglic, G. Green, A. Sicree, R. & King, H. (2004) Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care* 27(5),1047-1053.

Will, J.C. Galuska, D.A. Ford, E.S. Mokdad, A. & Calle, E.E. (2001) Cigarette smoking and diabetes mellitus; evidence of a positive association form a large prospective cohort study. *International Journal of Epidemiology* 30(3), 540-546.

Williams, R. Farrar, H. (2000) Diabetes mellitus in health care needs assessment: the epidemiologically based needs assessment reviews. 3rd series. Oxford, Radcliffe Medical Press. http://hcna.radcliffe-oxford.com/diabetes.htm.

Wong, J.S.K. Pearson, D.W.M. Murchison, L.E. Williams, M.J. & Narayan, V. (1991) Mortality in diabetes mellitus: experience of a geographically defined population. *Diabetic Medicine* 8: 135-9.

World Health Organisation (1997) *Consultation on obesity. Preventing and managing the global epidemic*. Geneva, World Health Organisation.

World Health Organisation (1998). *Obesity: preventing and managing the global epidemic*. Geneva: World Health Organisation.

World Health Organisation (2002a) *Diabetes Mellitus, Fact sheet No. 138*. Geneva, World Health Organisation. http://www.who.int/mediacentre/factsheets/fs138/en/

World Health Organisation (2002b) *Diabetes: the cost of diabetes, Fact sheet No. 236*, Geneva, World Health Organisation. http://www.int/mediacentre/factsheet/fs236/en/

## 6. STEERING GROUP MEMBERS

James Birrell – Chief Executive, Aintree Hospitals NHS Trust

Dr Dympna Edwards – Director of Public Health, North Liverpool Primary Care Trust

Dr Elizabeth Preston – Medical Director, Aintree Hospitals NHS Trust

Dr Diana Forrest – Director of Public Health, Knowsley Primary Care Trust

Mrs Hannah Chellaswamy – Director of Public Health, Southport & Formby Primary Care Trust

Mr Paul Langton – Public Health Intelligence Manager, Knowsley Primary Care Trust

Professor Mark Bellis – Director, North West Public Health Observatory

Margaret Jones – Public Health Associate, South Sefton Primary Care Trust

Sacha Wyke – Data Manager, North West Public Health Observatory

Sue Milner – Assistant Director of Public Health, North Liverpool Primary Care Trust

Dr John Wilding – Diabetes Consultant, Aintree Hospitals NHS Trust