# HEALTHY LIFE EXPECTANCY IN SCOTLAND

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March 2004

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## Acknowledgements

We are grateful to the following people for providing us with the data used in this project: Esta Clark (SE, Scottish Household Survey data); Sally Gray and Simon Hazelwood (GRO, Census data used to derive the deprivation quintiles); David Walsh (NHS Health Scotland, spreadsheet used to calculate Life Expectancy). We are also grateful to members of the HLE Steering Group for comments on previous work, especially Marion Bain (ISD) who chaired the group, and to Irene Sives (ISD), Jane James (ISD) and Jean Taylor (University of Glasgow) for administrative support.

## Author contributions

David Clark was responsible for obtaining information from the 2001 Census and data on populations and deaths, calculating the estimates of Life Expectancy and Healthy Life Expectancy, and deriving the deprivation quintiles. Amy McKeon was responsible for analysing the information on limiting longstanding illness, self-assessed health and ADLs from the General Household Surveys and Scottish Household Surveys. Matt Sutton provided analytical advice, derived the simulation-based confidence intervals and the inequality measures, and was responsible for writing this report. Rachael Wood led on the initial design of the study and contributed to the writing of the report.

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# 1. INTRODUCTION

Measures of population health are used for monitoring public health[1], to evaluate the outcomes of interventions[2], for resource allocation[3] and in needs assessments[4]. It is increasingly recognised that these measures of population health should reflect both the length and quality of life.

Life expectancy is widely used as a single summary measure that has an intuitive interpretation. Trends in life expectancy at birth for health and local authorities in the United Kingdom over the period 1991-2001 were published on the National Statistics website last year.[5] These data inform one of the health inequality targets for England and Wales.[6] Life expectancy in Scotland has also been compared to other European countries.[7]

However life expectancy counts all years of expected life the same regardless of whether they are enjoyed in good health or with significant disability. A variety of measures have therefore been derived for incorporating a "healthy" element into life expectancy. One such measure is *Healthy Life Expectancy*, which represents the number of years that an individual can expect to live in good health.

Following publication of a seminal report by Bone et al,[8] (near) annual estimates of healthy life expectancy have been published by the Office for National Statistics for Great Britain.[9,10] Sub-national estimates of healthy life expectancy in England have also been produced for NHS Regions and Health Authorities using the General Household Survey[11] and the Health Survey for England.[12]

The lack of healthy life expectancy estimates for Scotland as a whole and for areas within Scotland was noted in a recent report.[13] This led to the establishment of the Healthy Life Expectancy Measurement in Scotland Steering Group. This group (whose membership is listed at the end of this report) received funding from the Scottish Executive to produce HLE estimates for Scotland. This report provides the results of this work.

The health element of HLE can be taken from surveys of the population. We use the Scottish subset of the General Household Survey to compare trends in HLE with trends in life expectancy for the period 1980-2000. We use the Scottish Household Survey to examine inequalities in HLE between different groups and areas within Scotland, specifically deprivation groups, NHS Boards and Council Areas. An important recent development is the availability of information from the 2001 Census, which provides two health measures suitable for calculating HLE based on the health status of the entire Scottish population. We compare our results based on the two surveys with estimates generated from the 2001 Census to ascertain whether these surveys would be suitable for monitoring HLE on a regular basis.

The report is structured as follows. In the next chapter we describe the conceptual issues involved in the measurement of Healthy Life Expectancy, including the measurement of life expectancy and adding the health element into Healthy Life Expectancy. In the following chapter we provide a worked example and assess the level of uncertainty associated with estimates based on populations and survey samples of different sizes. In Chapter 4 we provide a series of HLE estimates at Scotland-level for the period 1980-2000 based on the General Household Survey. In Chapter 5 we produce a full set of HLE estimates based on the Scottish Household Survey. Chapter 6 compares the results from Chapters 4 and 5 with figures based on the 2001 Census and is concerned with whether we can produce reliable estimates of HLE in non-Census years. Chapter 7 concludes with a summary of the findings, priorities for future work and recommendations for measuring Healthy Life Expectancy.

# 2. MEASURING HEALTHY LIFE EXPECTANCY

## 2.1 Measuring Life Expectancy

Standard methods for measuring life expectancy have been established based on abridged life tables. These tables require only estimated counts of population and deaths at different ages. We have adopted the Chiang II life table, which caters for data in age-intervals by assuming an average age at death within age intervals including the open-ended, top age-interval. Details of our assumptions are discussed with a worked example in Chapter 3 and an Appendix.

It is important to note that these life expectancy estimates are based on cross-sectional data. The key statistics on life expectancy at particular ages are a way of summarising the mortality rates observed across a range of age intervals. Life expectancy at birth, for example, gives the average length of time that a cohort of individuals would live if they experienced the age-specific mortality rates observed in the period of study. Since cross-sectional estimates of life expectancy have risen over time (as age-specific mortality rates have fallen over time), the actual life expectancy of individuals born in the current period is likely to be higher than the cross-sectional estimates generated using the age-specific mortality rates observed in the current-period.

## 2.2 Adding the 'H' to Life Expectancy

The consideration of information on health status is designed to incorporate quality as well as length of life into the population health measure. There are three main issues to be considered in how quality of life considerations should be taken into account: (1) the measure of health status; (2) the definitions of 'healthy' and 'unhealthy'; and (3) individual versus group level information.

### 2.2.1 *Measure of health status*

The health measure can relate specifically to one aspect of health or be a more generic measure of quality-of-life. We consider three health measures in this report:

- Limiting long-term illness
- Self-assessed health
- Activities of Daily Living

<u>Limiting long-term illness</u>

Limiting long-term illness (LLI) is a measure of serious and chronic ill-health that has been collected in many surveys and was included in the decennial Census for the first time in 1991. The wording of the question(s) differs between sources.

In the 2001 Census the question was:

*"Do you have any long-term illness, health problem or disability which limits your daily activities or the work you can do?"*

In the Scottish Household Survey, a household member is asked:

*"whether each of the people in the houshold has any longstanding illness, health problem or disability that limits your/their daily activity or the kind of work that you/they can do? By disability as opposed to ill-health, I mean a physical or mental impairment, which has a substantial and long-term adverse effect on their ability to carry out normal day to day activities."*

In the General Household Survey, limiting longstanding illness is obtained from a series of two questions. First, respondents are asked

*"Do you have any longstanding illness, disability or infirmity? By longstanding I mean anything that has troubled you over a period of time or that is likely to affect you over a period of time."*

Respondents who answer yes to this question are then asked:

*"Does this illness or disability limit your activities in any way?"*

The different ways in which limiting long-term illness is measured, and particularly the two-stage approach adopted in the General Household Survey, may affect the reported prevalence rates.

Detailed studies of responses to questions on limiting long-term illness have shown that it is predominantly a measure of physical functioning[14] and that, while the question asks respondents to focus on long-term conditions, many individuals no longer report limiting long-term illnesses at seven-year follow-up.[15]

Self-assessed health

Self-assessed health (SAH) is a measure of perceived health status that has also been collected in many surveys and was included in the decennial Census for the first time in 2001. This more generic measure of heath status (which is asked consistently in the Census, GHS and SHoS) is captured by the following question on the respondent's self-assessment of their general health state:

*"Over the last 12 months would you say your health has on the whole been good, fairly good or not good?"*

While the nature of the question is inherently subjective, it has been shown to capture the prevalence of a wide variety of health conditions.[16] It has also been shown to be a good predictor of mortality in several studies.[17] Although concerns have been raised about whether subjective measures of quality of life may be determined by expectations and experience and may therefore not be comparable across the population,[18] recent analysis has shown that the predictive ability of SAH does not vary across socio-economic groups but does vary by gender and age.[19] For the purpose of this exercise, the ability of a health status to predict mortality is less relevant because we can incorporate differences in mortality directly.

Activities of Daily Living

The measure Activities of Daily Living or ADLs reflects individuals' ability to perform basic physical tasks on their own or with assistance. They are designed to reflect the impact of ill-health on physical functioning and are more often used in social care planning.[13] In our data source they are asked only of people aged 65 or over.

There are five parts to the ADL questions: feeding, toileting, getting in/out of bed, bathing/showering and washing hands and face. Each item has 2 questions. The first asks whether the respondents usually manage each of the above: on their own; only with help; or not at all. Those who usually manage on their own are then asked whether they find the activity very easy, fairly easy, fairly difficult, or very difficult.

*2.2.2. The definitions of 'healthy' and 'unhealthy'*

For all three of the health measures that we consider, we cannot interpret the health measure as reflecting an 'absorbent' or 'irreversible' state in the same way as death. While the life table considers a cohort of individuals moving out of the study population at different rates, individuals who report themselves as 'unhealthy' in one period may report themselves as 'healthy' in the next. The adjustment for health status is therefore a way of scaling life years by the probability of good health. This is typically achieved by dividing the study population into those that are healthy and those that are unhealthy.

In the case of limiting long-term illness, which is a dichotomous variable, this is a relatively simple exercise. For the other measures, which have multiple categories, this is a more arbitrary distinction. In the case of ADLs we define requiring help with any of the following activities as representing 'unhealthy': Feeding, Toileting, Getting in/out of bed, Bathing/Showering and Washing hands and face. In the case of self-assessed health, we follow the Census convention of defining those who report 'good' or 'fairly good' health as 'healthy' and those reporting 'not good' health as 'unhealthy'.

There are three reasons why this approach is unfortunate. First, it represents a loss of information, since individuals reporting different levels of health are treated as if they were the same. Second, it has been demonstrated that the dichotomisation of multiple-category health variables affects not only the average level of health but also the size of the differences between groups.[20] Third, the calculation of healthy life expectancy using a binary definition of health takes no account of changes in the number of years spent in an unhealthy state. Individuals surviving in an 'unhealthy' state do not contribute to healthy life expectancy, and their health experience can only be appreciated by comparison of life expectancy (in which they are counted) and healthy life expectancy (in which they are not).

Different approaches are possible if one considers the adjustment for health status as a 'quality-weighting', in which zero represents death and one represent full health. In this case, all live individuals contribute to the measure of population health, with more healthy individuals contributing more than less healthy individuals. Various generic health instruments can provide such quality scores, including the SF-12 and the EQ-5D. A method has also been proposed for converting ordinal measures such as self-assessed health into quality scores.[21] We do not adopt this type of approach in this report to be as consistent as possible with the measures of Healthy Life Expectancy that have already been derived for the UK. However, we propose that it be considered in future work, particularly as the SF-12 has been included in the 2003 Scottish Health Survey.

### *2.2.3. Individual versus group level information*

There is one final consideration that should be emphasised about the approach that we have adopted for the measurement of healthy life expectancy. Our mortality and health status information is obtained from different sources and we are therefore unable to link individual records. Several approaches have been suggested for measuring healthy life expectancy using longitudinal methods,[22] which will become more feasible in Scotland with the recently established *Scottish Longitudinal Study*.

While considerably more demanding of data, calculations based on individual-level information have the advantage of being able to take account of the link between poor health status and subsequent mortality. Because health status and mortality risk are likely to be correlated, and healthy life expectancy is obtained by multiplying the number of life-years by the probability of good health, figures based on combining population averages will be different from those that would be obtained from taking the average of healthy life across individuals.[23]

The use of methods that have been proposed to adjust for this bias is beyond the scope of this report but, since length-of-life and the probability of good health are found to be positively correlated, it should be noted that the results presented in this report are downwardly-biased estimates of the true average of healthy life across the relevant groups of individuals. We suggest that estimation of the size of this bias should be a priority for future work.

# 3. CALCULATING HEALTHY LIFE EXPECTANCY

In this chapter we describe how Healthy Life Expectancy is calculated with a worked example. We also provide estimates of the level of uncertainty in LE and HLE estimates for populations of different sizes and based on available survey samples.

## 3.1 How Healthy Life Expectancy is calculated

In the Appendix we give the details of how Healthy Life Expectancy is calculated. In this section we describe the main principles. We begin by calculating life expectancy through the construction of a standard life table based on information for age groups. These measures are most accurately calculated when the age bands are narrow. Our choice of age bands is guided by the availability of information from the 2001 Census. We use five-year age-bands, except the youngest age-band for which we have separate information for 0-2 and 3-4 year-olds. The top age-band includes all of the population aged 85 years and over.

To reflect the information on age intervals we need to estimate the average age of individuals dying in each age interval, including the open-ended top band. We assume that, on average, individuals that die within a certain age interval survive for half of the length of the age interval. For the youngest age group, we assume that the average death occurs just 10% into the age interval to reflect perinatal mortality. For the oldest age group, we assume that the average age at death is 87.5 years. These estimates are conventional and we checked these assumed values using a single-year life-table for Scotland.

Based on the population and death figures, we can calculate the death rate for each age interval. As expected, we find that the death rate is initially higher in the youngest age group, declines until the 5-9 age group, and then increases exponentially as age increases. The next step is to calculate the probabilities that individuals will survive through the next age interval, given that they have survived through each of the previous age intervals. These probabilities allow us to simulate what would happen to a cohort of individuals born today and experiencing the age-specific death rates that have been observed. The value of life expectancy at a particular age is then obtained by dividing the total number of years that would be lived by this cohort of individuals beyond this age by the number of survivors.

Healthy Life Expectancy is calculated by augmenting the life table with estimates of the proportions of each age group in good health. The figures in Table A1, for example, indicate that the proportion of Scottish residents free from limiting long-term illness falls from 0.98 in the 0-2 year age interval to 0.21 in the top age interval (85+ years). These estimated proportions are applied as weightings to the number of years that the cohort of individuals will live during each age interval. The value of Healthy Life Expectancy is then obtained by dividing the total number of years that the cohort of individuals will live in good health by the number of survivors.

The calculations in the augmented life table provide estimates of Life Expectancy and Healthy Life Expectancy for each age interval. We concentrate on these measures at birth and at age 65. The worked example in the appendix shows that Life Expectancy at birth is estimated to be 76.28 years while Healthy Life Expectancy at birth is estimated to be 60.08 years. This indicates that 78.8% (= 60.08 / 76.28) of total Life Expectancy is expected to be enjoyed in good health. At age 65, Life Expectancy is estimated to be 16.83 years, 44.2% (=7.44 / 16.83) of which is expected to be in good health.

The appendix shows how estimates of health status are combined with mortality information to produce estimates of HLE. The health status information is used to adjust the figures on years of life lived within each age interval. This information can therefore be obtained from a separate source to the mortality information. The health status information can also be seen as an adjustment for quality of life. Therefore, any scalar in the {0,1} range can be used to adjust life expectancy to reflect health status or quality of life.

Finally, the calculations make clear the cross-sectional nature of the LE and HLE calculations. While the intuitive interpretations of LE and HLE are longitudinal or birth-cohort in nature, the calculations are based on cross-sectional estimates obtained from a population at a particular point in time. This population will represent a mix of birth-cohorts. The LE and HLE estimates provided in this report represent a simple way of summarising complex cross-sectional information on the mortality and health status experience of the Scottish population. The figures represent a hypothetical individual born today and experiencing the mortality and health status experience of the current (or recent) Scottish population. They will not represent the actual LE and HLE anticipated for individuals born in Scotland today. In particular, the mortality and health status experience of today's older population will impact on the estimates of LE and HLE at birth provided in this report, even though the current Scottish birth-cohort may have substantially different mortality and health status experience when the survivors become older people themselves.

### 3.2 Levels of uncertainty in LE and HLE estimates

The Census provides a unique opportunity to generate HLE estimates based on information on the health status of the entire population. Nevertheless, there will be random fluctuations in mortality rates and health status that will generate uncertainty in the LE and HLE estimates. This will be more important for the disaggregated figures based on smaller population sizes.

In Chapters 4 and 5 we provide estimates of HLE based on surveys of the Scottish population living in private households. Reliance on surveys of a sample of the population for the health status figures generates additional uncertainty in the HLE estimates. The purpose of this section is to quantify the extent of uncertainty in the LE and HLE estimates provided in this report.

A variety of methods are available for estimating the degree of uncertainty in LE and HLE. Although approximate methods for confidence intervals for HLE have been derived, it is generally recommended that simulation-based techniques be used to generate estimates of the level of uncertainty in complex summary statistics such as HLE. This process is time-consuming so, rather than produce confidence intervals for each estimate, we estimated confidence intervals for standard combinations of population size (on which the mortality rates are based) and survey sample size (on which the morbidity rates are based). We estimated the level of uncertainty in LE and HLE estimates for four representative scenarios (see Table 3.1).

**Table 3.1 - Scenarios for which uncertainty intervals are estimated**

| Scenario | Geographical area | Source of mortality information | Source of health status information |
|---|---|---|---|
| 1 | Smallest Council Area (10,000 persons) | Death records, three-years | Entire population (hypothetical) |
| 2 | Scotland | Death records, one-year | One-year of GHS (750 persons) |
| 3 | Scotland | Death records, one-year | One-year of SHoS (15,000 persons) |
| 4 | Average Council Area (80,000 persons) | Death records, two-years | Two-years of SHoS (1,000 persons) |

Note: Since LE and HLE estimates are provided for males and females separately, “persons” refers to approximate numbers of females *or* numbers of males in the relevant geographical areas or sample surveys.

We treat the level of uncertainty in life expectancy for the three-year average for the smallest Council Area in Scotland in Scenario 1 as a baseline, because this is the series generated by the Office for National Statistics.[5] We assume (hypothetically) that the health status information is also obtained from the entire population to demonstrate the effect on the level of uncertainty of incorporating a “healthy” element into life expectancy estimates. Scenarios 2 and 3 demonstrate the level of uncertainty associated with annual estimates of HLE for Scotland as a whole using the two available surveys. Scenario 4 illustrates the level of uncertainty associated with HLE estimates produced for a typical geographical area within Scotland using data covering two-years (the period over which the Scottish Household Survey is designed to produce representative samples for all Council Areas).

Our results are summarised in Table 3.2. For each LE or HLE estimate we provide an estimated standard error (S.E.). The width of the 95% confidence interval that would be associated with that standard error can be calculated using ±1.96*S.E. For example, our results indicate that a three-year estimate of life expectancy for the smallest Council Area in Scotland will be estimated with a standard error of 0.81 (Scenario 1). The associated 95% confidence interval would range from 1.58 years below the estimate to 1.58 years above the estimate.

The general pattern of results in Table 3.2 is as follows:

- Uncertainty in LE and HLE estimates is smaller in absolute terms at age 65 than at birth, but greater as a percentage of the original estimate
- Uncertainty in HLE is lower than in LE when the health status information is based on the same size of population

- The degree of uncertainty in HLE estimates for Scotland as a whole based on annual samples of the GHS are approximately 25% larger than those for LE estimates based on three-years' data for the smallest Council Area
- The degree of uncertainty in HLE estimates for Scotland as a whole based on annual samples of the SHoS are approximately one-quarter of the size of those for LE estimates based on three-years' data for the smallest Council Area
- The degree of uncertainty in HLE estimates for an average Council Area based on two-year samples of the SHoS are of a similar magnitude to those for LE estimates based on three-years' data for the smallest Council Area.

**Table 3.2 - Simulated levels of uncertainty for the Table 3.1 scenarios**

| Scenario | Age | Standard Error | |
|---|---|---|---|
| | | LE | HLE |
| 1 | At birth | 0.81 | 0.49 |
| 2 | At birth | 0.09 | 0.98 |
| 3 | At birth | 0.09 | 0.23 |
| 4 | At birth | 0.35 | 0.89 |
| 1 | At age 65 | 0.52 | 0.21 |
| 2 | At age 65 | 0.06 | 0.70 |
| 3 | At age 65 | 0.06 | 0.17 |
| 4 | At age 65 | 0.23 | 0.65 |

It is clear from Table 3.2 that reliance on sample surveys for the information on health status generates a degree of additional uncertainty in HLE estimates. Caution will therefore be required in interpreting short-term fluctuations in HLE estimates. In particular, we can be 95% certain only that HLE at birth will lie within +/-2 years of an annual estimate based on the national sample of the General Household Survey or a Council Area sample from two-years of the Scottish Household Survey.

Whether or not this is tolerable, of course, depends on the need for the regular monitoring of population health and any temptation to over-interpret short-term fluctuations. It is important to note the relative uncertainty of the HLE estimates compared to LE figures, which are used on a routine basis. For this reason, we believe that the level of uncertainty in HLE estimates provided by sample surveys should not prohibit the production of regular updates to these figures.

# 4. HLE TIME TRENDS IN SCOTLAND

In this chapter we provide annual estimates of HLE based on the General Household Survey for 1980-2000. The General Household Survey is the only source of data on health status that has been measured consistently and regularly over a long period. The GHS is not a perfect data source for HLE estimates for Scotland because it does not sample from the whole of Scotland in every year. Nevertheless, it is invaluable for considering long-term trends in HLE alongside trends in LE.

For each series we provide a measure of the average annual growth in years between the start and end of the period. This is calculated using regression analysis, which assumes a linear trend. We also provide an estimate of the average annual growth *rate*, calculated by dividing the average annual growth in years by the average value at the start of the period (1980-1982). The methods and detailed regression results are provided in the Appendix.

### 4.1 Trends in life expectancy without limiting long-term illness

Our estimates of annual LE and HLE for Scottish females using health status information on limiting long-term illness from the GHS are provided in Tables 4.1. We find that while LE at birth has increased by an average of 0.17 years per annum, HLE at birth has increased by just 0.01 years per annum (and this increase is not statistically significant – see Appendix). Over the same period, LE at age 65 has increased by 0.09 years per annum while HLE at age 65 has increased by 0.06 years per annum. Relatively speaking, the gains in LE are larger at age 65 than at birth, and HLE at age 65 has grown at the highest *rate*.

A similar set of annual estimates for males is provided in Table 4.2. We find that LE and HLE has increased more rapidly for males than for females both at birth and at age 65. As for females, the increase in LE at birth is considerably larger than the increase in HLE at birth (and the increase in HLE at birth remains statistically insignificant). The gains in HLE at age 65 are smaller than the gains in LE at age 65 in absolute terms, but larger in relative terms.

**Table 4.1 - Annual estimates of HLE without LLI, Females 1980-2000**

| Year | At birth | | At age 65 | |
|---|---|---|---|---|
| | LE | HLE(LLI) | LE | HLE(LLI) |
| 1980 | 75.1 | 61.0 | 16.1 | 8.7 |
| 1981 | 75.4 | 60.6 | 16.1 | 8.8 |
| 1982 | 75.3 | 60.5 | 15.9 | 7.9 |
| 1983 | 75.7 | 61.5 | 16.2 | 8.8 |
| 1984 | 75.9 | 61.1 | 16.6 | 9.2 |
| 1985 | 75.8 | 61.4 | 16.3 | 9.3 |
| 1986 | 76.3 | 60.8 | 16.4 | 8.6 |
| 1987 | 76.6 | 59.0 | 16.7 | 7.5 |
| 1988 | 76.6 | 59.8 | 16.7 | 8.3 |
| 1989 | 76.2 | 62.3 | 16.3 | 9.5 |
| 1990 | 77.1 | 61.1 | 17.0 | 9.7 |
| 1991 | 77.2 | 61.9 | 17.0 | 9.6 |
| 1992 | 77.4 | 61.3 | 17.1 | 9.6 |
| 1993 | 76.9 | 59.7 | 16.6 | 9.0 |
| 1994 | 77.7 | 60.5 | 17.3 | 9.4 |
| 1995 | 77.7 | 60.1 | 17.2 | 8.9 |
| 1996 | 77.9 | 60.0 | 17.5 | 9.6 |
| 1998 | 78.2 | 61.1 | 17.6 | 9.9 |
| 2000 | 78.7 | 62.6 | 17.9 | 9.6 |
| Annual increase (years) | 0.174 | 0.014 | 0.090 | 0.063 |
| % annual change | 0.23% | 0.02% | 0.56% | 0.75% |

**Figure 4.1 – Trends in HLE without LLI, Females 1980-2000**

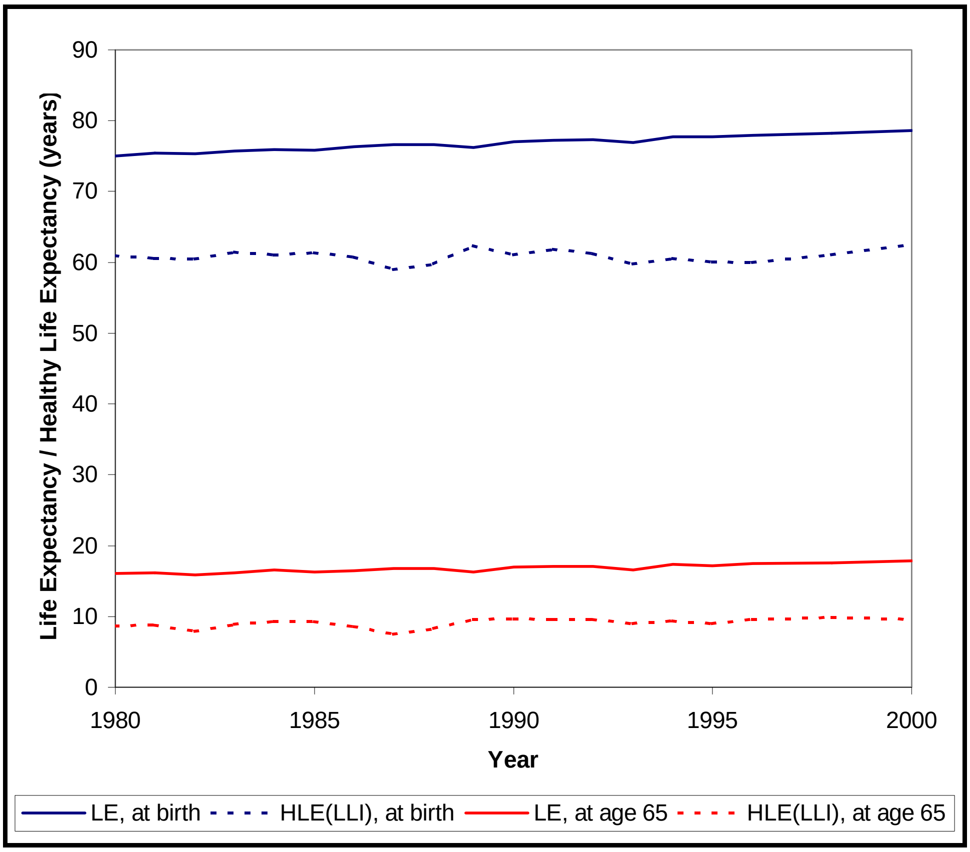
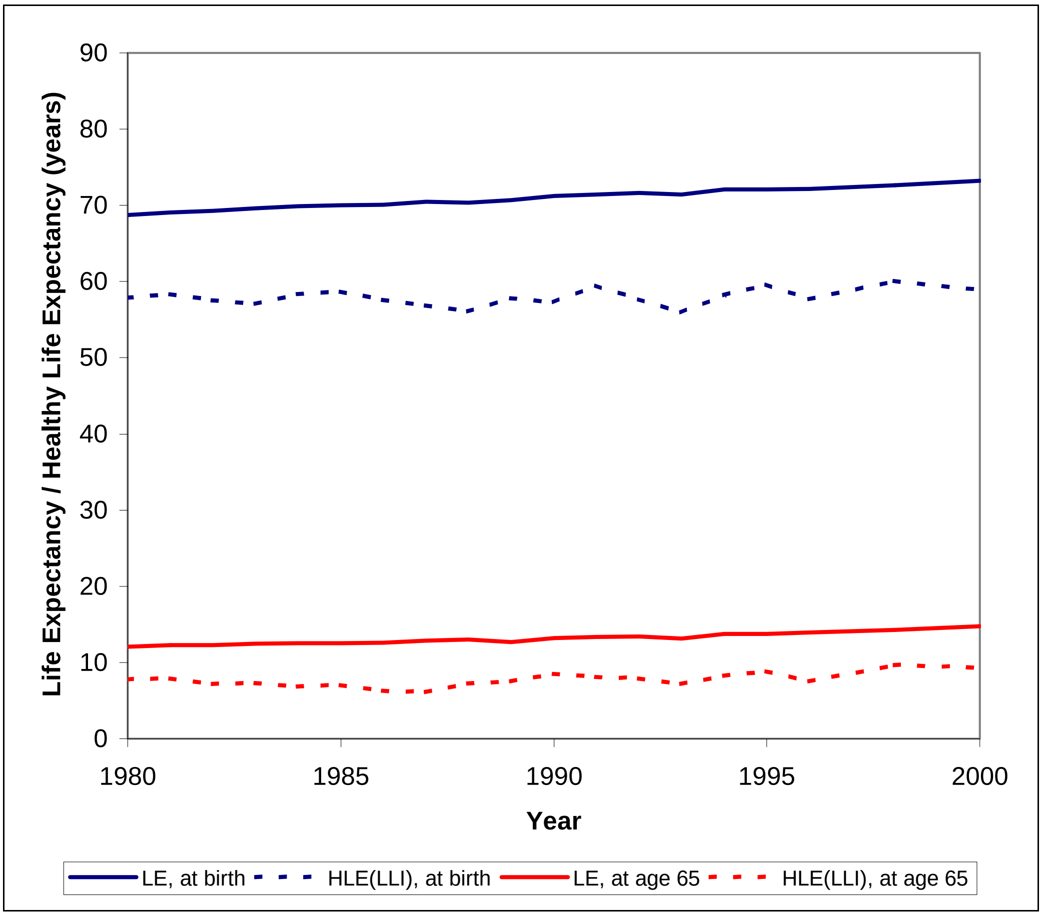


**Table 4.2 - Annual estimates of HLE without LLI, Males 1980-2000**

| Year | At birth | | At age 65 | |
|---|---|---|---|---|
| | LE | HLE(LLI) | LE | HLE(LLI) |
| 1980 | 68.7 | 57.9 | 12.1 | 7.8 |
| 1981 | 69.1 | 58.4 | 12.3 | 7.9 |
| 1982 | 69.3 | 57.5 | 12.3 | 7.2 |
| 1983 | 69.6 | 57.1 | 12.5 | 7.3 |
| 1984 | 69.9 | 58.3 | 12.5 | 6.9 |
| 1985 | 70.0 | 58.7 | 12.5 | 7.0 |
| 1986 | 70.1 | 57.6 | 12.6 | 6.3 |
| 1987 | 70.5 | 56.9 | 12.9 | 6.1 |
| 1988 | 70.3 | 56.0 | 13.0 | 7.3 |
| 1989 | 70.7 | 57.8 | 12.7 | 7.5 |
| 1990 | 71.2 | 57.3 | 13.2 | 8.5 |
| 1991 | 71.4 | 59.5 | 13.4 | 8.1 |
| 1992 | 71.6 | 57.7 | 13.4 | 7.9 |
| 1993 | 71.4 | 56.0 | 13.1 | 7.2 |
| 1994 | 72.1 | 58.2 | 13.7 | 8.3 |
| 1995 | 72.1 | 59.6 | 13.7 | 8.8 |
| 1996 | 72.1 | 57.7 | 13.9 | 7.5 |
| 1998 | 72.6 | 60.1 | 14.3 | 9.6 |
| 2000 | 73.3 | 58.9 | 14.8 | 9.3 |
| Annual increase (years) | 0.215 | 0.061 | 0.120 | 0.097 |
| % annual change | 0.31% | 0.11% | 0.98% | 1.28% |

**Figure 4.2 – Trends in HLE without LLI, Males 1980-2000**



### 4.2 Trends in life expectancy in good or fairly good general health

Annual estimates for HLE using SAH from the GHS are provided for females in Table 4.3. The growth in HLE at birth for females using SAH is approximately 0.11 years per annum (and is statistically significant at 1%). This represents a growth *rate* that is approximately two-thirds of the rate of increase in LE. The growth in HLE at 65 using SAH for females is estimated to be 0.07 years per annum. This is larger in absolute terms than the growth in HLE at 65 calculated using LLI, but smaller in relative terms.

HLE estimates for males using SAH from the GHS are shown in Table 4.4. Similar to when LLI is used, HLE for males is shown to have grown faster than that for females. At birth, the growth in HLE using SAH is 0.12 years per annum (and is statistically significant). HLE at age 65 using SAH has grown by 0.10 years per annum, which is equal to the growth in male HLE at age 65 using LLI and therefore a slightly lower *rate*.

**Table 4.3 - Annual estimates of HLE "Good" or "Fairly Good" SAH, Females 1980-2000**

| Year | At birth | | At age 65 | |
|---|---|---|---|---|
| | LE | HLE(SAH) | LE | HLE(SAH) |
| 1980 | 75.1 | 65.9 | 16.1 | 12.1 |
| 1981 | 75.4 | 67.0 | 16.1 | 12.8 |
| 1982 | 75.3 | 66.2 | 15.9 | 11.8 |
| 1983 | 75.7 | 66.5 | 16.2 | 12.3 |
| 1984 | 75.9 | 65.2 | 16.6 | 12.1 |
| 1985 | 75.8 | 67.5 | 16.3 | 12.9 |
| 1986 | 76.3 | 67.7 | 16.4 | 12.1 |
| 1987 | 76.6 | 66.6 | 16.7 | 12.0 |
| 1988 | 76.6 | 68.2 | 16.7 | 12.5 |
| 1989 | 76.2 | 68.7 | 16.3 | 12.5 |
| 1990 | 77.1 | 68.0 | 17.0 | 13.6 |
| 1991 | 77.2 | 67.9 | 17.0 | 13.5 |
| 1992 | 77.4 | 67.6 | 17.1 | 13.3 |
| 1993 | 76.9 | 68.1 | 16.6 | 13.2 |
| 1994 | 77.7 | 67.5 | 17.3 | 13.3 |
| 1995 | 77.7 | 67.8 | 17.2 | 12.3 |
| 1996 | 77.9 | 69.1 | 17.5 | 13.7 |
| 1998 | 78.2 | 68.2 | 17.6 | 14.7 |
| 2000 | 78.7 | 67.3 | 17.9 | 12.2 |
| Annual increase | 0.174 | 0.107 | 0.090 | 0.072 |
| % annual change | 0.23% | 0.16% | 0.56% | 0.59% |

**Figure 4.3 – Trends in HLE in "Good" or "Fairly Good" SAH, Females 1980-2000**

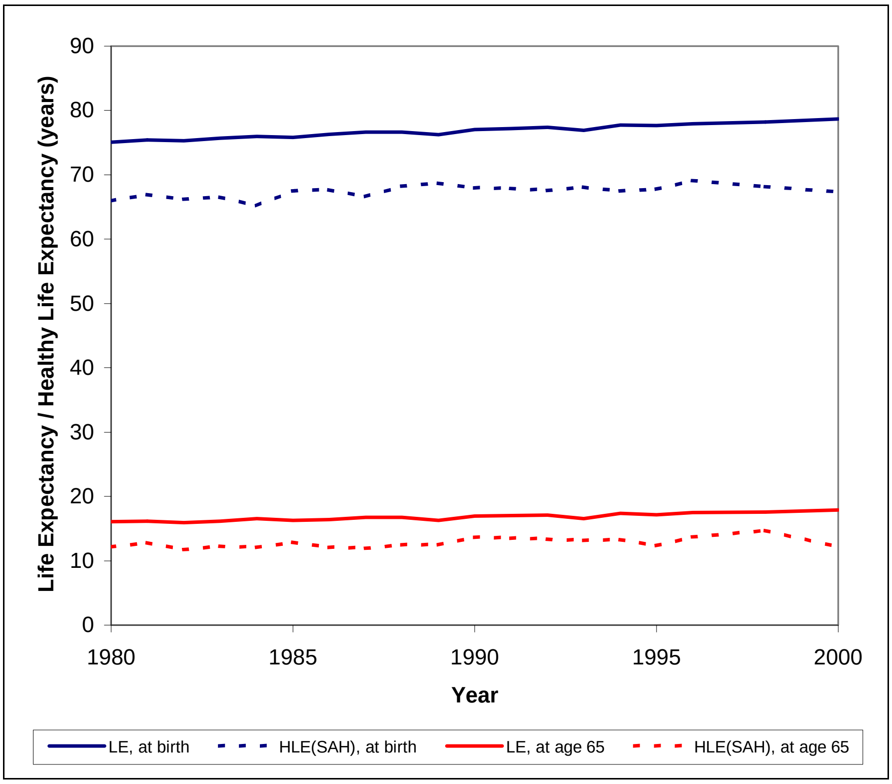
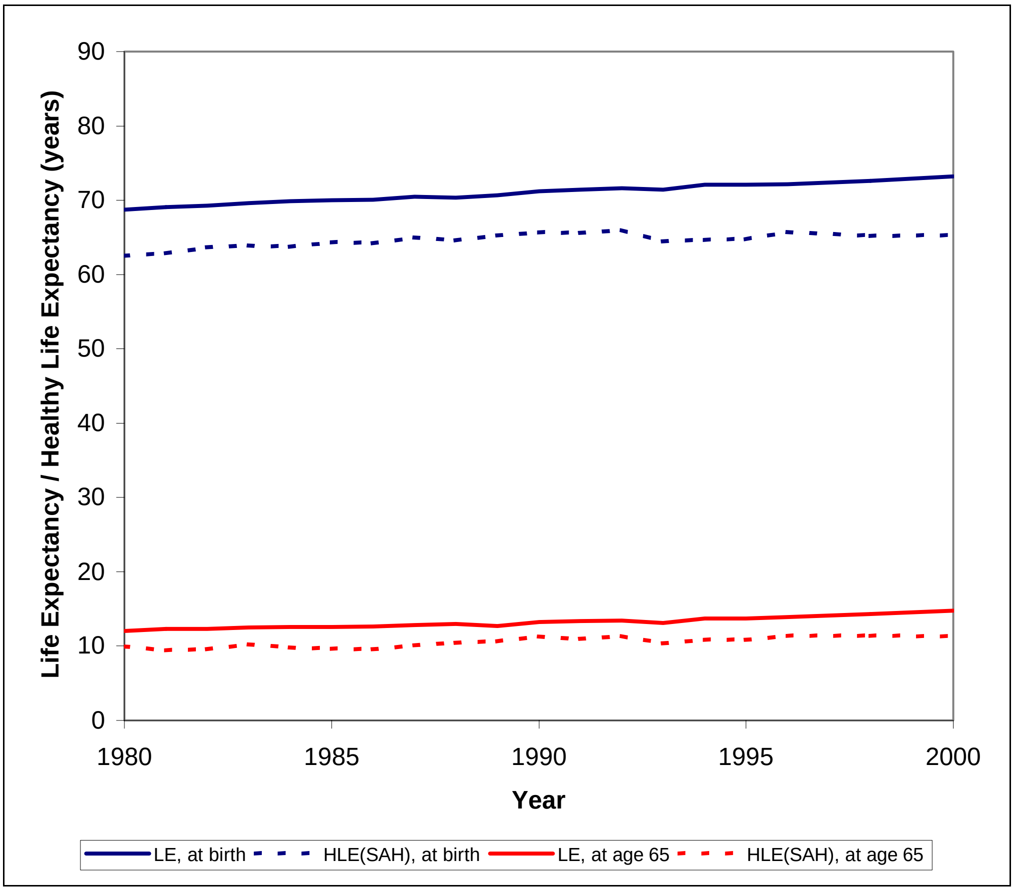


**Table 4.4 - Annual estimates of HLE "Good" or "Fairly Good" SAH, Males 1980-2000**

| Year | At birth | | At age 65 | |
|---|---|---|---|---|
| | LE | HLE(SAH) | LE | HLE(SAH) |
| 1980 | 68.7 | 62.6 | 12.1 | 10.0 |
| 1981 | 69.1 | 62.8 | 12.3 | 9.5 |
| 1982 | 69.3 | 63.7 | 12.3 | 9.6 |
| 1983 | 69.6 | 64.0 | 12.5 | 10.3 |
| 1984 | 69.9 | 63.7 | 12.5 | 9.9 |
| 1985 | 70.0 | 64.3 | 12.5 | 9.7 |
| 1986 | 70.1 | 64.2 | 12.6 | 9.6 |
| 1987 | 70.5 | 65.0 | 12.9 | 10.1 |
| 1988 | 70.3 | 64.6 | 13.0 | 10.4 |
| 1989 | 70.7 | 65.3 | 12.7 | 10.7 |
| 1990 | 71.2 | 65.7 | 13.2 | 11.3 |
| 1991 | 71.4 | 65.6 | 13.4 | 11.0 |
| 1992 | 71.6 | 66.0 | 13.4 | 11.4 |
| 1993 | 71.4 | 64.4 | 13.1 | 10.4 |
| 1994 | 72.1 | 64.6 | 13.7 | 10.8 |
| 1995 | 72.1 | 64.7 | 13.7 | 10.9 |
| 1996 | 72.1 | 65.7 | 13.9 | 11.4 |
| 1998 | 72.6 | 65.2 | 14.3 | 11.4 |
| 2000 | 73.3 | 65.3 | 14.8 | 11.3 |
| Annual increase | 0.215 | 0.122 | 0.120 | 0.097 |
| % annual change | 0.31% | 0.19% | 0.98% | 1.00% |

**Figure 4.4 – Trends in HLE in "Good" or "Fairly Good" SAH, Males 1980-2000**



### 4.3 Trends in life expectancy with unassisted Activities of Daily Living

In Table 4.5 we present our HLE estimates using the third measure of health status – ability to perform Activities of Daily Living "unassisted". The information is only available in particular years of the GHS and for calculating HLE at age 65. The figures show that the annual growth in LE for females between 1980 and 1998 is 0.09 years per annum and the growth in HLE with unassisted ADL is markedly lower at just 0.05 years per annum. The difference between the growth in LE and HLE is more marked for males. While males have enjoyed a larger increase in LE at age 65 of 0.12 years per annum, the growth in HLE with unassisted ADL is the same as that for females.

**Table 4.5 - Annual estimates of HLE at 65 "Unassisted" ADL, males & females 1980-1998**

| Year | Females at age 65 | | Males at age 65 | |
|---|---|---|---|---|
| | LE | HLE(ADL) | LE | HLE(ADL) |
| 1980 | 16.1 | 14.6 | 12.1 | 11.6 |
| 1985 | 16.3 | 14.6 | 12.5 | 11.6 |
| 1994 | 17.3 | 15.0 | 13.7 | 12.6 |
| 1996 | 17.5 | 14.8 | 13.9 | 12.0 |
| 1998 | 17.6 | 16.0 | 14.3 | 12.6 |
| Annual increase (years) | 0.090 | 0.054 | 0.122 | 0.054 |
| % annual change* | 0.56% | 0.37% | 1.01% | 0.47% |

* Relative to 1980 value.

### 4.4 Summary of trends

Comparison of the trends observed in Tables 4.1 to 4.5 demonstrates the importance of the choice of health status measure. The trends in LE and HLE at birth in Tables 4.1 to 4.4 show that males have enjoyed higher increases than females and that increases in HLE in 'Good' or 'Fairly Good' health have been larger than the increases in HLE free from limiting longstanding illness. At age 65, increases in HLE have been more similar to the increases in LE in absolute terms and generally larger in relative terms, with the largest relative growth *rates* in HLE free from limiting long-term illness.

# 5. INEQUALITIES IN HLE WITHIN SCOTLAND

The Scottish Household Survey provides health information on a larger sample of individuals resident in Scotland than the General Household Survey. In this section, therefore, we provide estimates for the entire population, for the fifteen NHS Boards and for the thirty-two Local Council Areas.

We have also grouped the Scottish population into five equal-sized groups (quintiles) based on deprivation scores for geographical areas. We have used the deprivation index created by Carstairs and Morris to measure the level of deprivation.[24,25] We created deprivation scores from the 2001 Census.[26] We used the Census Standard Tables to generate this index, as these tables provide the health variables that we use for smaller age-groups.

Our estimates of LE and HLE for Scotland as a whole are annual estimates based on data for 2000. We provide two-year (1999-2000) estimates of HLE for NHS Boards and Council Areas within Scotland. In each case we provide an all-Scotland figure for comparison, as there are small differences in the numbers of respondents and the age bands for which the Scottish Household Survey data are available for NHS Boards and Council Areas. For deprivation quintiles, we use Scottish Household Survey data for 2000 and calculate mortality rates based on Census 2001 populations and mortality information for 2001.

In each case we provide separate estimates for males and females and calculate LE and HLE at birth and at age 65. For each disaggregation of the Scottish population we summarise the level of inequality using three standard measures of inequality[27]:

- *Decile Ratio* – the ratio of the value at the 90th percentile to the value at the 10th percentile
- *Robin Hood Index* – the percentage of the total that would need to be redistributed from the groups above the average to the groups below the average[*]
- *Gini coefficient* – a measure of inequality between zero (no inequality) and one (maximum inequality) that reflects the entire distribution and is often used to summarise the level of income inequality.

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[*] It should be noted that the Robin Hood Index is used to summarise the level of inequality and does not necessarily indicate how these inequalities *should* be reduced. The Scottish Executive's policy on health improvement suggests that these inequalities should be reduced by differential rates of health improvement.

The Scottish Household Survey is a continuous survey of private households which, through differential sampling, provides representative samples for each Council Area from two years of data. The survey involves a household questionnaire with one household member and an individual questionnaire for one adult in the household. The household questionnaire asks the respondent to report whether each of the household members has a limiting long-term illness. We therefore have LLI information on all household members. Self-assessed health is only asked in the individual questionnaire and so is only available for a smaller number of respondents aged 16 and over. We have applied the self-assessed health data for 16-19 year-olds to the younger age groups. We have also used the sampling weights provided in the Scottish Household Survey.

**5.1 Scotland**

Table 5.1 shows our estimates of LE and HLE for males and females in 2000. LE for females at birth is 78.7 years. Our HLE estimates indicate that 73% of this life expectancy will be free from limiting long-term illness and 85% will be enjoyed in ‘Good’ or ‘Fairly Good’ health. LE at birth for males is shorter, and the proportions of those years that are free from limiting long-term illness (74%) and in ‘Good’ or ‘Fairly Good’ health (88%) are similar to the figures for females.

At age 65, life expectancy for females is 17.9 years and for males is 14.8 years. Females can expect only 50% of these years to be free from limiting long-term illness but 75% to be enjoyed in good or fairly good health. As for the at-birth figures, the proportions of life expectancy for males at age 65 that are free from limiting long-term illness (52%) and in good or fairly good health (78%) are similar to the figures for females, but the general trend is towards higher figures for males.

Life Expectancy at birth for females is approximately 5.4 years longer than for males, representing a difference of 7%. Differences between females and males are smaller, however, when we take account of health status. Our HLE estimates at birth for females are 5% and 4% higher than for males using limiting long-term illness and self-assessed health, respectively. A similar pattern of results is observed for the measures at age 65 years. LE and

HLE at age 65 is higher for females than males but the difference in both measures of HLE is smaller both in absolute and relative terms.

**Table 5.1 - LE and HLE estimates for Scotland, 2000**

| Age group | At birth | | | At age 65 | | |
|---|---|---|---|---|---|---|
| Group | LE | HLE(LLI) | HLE(SAH) | LE | HLE(LLI) | HLE(SAH) |
| | | | | | | |
| Females | 78.7 | 57.5 | 67.2 | 17.9 | 8.9 | 13.4 |
| Males | 73.3 | 54.5 | 64.6 | 14.8 | 7.7 | 11.5 |
| | | | | | | |
| Ratio (Female: Male) | 1.07 | 1.05 | 1.04 | 1.21 | 1.15 | 1.16 |

## 5.2 Deprivation quintiles

Table 5.2 shows our estimates of life expectancy and healthy life expectancy by deprivation quintile for females. Life expectancy is 76.4 years in the most deprived quintile and 81.1 years in the least deprived quintile, representing an absolute gap of 4.6 years. The gap in healthy life expectancy at birth however is almost three times wider when LLI is used as the health status measure. At age 65, HLE is almost 40% higher in the least deprived quintile than in the most deprived quintile.

**Table 5.2 - LE and HLE estimates for Deprivation Quintiles, Females 2000**

| Age group | At birth | | | At age 65 | | |
|---|---|---|---|---|---|---|
| Quintile | LE | HLE(LLI) | HLE(SAH) | LE | HLE(LLI) | HLE(SAH) |
| 5 - Most deprived | 76.4 | 51.2 | 61.6 | 17.2 | 7.8 | 11.6 |
| 4 | 77.9 | 54.6 | 64.9 | 17.6 | 8.3 | 12.1 |
| 3 | 79.2 | 56.4 | 68.0 | 18.3 | 8.9 | 13.7 |
| 2 | 80.6 | 61.5 | 70.8 | 18.9 | 9.6 | 15.0 |
| 1 - Least deprived | 81.1 | 64.2 | 72.7 | 19.2 | 10.7 | 16.0 |
| Decile Ratio | 1.061 | 1.255 | 1.180 | 1.120 | 1.378 | 1.381 |
| Robin Hood Index | 1.91% | 7.36% | 5.21% | 3.77% | 9.75% | 10.64% |
| Gini coefficient | 0.012 | 0.046 | 0.033 | 0.024 | 0.063 | 0.068 |

A similar set of figures for males are given in Table 5.3. While life expectancy at birth ranges from 69.1 to 77.6 years, the two healthy life expectancy series range from 47.8 to 62.4 years and 55.9 to 73.3 years. Males in the least deprived quintile have a healthy life expectancy at age 65 that is 50% higher than that of males in the most deprived quintile.

**Table 5.3 - LE and HLE estimates for Deprivation Quintiles, Males 2000**

| Age group | At birth | | | At age 65 | | |
|---|---|---|---|---|---|---|
| Quintile | LE | HLE(LLI) | HLE(SAH) | LE | HLE(LLI) | HLE(SAH) |
| 5 - Most deprived | 69.1 | 47.8 | 55.9 | 13.6 | 6.5 | 9.7 |
| 4 | 72.5 | 50.6 | 62.8 | 14.6 | 6.8 | 10.7 |
| 3 | 73.8 | 53.6 | 64.6 | 15.0 | 7.6 | 11.6 |
| 2 | 75.5 | 58.8 | 68.8 | 16.0 | 8.8 | 12.9 |
| 1 - Least deprived | 77.6 | 62.4 | 73.3 | 16.7 | 10.0 | 14.5 |
| Decile Ratio | 1.122 | 1.304 | 1.311 | 1.234 | 1.532 | 1.497 |
| Robin Hood Index | 3.12% | 8.76% | 7.34% | 6.19% | 14.50% | 12.18% |
| Gini coefficient | 0.022 | 0.055 | 0.050 | 0.040 | 0.090 | 0.079 |

As was observed for females in Table 5.2, the difference between the least deprived and most deprived quintiles is larger in relative terms but smaller in absolute terms at age 65 years than at birth. At birth, differences in absolute terms are larger using LLI as the health measure. At age 65, differences in absolute terms are larger using SAH as the health measure. Differences are larger in relative terms using LLI rather than SAH at both ages.

In Figures 5.1 and 5.2 we illustrate how these differences emerge by comparing the two dimensions of Healthy Life Expectancy between the most deprived and least deprived quintiles. Figures 5.1(a) and 5.2(a) show how the mortality rates at each age affect the proportions of the initial cohort that survive to the start of each age interval. It can be seen that the proportions surviving in the least deprived quintiles are higher than the proportions surviving in the most deprived quintiles at all ages. Figures 5.1(b) and 5.2(b) show how the probabilities of reporting “good” or “fairly good” general health at each age also diverge. For females (Figure 5.1(b)), the proportions reporting good health are similar in young adulthood but decline with age more rapidly in the most deprived quintile. For males (Figure 5.2(b)), the proportion reporting good health in the most deprived quintile is already below that in the least deprived quintile by young adulthood. From the age of 35 onwards, the probability of being healthy falls markedly in the most deprived quintile and reaches its lowest level in the 55-59 year age group. In the least deprived quintile, the probability of good health shows a more gradual decline.

**Figure 5.1 – Components of HLE in most and least deprived quintiles, Females**

Figure 5.1(a) Proportions surviving to each age category

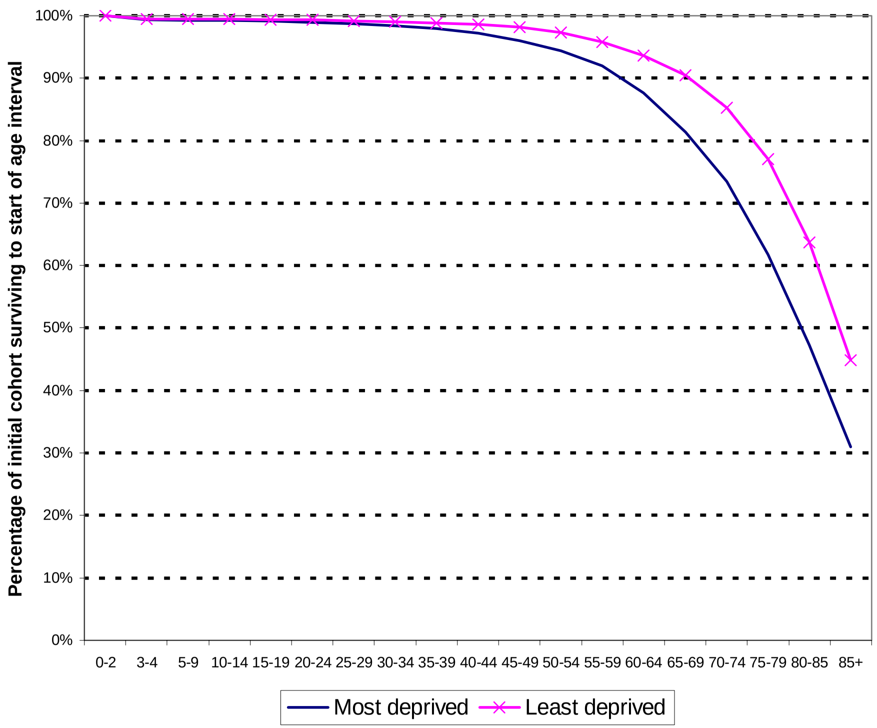



Figure 5.1(b) Proportions reporting good health

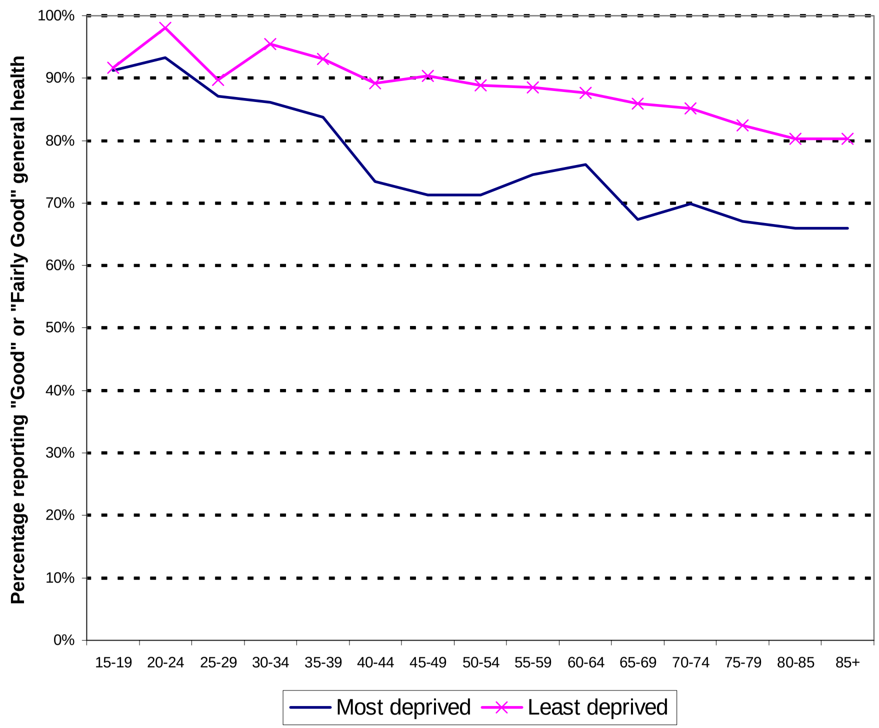


**Figure 5.2 - Components of HLE in most and least deprived quintiles, Males**

Figure 5.2(a) Proportions surviving to each age category

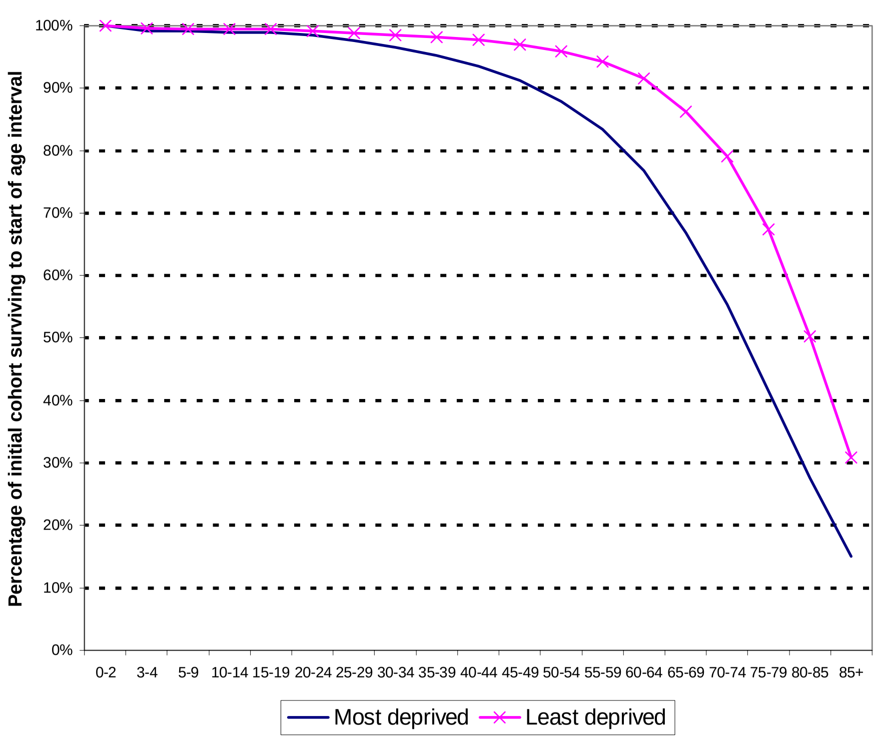
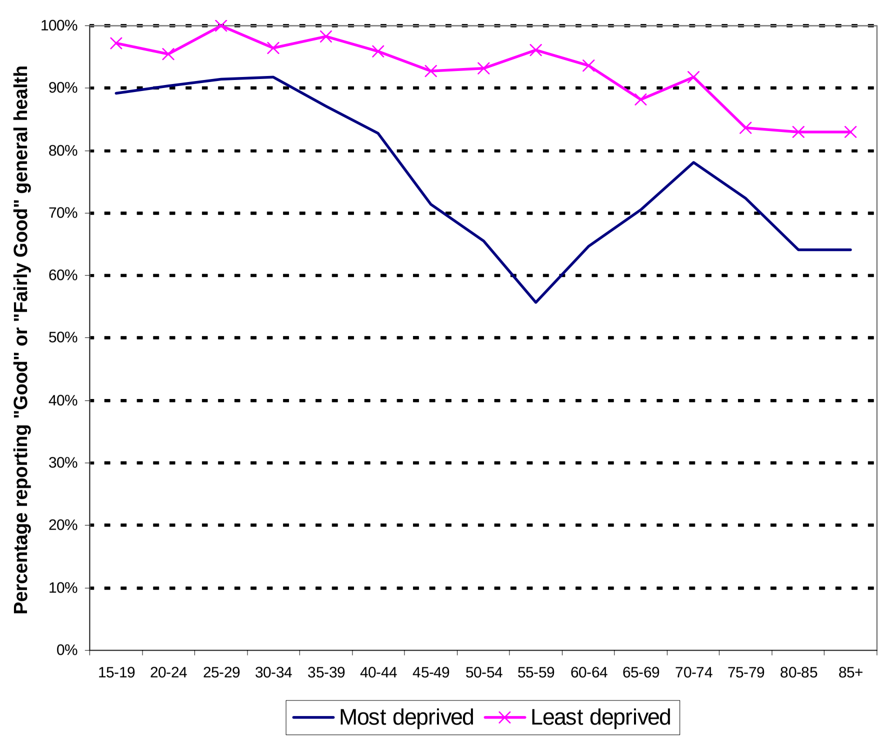



Figure 5.2(b) Proportions reporting good health



## 5.3 NHS Boards

Our LE and HLE estimates for females in 1999-2000 are shown by NHS Board in Table 5.4. Life expectancy at birth is highest in the three island Boards and Borders. In all of these Boards life expectancy is greater than eighty years. Life expectancy is lowest in Greater Glasgow, Ayrshire & Arran, Lanarkshire and Argyll & Clyde. The difference between the highest and lowest Boards is 5.2 years.

The differences in maximum and minimum healthy life expectancy estimates between Boards are wider, at 11.7 years (using LLI) and 8.3 years (using SAH). The Boards with the highest life expectancy also tend to have the highest proportions of these years in good health. In Borders, for example, 77% of life expectancy is free from limiting long-term illness while less than 70% of (the shorter) life expectancy in Greater Glasgow is free from LLI.

At age 65, the absolute differences in life expectancy are smaller, but represent larger differences in relative terms. The difference in life expectancy between the highest value (Orkney) and the lowest value (Lanarkshire) is 3.4 years. When we take account of health status using LLI, the difference between the highest value (Orkney) and the lowest value (Greater Glasgow) is wider at 3.9 years. With SAH, the difference widens again to 4.4 years between Orkney (highest) and Lanarkshire (lowest).

The levels of inequality are summarised in the bottom rows of Table 5.4. According to all three measures, inequalities are wider at age 65 than at birth. Inequalities are widest in HLE(LLI) and narrowest for LE.

**Table 5.4 - LE and HLE estimates for NHS Boards, Females 1999-2000**

| Age group | At birth | | | At age 65 | | |
|---|---|---|---|---|---|---|
| NHS Board | LE | HLE(LLI) | HLE(SAH) | LE | HLE(LLI) | HLE(SAH) |
| Argyll & Clyde | 77.7 | 56.1 | 65.6 | 17.3 | 8.8 | 12.7 |
| Ayrshire & Arran | 77.6 | 54.8 | 66.3 | 17.2 | 8.1 | 13.0 |
| Borders | 80.0 | 61.5 | 70.8 | 18.6 | 10.1 | 15.1 |
| Dumfries & Galloway | 79.4 | 57.5 | 69.2 | 18.4 | 8.9 | 14.0 |
| Fife | 79.6 | 56.8 | 66.1 | 18.2 | 8.6 | 13.9 |
| Forth Valley | 78.7 | 57.3 | 65.6 | 17.5 | 9.1 | 13.1 |
| Grampian | 79.5 | 59.1 | 70.5 | 18.1 | 9.4 | 13.9 |
| Greater Glasgow | 77.0 | 53.9 | 63.3 | 17.0 | 7.8 | 11.7 |
| Highland | 79.4 | 57.9 | 69.0 | 18.5 | 9.1 | 13.7 |
| Lanarkshire | 77.7 | 53.3 | 63.5 | 17.0 | 8.0 | 11.3 |
| Lothian | 78.8 | 59.0 | 69.3 | 17.9 | 9.5 | 14.2 |
| Orkney | 82.2 | 65.0 | 71.6 | 20.4 | 11.7 | 15.7 |
| Shetland | 81.8 | 61.1 | 71.6 | 19.7 | 10.8 | 13.8 |
| Tayside | 79.2 | 59.6 | 65.9 | 18.1 | 9.9 | 14.5 |
| Western Isles | 80.1 | 62.0 | 70.4 | 18.7 | 10.6 | 13.5 |
| | | | | | | |
| Scotland | 78.4 | 57.0 | 66.8 | 17.6 | 8.9 | 13.2 |
| | | | | | | |
| Decile Ratio | 1.034 | 1.118 | 1.113 | 1.079 | 1.268 | 1.244 |
| Robin Hood Index | 1.16% | 3.80% | 3.41% | 2.92% | 7.42% | 7.67% |
| Gini coefficient | 0.007 | 0.024 | 0.022 | 0.018 | 0.049 | 0.049 |

A similar set of estimates for males is shown in Table 5.5. Three of the five Boards with the highest level of life expectancy for females are also amongst the top five for male life expectancy – Shetland, Borders and Fife. Three of the four Boards with the lowest levels of life expectancy for females also have the lowest levels of male life expectancy – Greater Glasgow, Argyll & Clyde and Lanarkshire. One Board has remarkably different life expectancy figures for males and females - Western Isles NHS Board has the third highest life expectancy for females and the fourth lowest life expectancy for males. The difference in male life expectancy between the highest Board (Shetland) and the lowest Board (Greater Glasgow) is 5.0 years.

As was observed for females, NHS Boards with the highest level of male life expectancy tend also to have the highest proportions of life expectancy spent in a healthy state, and therefore also the highest levels of healthy life expectancy. The gaps between healthy life expectancy in the highest (Orkney and Shetland) and lowest (Greater Glasgow) Boards are 11.4 years (based on LLI) and 10.8 years (based on SAH).

Using LLI as the health measure, Greater Glasgow's healthy life expectancy is just 49.9 years, representing 71% of its total life expectancy. The comparable figure for Orkney is 61.3 years, representing 83% of its life expectancy. Expressing the comparisons in a different way, while males in Orkney can expect to be in good or fairly good health for 97% of the average Scottish male's total life expectancy, males in Greater Glasgow can expect only 83% of the average male lifespan in good or fairly good health.

The ranking of Boards by life expectancy at age 65 is similar to that for life expectancy at birth. The widest gap in life expectancy at age 65 is 2.3 years, occurring between Borders and Greater Glasgow. In terms of healthy life expectancy (based on LLI), Greater Glasgow lags 3.3 years behind Orkney. Using SAH, Lanarkshire has the lowest healthy life expectancy at age 65, which, equalling 9.5 years, is 4.5 years behind Shetland.

The inequality measures at the foot of the table confirm that geographic inequalities in healthy life expectancy are wider than in life expectancy, and widest when measured using limiting long-term illness to reflect health status. In relative terms, inequalities in health between NHS Boards are wider at age 65 than at birth. Comparing with Table 5.4, inequalities in male life expectancy and healthy life expectancy are wider than those observed for females.

**Table 5.5 - LE and HLE estimates for NHS Boards, Males 1999-2000**

| Age group | At birth | | | At age 65 | | |
|---|---|---|---|---|---|---|
| NHS Board | LE | HLE(LLI) | HLE(SAH) | LE | HLE(LLI) | HLE(SAH) |
| Argyll & Clyde | 71.5 | 52.4 | 62.6 | 14.1 | 6.9 | 11.1 |
| Ayrshire & Arran | 73.2 | 51.1 | 62.3 | 14.5 | 6.8 | 10.7 |
| Borders | 75.2 | 55.4 | 68.3 | 15.9 | 8.3 | 12.2 |
| Dumfries & Galloway | 75.0 | 55.5 | 68.1 | 15.5 | 8.0 | 12.6 |
| Fife | 74.3 | 54.1 | 65.9 | 14.9 | 7.5 | 11.5 |
| Forth Valley | 73.7 | 53.5 | 65.1 | 14.5 | 7.4 | 10.7 |
| Grampian | 74.6 | 57.1 | 66.2 | 15.3 | 8.5 | 12.3 |
| Greater Glasgow | 70.4 | 49.9 | 60.3 | 13.6 | 6.7 | 10.0 |
| Highland | 72.9 | 54.4 | 66.1 | 14.7 | 8.1 | 12.8 |
| Lanarkshire | 72.3 | 50.3 | 60.6 | 13.7 | 6.8 | 9.5 |
| Lothian | 73.8 | 55.6 | 66.6 | 14.8 | 8.0 | 12.0 |
| Orkney | 74.2 | 61.3 | 70.6 | 15.0 | 10.0 | 13.5 |
| Shetland | 75.4 | 59.0 | 71.1 | 15.4 | 9.6 | 14.0 |
| Tayside | 73.8 | 57.1 | 65.6 | 15.1 | 8.6 | 12.4 |
| Western Isles | 72.5 | 57.3 | 66.6 | 13.8 | 7.6 | 11.6 |
| | | | | | | |
| Scotland | 73.0 | 53.8 | 64.3 | 14.5 | 7.6 | 11.3 |
| | | | | | | |
| Decile Ratio | 1.060 | 1.143 | 1.105 | 1.129 | 1.259 | 1.244 |
| Robin Hood Index | 1.74% | 4.54% | 3.97% | 3.83% | 8.67% | 8.53% |
| Gini coefficient | 0.011 | 0.029 | 0.024 | 0.025 | 0.053 | 0.054 |

## 5.4 Local Council Areas

Our estimates of life expectancy and health life expectancy for females by Local Council Areas are listed in Table 5.6. Glasgow City has the lowest female life expectancy, which, at 75.8 years, is 6.3 years shorter than in Orkney Islands, the highest Council Area. Other Council Areas with low female life expectancy are East Ayrshire, West Dunbartonshire, Inverclyde and North Lanarkshire. Four of these five Council Areas (East Ayrshire, Glasgow City, West Dunbartonshire and North Lanarkshire) are also amongst the five Council Areas with the lowest life expectancy figures at age 65 (with West Lothian).

The five Council Areas with the highest female life expectancy at birth are Orkney Islands, Shetland Islands, Perth & Kinross, East Renfrewshire and Aberdeenshire. At age 65, the Eilean Siar and Scottish Borders replace Perth & Kinross and Aberdeenshire in the top five Local Council Areas.

As was observed for NHS Boards in the preceding section, Council Areas with low levels of life expectancy also tend to have the lowest proportion of those years without limiting long-term illness or in good or fairly good health. The two Council Areas with the lowest levels of health life expectancy (LLI) as a percentage of total life expectancy are North Lanarkshire (64.5%) and Glasgow City (68.0%). The percentage of life expectancy free from limiting long-term illness is highest in the Orkney Islands and Stirling, at 79% and 78% respectively. Using SAH, North Lanarkshire and Clackmannanshire are amongst the Council Areas with the lowest proportions of life expectancy in good or fairly good health (78.8% and 80.0%, respectively). Good or fairly good health is enjoyed for the largest proportion (90.0% and 89.5%) of life expectancy in East Lothian and Edinburgh City.

The gaps in healthy life expectancy at birth between the highest and lowest Council Areas are 14.9 years and 11.1 years, using LLI and SAH respectively. At age 65, these figures are 4.9 years and 5.5 years respectively. A comparison of the inequality measures in Tables 5.4 and 5.6 shows that inequalities in life expectancy and healthy life expectancy are wider between Local Council Areas than NHS Boards. Inequalities in healthy life expectancy at age 65 are particularly larger between Council Areas than observed between NHS Boards.

Our estimates of male life expectancy and healthy life expectancy for Local Council Areas are shown in Table 5.7. The Council Areas with low and with high male life expectancy are broadly similar to those with low and with high female life expectancy. The gap in male life expectancy at birth between the highest Council Area (East Dunbartonshire) and the lowest Council Area (Glasgow City) is 7.7 years. When we take account of differences in health status, the gap widens to 14.5 years (HLE-LLI) or 14.1 years (HLE-SAH). The gap at age 65 widens from 2.9 years (LE) to 4.5 years (HLE-LLI) or 5.3 years (HLE-SAH) when we take account of health status. As for females, the degree of geographic inequality is wider between Council Areas than between NHS Boards, particularly for healthy life expectancy at age 65.

**Table 5.6 - LE and HLE estimates for Local Council Areas, Females 1999-2000**

| Age | At birth | | | At age 65 | | |
|---|---|---|---|---|---|---|
| Council Area | LE | HLE(LLI) | HLE(SAH) | LE | HLE(LLI) | HLE(SAH) |
| Aberdeen City | 78.9 | 57.3 | 70.3 | 17.7 | 8.5 | 13.2 |
| Aberdeenshire | 80.2 | 60.7 | 71.6 | 18.6 | 9.9 | 14.4 |
| Angus | 78.4 | 58.3 | 62.7 | 17.9 | 9.1 | 12.1 |
| Argyll & Bute | 78.8 | 60.9 | 69.8 | 18.1 | 9.6 | 14.9 |
| Clackmannanshire | 78.4 | 55.5 | 62.7 | 17.7 | 8.3 | 12.2 |
| Dumfries & Galloway | 79.4 | 57.5 | 69.5 | 18.4 | 9.0 | 14.3 |
| Dundee City | 78.3 | 57.8 | 64.7 | 17.8 | 9.6 | 14.5 |
| East Ayrshire | 76.4 | 52.1 | 66.1 | 16.5 | 7.4 | 12.5 |
| East Dunbartonshire | 79.9 | 57.8 | 68.8 | 18.3 | 7.1 | 12.1 |
| East Lothian | 79.3 | 59.7 | 71.4 | 17.9 | 9.7 | 13.9 |
| East Renfrewshire | 80.8 | 61.0 | 68.9 | 19.0 | 10.1 | 14.1 |
| Edinburgh City | 79.0 | 60.6 | 70.7 | 18.4 | 10.3 | 15.4 |
| Eilean Siar | 80.1 | 62.4 | 70.6 | 18.7 | 10.7 | 13.7 |
| Falkirk | 78.3 | 54.8 | 64.4 | 17.4 | 8.7 | 12.8 |
| Fife | 79.6 | 56.7 | 66.1 | 18.2 | 8.6 | 13.8 |
| Glasgow City | 75.8 | 51.5 | 60.8 | 16.5 | 7.8 | 11.0 |
| Highland | 79.4 | 57.9 | 68.9 | 18.5 | 9.1 | 13.7 |
| Inverclyde | 77.2 | 53.0 | 65.4 | 17.2 | 8.0 | 13.3 |
| Midlothian | 79.0 | 56.9 | 66.3 | 17.7 | 7.8 | 13.0 |
| Moray | 79.1 | 59.0 | 68.3 | 18.0 | 10.3 | 13.4 |
| North Ayrshire | 77.9 | 56.3 | 64.4 | 17.2 | 7.9 | 13.2 |
| North Lanarkshire | 77.5 | 50.0 | 61.0 | 16.9 | 7.0 | 10.5 |
| Orkney Islands | 82.2 | 64.9 | 71.8 | 20.4 | 11.8 | 15.9 |
| Perth & Kinross | 80.8 | 62.5 | 69.1 | 18.6 | 11.1 | 16.0 |
| Renfrewshire | 77.6 | 57.0 | 63.7 | 17.0 | 8.9 | 11.3 |
| Scottish Borders | 80.0 | 61.2 | 70.7 | 18.6 | 10.0 | 15.1 |
| Shetland Islands | 81.8 | 60.8 | 71.4 | 19.7 | 10.5 | 13.6 |
| South Ayrshire | 78.4 | 55.6 | 68.6 | 17.9 | 8.9 | 13.2 |
| South Lanarkshire | 77.7 | 55.6 | 66.2 | 17.2 | 8.1 | 12.2 |
| Stirling | 79.6 | 62.1 | 69.8 | 17.7 | 10.4 | 14.1 |
| West Dunbartonshire | 77.1 | 55.5 | 67.2 | 17.0 | 8.9 | 12.6 |
| West Lothian | 77.5 | 54.5 | 65.5 | 16.5 | 7.5 | 10.9 |
| | | | | | | |
| Scotland | 78.4 | 56.9 | 66.7 | 17.6 | 8.8 | 13.1 |
| | | | | | | |
| Decile Ratio | 1.056 | 1.180 | 1.164 | 1.124 | 1.381 | 1.399 |
| Robin Hood Index | 1.45% | 5.03% | 4.57% | 3.73% | 10.40% | 9.96% |
| Gini coefficient | 0.010 | 0.035 | 0.030 | 0.024 | 0.071 | 0.068 |

**Table 5.7 - LE and HLE estimates for Local Council Areas, Males 1999-2000**

| Age | At birth | | | At age 65 | | |
|---|---|---|---|---|---|---|
| Council Area | LE | HLE(LLI) | HLE(SAH) | LE | HLE(LLI) | HLE(SAH) |
| Aberdeen City | 73.6 | 55.6 | 64.5 | 15.0 | 7.4 | 11.1 |
| Aberdeenshire | 75.5 | 58.2 | 65.1 | 15.8 | 9.7 | 12.9 |
| Angus | 74.6 | 57.3 | 68.4 | 15.5 | 8.8 | 12.1 |
| Argyll & Bute | 73.4 | 56.4 | 64.8 | 15.3 | 9.1 | 12.0 |
| Clackmannanshire | 73.1 | 51.6 | 63.1 | 14.1 | 6.3 | 11.0 |
| Dumfries & Galloway | 75.0 | 55.4 | 68.1 | 15.5 | 7.9 | 12.7 |
| Dundee City | 71.7 | 55.4 | 60.6 | 14.4 | 7.8 | 11.9 |
| East Ayrshire | 72.7 | 46.8 | 57.8 | 14.0 | 6.0 | 11.0 |
| East Dunbartonshire | 76.2 | 56.5 | 69.0 | 15.8 | 7.1 | 12.9 |
| East Lothian | 75.1 | 54.7 | 67.7 | 15.5 | 7.6 | 11.1 |
| East Renfrewshire | 76.1 | 58.5 | 68.9 | 15.8 | 9.2 | 12.0 |
| Edinburgh City | 73.8 | 57.5 | 67.4 | 15.0 | 8.8 | 12.1 |
| Eilean Siar | 72.5 | 57.5 | 66.5 | 13.8 | 7.6 | 11.4 |
| Falkirk | 73.3 | 51.3 | 65.2 | 14.3 | 6.0 | 10.5 |
| Fife | 74.3 | 54.1 | 65.9 | 14.9 | 7.5 | 11.6 |
| Glasgow City | 68.5 | 46.7 | 57.3 | 12.9 | 6.4 | 9.1 |
| Highland | 72.9 | 54.2 | 66.2 | 14.7 | 8.1 | 12.9 |
| Inverclyde | 70.1 | 50.5 | 61.0 | 13.7 | 5.5 | 10.2 |
| Midlothian | 74.2 | 54.0 | 65.5 | 14.9 | 6.6 | 13.1 |
| Moray | 74.6 | 57.3 | 67.4 | 15.1 | 8.2 | 13.0 |
| North Ayrshire | 72.8 | 52.6 | 63.1 | 14.5 | 6.6 | 9.2 |
| North Lanarkshire | 71.7 | 46.8 | 59.5 | 13.4 | 5.9 | 9.4 |
| Orkney Islands | 74.2 | 61.2 | 70.8 | 15.0 | 10.0 | 13.7 |
| Perth & Kinross | 75.3 | 58.5 | 68.6 | 15.6 | 9.1 | 13.2 |
| Renfrewshire | 71.0 | 53.2 | 63.8 | 13.8 | 7.0 | 10.5 |
| Scottish Borders | 75.2 | 55.1 | 68.3 | 15.9 | 8.2 | 12.2 |
| Shetland Islands | 75.4 | 58.9 | 71.4 | 15.4 | 9.6 | 14.4 |
| South Ayrshire | 74.4 | 53.6 | 64.9 | 15.2 | 7.8 | 11.5 |
| South Lanarkshire | 73.0 | 53.8 | 62.0 | 13.9 | 7.0 | 9.5 |
| Stirling | 74.7 | 57.5 | 66.3 | 15.2 | 9.5 | 11.1 |
| West Dunbartonshire | 70.7 | 48.3 | 61.0 | 13.7 | 6.2 | 11.7 |
| West Lothian | 72.8 | 51.6 | 65.6 | 13.7 | 7.4 | 12.1 |
| | | | | | | |
| Scotland | 73.0 | 53.8 | 64.3 | 14.5 | 7.6 | 11.3 |
| | | | | | | |
| Decile Ratio | 1.099 | 1.231 | 1.192 | 1.219 | 1.504 | 1.425 |
| Robin Hood Index | 2.20% | 6.09% | 4.88% | 5.29% | 12.47% | 10.37% |
| Gini coefficient | 0.016 | 0.041 | 0.032 | 0.035 | 0.086 | 0.069 |

## 5.5 Summary of inequality results

The inequality measures at the bottom of Tables 5.2-5.7 show a broadly consistent pattern. In relative terms, inequalities are wider for:

- males than females
- at age 65 than at birth
- healthy life expectancy than life expectancy
- HLE measured with limiting long-term illness rather than self-assessed health.

# 6. COMPARISONS WITH THE 2001 CENSUS

The 2001 Census provides a rare opportunity to compare HLE estimates based on household surveys with HLE estimates derived for the entire population. We have calculated HLE estimates from the 2001 census for each of the groups considered in Chapter 5. To maximise comparability, we exclude communal establishment residents from the Census health status figures as these individuals are not included in household surveys. The first section of this chapter compares the HLE estimates that exclude communal establishments with those that include communal establishments. In the two later sections we present a subset of the comparisons between Census-based and survey-based results that reflects our broad findings. Detailed results can be obtained from the authors on request.

## 6.1 Effect of excluding the health status of population in communal establishments

Because the surveys used to generate HLE estimates in chapters 4 and 5 sample only from those living in private households they do not represent the health status of the entire population (even though these individuals are included in the calculation of the mortality rates and life expectancy). Individuals living in communal establishments are likely to have worse health status. Therefore, comparisons between areas and over time may be biased by differences in the proportion of the population living in communal establishments.

Previous studies have attempted to correct HLE estimates for the health status of individuals excluded from household surveys.[8] Unfortunately, however, there is little information upon which to base these adjustments and analysts are often forced to rely on Census information and assume linear trends between Census years. We have not adopted this approach in this report and instead take the opportunity provided by the 2001 Census to ascertain the magnitude of the effect of excluding people in communal establishments.

Estimates of HLE derived from the 2001 Census based on health status information from the entire population (including communal establishments) and the population not in communal establishments (CEs) are compared in Table 6.1. As expected, HLE estimates excluding CEs are higher than those including CEs, as the population in CEs tend to have higher rates of morbidity. The magnitude of the effect is larger for women than men but is small (<0.3 years) in all cases. The observed effect is the same magnitude in the HLE estimates at age 65 as at birth, indicating that it is the over-65 population that influences the HLE estimates. For the HLE estimates at age 65, the effect is less than 4% for HLE using LLI and less than 1.5% for HLE using SAH.

**Table 6.1 - HLE estimates excluding and including communal establishments, 2001**

| Health variable | HLE(LLI) | | | HLE(SAH) | | |
|---|---|---|---|---|---|---|
| CE | including CE | excluding CE | Difference | including CE | excluding CE | Difference |
| Female, at birth | 61.6 | 61.9 | 0.3 | 70.3 | 70.4 | 0.2 |
| Males, at birth | 58.6 | 58.8 | 0.2 | 66.3 | 66.4 | 0.1 |
| Females, at age 65 | 7.9 | 8.2 | 0.3 | 13.8 | 13.9 | 0.2 |
| Males, at age 65 | 6.9 | 7.1 | 0.2 | 11.7 | 11.8 | 0.1 |

## 6.2 Comparisons at Scotland level

In Table 6.2 we provide Scotland-level estimates of HLE from the three available data sources close to the Census date. The 2001 Census estimates of LE are slightly higher than the 2000 estimates upon which the GHS and SHoS estimates are based. This is to be expected given the general increase over the period. However, the 2000 figures for HLE based on LLI from the GHS are higher than those for 2001 based on the Census. Since the Census figures relate only to the population living in private households, this does not reflect lower HLE for the population living in communal establishments. Individuals sampled by the GHS appear to be less likely to have a limiting long-term illness than the general population, particularly at older ages. The two-stage process by which limiting long-term illness data are obtained in the GHS may also influence the comparability with the 2001 values from the Census.

Table 6.2 also shows that the SHoS under-estimates HLE at birth compared to the Census when using LLI but conversely over estimates the LLI-based HLE at age 65. The figures are closer to the census figures using self-assessed health. These findings suggest that there is a systematic difference in the health status of respondents to the SHoS from the general population surveyed in the Census. The results suggest that SHoS respondents under the age of 65 tend to be more likely to have LLI than the general population living in private households. Conversely, SHoS respondents over the age of 65 years tend to be less likely to have LLI than the general population. The difference is less marked for SAH, but there remains a general tendency for SHoS respondents (particularly females) to have worse SAH than the general population with the difference falling at older ages. Recent findings from the 2001 SHoS also show differences in the health variables from the 2001 Census.[28]

**Table 6.2 - HLE estimates for Scotland based on the GHS, SHoS and the 2001 Census**

| Gender | Age | Measure | GHS | SHoS | Census | GHS v Census | SHoS v Census |
|---|---|---|---|---|---|---|---|
| Females | At birth | LE | 78.7 | 78.7 | 78.9 | -0.4% | -0.4% |
| Females | At birth | HLE-LLI | 62.6 | 57.5 | 61.9 | 1.2% | -7.1% |
| Females | At birth | HLE-SAH | 67.3 | 67.2 | 70.4 | -4.4% | -4.5% |
| Males | At birth | LE | 73.3 | 73.3 | 73.5 | -0.3% | -0.3% |
| Males | At birth | HLE-LLI | 58.9 | 54.5 | 58.8 | 0.1% | -7.3% |
| Males | At birth | HLE-SAH | 65.3 | 64.6 | 66.4 | -1.7% | -2.7% |
| Females | At age 65 | LE | 17.9 | 17.9 | 18.2 | -1.6% | -1.7% |
| Females | At age 65 | HLE-LLI | 9.6 | 8.9 | 8.2 | 16.6% | 8.1% |
| Females | At age 65 | HLE-SAH | 12.2 | 13.4 | 13.9 | -12.8% | -3.8% |
| Males | At age 65 | LE | 14.8 | 14.8 | 15.1 | -2.3% | -2.3% |
| Males | At age 65 | HLE-LLI | 9.3 | 7.7 | 7.1 | 31.9% | 9.3% |
| Males | At age 65 | HLE-SAH | 11.3 | 11.5 | 11.8 | -4.4% | -2.4% |

## 6.3 Comparisons for deprivation quintiles

In Tables 6.3 and 6.4 we consider whether the difference is related to the deprivation of the areas. We have presented results for males only, though the results for females demonstrate a similar pattern. Table 6.3 shows the results for LLI. The SHoS results in an underestimate of HLE at birth for all groups but the under-estimate is larger in the most deprived areas. SHoS respondents under the age of 65 years in deprived areas are particularly more likely to have LLI than the general population of deprived areas. This results in an over-estimate of the gap in HLE between affluent and deprived areas. For HLE at age 65, we observe the opposite pattern. There is a general tendency for the SHoS to over-estimate HLE at age 65 and this is particularly marked for the most deprived areas. SHoS respondents over the age of 65 in deprived areas are less likely to have LLI than their non-surveyed counterparts and this results in an under-estimation of the gap between affluent and deprived areas.

Table 6.4 shows a similar set of results using SAH. There is a tendency to underestimate HLE at birth using the SHoS and there is some evidence that this is greater in deprived areas, although the differences are less marked for SAH than for LLI. For HLE at age 65 the SHoS-based estimates using SAH are close to the Census estimates and there is little evidence of any systematic bias.

**Table 6.3 - Comparison of Male HLE estimates for Deprivation Quintiles based on LLI**

| Age Group | At birth | | | At age 65 | | |
|---|---|---|---|---|---|---|
| Quintile | SHoS | Census | Difference | SHoS | Census | Difference |
| 5 - Most Deprived | 47.8 | 51.2 | -7% | 6.5 | 5.0 | 30% |
| 4 | 50.6 | 56.5 | -10% | 6.8 | 6.1 | 11% |
| 3 | 53.6 | 59.1 | -9% | 7.6 | 6.9 | 11% |
| 2 | 58.8 | 62.0 | -5% | 8.8 | 7.9 | 11% |
| 1 - Least Deprived | 62.4 | 65.2 | -4% | 10.0 | 8.8 | 13% |

**Table 6.4 - Comparison of Male HLE estimates for Deprivation Quintiles based on SAH**

| Age Group | At birth | | | At age 65 | | |
|---|---|---|---|---|---|---|
| Quintile | SHoS | Census | Difference | SHoS | Census | Difference |
| 5 – Most Deprived | 55.9 | 59.0 | -5% | 9.7 | 9.4 | 3% |
| 4 | 62.8 | 64.5 | -2% | 10.7 | 10.9 | -2% |
| 3 | 64.6 | 66.9 | -3% | 11.6 | 11.7 | -1% |
| 2 | 68.8 | 69.6 | -1% | 12.9 | 12.9 | 0% |
| 1 - Least Deprived | 73.3 | 72.6 | 1% | 14.5 | 13.9 | 4% |

## 6.4 Implications of comparisons with the Census

The findings of this section suggest that caution is required when using household surveys to calculate an estimate of HLE that can be taken as an estimate for the population as a whole. However, it is important to remember that the Census is a rare opportunity to assess population health and there can be few policy and planning processes that could afford to wait ten years to measure changes in population health. While there do appear to be systematic differences between the Census-based and SHoS-based estimates presented in this section, these differences do not overturn any of the differences in HLE observed between population groups. For monitoring purposes, it may be safe to assume that the differences between the SHoS respondents and the general population are likely to be constant over time and it would be safe to interpret trends. The trends obtained from the GHS that were presented in section 4 demonstrated long-term trends and the SHoS offers a sample size that is more than ten times the size.

# 7. SUMMARY AND RECOMMENDATIONS

In this final chapter of the report we summarise the main findings and make recommendations for (a) future work and (b) routine monitoring of Healthy Life Expectancy in Scotland.

## 7.1 Summary of findings

This report provides the first estimates of HLE for Scotland. Separate figures for males and females, at birth and at age 65, have been produced for Scotland as a whole, deprivation quintiles, NHS Boards and Council Areas. Figures have been derived from the 1980-2000 waves of the General Household Survey and the 1999 and 2000 waves of the Scottish Household Survey. Two main health status measures have been used throughout (absence of limiting long-term illness and 'Good' or 'Fairly Good' self-assessed health), though we additionally considered Activities of Daily Living in the GHS.

We found that approximately 73% of life-years from birth are expected to be free from limiting long-term illness and 87% enjoyed in 'Good' or 'Fairly Good' self-assessed. There is a slight tendency for males to have less morbidity while alive, so that differences in HLE between males and females are slightly smaller than differences in LE. At age 65, only 51% of life expectancy is free from limiting long-term illness while 76% is in 'Good' or 'Fairly Good' self-assessed health.

We examined trends in LE and HLE at Scotland-level using the GHS for 1980-2000 (Section 4). HLE at birth has increased over time, but has not kept pace with the increases in LE at birth. HLE at age 65 has increased at a similar rate to LE at age 65. The rate of increase in HLE is higher using self-assessed health rather than limiting long-term illness as the measure of health status. The increases in HLE are also larger for males than females.

We then examined HLE estimates for sub-groups of Scotland using the Scottish Household Survey (Section 5). We found that male HLE at birth using SAH varied between 55.9 years and 73.3 years in the most deprived and most affluent quintiles. Affluent areas therefore have HLE at birth using SAH that is only 0.3 years short of average LE, while in deprived areas HLE at birth is 17.7 years less than LE. We also provided HLE estimates for fifteen NHS

Boards and thirty-two Council Areas. We find that areas with relatively low life expectancy also have higher levels of morbidity whilst alive, so that differences in HLE between areas are more marked. While there is substantial variation between NHS Boards and Council Areas, only two Council Areas (Glasgow City and North Lanarkshire) have HLE estimates below the figures for the most deprived 20% of the population.

Finally, we compared our HLE estimates based on household surveys with estimates derived from the 2001 Census (Section 6). The estimates based on the Scottish Household Survey using limiting long-term illness are below the Census estimates at birth and above the Census estimates at age 65. The results using self-assessed health are closer to the Census estimates. The differences between the Census and the Scottish Household Survey in LLI-based estimates also vary by the level of deprivation, whereas the (smaller) differences in the SAH-based estimates are more independent of the level of deprivation.

## 7.2 Recommendations

Our recommendations are divided into two sections: (a) recommendations for future work and (b) recommendations for routine monitoring of Healthy Life Expectancy.

### *7.2.1. Recommendations for future work*

We have noted a number of areas in which future work would be valuable throughout this report. First, we emphasised that the adjustment for health status in the calculation of HLE could be seen as a quality of life adjustment with years spent in full health weighted as one and years spent in less than full health weighted between zero and one. Further work should be undertaken to derive an appropriate set of weights. Second, we noted that HLE estimates based on grouped data will differ from those obtained from individual level data if health status and mortality risk are correlated. Further work could be undertaken to adjust the group level estimates for this correlation or to use individual level data sources (such as the *Scottish Longitudinal Study*) to derive estimates based on individual level data. Third, in the Appendix (Section A.3), we note that techniques are available for smoothing random fluctuations in the health status data. We attempted a simple technique in this paper, which did not demonstrate a clear improvement. More complex techniques may help to reduce random fluctuations in the estimates and provide a better understanding of trends in health status over time.

Our other recommendations for future work relate to the use of alternative or new data sources. The Scottish Health Survey has been undertaken in 1995 and 1998 and the latest wave of data collection is currently underway. While the Scottish Health Survey may not be appropriate for routine monitoring, it contains richer information on the health status of individuals. We propose that use of these data would help in understanding how different health conditions and individual characteristics affect the reporting of limiting long-term illness and self-assessed health. Such work would help in understanding which conditions and circumstances are constraining perceived health status and, coupled with an understanding of which factors affect life expectancy, what may be the priorities for future action to improve Healthy Life Expectancy.

Finally, it would be useful to examine the international information within this area. This would include comparing approaches to assessing Healthy Life Expectancy in different countries and investigating methods that would allow for international comparisons. Life expectancy differences between Scotland and other countries have already been produced. These show Scotland to be lagging behind most other Western European countries.[7] An examination of Healthy Life Expectancy differences between countries would help to identify where action is best targeted to close the health gap.

### *7.2.2. Recommendations for routine monitoring*

In the introduction to this report we noted the various ways in which measures of population health can contribute to the evidence-base for practice and policy. Our findings demonstrate that trends over time and differences between areas and groups in Healthy Life Expectancy are different from those in Life Expectancy in many cases. This indicates the importance of incorporating a health status element into measures of population health and, given the demands for evidence, to obtain regular updates of Healthy Life Expectancy.

Our examination of the levels of uncertainty in HLE estimates (Section 3.1) demonstrated that we would expect more random fluctuation in estimates produced for smaller areas/groups and using survey data. We do not think that these levels of uncertainty are prohibitive, especially in comparison to the uncertainty in the life expectancy estimates themselves. In section 5 we compared the Census results with results from two surveys. We found some differences in particular estimates but none of the general trends or differences between groups were different using survey data. We therefore recommend that, with the usual notes of caution, regular estimates of HLE can be obtained from survey data sources.

The Scottish Household Survey is the preferred data source for obtaining regular HLE estimates because it is larger than the General Household Survey and, every two years, offers representative estimates for areas within Scotland. As the General Household Survey offers the opportunity to examine long-term trends, we recommend that HLE trends are monitored using both data sources. If one data source is required, we recommend the use of the Scottish Household Survey.

The choice of health status measure depends, in part, on the purpose for which HLE estimates are required. Limiting long-term illness is primarily a measure of physical functioning whereas self-assessed health is a more global measure, which has been shown to reflect mental as well as physical health. Our comparison of the Scottish Household Survey estimates of HLE with the Census figures showed that the figures are closer using SAH rather than LLI. If a single measure of health status is required, we recommend the use of self-assessed health.

Throughout this report we have provided estimates at birth and at age 65. For some purposes, such as social care planning, the estimates at age 65 are likely to be more informative. Nevertheless, if a single measure is required we recommend the use of HLE estimates at birth since it reflects the health experience of the entire population.

Our recommended single measure of Healthy Life Expectancy is therefore:

> *The number of years that an individual at birth can expect to live in ‘Good’ or ‘Fairly Good’ general health*

We recommend that it is measured with data from the Scottish Household Survey, using annual estimates for Scotland as a whole and deprivation quintiles, and two-year rolling averages for NHS Boards and Council Areas.

# APPENDIX: CALCULATING HLE – TECHNICAL DETAILS

In Table A1 we give detailed calculations for Healthy Life Expectancy. We use data on population based on Mid-Year Estimates for 2001 and deaths in the 2001 calendar year. The health status information comes from limiting long-term illness data from the 2001 Census. We show the calculation for the entire Scottish population (i.e. males and females combined), although all of our main calculations are provided separately by gender.

## A.1 Calculating Life Expectancy

The LE and HLE estimates are based on information on the population and the number of deaths. We have calculated LE and HLE based on information for age groups. These measures are most accurately calculated when the age bands are narrow. Our choice of age bands is guided by the availability of information from the 2001 Census. We use five-year age-bands, except the youngest age-band for which we have separate information for 0-2 and 3-4 year-olds. The top age-band includes all of the population aged 85 years and over.

To reflect the information on age intervals we need to estimate the average age of individuals dying in each age interval. In the life table, this is reflected by the width of the age interval in years ($n_x$) and the average fraction of the age interval survived by the individuals who die within the age interval ($a_x$). $n_x$ is given for most of the age groups but must be estimated for the top age-band, which is open-ended. We follow convention and adopt a value of five. Our estimates of $a_x$ are also the conventional estimates, although we checked these assumed values using a single-year life-table for Scotland. We assume that, on average, individuals that die within a certain age interval survive for half of the length of the age interval. For the youngest age group, we adopt a value of 0.1 for $a_x$ to reflect perinatal mortality.

Based on the population and deaths figures, we can calculate the death rate for each age interval ($M_x$). Table 3.1 shows the expected *J*-shaped pattern of death rates – the death rate is initially higher in the youngest age group, declines until the 5-9 age group, and then increases exponentially as age increases.

The next step is to calculate the probability that an individual will die during the age interval, conditional on having survived to enter the age interval ($q_x$). The formula for calculating $q_x$ is given by:

$$q_x = \frac{n_x M_x}{(1 + n_x (1 - a_x) M_x)}.$$

This is applied to all age groups excluding the top age interval where $q_x$ is set equal to one. The life table actually makes use of the conditional probability that an individual entering the age interval will survive the age interval, given by $p_x$=1-$q_x$.

The value of $p$ for each age band are used to construct a standing cohort population ($I_x$) for the life table. The standing cohort population reflects the number of individuals who would survive to the start of each age interval if the initial population experienced the death rates given by $M_x$. The value of Ix is calculated by multiplying the previous interval's value ($I_{x-1}$) by the previous interval's survival probability ($p_{x-1}$). A value of 100,000 is usually adopted for the initial size of the cohort. For presentational purposes we have adopted a value of one in Table A1. The value adopted makes no difference to the LE and HLE results.

In the next column of the table, we calculate the number of deaths that would have occurred in the age interval in the life table population ($d_x$). It is calculated by subtracting the next interval's value for $I_x$ ($I_{x+1}$) from the current interval's value. This statistic is used in the calculation of the number of years lived during the age interval ($L_x$). This reflects the full width of the age interval for those that will survive the age interval plus the average number of years lived by those who will die during the interval, given by:

$$L_x = n_x l_{x+1} + (n_x a_x) d_x$$

The value of $L_x$ for the top age interval is estimated by $L_{85+} = I_{85+} / M_{85+}$ because it is undefined. The statistic $T_x$ reflects the total number of years lived beyond the age interval. It is calculated by cumulating the values of $L_x$ for all of the remaining age intervals. The value of life expectancy at the beginning of the age interval ($e_x$) is then obtained by dividing $T_x$ by the number of survivors ($I_x$). It is higher than $T_x$ because it reflects the expected life experience of the selected sample of the initial cohort who survive to the start of the age interval.

## A.2 Calculating Healthy Life Expectancy

HLE is calculated by adding four columns to the life table. The first additional column shows the proportion of the age group with good health ($H_x$). The figures in Table A1 shows that the Census 2001 results indicate that the proportion of Scottish residents free from limiting long-term illness falls from 0.98 in the 0-2 age interval to 0.21 in the top age interval (85+). These estimated proportions are applied to the estimates of the number of years lived during the age interval ($L_x$) to obtain an estimate of the number of person years lived healthy during the age interval. In a similar way as was undertaken for $T_x$, we can cumulate across the age intervals to obtain an estimate of the total years lived healthy from age x ($HT_x$). Healthy Life Expectancy ($He_x$) is then estimated by dividing $HT_x$ by the number of survivors $I_x$.

The calculations in Table A1 provide four important estimates of Life Expectancy and Healthy Life Expectancy for the Scottish population in 2001. Life Expectancy at birth is estimated to be 76.28 years while Healthy Life Expectancy at birth is estimated to be 60.08 years. This indicates that 78.8% (= 60.08 / 76.28) of total Life Expectancy is expected to be free from limiting long-term illness. At age 65, Life Expectancy is estimated to be 16.83 years, 44.2% (=7.44 / 16.83) of which is expected to be free from limiting long-term illness.

**Table A 1 - Details of the calculation of Life Expectancy and Health Life Expectancy (LLI) for the Scottish population, 2001**

| Age group (x) | Life expectancy calculation | | | | | | | | | | | | Healthy Life Expectancy calculation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Population* | *Deaths* | $n_x$ | $a_x$ | $M_x$ | $q_x$ | $p_x$ | $l_x$ | $d_x$ | $L_x$ | $T_x$ | $e_x$ | $H_x$ | $HL_x$ | $HT_x$ | $He_x$ |
| 0-2 | 160,755 | 309 | 3 | 0.1 | 0.00192 | 0.00574 | 0.99426 | 1.00000 | 0.006 | 2.98 | 76.28 | 76.28 | 0.98 | 2.91 | 60.08 | 60.08 |
| 3-4 | 115,506 | 22 | 2 | 0.5 | 0.00019 | 0.00038 | 0.99962 | 0.99426 | 0.000 | 1.99 | 73.30 | 73.72 | 0.96 | 1.91 | 57.17 | 57.50 |
| 5-9 | 305,813 | 43 | 5 | 0.5 | 0.00014 | 0.00070 | 0.99930 | 0.99388 | 0.001 | 4.97 | 71.31 | 71.75 | 0.95 | 4.71 | 55.26 | 55.60 |
| 10-14 | 322,923 | 54 | 5 | 0.5 | 0.00017 | 0.00084 | 0.99916 | 0.99319 | 0.001 | 4.96 | 66.34 | 66.80 | 0.95 | 4.69 | 50.55 | 50.89 |
| 15-19 | 317,605 | 177 | 5 | 0.5 | 0.00056 | 0.00278 | 0.99722 | 0.99236 | 0.003 | 4.95 | 61.38 | 61.85 | 0.95 | 4.69 | 45.85 | 46.21 |
| 20-24 | 315,395 | 249 | 5 | 0.5 | 0.00079 | 0.00394 | 0.99606 | 0.98959 | 0.004 | 4.94 | 56.42 | 57.02 | 0.93 | 4.61 | 41.16 | 41.60 |
| 25-29 | 314,885 | 276 | 5 | 0.5 | 0.00088 | 0.00437 | 0.99563 | 0.98570 | 0.004 | 4.92 | 51.48 | 52.23 | 0.91 | 4.50 | 36.56 | 37.09 |
| 30-34 | 381,237 | 418 | 5 | 0.5 | 0.00110 | 0.00547 | 0.99453 | 0.98139 | 0.005 | 4.89 | 46.57 | 47.45 | 0.90 | 4.40 | 32.06 | 32.67 |
| 35-39 | 403,232 | 567 | 5 | 0.5 | 0.00141 | 0.00701 | 0.99299 | 0.97602 | 0.007 | 4.86 | 41.67 | 42.70 | 0.88 | 4.29 | 27.66 | 28.34 |
| 40-44 | 378,888 | 817 | 5 | 0.5 | 0.00216 | 0.01072 | 0.98928 | 0.96918 | 0.010 | 4.82 | 36.81 | 37.98 | 0.86 | 4.13 | 23.37 | 24.11 |
| 45-49 | 338,208 | 1,140 | 5 | 0.5 | 0.00337 | 0.01671 | 0.98329 | 0.95879 | 0.016 | 4.75 | 31.99 | 33.36 | 0.82 | 3.90 | 19.24 | 20.07 |
| 50-54 | 350,883 | 1,783 | 5 | 0.5 | 0.00508 | 0.02509 | 0.97491 | 0.94276 | 0.024 | 4.65 | 27.24 | 28.89 | 0.77 | 3.57 | 15.34 | 16.27 |
| 55-59 | 290,138 | 2,533 | 5 | 0.5 | 0.00873 | 0.04272 | 0.95728 | 0.91911 | 0.039 | 4.50 | 22.58 | 24.57 | 0.69 | 3.09 | 11.77 | 12.81 |
| 60-64 | 261,551 | 3,576 | 5 | 0.5 | 0.01367 | 0.06610 | 0.93390 | 0.87985 | 0.058 | 4.25 | 18.08 | 20.55 | 0.61 | 2.57 | 8.69 | 9.87 |
| 65-69 | 239,464 | 4,952 | 5 | 0.5 | 0.02068 | 0.09831 | 0.90169 | 0.82169 | 0.081 | 3.91 | 13.83 | 16.83 | 0.56 | 2.19 | 6.11 | 7.44 |
| 70-74 | 207,178 | 7,160 | 5 | 0.5 | 0.03456 | 0.15906 | 0.84094 | 0.74090 | 0.118 | 3.41 | 9.92 | 13.39 | 0.51 | 1.74 | 3.92 | 5.29 |
| 75-79 | 165,616 | 9,031 | 5 | 0.5 | 0.05453 | 0.23994 | 0.76006 | 0.62306 | 0.149 | 2.74 | 6.51 | 10.45 | 0.42 | 1.15 | 2.18 | 3.51 |
| 80-85 | 106,129 | 9,023 | 5 | 0.5 | 0.08502 | 0.35058 | 0.64942 | 0.47356 | 0.166 | 1.95 | 3.77 | 7.97 | 0.33 | 0.65 | 1.04 | 2.19 |
| 85+ | 88,794 | 15,010 | 5 | 0.5 | 0.16904 | 1.00000 | 0.00000 | 0.30754 | 0.308 | 1.82 | 1.82 | 5.92 | 0.21 | 0.39 | 0.39 | 1.27 |

Notes:

| | |
|---|---|
| $n_x$ | Width of age interval |
| $a_x$ | Fraction of the age interval lived by those in the cohort who die in the interval. |
| $M_x$ | Age-specific death rate. |
| $q_x$ | Conditional probability that an indivdual entering the age interval will die in the age interval. |
| $p_x$ | Conditional probability that an indivdual entering the age interval will survive the age interval. |
| $I_x$ | Standing cohort population. |
| $d_x$ | Number of life table deaths in the age interval |
| $L_x$ | Number of years lived during the age interval. |
| $T_x$ | Total number of years lived beyond entering the age interval. |
| $e_x$ | Life expectancy at the beginning of the age interval. |
| $H_x$ | Proportion of age group that are healthy. |
| $HL_x$ | Person years lived healthy in interval. |
| $HT_x$ | Total years lived healthy from age x |
| $He_x$ | Healthy Life Expectancy at the beginning of the age interval. |

## A.3 Calculating confidence intervals

A variety of methods are available for estimating the degree of uncertainty in LE and HLE. A formula for calculating standard errors around LE estimates generated using the Chiang II method is available in the standard life table spreadsheet. Analysis of uncertainty in LE estimates generated for small areas by the Office National Statistics compared this formula with other approaches and recommended its use.[29] They also concluded that LE estimates should not be produced by ONS for populations below 5,000 persons.

A formula for approximating the standard error in HLE was proposed by Jagger and Reyes-Frausto.[22] Salomon et al[30] on the other hand proposed the use of simulation-based techniques to generate estimates of the level of uncertainty in complex summary statistics such as HLE. We compared simulation-based confidence intervals with the confidence intervals generated by the Jagger and Reyes-Frausto formula. We found that, while the simulated confidence intervals for LE were very similar to those based on the Chiang II formula, the simulated confidence intervals for HLE were considerably wider than those generated by the Jagger and Reyes-Frausto formula. We have therefore based our estimates of the degree of uncertainty in the HLE estimates on the simulation-based results.

To construct simulation-based confidence intervals we undertook the following process 999 times:

- *For each age interval generate a sample of simulated data of size equal to the population*
- *For each data-point generate a random number from the uniform(0,1) distribution*
- *Convert these random numbers to draws from a Bernoulli distribution based on the observed mortality rate*
- *For each age interval generate a sample of simulated data of size equal to the survey sample*
- *For each data-point generate a random number from the uniform(0,1) distribution*
- *Convert these random numbers to draws from a Bernoulli distribution based on the observed morbidity rate*
- *Aggregate the data by age interval to calculate simulated age-specific mortality and morbidity rates*
- *Calculate life expectancy and healthy life expectancy*

The resulting 999 simulated values for life expectancy and healthy life expectancy can be used to estimate the standard error in these estimates or to generate non-parametric 95% confidence intervals based on the percentiles.

We compared the standard errors under four scenarios (see Table 3.1). To ensure comparability, we adopted the same age structures for the (hypothetical) populations and the same mortality and morbidity rates. These figures were taken from Table A1 and the results therefore represent the levels of uncertainty under each of the scenarios if the hypothetical populations reflected the Scottish population in 2001.

It may be possible to generate more stable series of HLE estimates using statistical models that are designed to smooth out random fluctuations.[31] In preparing this report, we considered a relatively simple approach in which we generated a best-fit age profile for the health variables rather than using crude average values of the health variables in discrete age groups. Our evaluation of this method showed that it did not generate a more stable annual series of HLE estimates and we have therefore used average values for age groups in the remainder of this report. Consideration of more complex techniques may be a fruitful area for future work.

## A.4 Calculating annual trends

We use linear regression to estimate annual growth in the LE and HLE estimates. Annual estimates are regressed on the year variable to obtain an average slope, which represents the average annual growth in LE or HLE. For presentational purposes, the year variable is rescaled to be the number of years since the start of the period, so that the initial value is zero and the constant term provides an estimate of the value at the start of the period.

Formally, the regression model can be expressed as follows:

$$h_t = \alpha + \beta(t - t_0) + \varepsilon_t$$

in which $h_t$ is the estimate of LE or HLE at time $t$, $t_0$ is the initial year (=1980 in most cases) and $\varepsilon_t$ is a series of error terms with zero mean. The value of $\alpha$ (the constant term) is an estimate of $h$ when ($t$-$t_0$) is zero (i.e. at the start of the period). The estimated value of $\beta$ gives the average annual growth in $h$ in years. The regression models are estimated in *Stata* (version 8.1), and probability values are estimated using *robust* standard errors, which allows the variation in the error terms to change over time.

The estimated value of $\beta$ represents the annual growth in *absolute* terms. For some comparisons it may also be useful to consider *relative* growth. We calculate relative growth by dividing the absolute growth estimate ($\beta$) by the average value of LE or HLE in the first three years.

The regression results and calculation of annual trend estimates for female HLE without LLI are shown in Table A4.1. Annual growth in life expectancy at birth was 0.174 years. Expressed as a percentage of the average value in the first three years of the period (1980-1982), this represents an average annual growth rate of 0.23%. The time trend and initial value (the constant term) are both significantly different from zero.

**Table A4.1- Calculation of annual trends in LE and HLE without LLI, females 1980-2000**

| Age | At birth | | | | At age 65 | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | LE | | HLE(LLI) | | LE | | HLE(LLI) | |
| | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value |
| Time trend | 0.174 | <0.001 | 0.014 | 0.693 | 0.090 | <0.001 | 0.063 | 0.001 |
| Constant | 75.130 | <0.001 | 60.726 | <0.001 | 15.942 | <0.001 | 8.466 | <0.001 |
| Mean 1980-1982 | 75.267 | | 60.700 | | 16.033 | | 8.467 | |
| % change | 0.23% | | 0.02% | | 0.56% | | 0.75% | |

Table A4.1 also shows annual growth estimates for HLE without LLI. Annual growth in HLE without LLI at birth is just 0.014 years and we cannot reject the null hypothesis that the annual growth is zero. At age 65, the annual growth estimates in LE and HLE are smaller in absolute terms than for LE at birth, but larger in relative terms. In relative terms, HLE without LLI at age 65 has increased at a faster rate than LE at age 65.

Similar figures for HLE without LLI for males, and for HLE using SAH and ADLs for females and males, are given in Tables A4.2-A4.5. The results are discussed in more detail in the main text of chapter 4.

**Table A4.2 - Calculation of annual trends in LE and HLE without LLI, males 1980-2000**

| Age | At birth | | | | At age 65 | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | LE | | HLE(LLI) | | LE | | HLE(LLI) | |
| | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value |
| Time trend | 0.215 | <0.001 | 0.061 | 0.119 | 0.120 | <0.001 | 0.097 | 0.007 |
| Constant | 68.877 | <0.001 | 57.395 | <0.001 | 11.999 | <0.001 | 6.818 | <0.001 |
| Mean 1980-1982 | 69.033 | | 57.933 | | 12.233 | | 7.633 | |
| % change | 0.31% | | 0.11% | | 0.98% | | 1.28% | |

**Table A4.3 - Calculation of annual trends in LE and HLE using SAH, females 1980-2000**

| Age | At birth | | | | At age 65 | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | LE | | HLE(SAH) | | LE | | HLE(SAH) | |
| | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value |
| Time trend | 0.174 | <0.001 | 0.107 | 0.005 | 0.090 | <0.001 | 0.072 | 0.056 |
| Constant | 75.130 | <0.001 | 66.444 | <0.001 | 15.942 | <0.001 | 12.126 | <0.001 |
| Mean 1980-1982 | 75.267 | | 66.367 | | 16.033 | | 12.233 | |
| % change | 0.23% | | 0.16% | | 0.56% | | 0.59% | |

**Table A4.4 - Calculation of annual trends in LE and HLE using SAH, males 1980-2000**

| Age | At birth | | | | At age 65 | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | LE | | HLE(SAH) | | LE | | HLE(SAH) | |
| | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value |
| Time trend | 0.215 | <0.001 | 0.122 | <0.001 | 0.120 | <0.001 | 0.097 | <0.001 |
| Constant | 68.877 | <0.001 | 63.485 | <0.001 | 11.999 | <0.001 | 9.619 | <0.001 |
| Mean 1980-1982 | 69.033 | | 63.033 | | 12.233 | | 9.700 | |
| % change | 0.31% | | 0.19% | | 0.98% | | 1.00% | |

**Table A4.5 - Calculation of annual trends in LE and HLE using ADLs, 1980-1998**

| Gender | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | LE | | HLE(ADL) | | LE | | HLE(ADL) | |
| | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value |
| Time trend | 0.090 | 0.001 | 0.054 | 0.172 | 0.122 | 0.001 | 0.054 | 0.039 |
| Constant | 16.002 | <0.001 | 14.433 | <0.001 | 12.006 | <0.001 | 11.506 | <0.001 |
| Initial value 1980 | 16.100 | | 14.600 | | 12.100 | | 11.600 | |
| % change | 0.56% | | 0.37% | | 1.01% | | 0.47% | |

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