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# Chapter 7

## Standard errors

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All survey estimates are subject to sampling error because they are derived from a sample of a population rather than the whole population. This chapter describes how the sampling errors of the key 2014-15 EHS variables were calculated. The sampling errors of the key 2014-15 EHS variables are available as a separate document on Gov.uk.<sup>17</sup>

### Overview

- 7.1 The sampling errors associated with survey estimates are expressed in terms of standard errors which measure the uncertainty around survey estimates. Standard errors for the 2014-15 EHS were calculated on weighted data using the statistical package Stata. The variance of survey estimates is affected by features of the survey or sample design such as weighting, clustering and stratification. The effect of those features on the standard errors of the estimates from the 2014-15 EHS has been taken account of in the calculation of the standard errors.

### Sources of error in surveys

- 7.2 The total error in a survey estimate is the difference between the estimate derived from the data collected and the true value for the population. Survey estimates are subject to various sources of error; the two main types of error are systematic and random error.

#### Systematic error

- 7.3 Systematic error, or bias, covers those sources of error which will not average to zero over repeats of the survey. Bias may occur, for example, if a certain section of the population is excluded from the sampling frame, because non-respondents to the survey have different characteristics to respondents, or if interviewers systematically influence responses in one way or another. When carrying out a survey, substantial efforts are put into the avoidance of systematic errors but it is possible that some may still occur.

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<sup>17</sup> The sampling errors of the key 2014-15 EHS variables are available from <https://www.gov.uk/government/collections/english-housing-survey-technical-advice>.

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## Random error

- 7.4 The most important component of random error is sampling error, which is the error that arises because the estimate is based on a random sample rather than a full census of the population. The results obtained for any single sample may, by chance, vary from the true values for the population but the variation would be expected to average to zero over a number of repeats of the survey. The extent of the variation from the population value depends on the size of the sample, the sample design and the weighting methodology.
- 7.5 Random errors may also result from other sources such as variations in respondents' interpretation of the questions, or variations in the way different interviewers ask the questions. The effect of these can be minimised through pilot work and interviewer training.

## Standard errors for complex sample designs

- 7.6 Key features of the design of a survey such as weighting, clustering and stratification can have an impact on standard errors. The effect of those complex design features has to be taken into account when assessing the reliability of estimates. Standard errors calculated on the basis of a simple random sample design will not reflect the true variation because the effect of the complex sample design has not been taken into account.
- 7.7 The sample design features of the EHS that has an impact on standard errors are the use of a two-stage stratified sample design to select a clustered sample and differential sampling probabilities. The methodology used to weight the data also affects the standard errors.
- 7.8 The two-stage sample selection process described in Chapter 1 can lead to an increase in standard error if the households or people within individual primary sampling units (PSUs) are relatively homogenous but the mix of households or people between PSUs differ from one another. As each year's EHS sample covers half of the PSUs in England, the loss in precision from clustering should be fairly small. In addition, half the PSUs in England are included in the survey in one year and the other half in the following year, so the sample combining two years of data is, in fact, unclustered. Stratification, on the other hand, tends to reduce standard error and is most advantageous where the stratification factor is related to the characteristics of interest on the survey.
- 7.9 In order to obtain a sufficiently large number of cases for detailed analysis, households in the rented sector are given a higher probability of selection compared with owner occupiers. The methodology used to weight the data to adjust for differential sampling probabilities will increase the standard errors.

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On the other hand, the use of population totals to control for differential non-response tends to lead to a small reduction in sampling errors.

## Design factors

- 7.10 The design factor, or *deft*, is the ratio of the standard error of an estimate from a complex sample to the standard error that would have resulted had the survey design been a simple random sample of the same size. The size of the design factor depends on the degree to which a characteristic is clustered within PSUs, varies across the strata and is correlated with the weights. Design factors below 1.0 show that adopting the complex sample design has improved the reliability of the estimate compared with using a simple random sample design, probably due to the benefits of stratification. Design factors greater than 1.0 show that, due to the effects of clustering, weighting or other design features, the complex sample design has resulted in less reliable estimates than might be gained from a simple random sample.
- 7.11 The design factors for selected survey estimates are shown with the corresponding sampling errors in the tables released on Gov.uk. These can be used to estimate likely sampling errors for other variables on the basis of their similarity to one of the variables presented. As shown in the formulas below, the standard error (*se*) of a proportion (*p*) based on a simple random sample (*srs*) multiplied by the *deft* gives the standard error of a complex design.

$$se(p) = deft \times se(p)_{srs}$$

where:

$$se(p)_{srs} = \sqrt{\frac{p \times (100 - p)}{n}}^{18}$$

- 7.12 The formula to calculate the standard error of the difference between two percentages for a complex sample design is:

$$se(p_1 - p_2) = \sqrt{\frac{deft_1^2 \times (p_1 \times (100 - p_1))}{n_1} + \frac{deft_2^2 \times (p_2 \times (100 - p_2))}{n_2}}$$

Where  $p_1$  and  $p_2$  are observed percentages for the two subsamples and  $n_1$  and  $n_2$  are the subsample sizes.

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<sup>18</sup> The precise formula uses  $n-1$  as the denominator but this equates to  $n$  in large samples.

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## Confidence intervals

7.13 Although an estimate produced from a sample survey will rarely be identical to the population value, statistical theory allows us to measure the accuracy of any survey result. The standard error can be estimated from the values obtained from the sample and allows the calculation of confidence intervals, which indicate the range of random variation in the survey estimates.

7.14 It is common, when quoting confidence intervals, to refer to the 95% confidence interval around a survey estimate. This is calculated at 1.96 times the standard error on either side of the estimated percentage or mean since, under a normal distribution, 95% of values lie within 1.96 standard errors of the mean value. If it were possible to repeat the survey under the same conditions many times, 95% of these confidence intervals would contain the population values.

7.15 The 95% confidence interval for the difference between two percentages is given by:

$$p_1 - p_2 \pm 1.96 \times se(p_1 - p_2)$$

7.16 If this confidence interval includes zero then the hypothesis that the two proportions are the same and the observed difference is due to chance alone is not rejected. If the interval does not include zero then it is unlikely (less than five per cent probability) that the observed difference could have occurred by chance and this constitutes a 'significant difference' at the 95% confidence level.

## Sampling errors of the 2014-15 EHS estimates

7.17 The sampling errors of the key 2014-15 EHS variables are released on Gov.uk. Weighted data were used to calculate the standard errors so that the values of the percentages and means are the same as those in the EHS annual reports. The method used to calculate the sampling errors correctly allows for the inflation in the sampling errors caused by the sample design and weighting methodology except for the positive effects of using population totals to control for differential nonresponse. As a result, the standard errors and design factors (defts) presented in the tables released on Gov.uk are likely to be slight over-estimates.