Obesity Trends for Adults
Analysis from the Health Survey for England

1993 – 2007

Report by the National Heart Forum

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1 Executive summary 3
2 Introduction 3
2.1 Scope 4
2.2 Organisation of this report 4
3 Background 5
3.1 Data processing 5
3.2 The BMI groupings and stratified variables 6
3.3 Data 7
3.4 Computing 7
4 Trend analysis 8
4.1 Trend analysis: Age Group 20-65 9
4.1.1 Trends for BMI-distributions stratified by Age and Sex 9
4.1.2 Trends for BMI-distributions stratified by Age, Sex and Social Class 12
4.2 Trend analysis: Age Group 40-65 16
4.2.1 Trends for BMI-distributions stratified by Age and Sex 16
4.2.2 Trends for BMI-distributions stratified by Age, Sex and Social Class 19
4.3 Trend analysis: Age Group 45-65 21
4.3.1 Trends for BMI-distributions stratified by Age and Sex 21
4.3.2 Trends for BMI-distributions stratified by Age, Sex and Social Class 25
5 Micro-simulation 28
5.1 Introduction 28
5.2 Disease statistics 28
5.3 Interventions simulation 28
5.4 BMI related diseases 29
5.4.1 Disease Prevalence 29
5.4.2 Disease Incidence 31
6 Conclusions 37
7 Appendix 37

1 Executive summary

The publication of the Foresight Tackling Obesities[i] report in 2007 highlighted the significant public health threat posed by the growth of obesity in the English population and mirrored throughout the UK. Micro-simulation modelling was employed by the National Heart Forum (NHF) to predict future trends in obesity and their consequences for population health. The NHF have continued to develop this work and here present an update to the adult obesity and associated disease statistics.

The original Foresight[ii] report used Health Survey for England (HSE) data from the years 1993 to 2004 inclusive. Since then there have been three more years of data published. This report uses the complete data set 1993 to 2007 from which to make future predictions of obesity growth in adults and goes on to set out updated projections for obesity related disease incidence.This work makes use of the most recently available disease incidence, prevalence, mortality and relative-risk statistics to present predictions for arthritis, coronary heart disease, diabetes, gall bladder disease, hypertension, stroke and the following cancers: breast, colorectal, endometrial, kidney, oesophageal and liver.

Unlike the recent report on child obesity[iii] which showed some indications of a flattening or at least a significant reduction in the rate of obesity, the future projections for adults are less optimistic. Table 1 below shows that by 2020 rates of obesity in adult males and females are predicted to be only marginally less than those predicted in the original Foresight[iv] report. When examined the figures for the older age group are even less optimistic. In both cases the predictions for males and females are within the confidence intervals specified in the Foresight report.

Predictions to 2020	Foresight 1993-2004	All years 1993-2007
Aged 20-65, male	44 (+4,-4)	41 (+2,-2)
Aged 20-65,female	39 (+3,-3)	36 (+2,-2)
Aged 40-65, male	45 (+5,-5)	44 (+3,-3)
Aged 40-65, female	41 (+4,-4)	38 (+3,-3)

Table 1: Adults, predicted BMI distributions >30 at 2020. The numbers in brackets are the statistical uncertainty to the 95% confidence level.

These trends in adult obesity lead to significant rises in the levels of obesity related diseases, particularly the vascular diseases: coronary heart disease, diabetes, hypertension and stroke.

2 Introduction

This report presents analysis that uses the most recent Health Survey for England data to predict future obesity trends and their consequences in terms of the increase incidence of BMI related diseases. The incidence of disease is modelled using a micro-simulation. The simulation makes use of the most recently available disease incidence, prevalence, mortality and relative-risk statistics to present predictions for arthritis, coronary heart disease, diabetes, gall bladder disease, hypertension, stroke

and the following cancers: breast, colorectal, endometrial, kidney, oesophageal and liver. An important development to the disease-modelling is the inclusion of hypertension: it is a significant illness in its own right but it also plays an important intermediate role in raising the relative risks of other diseases. Micro-simulation can easily capture and model such dependencies.

2.1 Scope

The new HSE 2007 datasets, as with other data sets when they become available , are incorporated into the software developed for Foresight to show trends until 2020, by gender, age, social class etc. The analysis of these new data are divided into two parts: firstly, the future obesity trends for the UK population are produced and these are then inputted into the micro-simulation, the second part, to predict their consequences in terms of the rise and costs of BMI related diseases.

Since its creation for the Foresight report the micro-simulation has been further developed by the National Heart Forum. The key elements of its forecasting methods remain much the same but it has a significantly enhanced ability to handle different data sets. In this report, this capability allows for easy comparisons of the predictions made using the current data set {1993-2007} and the same data set but with different parameters. These comparisons and others are described in section 5.4.

This report makes use of the most recently available disease incidence, prevalence, mortality and relative-risk statistics. To the set of BMI related diseases studied in the Foresight report are added liver cancer and hypertension. Hypertension is a significant illness in its own right but it also plays an important intermediate role in raising the relative risks of other diseases. Micro-simulation easily captures and models such dependencies.

2.2 Organisation of this report

The report is divided into a number of sections.

Section 3 describes the background to this report and comments briefly on those features of the data processing that are necessary for an understanding of the main content of the report.

Section 4 reports on the analysis of the HSE data from 1993 up to and including the most recent data set, that for 2007, which was released in March 2009. Almost all measures used for comparison are predictions from subsets of these data for the year 2020. This section deals exclusively with data that are stratified by, for each Age Group (A) 20-40, 40-65 and 45-65: Sex (S); and Sex and Social Class (C).

Section 5 details the work carried for the micro-simulation cataloguing the predictions for the set of BMI related diseases.

Finally, section 6 presents all the conclusions.

3 Background

3.1 Data processing

Processing is essentially the same as for the original Foresight report. It is carried out by the purpose built C++ program Obesity_distribution.exe.

Each year relevant data are drawn from the The Health Survey for England (HSE) published data files and are sorted by age, sex and BMI group.

The program Obesity_distribution sorts HSE files to obtain estimates for the proportion of the sampled population that (for example) belong to a particular age group, sex group and BMI group. These annual estimates are variously termed *plots* or *data points* and consist of three components: the year for which the data are valid, the proportion or percentage of the population in that year and the standard deviation of the proportion of the population in that year.

Trends for particular age-sex-BMI subgroups are obtained by performing regression analysis on collections of data points drawn from a number of years. For example figure 2 draws the five sets of fifteen plots for adult males, aged 20-65, that is divided into the five BMI-subgroupings.

In Figure 2 the short, solid vertical lines show the data points: for each year for which data are available (in the case of Figure 2, 1993 to 2007). The centre of these lines is the best estimate for the proportion of the population; the vertical lines are drawn to show ± 2 standard deviations either side of the best estimate. The x-axis is time in years (here, 1993 to 2020) and the y-scale the proportion of the total population in each BMI category.

The solid trend lines, for each BMI subgroup, are the two (two-parameter) regression lines that are calculated by standard Bayesian, maximum likelihood analysis from the sets of plots.

The maximum likelihood estimates of the regression parameters and their probability distributions are determined by standard analysis from the relevant set of plots. The probability distribution of the parameters is used to determine the confidence limits for the regression line – these are shown as dotted lines – with the associated confidence region being shaded.

The program Obesity_distribution can perform a similar regression analysis for any selected subset of plots and this feature is exploited in this report.
The next stage in the data analysis method involves importing into the micro simulation program the complete set of these regression parameters. These are grouped into a single named text file (with a .ab extension) and can be identified and selected from the simulation's editor.

3.1.1 Micro simulation of individuals

In its key functional elements the micro simulation program, obesity.exe, is essentially the same as that used for the original Foresight report. This can be briefly summarised as follows: The micro simulation gathers population level statistics by simulating the lives of statistically generated individuals. These individuals have a population age and sex profile that matches the England and Wales population in the start-year 2008. In the course of the simulation they live their lives in increments of one year. Each year their BMI is changed according to the selected BMI model and they can contract, die or recover from, any one of a number of modelled diseases. The disease incidence statistics will vary according to the person's age, sex, BMI and disease history.

The simulation operates by conducting a series of Monte Carlo trials – one trial for each simulated individual lifetime. Data that are generated for individuals are stored and processed to provide a large number of output statistics and graphics. A selection of these statistics are provided in this report.

3.2 The BMI groupings and stratified variables

This report uses the following five BMI classifications:

- BMI: <20 (underweight);
- BMI: 20-25 (OK/appropriate);
- BMI: 25-30 (overweight);
- BMI: 30-40 (obese);
- BMI: >40 (morbidly obese).

The social class groups used were:

- Class I-Professional;
- Class II-Managerial technical;
- Class IIIN-Skilled non-manual;
- Class IIIM-Skilled manual;
- Class IV-Semi-skilled manual;
- Class V-Unskilled.

In this report for the BMI distributions we shall continue to provide predictions, for 2020 mainly, that make use of the two different sets of data points: all years [1993 to 2007] and the last eight years [2000 to 2007]. Each set of data points is included for a different reason:

All years [1993 to 2007]: to provide continuity and a comparison with Foresight.
The last eight years [2000 to 2007]: the best estimate of the most recent trends.

For the tabulated data two additional different sets of data points have been included: the Foresight years [1993 to 2004]; and the first eight years [1993 to 2000] for the following reasons:

The first eight years [1993 to 2000]: to compare early trends with most recent trends.

The Foresight years [1993 to 2004]: to provide a necessary reference.

3.3 Data

The micro simulation uses a considerable quantity of input data. Disease and population statistics are listed in the Appendices.

Since the foresight report, wherever possible, these data have been changed to be the most recently available. Population statistical data are those valid for the year 2008. Disease data are mostly valid for the year 2006.

3.4 Computing

The micro simulation used for this report is version 7.0 of the program obesity.exe. Since the Foresight report the program has been significantly enhanced in its structural design and its input/output and graphical methods.

3.4.1 Disease editor

A disease editor and disease input editor have been added to the micro simulation. Simulated diseases can now be fully edited. Groups of diseases can be gathered into batch files and selected via the Disease editor window. Figure 1 shows the disease editor window. A run of the micro-simulation accesses the specified disease batch file. Individual disease statistics are edited via the Disease Input editor.

Before any disease batch file is used by the simulation its component diseases are used to construct the appropriate simulation death model. This is constructed from known population death statistics and is implemented as the *unspec* disease object. It allows for deaths in the simulated population that are not a consequence of the terminal diseases already in the Disease batch file. The population death statistics are themselves coded into the *deaths only* disease object and this like the disease batch file, is selectable via the disease editor – see Figure 1.

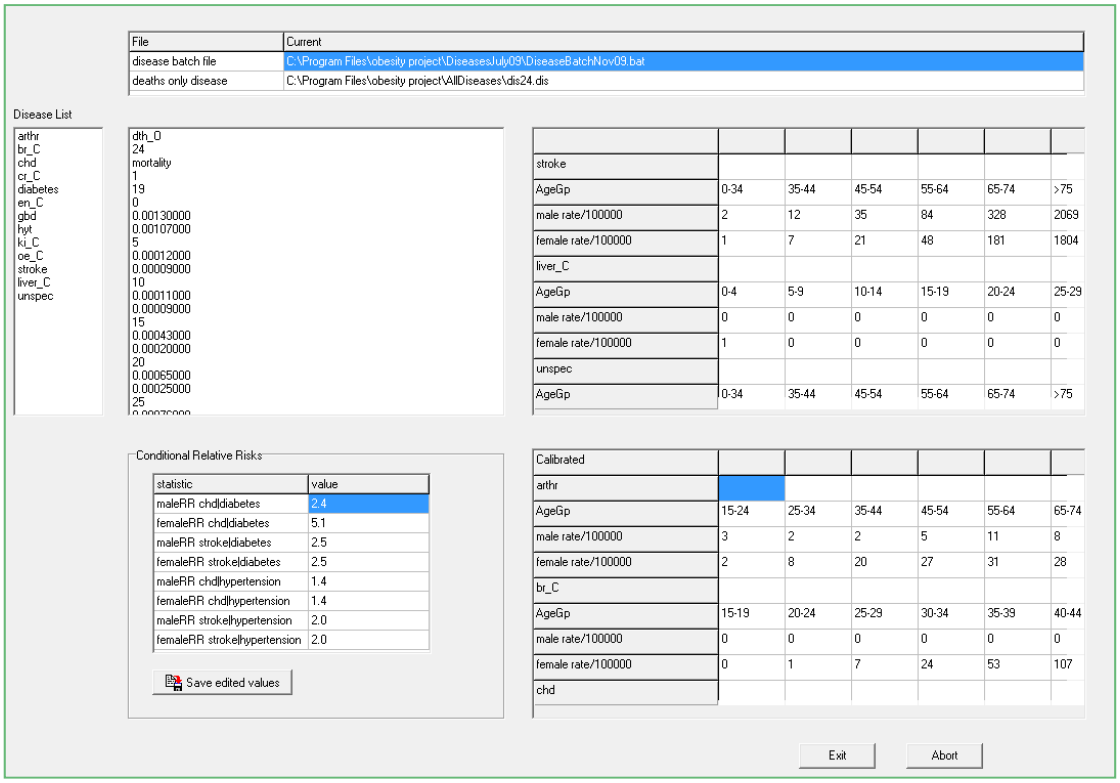


Figure 1: Disease editor window showing the selected disease batch file

In order to improve the speed of the simulation, Diseases are *calibrated* – a process by which the disease incidence statistics and relative risk statistics are used to compute a base disease-incidence rate. For a simulated person with a particular age sex and BMI the incidence risk is computed as the base incidence rate multiplied by the appropriate relative risk.

3.4.2 Interventions simulation

The scope for different interventions has been considerably enhanced from the Foresight standard. Many of these new functions need not be described here but one is worth mentioning as it is used in what follows in the body of this report.

Broadly speaking, the runs of the micro simulation are identified as particular *Interventions*. Each Intervention now identifies a particular BMI prediction model as well as a scenario which may or may not involve alterations to that model. Comparisons can be made by grouping together sets of interventions into batches and performing successive sets of Monte Carlo trials - one for each Intervention in the batch. Batch processing of Interventions was possible at the software standard of the Foresight report, what is new is that each Intervention can now identify its own BMI prediction model.

This feature is used in Section 5.4 where some high level comparisons are made between the most recent predictions of the frequency of obesity related diseases with those where the obesity levels are held constant at 2006 values.

4 Trend analysis

This section details some of the results carried out for the trend analysis.

4.1 Trend analysis: Age Group 20-65

A selection of the BMI distributions is given within the next few subsections. For the remaining set of BMI distributions for each age group the reader is referred to the corresponding section of the appendix.

4.1.1 Trends for BMI-distributions stratified by Age and Sex

At the time of the Foresight report, appropriate HSE data sets existed from 1993 to 2004 inclusive. By the time of writing of this report three more years have been added: 2005, 2006 and 2007. Figure 2 shows the predicted BMI distribution for 20-65 adult males that is based on the complete set of data points 1993 to 2007 inclusive. The figure shows the prediction for the population's membership of the five BMI subgroups: BMI<20, 20<BMI<25, 25<BMI<30, 30<BMI<40 and BMI>40 to the year 2020. The 95% confidence limits are shown as the shaded regions.

It is apparent form Figure 2 that there is a clear downward gradient for normal weight (blue line) whilst levels of over-weight (red line) remain relatively stable so that decline in normal weight is mirrored by a significant increase in levels of obesity (brown line) and in levels of morbid obesity (orange line). These obesity levels are within the confidence limits of the levels recorded in the earlier Foresight report.

Figure 3 is identical to figure 2 excepting only that it makes its predictions using those data of the last eight years– the years [2000-2007].

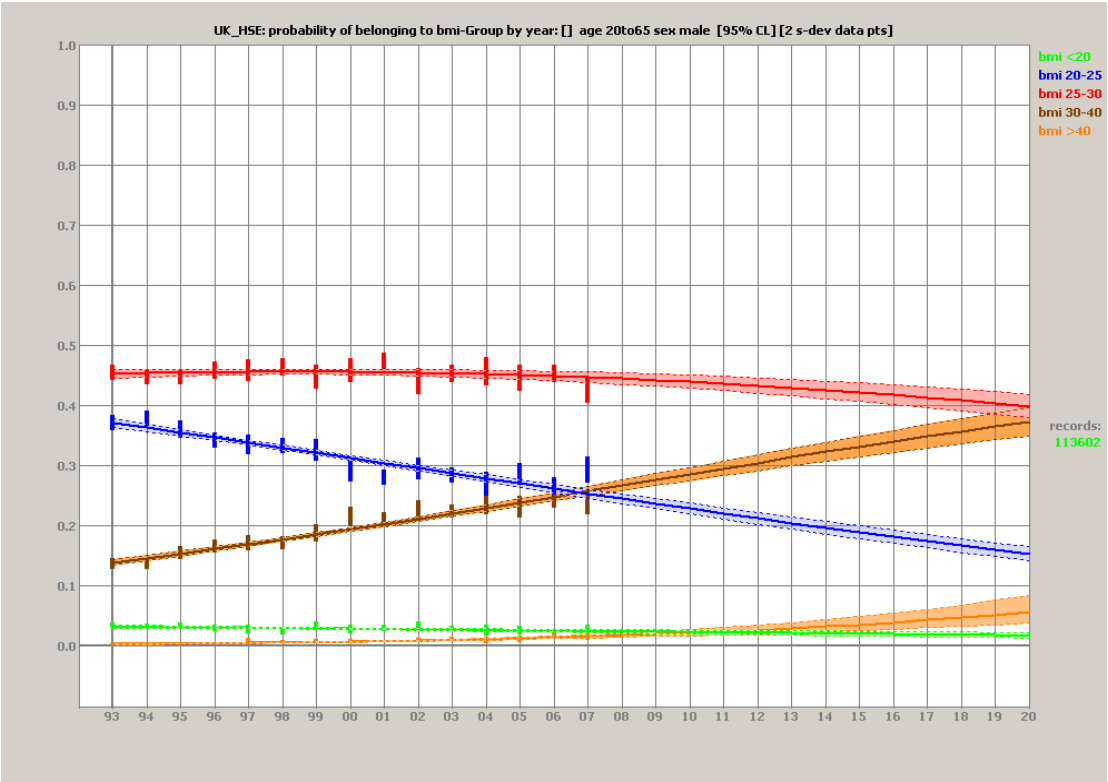


Figure 2: Adult males aged 20-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive

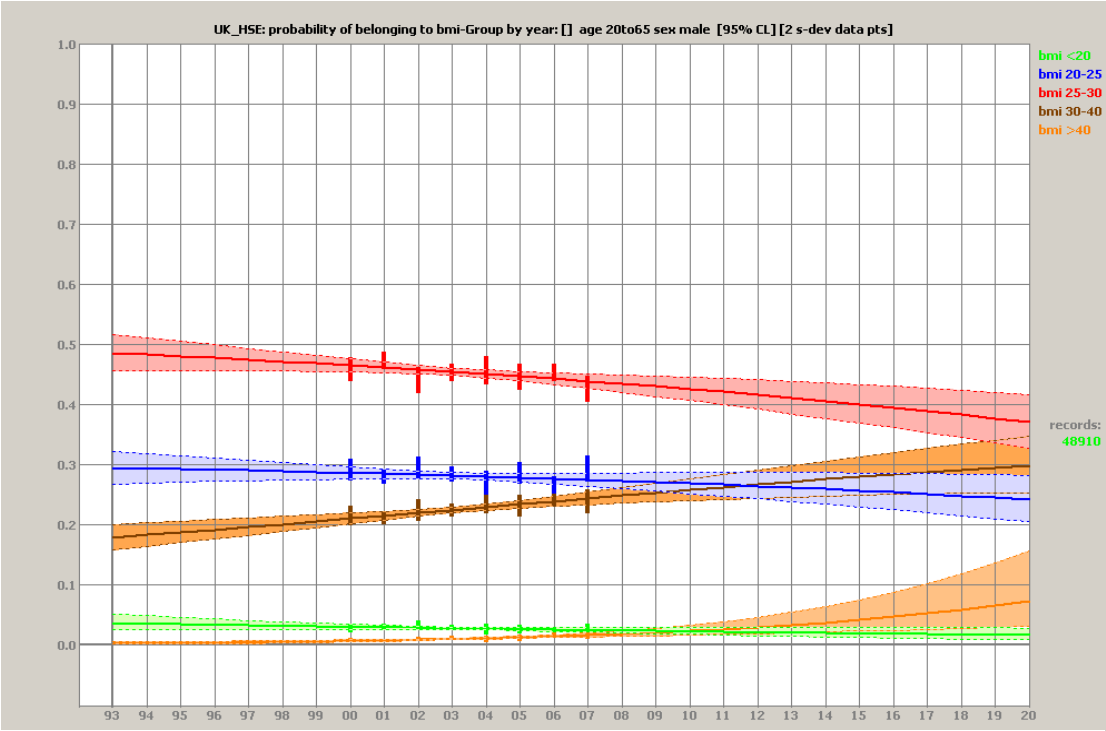


Figure 3: Adult males aged 20-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data

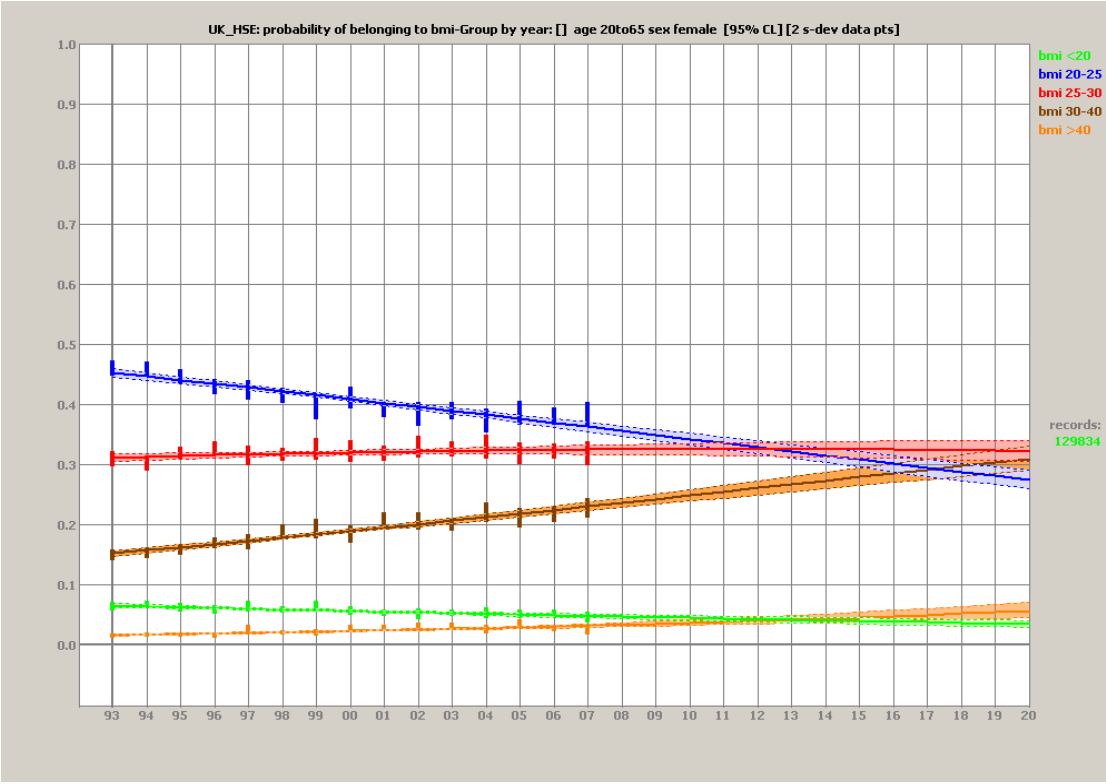


Figure 4: Adult females aged 20-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive

Figure 4 shows the trends for adult females aged 20-65. As for the males, normal weight declines, overweight remains relatively constant and obesity and morbid obesity rise - though not to the same extent as the males. Again, these predictions fall within the confidence intervals for female rates of obesity published in the Foresight report.

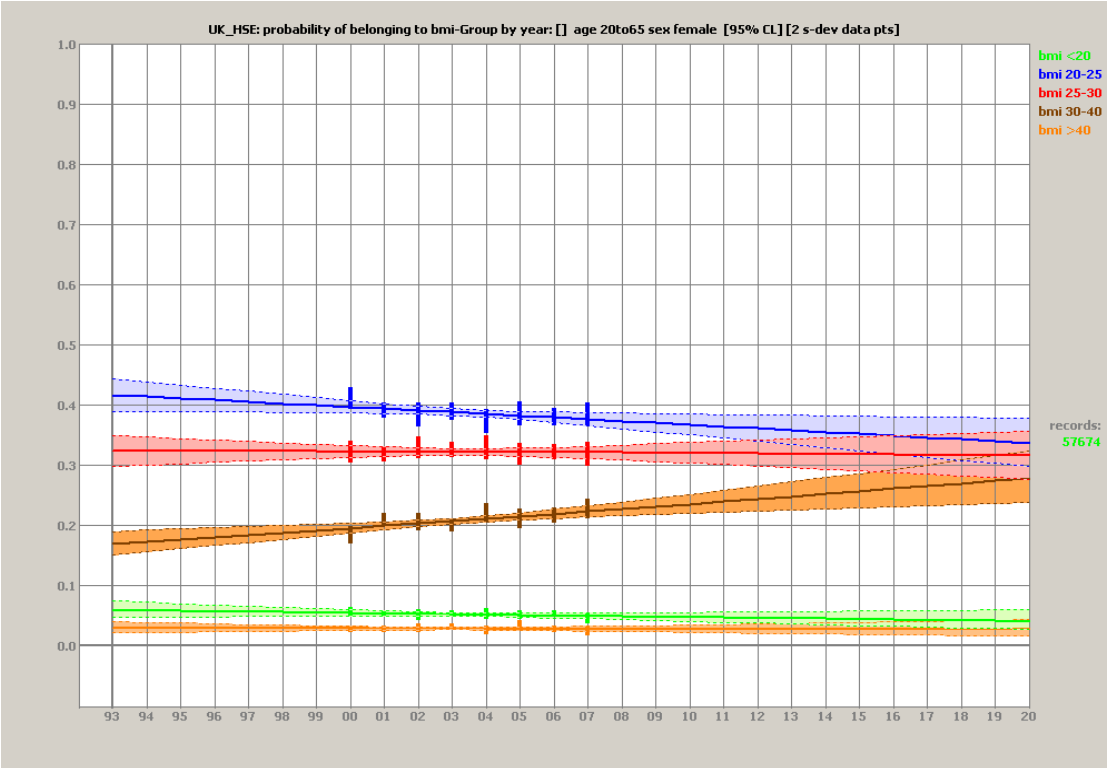


Figure 5: Adult females aged 20-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data

Figures 2-5 suggest that there is a slowing in the rate of increase in obesity amongst adults of ages 20-65 with the last eight years of data (2000 to 2007) reducing the expected proportion of adults aged 20-65 who will be obese in future years by the year 2020 from 37% to 30% and 31% to 28% for males and females respectively. There is slight drop in overweight (40% to 37%) for males but remaining constant for females (at 32%).

However, the analysis also suggests that the rate of OK people in both sexes still remains on the decrease although the rate of decrease has slowed in recent years.

As was the case with the equivalent child obesity report[v] the same subsidiary question arises and that has yet to be answered, namely: How many data points should be used in identifying the recent trend? This question is particularly relevant when the data points span a period over which the trend appears to be changing. In particular, should the early data points, 1993, 1994….continue to influence predictions of the population from 2008 onwards? The answer to this last question, we believe, is probably not.

The results for these first four graphs are summarized in table 2 that gives the predicted BMI distribution in the year 2020 as calculated from four different sets of

data points together with the statistical uncertainty to the 95% confidence level. [The numbers in each column should add to 100 for the first five BMI groups, any discrepancies are due to rounding errors]:

Predictions to 2020	Foresight [1993-2004]	All years [1993-2007]	First 8 years [1993-2000]	Last 8 years [2000-2007]
BMI<20				
20-65, male	2 (+1,-1)	2 (+0,-0)	1 (+1,0)	2 (+1,-1)
20-65, female	3 (+1,-1)	4 (+1,-1)	4(+2,-1)	4 (+2,-1)
20<BMI<25				
20-65, male	13 (+1,-1)	15 (+1,-1)	12 (+3,-2)	24 (+4,-4)
20-65, female	24 (+2,-2)	27 (+2,-2)	21 (+4,-3)	34 (+4,-4)
25<BMI<30				
20-65, male	40 (+3,-3)	40 (+2,-2)	38 (+6,-5)	37 (+5,-4)
20-65, female	33 (+3,-2)	32 (+2,-2)	33 (+5,-5)	32 (+4,-4)
30<BMI<40				
20-65, male	40 (+4,-4)	37 (+2,-2)	40 (+8,-7)	30 (+5,-4)
20-65, female	32 (+3,-3)	31 (+2,-2)	34 (+7,-6)	28 (+4,-4)
BMI>40				
20-65, male	5 (+5,-2)	6 (+3,-2)	9 (+23,-7)	9 (+8,-4)
20-65, female	8 (+3,-2)	6 (+1,-1)	8 (+8,-4)	8 (+2,-1)
BMI>30				
20-65, male	44 (+4,-4)	41 (+2,-2)	46 (+8,-7)	35 (+5,-5)
20-65, female	39 (+3,-3)	36 (+2,-2)	41 (+7,-7)	31 (+4,-4)

Table 2: Adults aged 20-65, predicted BMI distributions at 2020. The numbers in the brackets is the statistical uncertainty to the 95% confidence level.

4.1.2 Trends for BMI-distributions stratified by Age, Sex and Social Class

This subsection simply reproduces the analysis of subsection 4.1.1 but with the additional stratified variable, social class.

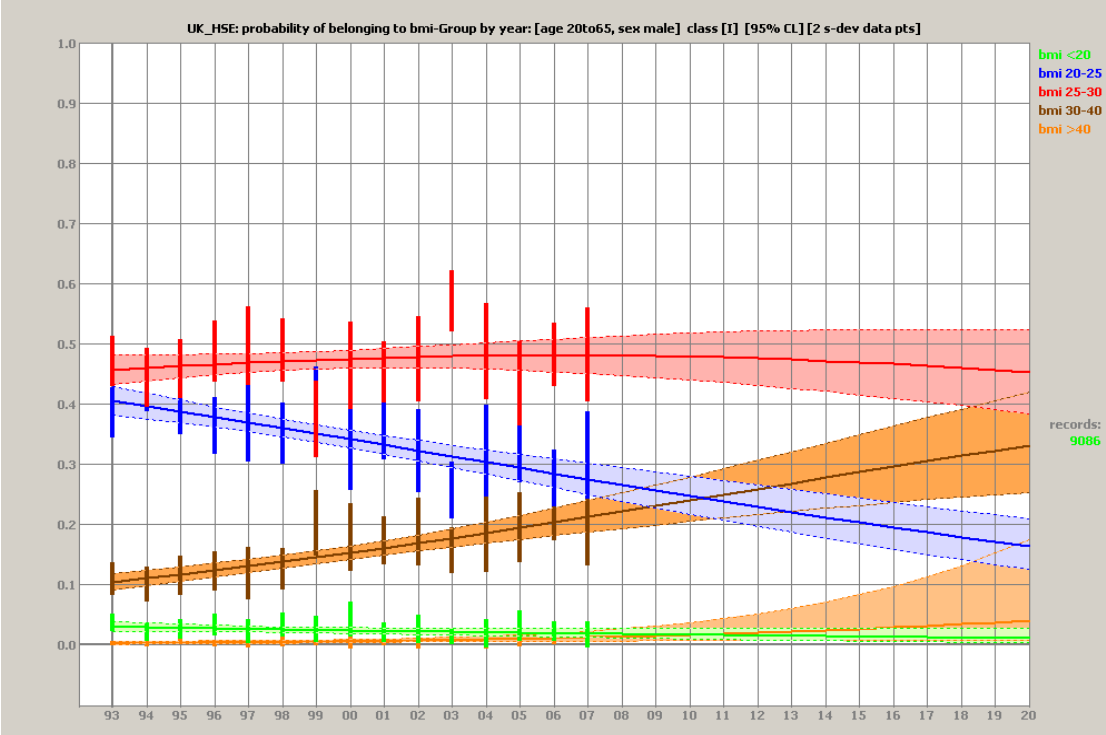


Figure 6: Adult males aged 20-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive, stratified by Sex, Age and Social Class I

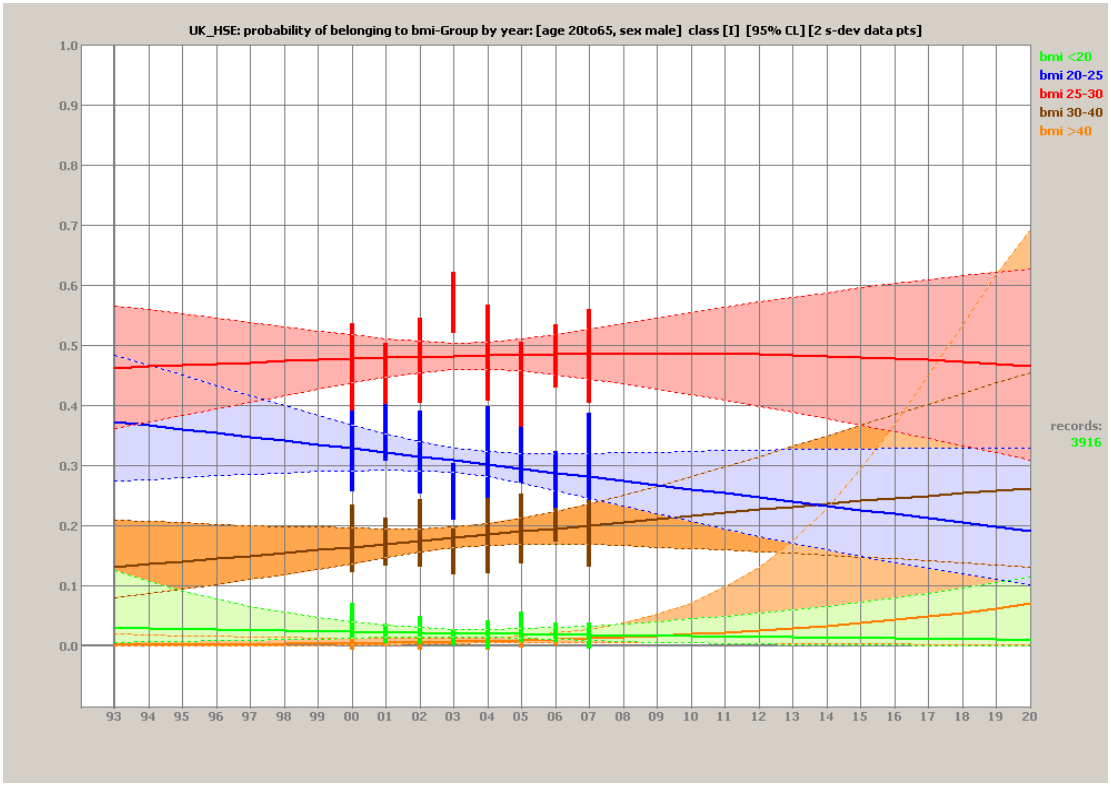


Figure 7: Adult males aged 20-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data, stratified by Sex, Age and Social Class I

Figures 6 and 7 show that for males aged 20-65 the proportion of OK is still falling although the proportion of obese is rising at a slower rate.

The results for these four graphs, stratified by sex, age and social class are summarized in table 3 that gives the predicted BMI distribution in the year 2020 as calculated from four different sets of data points.

The BMI distributions stratified by sex, age and social class remain homogeneous for both sexes excepting for the case of class V for males.

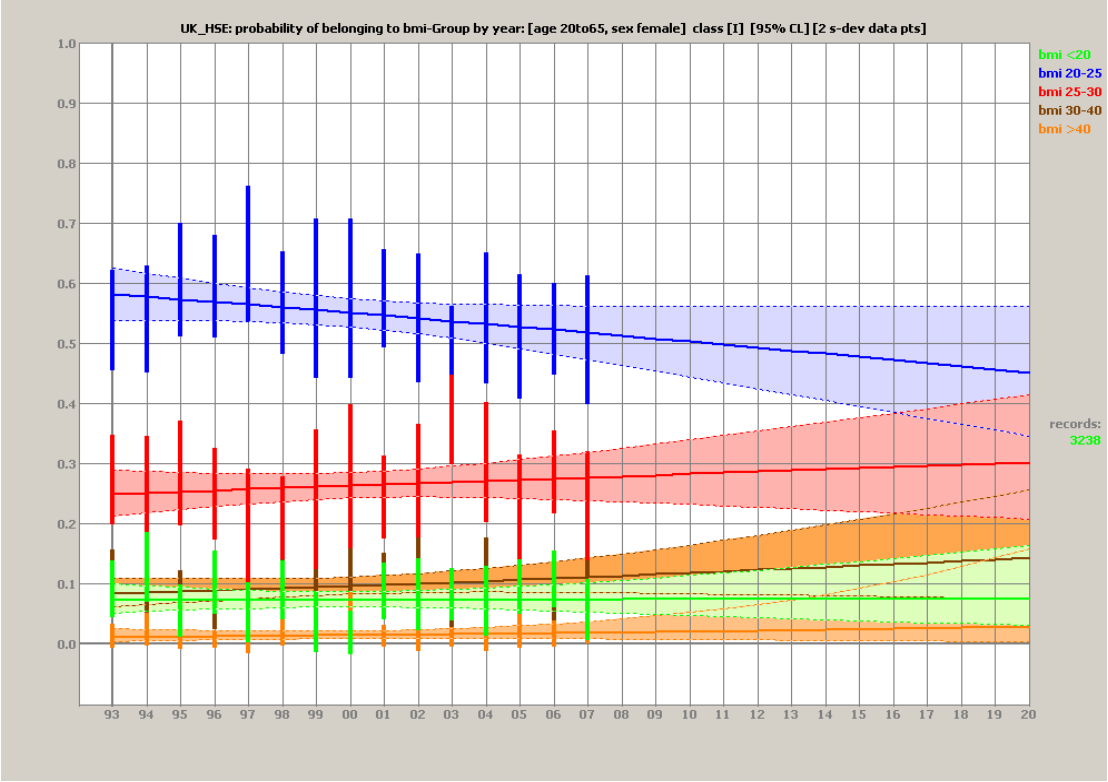


Figure 8: Adult females aged 20-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive, stratified by Sex, Age and Social Class I

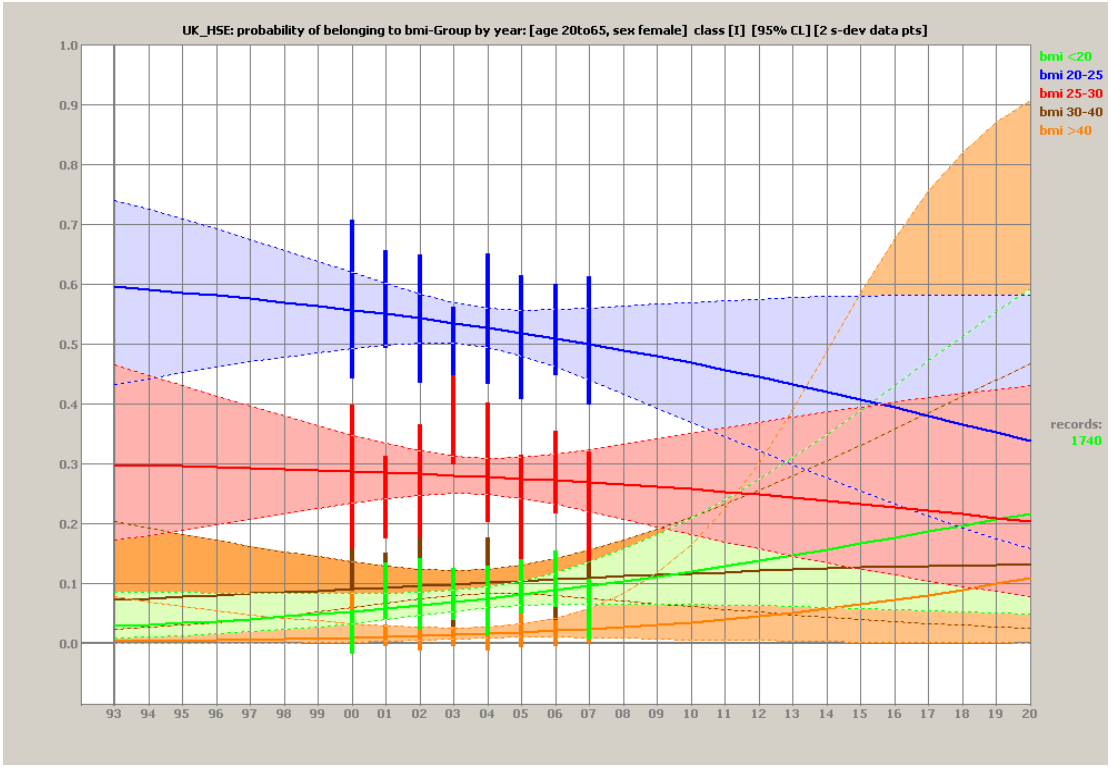


Figure 9: Adult females aged 20-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data, stratified by Sex, Age and Social Class I

predictions to 2020	Foresight [1993-2004]	All years [1993-2007]	first 8 years [1993-2000]	last 8 years [2000-2007]
BMI<20				
20-65, male	1 (+2,-1)	1 (+2,-1)	3 (+26,-3)	1 (+10,-10)
20-65, female	3 (+9,-2)	7 (+9,-4)	0 (+1,-0)	22 (+38,-17)
20<BMI<25				
20-65, male	14 (+6,-4)	16 (+5,-4)	15 (+14,-8)	19 (+14,-9)
20-65, female	45 (+16,-15)	45 (+11,-11)	33 (+37,-24)	34 (+24,-18)
25<BMI<30				
20-65, male	48 (+10,-10)	45 (+7,-7)	29 (+19,-14)	46 (+16,-15)
20-65, female	39 (+19,-16)	30 (+11,-9)	5 (+19,-4)	20 (+23,-12)
30<BMI<40				
20-65, male	33 (+14,-11)	33 (+9,-8)	40 (+29,-23)	26 (+19,-13)
20-65, female	11 (+16,-7)	14 (+11,-7)	34 (+53,-30)	13 (+34,-11)
BMI>40				
20-65, male	3 (+27,-3)	4 (+13,-3)	13 (+84,-13)	7 (+62,-7)
20-65, female	1 (+16,-1)	3 (+13,-2)	28 (+72,-28)	11 (+80,-11)
BMI>30				
20-65, male	35 (+14,-12)	36 (+9,-8)	47 (+28,-26)	30 (+20,-15)
20-65, female	12 (+16,-7)	17 (+12,-8)	54 (+40,-45)	22 (+39,-17)

Table 3: Adults aged 20-65, predicted BMI distributions at 2020 stratified by sex, age and social class I. The numbers in the brackets is the statistical uncertainty to the 95% confidence level.

4.2 Trend analysis: Age Group 40-65

4.2.1 Trends for BMI-distributions stratified by Age and Sex

Figure 10 shows predicted trends for adult males aged 40-65. These are broadly similar to those for all adult males but with steeper trajectories for the obese. Figure 12 shows the predicted trends for females aged 40-65. Again similar to their male counterparts, the older females are more obese. Both sets of results are broadly similar to those published in the Foresight report.

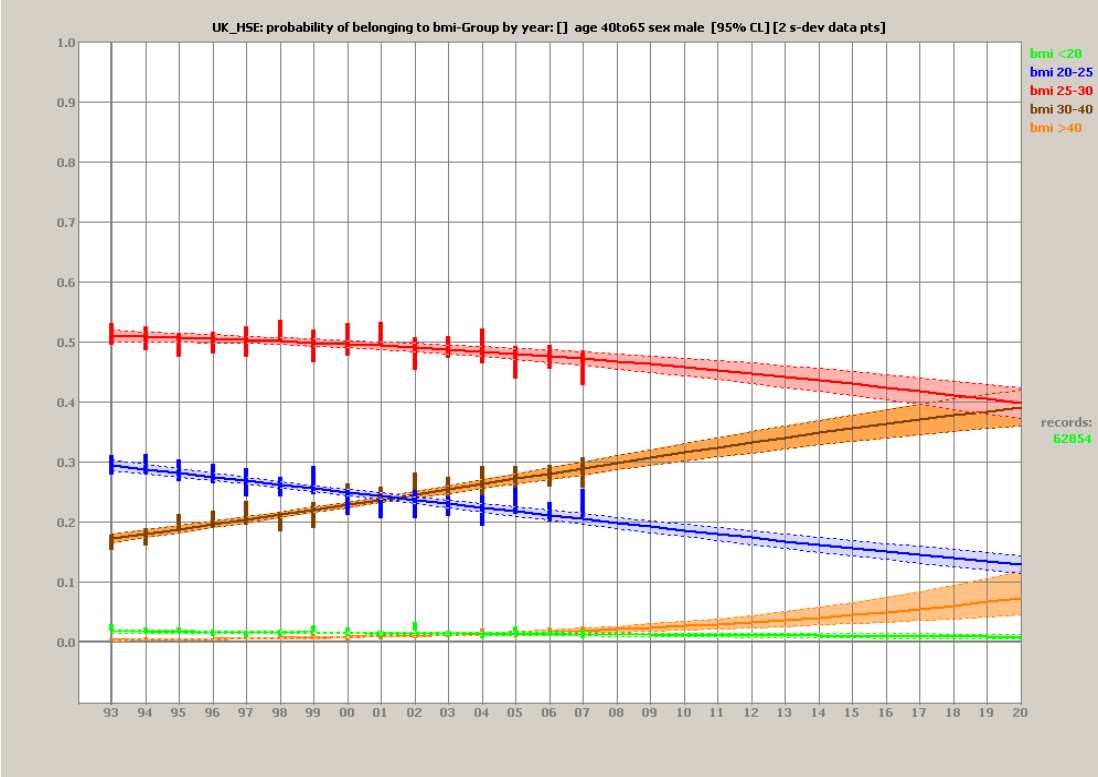


Figure 10: Adult males aged 40-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive

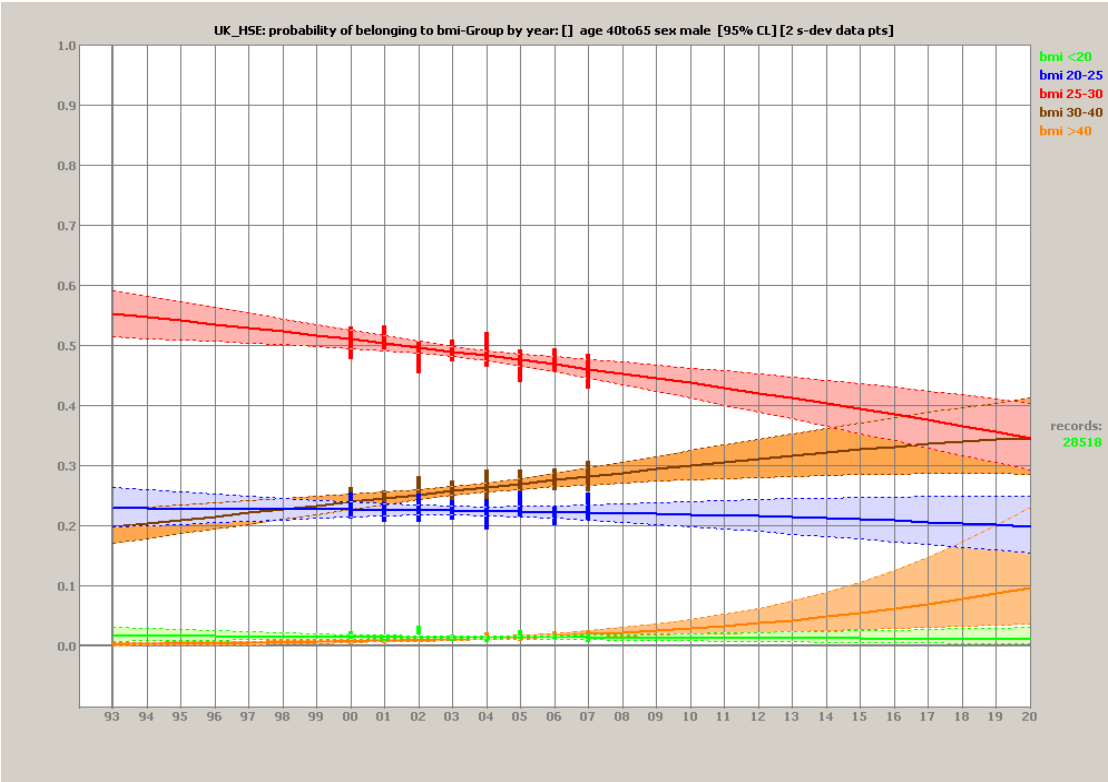


Figure 11: Adult males aged 40-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data

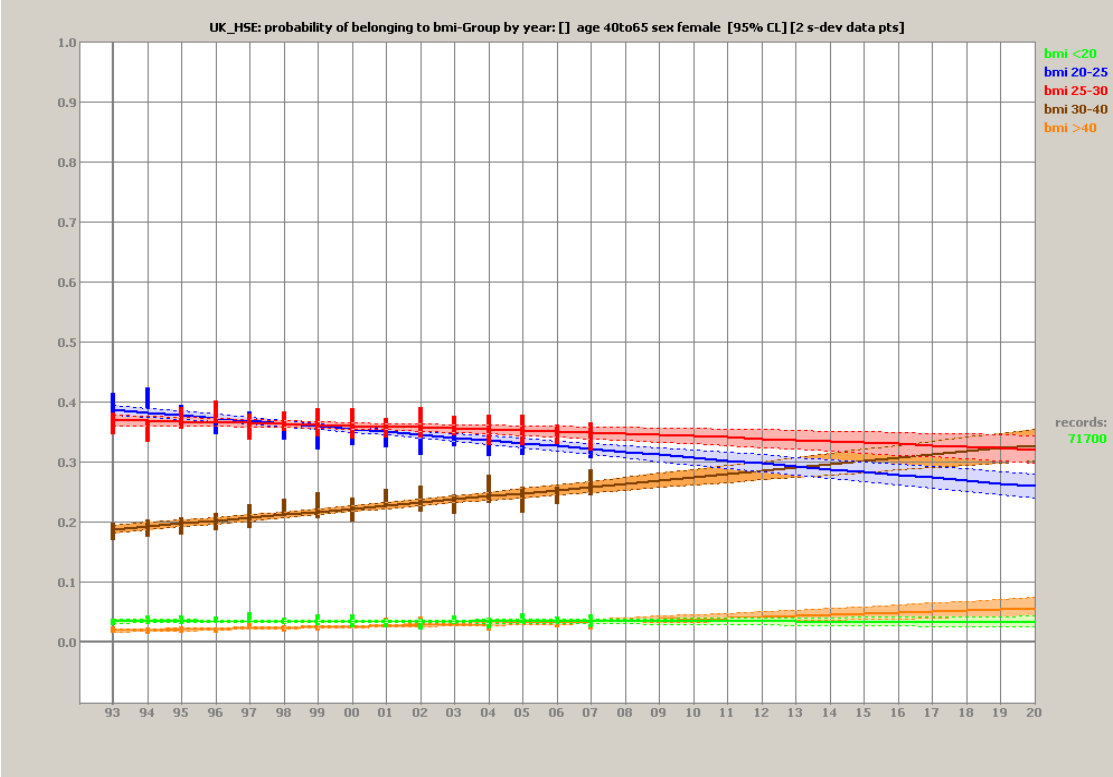


Figure 12: Adult females aged 40-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive

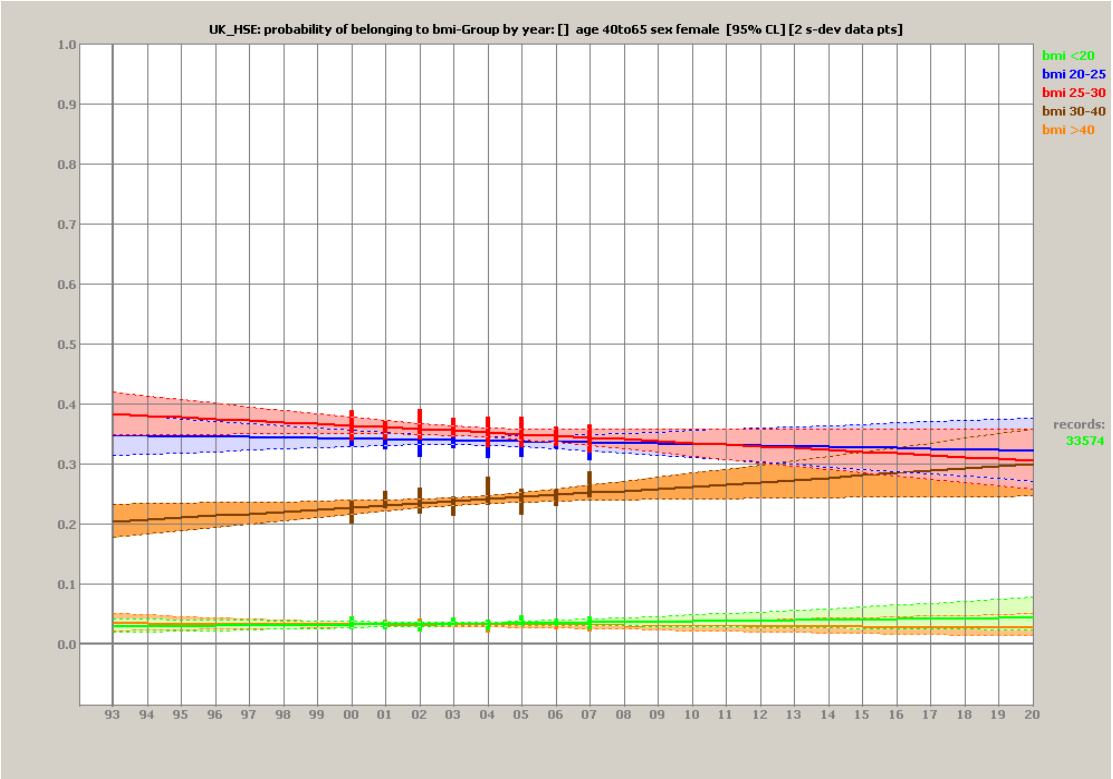


Figure 13: Adult females aged 40-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data

The obesity trend continues to rise but has started to abate for both males and females if one looks, again, at the last eight years of data where the rate of increase is less rapid than for the equivalent trends using all years data.
There was a mild decrease of 5% in the proportion of OW for males when one contrasts all years data with the last eight years worth, with the percentages of the population who were OW of 39% and 34% respectively.

The results for these first four graphs are summarized in table 4 that gives the predicted BMI distribution in the year 2020 as calculated from four different sets of data points together with the statistical uncertainty to the 95% confidence level. [The numbers in each column should add to 100 for the first five BMI groups, any discrepancies are due to rounding errors]:

predictions to 2020	Foresight [1993-2004]	All years [1993-2007]	first 8 years [1993-2000]	last 8 years [2000-2007]
BMI<20				
40-65, male	1 (+1,0)	1 (+1,0)	0 (+1,0)	1 (+2,-1)
40-65, female	3 (+1,-1)	3 (+1,-1)	4 (+4,-2)	4 (+2,-2)
20<BMI<25				
40-65, male	11 (+2,-2)	13 (+2,-1)	10 (+4,-3)	20 (+5,-4)
40-65, female	23 (+3,-3)	26 (+2,-2)	17 (+5,-4)	32 (+5,-5)
25<BMI<30				
40-65, male	41 (+4,-4)	40 (+3,-3)	40 (+8,-7)	35 (+6,-5)
40-65, female	33 (+3,-3)	32 (+2,-2)	34 (+7,-7)	31 (+5,-5)
30<BMI<40				
40-65, male	40 (+5,-4)	39 (+3,-3)	37 (+9,-8)	35 (+7,-6)
40-65, female	34 (+4,-4)	33 (+3,-3)	37 (+9,-8)	30 (+6,-5)
BMI>40				
40-65, male	7 (+8,-4)	7 (+4,-3)	12 (+38,-10)	10 (+13,-6)
40-65, female	7 (+4,-3)	6 (+2,-1)	8 (+11,-5)	3 (+2,-1)
BMI>30				
40-65, male	45 (+5,-5)	44 (+3,-3)	44 (+10,-9)	41 (+7,-6)
40-65, female	41 (+4,-4)	38 (+3,-3)	44 (+9,-9)	33 (+6,-5)

Table 4: Adults aged 40-65, predicted BMI distributions at 2020. The numbers in the brackets is the statistical uncertainty to the 95% confidence level.

4.2.2 Trends for BMI-distributions stratified by Age, Sex and Social Class

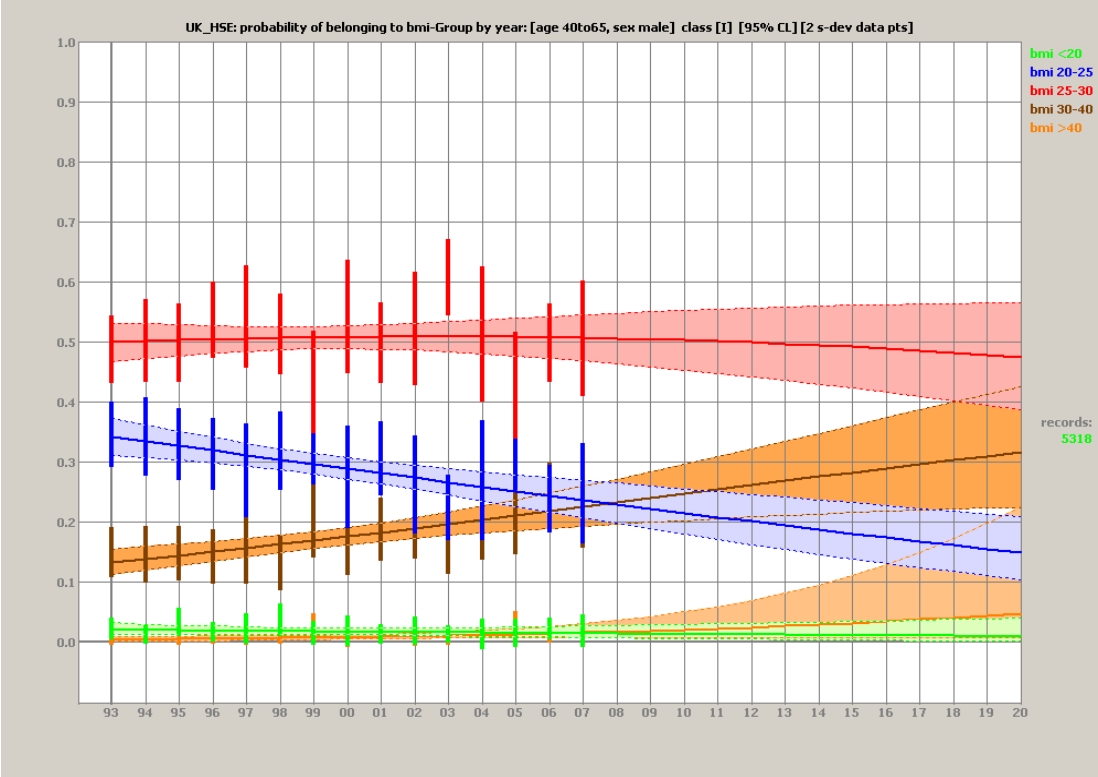


Figure 14: Adult males aged 40-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive, stratified by Sex, Age and Social Class I

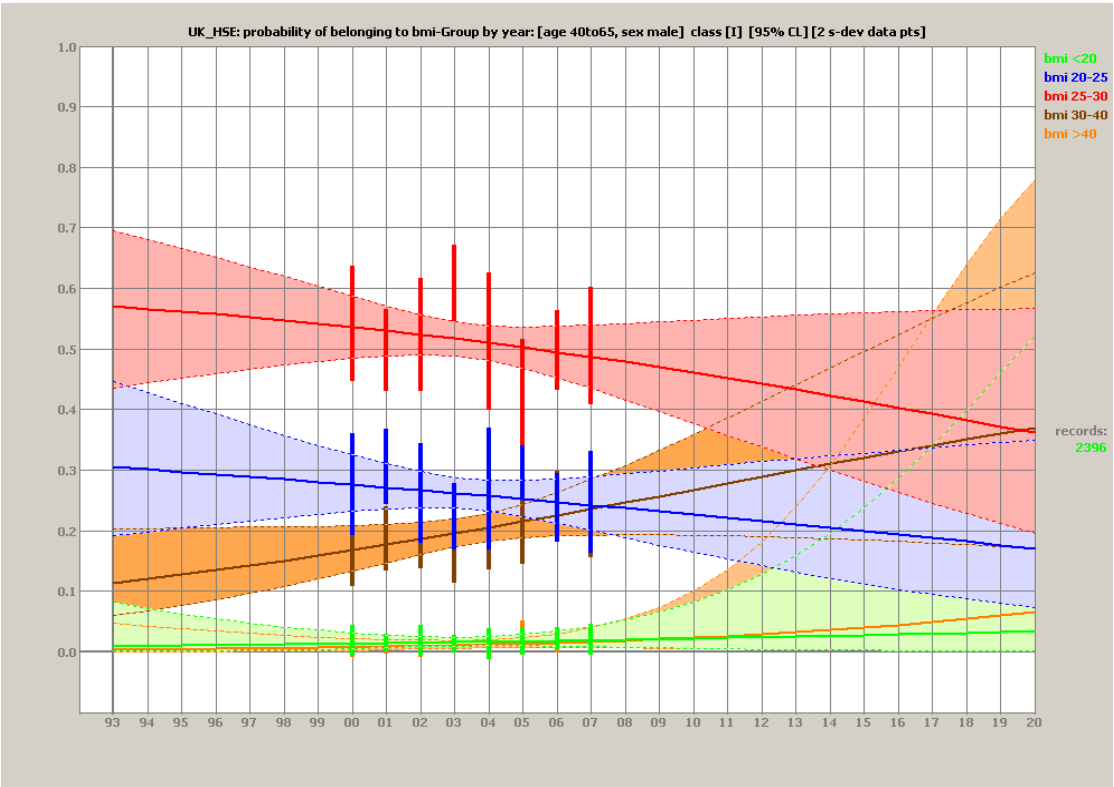


Figure 15: Adult males aged 40-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data, stratified by Sex, Age and Social Class I

The results for these four graphs, stratified by sex, age and social class, are summarized in table 5 that gives the predicted BMI distribution in the year 2020 as calculated from four different sets of data points.

Again, as was the case for the age group 20-65 the BMI distributions stratified by sex, age group 40-65 and social class remain relatively homogeneous for both sexes excepting for the case of class IIIM for females.

predictions to 2020	Foresight [1993-2004]	All years [1993-2007]	first 8 years [1993-2000]	last 8 years [2000-2007]
BMI<20				
40-65, male	1 (+4,-1)	1 (+3,-1)	1 (+36,-1)	3 (+49,-3)
40-65, female	4 (+26,-4)	10 (+23,-8)	5 (+88,-5)	22 (+63,-20)
20<BMI<25				
40-65, male	13 (+8,-5)	15 (+6,-4)	13 (+19,-8)	17 (+18,-10)
40-65, female	35 (+25,-19)	32 (+16,-12)	27 (+54,-24)	16 (+28,-11)
25<BMI<30				
40-65, male	57 (+12,-13)	48 (+9,-9)	37 (+26,-20)	36 (+21,-16)
40-65, female	39 (+26,-21)	32 (+16,-13)	4 (+33,-4)	24 (+34,-17)
30<BMI<40				
40-65, male	26 (+16,-11)	32 (+11,-9)	18 (+32,-13)	37 (+26,-20)
40-65, female	19 (+33,-14)	22 (+21,-12)	46 (+51,-44)	32 (+50,-27)
BMI>40				
40-65, male	4 (+36,-4)	5 (+18,-4)	31 (+69,-30)	7 (+71,-6)
40-65, female	3 (+30,-3)	4 (+16,-3)	18 (+82,-18)	7 (+80,-7)
BMI>30				
40-65, male	28 (+16,-12)	35 (+11,-10)	30 (+36,-21)	42 (+25,-22)
40-65, female	15 (+29,-11)	21 (+20,-12)	55 (+43,-51)	45 (+42,-36)

Table 5: Adults aged 40-65, predicted BMI distributions at 2020 stratified by sex, age and social class I. The numbers in the brackets is the statistical uncertainty to the 95% confidence level.

4.3 Trend analysis: Age Group 45-65

4.3.1 Trends for BMI-distributions stratified by Age and Sex

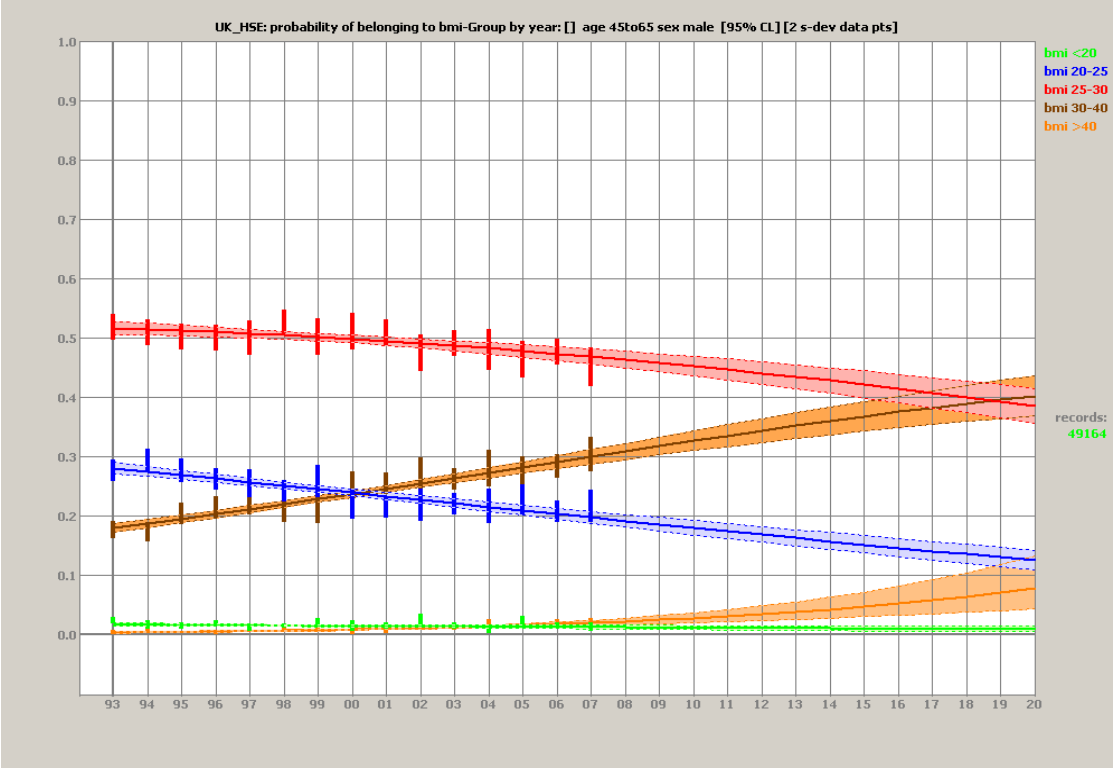


Figure 16: Adult males aged 45-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive

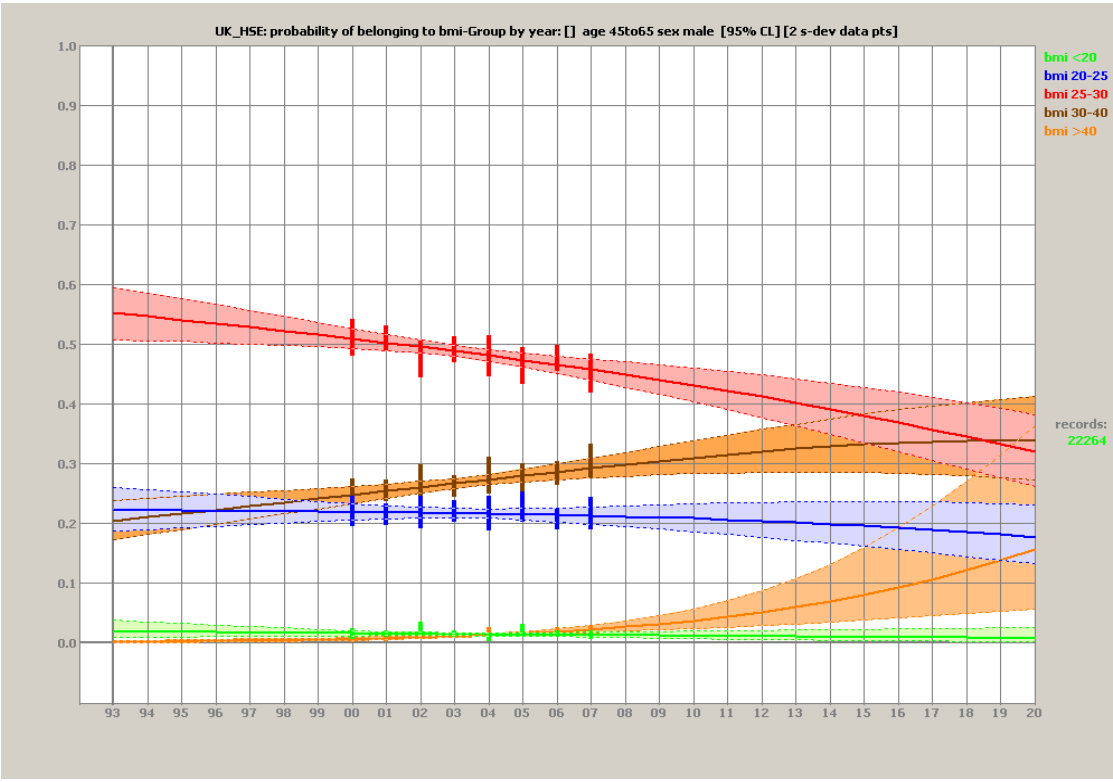


Figure 17: Adult males aged 45-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data

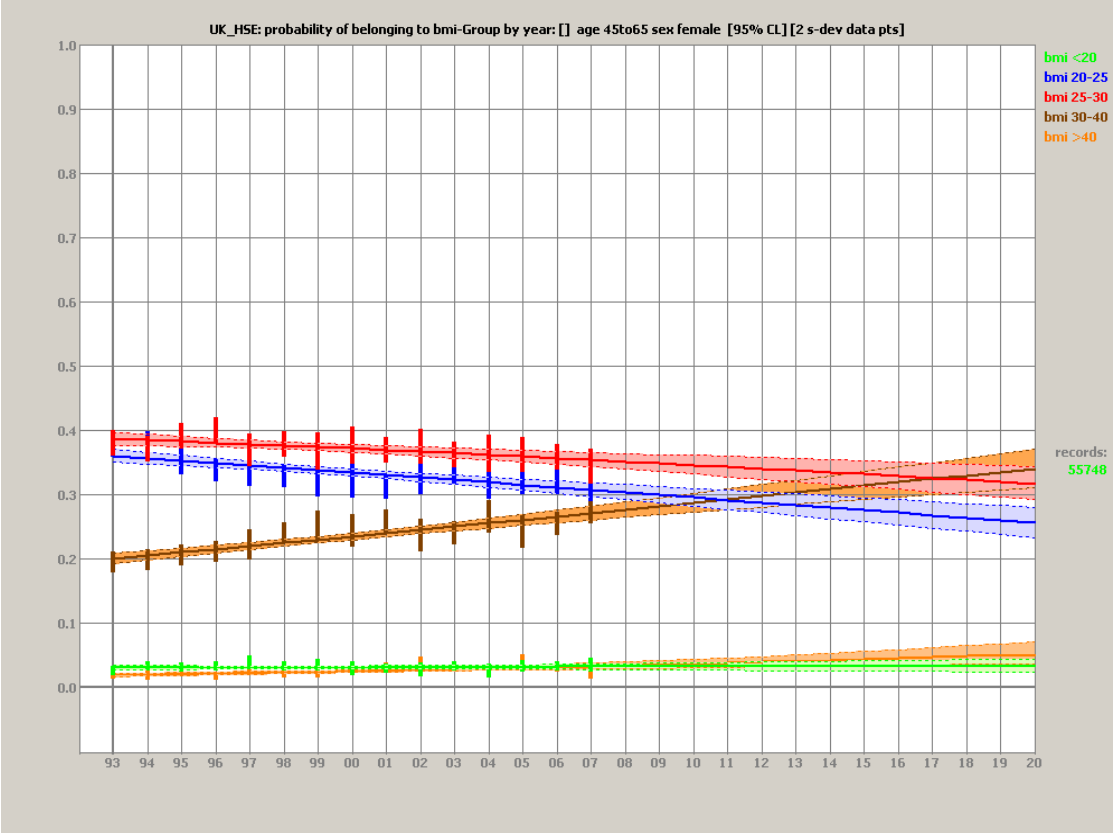


Figure 18: Adult females aged 45-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive

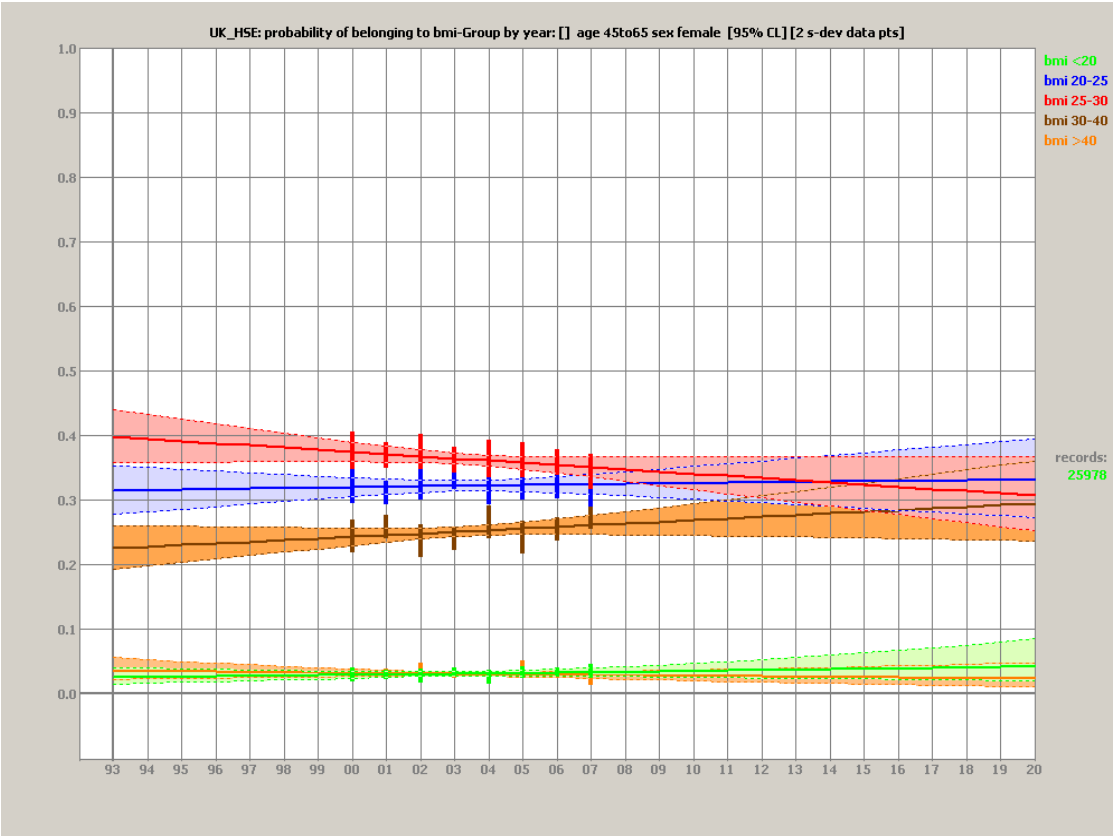


Figure 19: Adult females aged 45-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data

The results for these first four graphs are summarized in table 6 that gives the predicted BMI distribution in the year 2020 as calculated from four different sets of data points together with the statistical uncertainty to the 95% confidence level. [The numbers in each column should add to 100 for the first five BMI groups, any discrepancies are due to rounding errors]:

predictions to 2020	Foresight [1993-2004]	All years [1993-2007]	first 8 years [1993-2000]	last 8 years [2000-2007]
BMI<20				
45-65, male	1 (+1,0)	1 (+1,0)	0 (+1,0)	1 (+2,-1)
45-65, female	3 (+2,-1)	3 (+1,-1)	5 (+7,-3)	4 (+4,-2)
20<BMI<25				
45-65, male	11 (+2,-2)	13 (+2,-2)	10 (+4,-3)	18 (+5,-4)
45-65, female	22 (+3,-3)	26 (+2,-2)	15 (+5,-4)	33 (+6,-6)
25<BMI<30				
45-65, male	41 (+4,-4)	39 (+3,-3)	43 (+9,-9)	32 (+6,-5)
45-65, female	32 (+4,-4)	32 (+3,-2)	32 (+8,-7)	31 (+6,-5)
30<BMI<40				
45-65, male	42 (+5,-5)	40 (+3,-3)	40 (+11,-10)	34 (+7,-7)
45-65, female	36 (+5,-4)	34 (+3,-3)	43 (+10,-10)	30 (+7,-6)
BMI>40				
45-65, male	6 (+9,-4)	8 (+6,-3)	6 (+30,-5)	16 (+21,-10)
45-65, female	7 (+4,-3)	5 (+2,-1)	6 (+11,-4)	2 (+2,-1)
BMI>30				
45-65, male	46 (+5,-5)	46 (+3,-3)	44 (+11,-10)	43 (+8,-7)
45-65, female	42 (+5,-4)	39 (+3,-3)	48 (+10,-10)	32 (+7,-6)

Table 6: Adults aged 45-65, predicted BMI distributions at 2020. The numbers in the brackets is the statistical uncertainty to the 95% confidence level.

It is apparent from Figures 16-19 that obesity is still increasing but slowing for both males and females aged 45-65. Using the last eight years of data the extrapolations indicate that by 2020 34% of males and 30% females will be obese.
The proportion of OW individuals is still decreasing for both sexes but more rapidly for the cohort of males. Again, if one uses the last eight years of data the extrapolations indicate that by 2020 32% of males and 31% females will be overweight.

4.3.2 Trends for BMI-distributions stratified by Age, Sex and Social Class

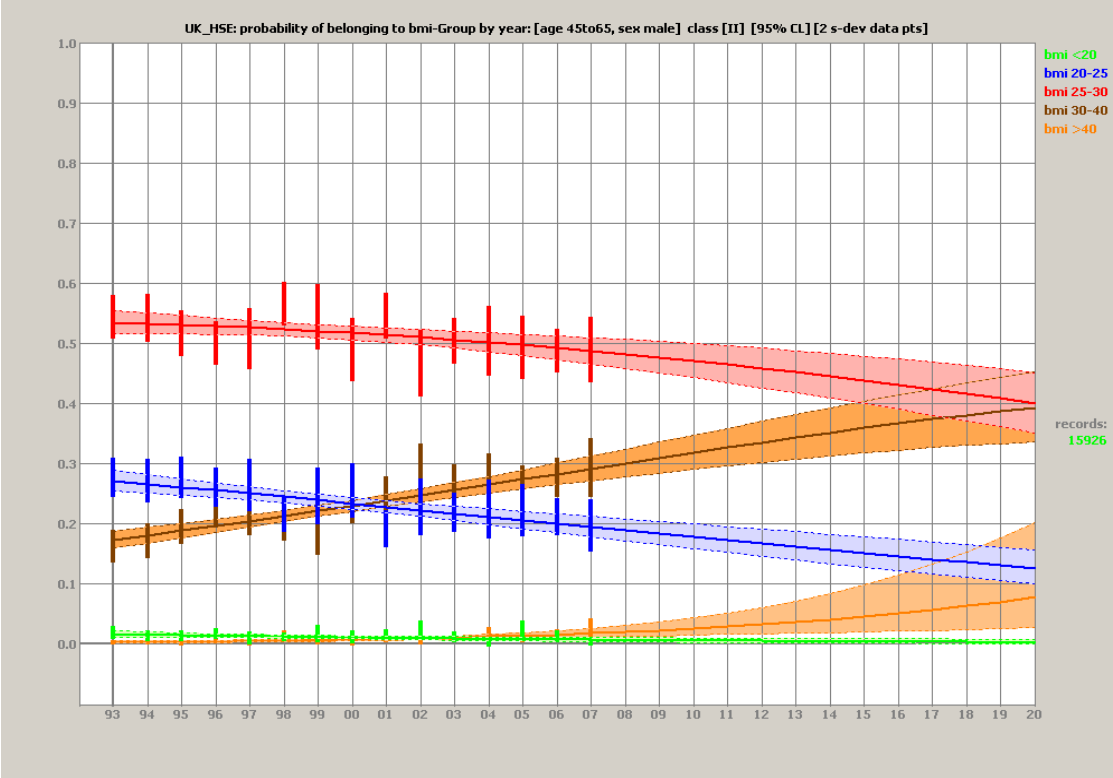


Figure 20: Adult males aged 45-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive, stratified by Sex, Age and Social Class II

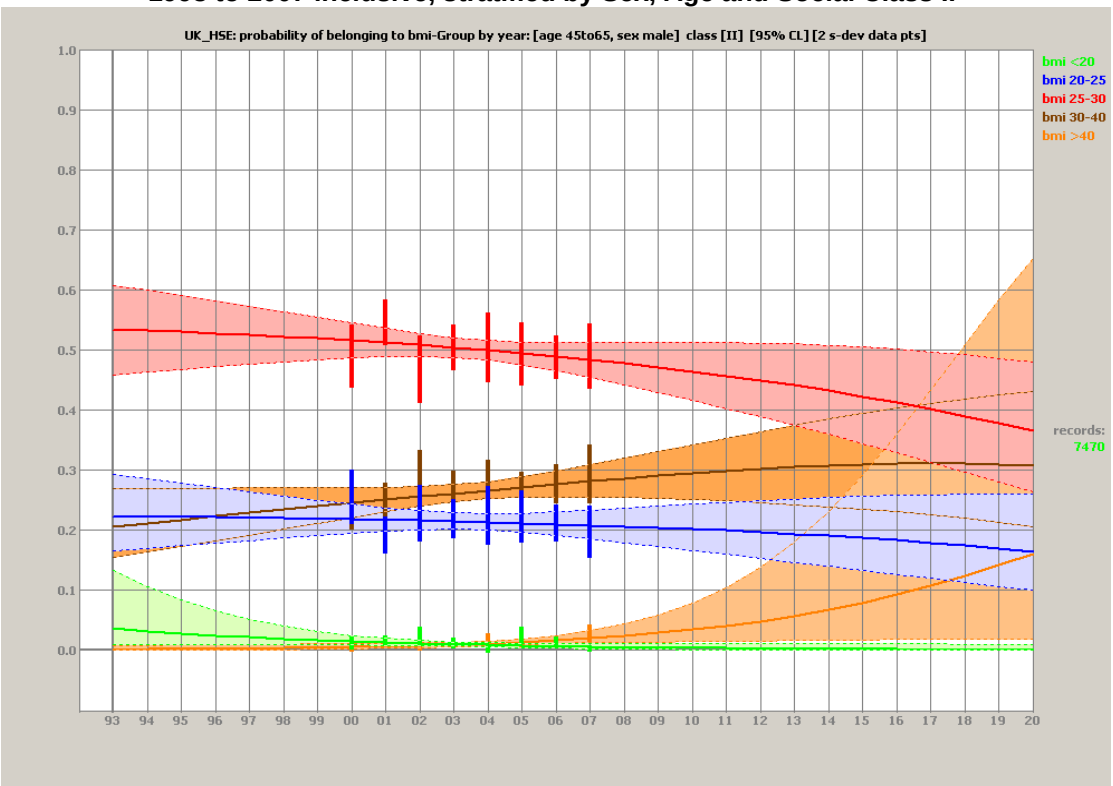


Figure 21: Adult males aged 45-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data stratified by Sex, Age and Social Class II

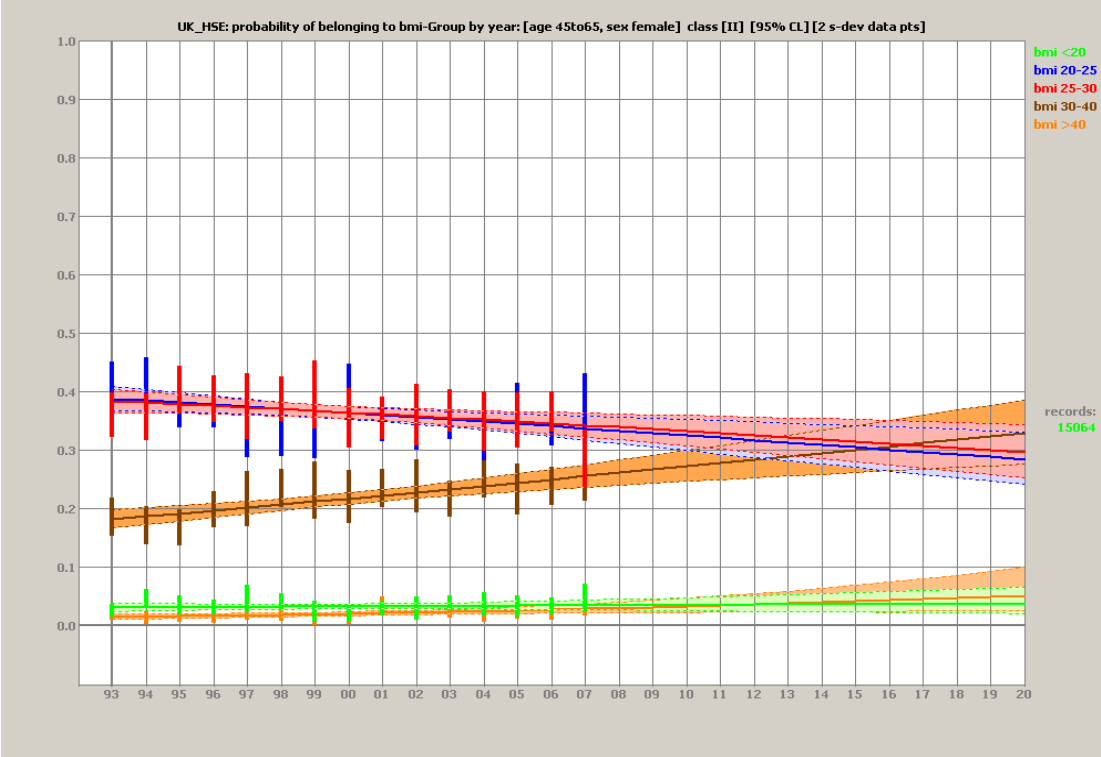


Figure 22: Adult females aged 45-65, predicted BMI membership to 2020 for data years 1993 to 2007 inclusive, stratified by Sex, Age and Social Class II

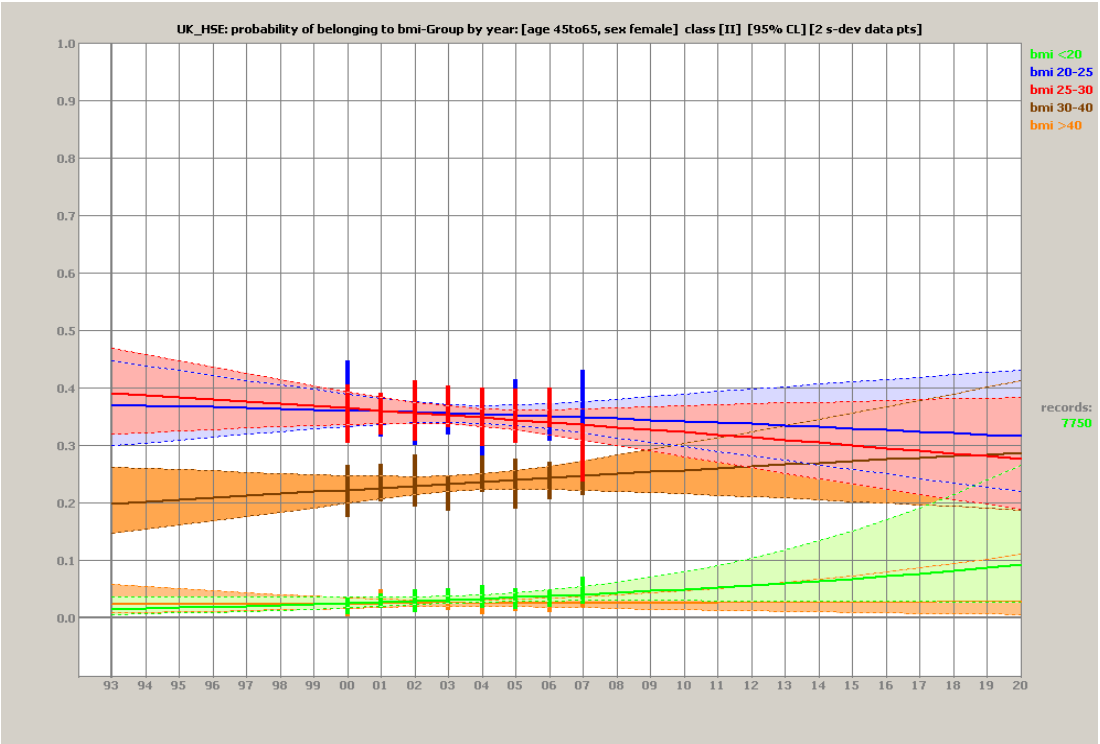


Figure 23: Adult females aged 45-65, predicted BMI membership to 2020 for data years 2000 to 2007 inclusive – the last eight years of data stratified by Sex, Age and Social Class II

The results for these four graphs, stratified by sex, age and social class, are summarized in table 7 that gives the predicted BMI distribution in the year 2020 as calculated from four different sets of data points for adults aged 45-65.

predictions to 2020	Foresight [1993-2004]	All years [1993-2007]	first 8 years [1993-2000]	last 8 years [2000-2007]
BMI<20				
45-65, male	0 (+1,0)	0 (+1,0)	0 (+4,0)	0 (+1,0)
45-65, female	3 (+4,-2)	4 (+3,-2)	2 (+7,-1)	9 (+17,-6)
20<BMI<25				
45-65, male	11 (+4,-3)	13 (+3,-3)	8 (+7,-4)	16 (+9,-6)
45-65, female	24 (+6,-5)	28 (+5,-4)	15 (+11,-7)	32 (+11,-10)
25<BMI<30				
45-65, male	41 (+8,-7)	40 (+5,-5)	32 (+15,-12)	37 (+11,-10)
45-65, female	31 (+7,-7)	30 (+5,-4)	37 (+17,-14)	28 (+11,-9)
30<BMI<40				
45-65, male	43 (+9,-9)	39 (+6,-6)	31 (+19,-14)	31 (+12,-10)
45-65, female	35 (+9,-8)	33 (+6,-5)	44 (+20,-19)	29 (+12,-10)
BMI>40				
45-65, male	5 (+19,-4)	8 (+12,-5)	29 (+67,-28)	16 (+49,-14)
45-65, female	7 (+11,-4)	5 (+5,-3)	2 (+20,-2)	3 (+8,-2)
BMI>30				
45-65, male	46 (+9,-9)	44 (+6,-6)	46 (+19,-18)	40 (+13,-12)
45-65, female	27 (+7,-6)	32 (+5,-5)	17 (+12,-8)	39 (+12,-11)

Table 7: Adults aged 45-65, predicted BMI distributions at 2020 stratified by sex, age and social class II. The numbers in the brackets is the statistical uncertainty to the 95% confidence level.

Due to the sparsity in the data when stratified by a third variable one is not readily able to discern any common traits or distinguishing features. However, one can say that from figures 20 to 23 for class II for both males and females that these figures do display the general trend applicable to the five other classes: I, IIIN, IIIM, IV and V. That is, both overweight and OK are decreasing and obese is increasing although all rates are slowing for the last eight years of data.

5 Micro-simulation

This section details the work carried out for the micro-simulation cataloguing the predictions for the set of BMI related diseases.

5.1 Introduction

The original Foresight report used HSE BMI data from the years 1993 to 2004 inclusive. Since then there have been three more years of data: 2005, 2006 and 2007. Amongst children there are some indications that the rate of rise in obesity levels has slowed a little; the trends for adults are published in a companion report (Brown, Byatt, Marsh, & McPherson, Adult Obesity trends, 2009) to this; although there are some possible exceptions, adult trends continue to rise much as before. The main body of this report uses the complete data set 1993 to 2007 from which to make future predictions of obesity growth.

The micro simulation uses BMI data that is preprocessed by its companion program obesity_distribution. This program can take any specified set of data years and uses non-linear regression analysis to manufacture predictions of future BMI distributions by age group, sex and year. These predictions are written to a formatted text file that can be accessed by the micro-simulation. These text files are identified by .ab extension and can be appended to a particular Intervention in the micro-simulation.

Thus, for the micro-simulation to compare predictions for the data set {93-07} with a different set of predictions that uses the same data set {93-04} but which allows obesity growth as people age but the BMI distributions for the various ages are fixed at their 2006 values all one has to do is to form a batch of Interventions in which the appropriate *.ab file is appended to scenario_0 – scenario_0 is a null Intervention in which BMI is allowed to grow as predicted by the *.ab file.

This is essentially what is shown in Figures 24-26: Intervention 0 uses the complete data set; whilst Intervention 1 utilizes scenario_7 which allows obesity growth as people age but the BMI distributions for the various ages are fixed at their 2006 values. This scenario is included to allow the population ageing effects to be distinguished from obesity growth effects.

5.2 Disease statistics

The figures presented in this report were produced using the most recent software version of the micro simulation (version 7.0) using the most recent (2006) disease statistics. These statistics differ from those (2004) used in the Foresight report. Most notably: coronary heart disease (CHD) and stroke incidence rates have fallen; hypertension and liver cancer have been added to the simulation; most of the relative risk data have been revised in line with recent work [vi].

5.3 Interventions simulation

The scope for different interventions has been considerably enhanced from the Foresight standard. Many of these new functions need not be described here but one is worth mentioning as it is used in what follows in the body of this report.

Broadly speaking, the runs of the micro-simulation are identified as particular *Interventions*. Each Intervention now identifies a particular BMI prediction model as well as a scenario which may or may not involve alterations to that model. Comparisons can be made by grouping together sets of interventions into batches and performing successive sets of Monte Carlo trials - one for each Intervention in the batch. Batch processing of Interventions was possible at the software standard of the Foresight report, what is new is that each Intervention can now identify its own BMI prediction model. This feature is used in section 5.4.

The impact of the predicted future growth in obesity is calculated by comparing two scenarios, scenario 0 which allows for growth in obesity in line with the predicted trends and scenario 7 where obesity levels are held constant at their 2006 values. This comparison allows population ageing effects to be distinguished from obesity growth effects.

5.4 BMI related diseases

This section catalogues predictions for the set of BMI related diseases.

5.4.1 Disease Prevalence

The following figures, figures 24-26, show the predicted prevalence expressed as rates per 100,000 for the adult male and female populations. All graphs show the rate per year – results were recorded in 5 year intervals starting in 2006.

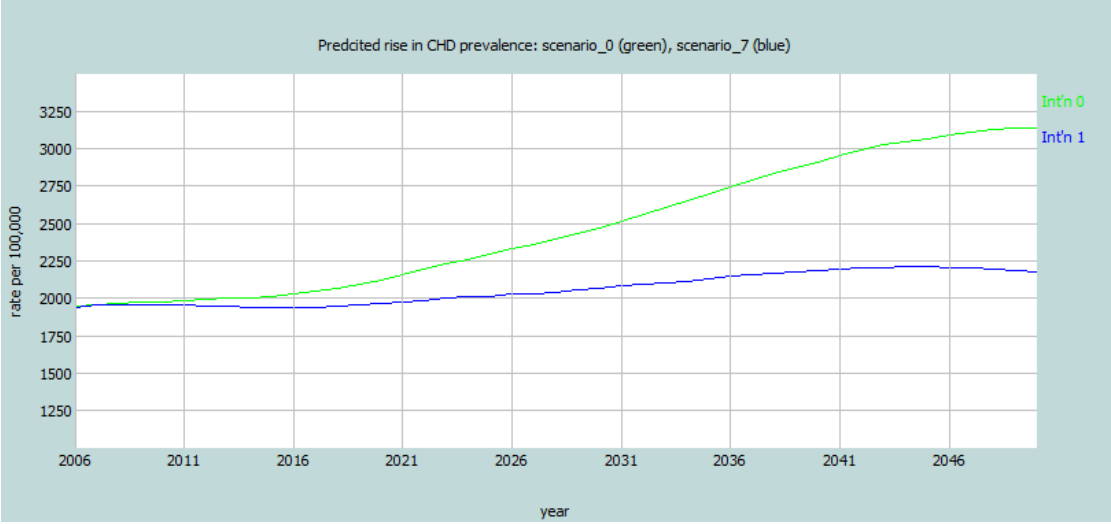


Figure 24: Predicted rise in coronary heart disease prevalence

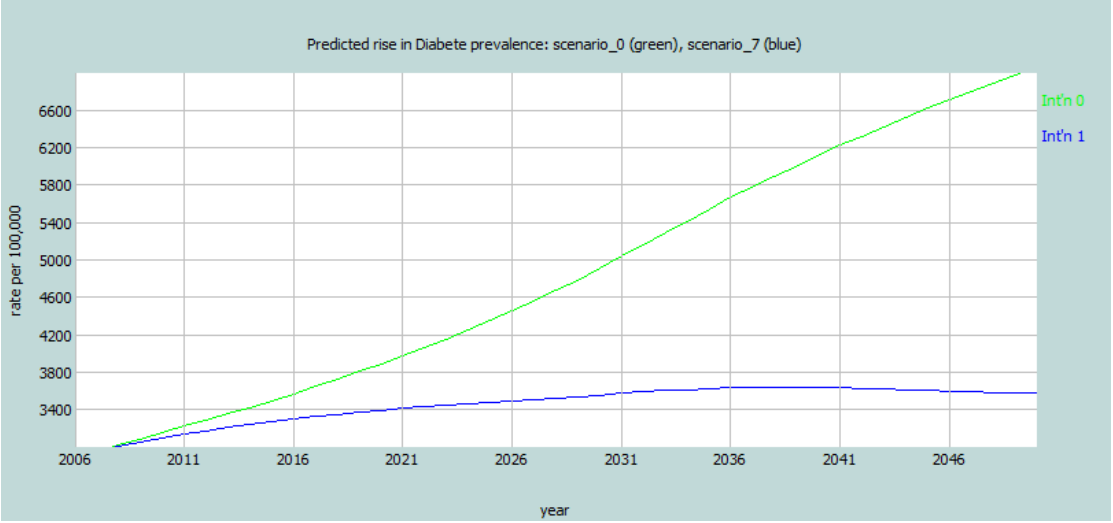


Figure 25: Predicted rise in diabetes prevalence

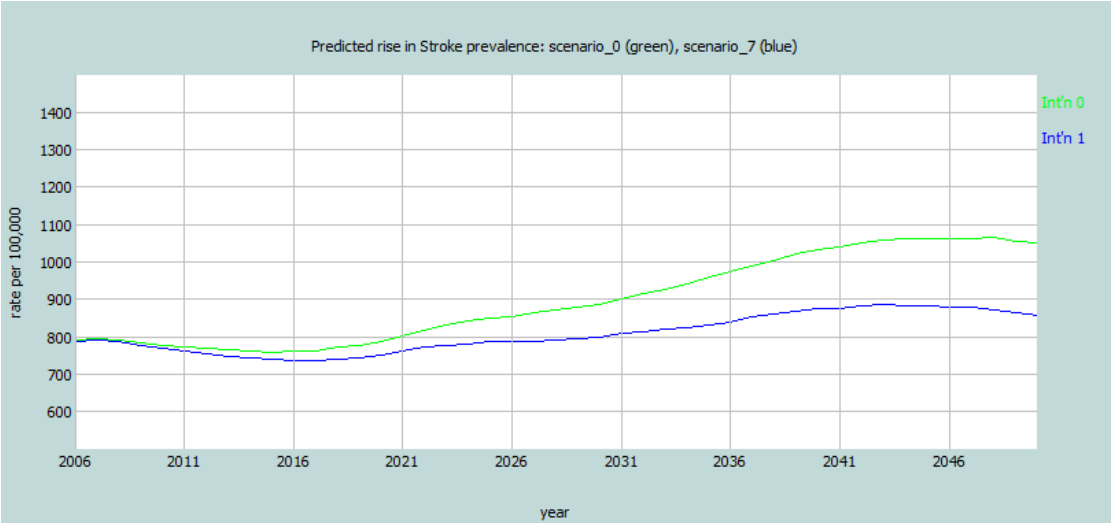


Figure 26: Predicted rise in stroke prevalence

Figure 24, figure 25 and figure 26 draw the changes in disease prevalence for scenario 0 {93-07} compared with scenario 7 for CHD, diabetes and stroke. Similar results obtained for all BMI related diseases, their prevalence rates are given for ten year intervals in Table 8. The prevalence of all diseases shows a steady rise, diabetes is more dramatic than the others.

BMI related diseases: predicted rates per 100 000 in ten year intervals						
year	2006	2010	2020	2030	2040	2050
arthritis	603	596	612	649	682	695
breast cancer	792	781	794	827	841	823
chd	1944	1974	2123	2471	2909	3139
colorectal cancer	275	293	317	349	370	375
diabetes	2869	3151	3888	4908	6115	7072
endometrial cancer	110	107	116	132	146	156
gall bladder disease	47	44	45	49	54	52
hypertension	5510	5757	6234	6851	7482	7877
kidney cancer	44	49	56	62	68	68
oesophageal cancer	20	27	31	38	43	44
stroke	792	778	789	887	1033	1050
liver cancer	6	7	9	11	13	13

Table 8: predicted disease prevalence rates (per 100,000)

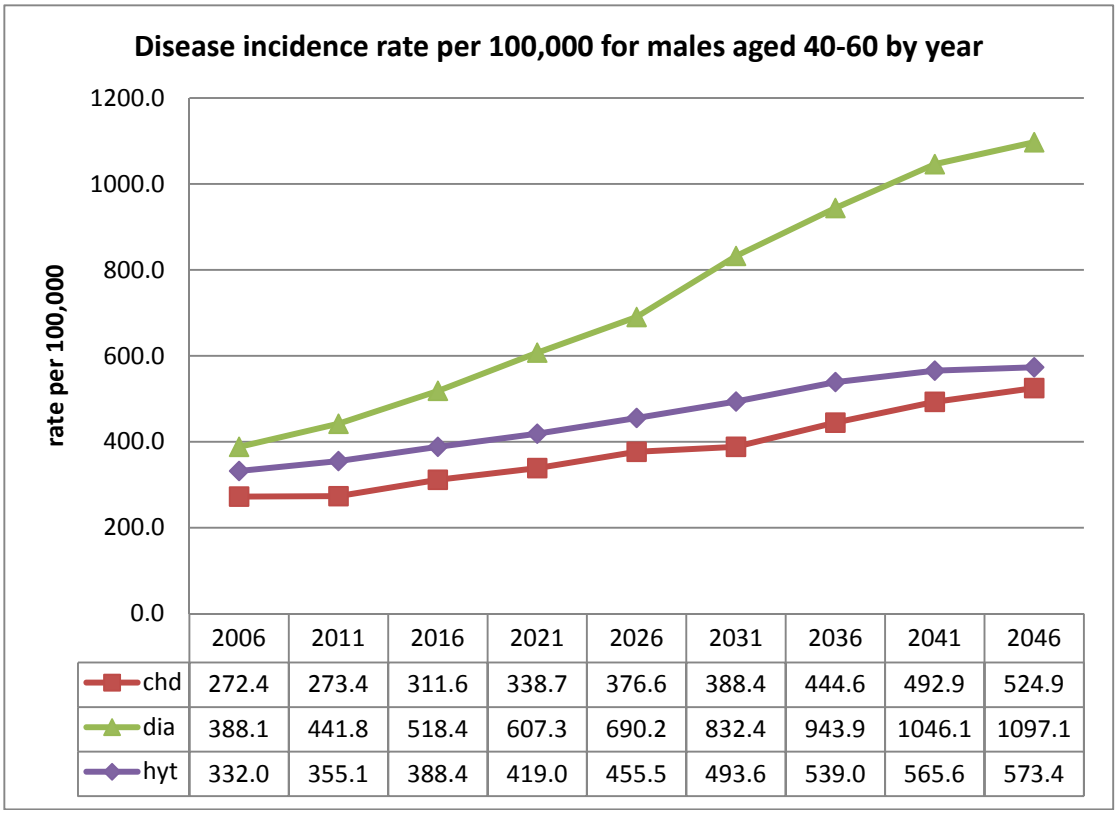
The changing age profile of the population causes some fluctuation in these rates. The percentage increases in rates over their scenario_7 values are listed in Table 9.

predicted percentage increase in disease rates					
year	2010	2020	2030	2040	2050
arthritis	1	3	6	11	16
breast cancer	2	2	3	4	6
chd	1	8	20	33	44
colorectal cancer	3	5	8	12	14
diabetes	2	15	38	68	98
endometrial cancer	1	8	17	29	41
gall bladder disease	0	7	11	13	16
hypertension	1	5	13	23	34
kidney cancer	7	10	15	19	21
oesophageal cancer	8	19	36	54	57
stroke	1	5	11	18	23
liver cancer	0	29	38	44	63

Table 9: Predicted percentage increase in disease prevalence rates relative to scenario_7

5.4.2 Disease Incidence

The following figures show predicted, sample incidence statistics expressed as rates per 100,000 for the adult male and female populations. All graphs show the rate per year – results were recorded in 5 year intervals starting in 2006.



	2006	2011	2016	2021	2026	2031	2036	2041	2046
chd	272.4	273.4	311.6	338.7	376.6	388.4	444.6	492.9	524.9
dia	388.1	441.8	518.4	607.3	690.2	832.4	943.9	1046.1	1097.1
hyt	332.0	355.1	388.4	419.0	455.5	493.6	539.0	565.6	573.4

Figure 27: CHD, Diabetes and Hypertension incidence rates for males aged 41-60

Figure 27 shows the growth of the incidence rates of CHD, diabetes and hypertension for males aged 40 to 60; Figure 29 shows the comparable graphs for females. Both graphs were produced using the complete data set {1993-2007} running scenario 0 for which there are no interventions

Figure 28 shows the essentially the same set of male graphs with the addition of the results for scenario 7 – zero BMI growth. The scenario 7 rates remain, as might be expected, roughly equal to their 2006 starting values.

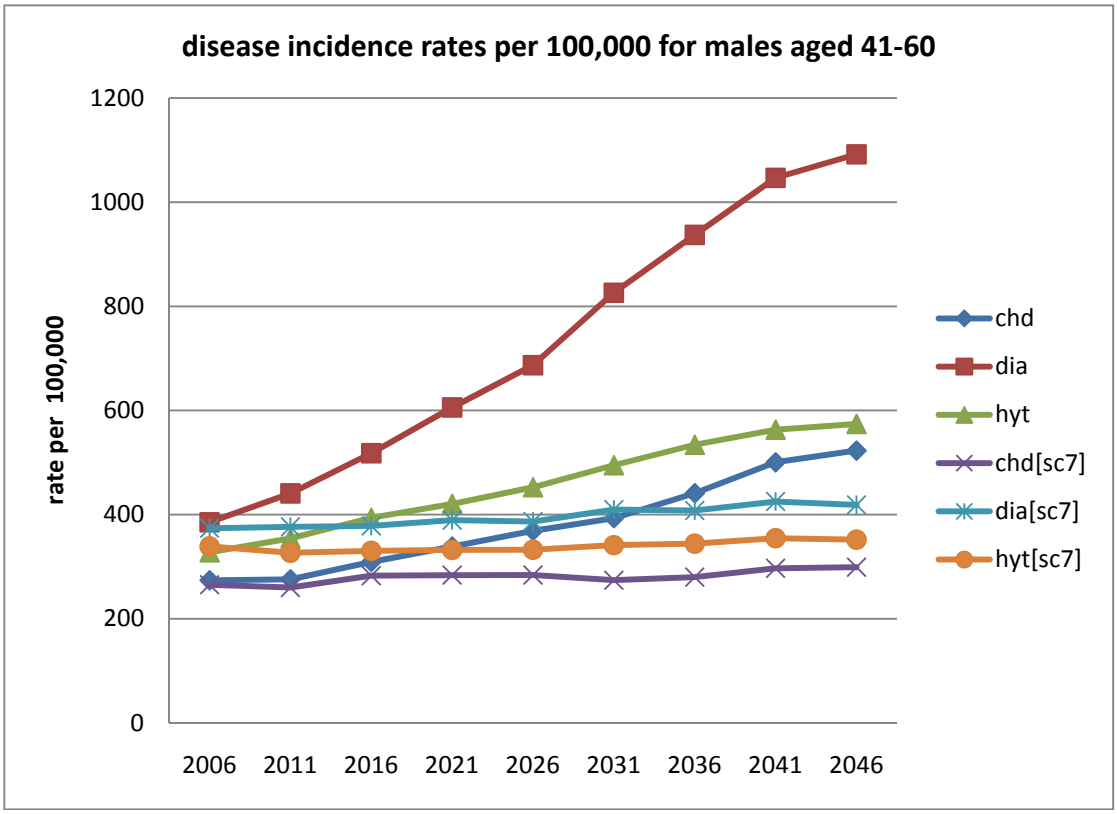
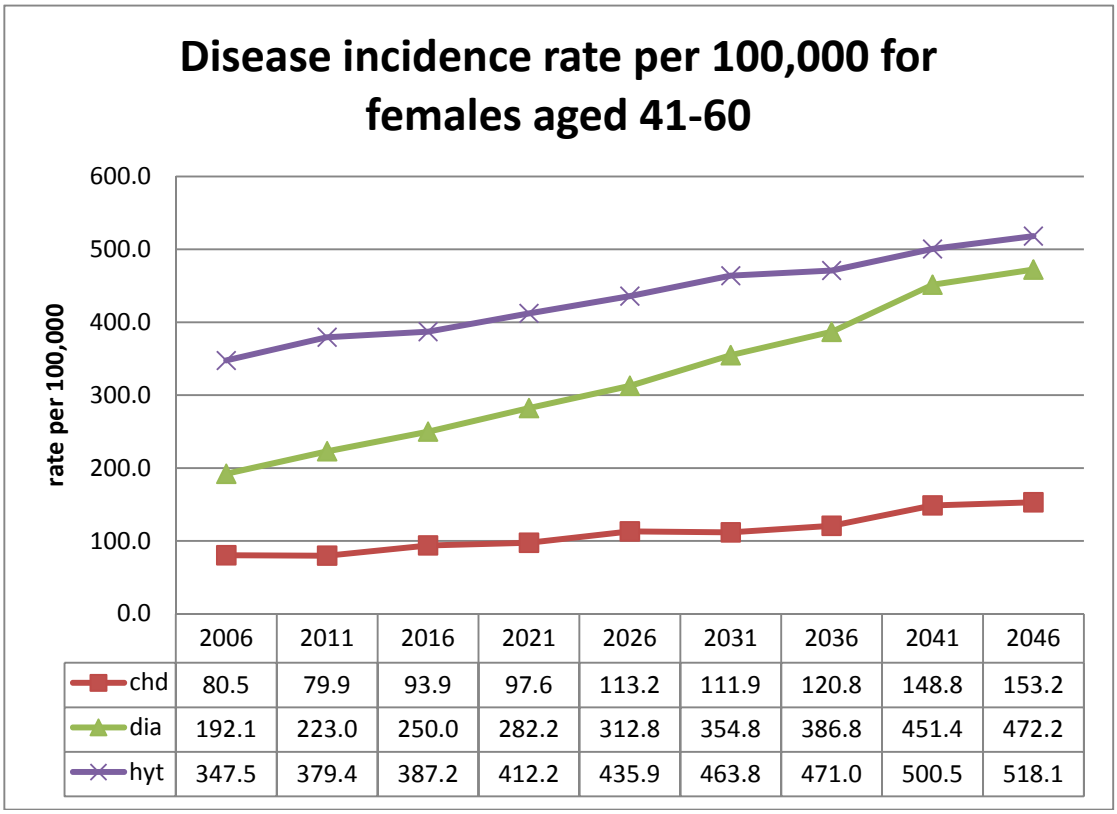
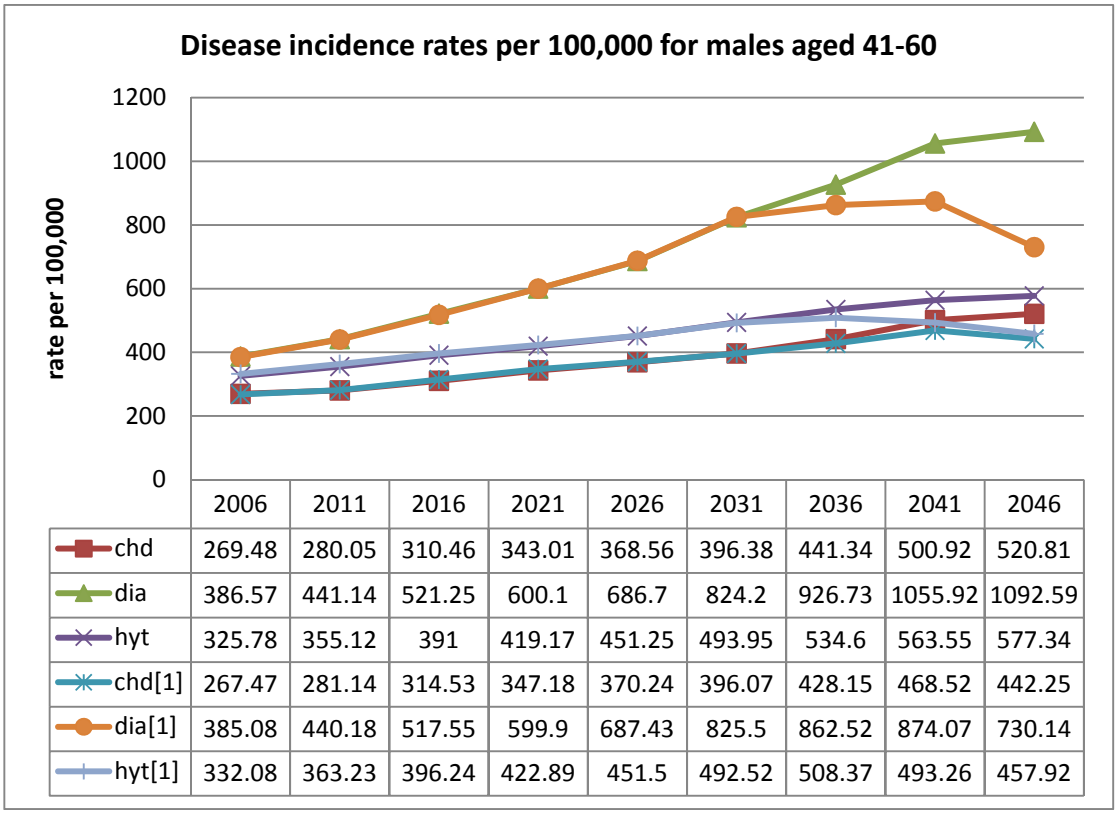


Figure 28: Scenario 0 (as Figure 27) and scenario 7 comparison



	2006	2011	2016	2021	2026	2031	2036	2041	2046
chd	80.5	79.9	93.9	97.6	113.2	111.9	120.8	148.8	153.2
dia	192.1	223.0	250.0	282.2	312.8	354.8	386.8	451.4	472.2
hyt	347.5	379.4	387.2	412.2	435.9	463.8	471.0	500.5	518.1

Figure 29: CHD, Diabetes and Hypertension incidence rates for females aged 41-60



	2006	2011	2016	2021	2026	2031	2036	2041	2046
chd	269.48	280.05	310.46	343.01	368.56	396.38	441.34	500.92	520.81
dia	386.57	441.14	521.25	600.1	686.7	824.2	926.73	1055.92	1092.59
hyt	325.78	355.12	391	419.17	451.25	493.95	534.6	563.55	577.34
chd[1]	267.47	281.14	314.53	347.18	370.24	396.07	428.15	468.52	442.25
dia[1]	385.08	440.18	517.55	599.9	687.43	825.5	862.52	874.07	730.14
hyt[1]	332.08	363.23	396.24	422.89	451.5	492.52	508.37	493.26	457.92

Figure 30: male incidence rates for scenario 0 and scenario 1

Figure 30 shows the effect of an intervention (scenario 1) for which, from 2010, there was no BMI growth for people aged less than 20. There is an obvious lag of 20 years or so before the effects of this unrealizable Intervention are apparent. More realistic interventions directed at reducing child obesity would be expected produce disease incidence curves lying between the upper and lower limits shown here – for example, obesity reduction interventions aimed solely at the under 20s should result in diabetes incidence rates in 2014 lying between 875 and 1056 cases per 100000 of the population; in subsequent years the gap should widen.

Figure 30 was produced as the result of 50 million monte carlo trials; the earlier graphs used 10 or 20 million.

Incidence rates for all BMI related diseases are listed in Table 10 (for age group 41-60) and Table 11 (for age group 51-60).

male				Rates per 100,000										
Age Group	year	male	art	br_C	chd	cr_C	dia	en_C	gbd	hyt	ki_C	oe_C	str	li_C
41-60	2006		9.9	0.0	272.4	46.7	388.1	0.0	13.6	332.0	15.3	13.4	53.2	4.8
41-60	2011		9.9	0.0	273.4	47.3	441.8	0.0	13.0	355.1	18.0	14.6	53.5	6.0
41-60	2016		12.2	0.0	311.6	54.4	518.4	0.0	15.0	388.4	18.4	15.6	58.9	6.7
41-60	2021		10.1	0.0	338.7	56.8	607.3	0.0	15.1	419.0	18.1	19.1	66.3	7.7
41-60	2026		12.6	0.0	376.6	55.3	690.2	0.0	14.8	455.5	20.9	22.5	71.7	8.9
41-60	2031		11.9	0.0	388.4	55.6	832.4	0.0	16.3	493.6	18.4	22.0	72.2	9.1
41-60	2036		14.7	0.0	444.6	62.5	943.9	0.0	16.4	539.0	20.1	26.8	73.7	11.0
41-60	2041		15.8	0.0	492.9	69.3	1046.1	0.0	18.8	565.6	22.7	27.0	84.5	10.4
41-60	2046		16.5	0.0	524.9	72.0	1097.1	0.0	17.6	573.4	23.6	31.9	87.1	11.3
female				Rates per 100,000										
Age Group	year	male	art	br_C	chd	cr_C	dia	en_C	gbd	hyt	ki_C	oe_C	str	li_C
41-60	2006		40.5	216.0	80.5	35.1	192.1	25.2	15.4	347.5	8.7	5.1	30.7	2.1
41-60	2011		40.6	208.7	79.9	32.8	223.0	28.0	15.1	379.4	9.8	5.3	31.0	2.3
41-60	2016		42.9	225.0	93.9	34.8	250.0	32.3	18.3	387.2	8.7	5.4	34.5	2.9
41-60	2021		42.4	227.0	97.6	35.4	282.2	32.0	20.0	412.2	8.4	5.0	34.6	2.9
41-60	2026		46.0	232.0	113.2	38.8	312.8	36.2	20.1	435.9	8.9	5.6	34.9	3.1
41-60	2031		42.6	222.8	111.9	39.1	354.8	33.2	19.6	463.8	8.8	6.8	35.9	2.1
41-60	2036		50.4	235.6	120.8	37.4	386.8	33.1	19.7	471.0	9.1	5.8	37.6	2.4
41-60	2041		52.7	241.6	148.8	42.3	451.4	41.5	22.1	500.5	11.8	6.6	39.2	3.4
41-60	2046		56.2	241.9	153.2	41.1	472.2	44.2	20.5	518.1	11.4	8.5	40.7	2.9

Table 10: Predicted disease incidence statistics for males and females aged 41-60

male				Rates per 100,000									
age group	year	art	br_C	chd	cr_C	dia	en_C	gbd	hyt	ki_C	oe_C	str	li_C
51-60	2006	14.0	0.0	420.9	77.8	459.4	0.0	18.1	381.6	23.8	24.1	83.5	8.8
51-60	2011	14.5	0.0	403.5	76.7	518.6	0.0	19.2	395.6	27.1	25.1	80.8	9.9
51-60	2016	16.5	0.0	436.5	82.4	606.5	0.0	21.8	424.1	27.2	25.2	83.8	9.6
51-60	2021	13.9	0.0	472.4	86.3	681.5	0.0	22.1	453.4	26.5	30.8	94.5	10.8
51-60	2026	16.6	0.0	550.4	88.3	797.2	0.0	22.7	500.8	31.9	35.8	103.4	13.9
51-60	2031	17.3	0.0	567.7	87.0	897.7	0.0	25.9	539.1	28.6	35.5	107.2	13.7
51-60	2036	18.2	0.0	628.1	96.2	1036.4	0.0	24.6	577.8	30.3	44.5	107.5	15.5
51-60	2041	20.8	0.0	698.9	106.0	1140.3	0.0	27.1	623.4	32.0	39.9	122.7	16.2
51-60	2046	23.5	0.0	758.9	113.6	1185.3	0.0	25.9	620.9	33.8	50.9	128.3	16.6
female				Rates per 100,000									
agegroup	year	art	br_C	chd	cr_C	dia	en_C	gbd	hyt	ki_C	oe_C	str	li_C
51-60	2006	42.8	273.8	137.0	55.1	249.4	42.0	24.4	390.0	13.4	8.5	44.6	3.9
51-60	2011	42.6	265.6	127.4	51.1	274.1	43.7	20.1	417.1	15.8	8.9	49.1	3.4
51-60	2016	47.0	278.2	144.7	49.6	293.1	49.1	25.4	406.5	13.7	8.6	48.7	3.9
51-60	2021	45.3	275.5	143.5	47.6	317.2	48.8	28.8	441.4	11.4	6.9	48.5	4.9
51-60	2026	50.1	283.9	177.0	54.5	344.9	53.2	27.2	442.5	13.4	9.0	49.1	4.7
51-60	2031	43.9	273.2	166.8	57.1	373.1	52.9	26.9	463.2	14.3	10.6	49.8	3.7
51-60	2036	48.9	287.0	174.9	51.8	389.1	48.3	25.8	471.8	13.5	8.2	51.0	2.7
51-60	2041	57.5	286.2	212.1	61.2	444.8	57.7	28.6	487.9	17.1	10.2	52.3	4.5
51-60	2046	56.7	296.3	233.9	58.4	457.4	63.8	27.2	503.8	15.3	13.1	56.0	4.1

Table 11: Predicted disease incidence statistics for males and females aged 51-60

6 Conclusions

Unlike the latest trends for child obesity which give some measured cause for optimism the trends for adults are broadly similar to those published in the original Foresight report. The number of normal weight individuals is inexorably falling, those overweight remains broadly steady and those obese rising. Of equal concern is a significant rise in rates of morbid obesity (BMI>40) which have extremely high associated disease risks. These predicted levels of obesity will lead to significant rises in the levels of vascular diseases. Though not calculated here this will create substantial resource implications for both the NHS and the wider society.

These trends demonstrate that Government will have a large challenge just to arrest the growth in obesity. As better evidence becomes available we will be able to incorporate evidence from real rather than hypothetical interventions into the micro-simulation. However, at present, that evidence is sketchy particularly with respect to upstream interventions.

7 Appendix

Appendix A BMI distributions by sex and age; sex age and social class; and sex, age and ethnicity

Appendix A.1 BMI distributions for age group 20-65

Appendix A.2 BMI distributions for age group 40-65

Appendix A.3 BMI distributions for age group 45-65

Appendix B

specification	Value at end of last run
time of run	Friday, Dec 11, 2009, 7:41:38
data set	UK_HSE
trials	10000000
start year	2006
stop year	2050
random number seed	-27
stats year	2006
all deaths file	C:\Program Files\obesity project\diseases\alldeaths.tab
male age distribution file	MbyAGE-2008.pf
female age distribution file	FbyAGE-2008.pf
sex distribution file	EWPopbySex.pf
class distribution file	ClassPdf.pf
ethnicity distribution file	PopByEth07.pf
region distribution file	RegionPdf.pf
birth distribution file	BirthByAge.pf
males	26780300
females	27659400
births mean TFR	2
bmi related disease batch	C:\Program Files\obesity project\DiseasesJuly09\DiseaseBatchNov09.bat
bmi *.ab file	ASbmi6_00to07.ab
bmi intervention	scenario_0: 2000 to 2080; No interventions; ASbmi6_00to07.ab
bmi parameters	{UK|RR+, RR|dia+, sd 0.2, ASbmi6_00to07.ab}
smk related disease batch	
smk *.ab file	ASsmk2000_2006.ab
smk intervention	
smk parameters	
this config filename	C:\Program Files\obesity project\RunData\Friday_Dec_11_2009_7_41_38.tab

Table 12: micro-simulation configuration file

Appendix C

disease incidence rates per 100000									
arthr									
AgeGp	15-24	25-34	35-44	45-54	55-64	65-74	>75		
male	3	3	3	9	19	13	54		
female	3	12	30	41	48	44	25		
br_C									
AgeGp	15-19	20-24	25-29	30-34	35-39	40-44	45-49		
male	0	0	0	0	0	0	0		
female	0	1	8	27	58	120	185		
AgeGp	50-54	55-59	60-64	65-69	70-74	75-79	80-84	>85	
male	0	0	0	0	0	0	0	0	
female	263	282	334	405	328	349	397	410	
chd									
AgeGp	0-34	35-44	45-54	55-64	65-74	>75			
male	3	61	197	446	799	2158			
female	1	13	41	135	327	1473			
cr_C									
AgeGp	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	
male	0	0	1	2	3	5	12	26	
female	0	0	1	2	2	6	10	23	
AgeGp	50-54	55-59	60-64	65-69	70-74	75-79	80-84	>85	
male	47	89	143	230	323	410	488	473	
female	38	57	89	133	192	255	314	332	
diabetes									
AgeGp	0-15	16-24	25-34	35-44	45-54	55-64	65-74	>75	
male	0	20	50	202	439	543	691	141	
female	0	30	20	111	181	345	533	151	
en_C									
AgeGp	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	
male	0	0	0	0	0	0	0	0	
female	0	0	2	2	6	14	29	54	
AgeGp	60-64	65-69	70-74	75-79	80-84	>85			
male	0	0	0	27	38	50			
female	65	75	78	69	64	55			
gbd									
AgeGp	35-44	45-54	55-64	65-74	>75				
male	5	11	29	93	265				
female	7	11	33	95	517				
hyt									
AgeGp	16-44	45-64	65-74	>75					
male	153	409	487	778					
female	173	439	495	767					

ki_C									
AgeGp	0-4	5-19	10-14	15-19	20-24	25-29	30-34	35-39	40-44
male	0	0	0	0	0	0	0	0	6
female	2	0	0	0	0	0	1	1	2
AgeGp	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	>85
male	10	17	27	38	50	68	83	90	96
female	5	9	13	18	26	35	39	41	41
oe_C									
AgeGp	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69
male	0	0	1	3	7	16	27	42	55
female	0	0	0	1	2	5	8	15	20
AgeGp	70-74	75-79	80-84	>85					
male	70	92	109	117					
female	30	44	58	62					
stroke									
AgeGp	0-34	35-44	45-54	55-64	65-74	>75			
male	2	12	35	84	328	2069			
female	1	7	21	48	181	1804			
liver_C									
AgeGp	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44
male	0	0	0	0	0	0	0	1	2
female	1	0	0	0	0	0	0	0	1
AgeGp	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	>85
male	3	7	8	13	19	32	40	46	47
female	1	3	3	6	9	14	18	20	25
unspec									
AgeGp	0-34	35-44	45-54	55-64	65-74	>75			
male	60	126	230	513	1341	11713			
female	35	60	144	333	847	9747			

Table 13: Disease incidence statistics

abbreviation	disease	abbreviation	disease
arthr	Arthritis	ki_c	Kidney cancer
br_C	Breast cancer	oe_C	Oesophageal cancer
cr_C	Colo-rectal cancer	stroke	Stroke
diabetes	Diabetes	liver_c	Liver cancer
en_C	Endometrial cancer	unspec	unspecified
gbd	Gall bladder disease		
hyt	hypertension		

Table 14: Key to disease abbreviations

Appendix D

The relative risk statistics are too numerous to include here and supplied on the Excel file diseaseRelRisk.xls that accompanies this report.

[i] McPherson K., Marsh T., Brown M. (2007), Foresight Tackling Obesity: Future Choices – Modelling Future Trends in Obesity and Their Impact on Health. Government Office for Science

[ii] ibid

[iii] McPherson K., Marsh T., Brown M. (2007), Obesity Trends for Children Aged 2-11: Analysis from the Health Survey for England 1993 - 2007

[iv] McPherson K., Marsh T., Brown M. (2007), Foresight Tackling Obesity: Future Choices – Modelling Future Trends in Obesity and Their Impact on Health. Government Office for Science

[v] McPherson K., Marsh T., Brown M. (2007), Obesity Trends for Children Aged 2-11: Analysis from the Health Survey for England 1993 – 2007

[vi] Relative Risk estimates for the majority of the diseases were derived from estimates by the International Association for the Study of Obesity as part of the EU-funded project on dynamic modeling for health impact assessment (DYNAMO-HIA, http://www.dynamo-hia.eu/). Relative Risk estimates for the remaining diseases were calculated by the authors from published sources.