**ONS(ONC(SC))98/12**

**ONE NUMBER CENSUS STEERING COMMITTEE**

# CENSUS COVERAGE SURVEY DESIGN

1. This paper outlines the further work completed on the design of the Census Coverage Survey (CCS), including the overall sample size. Specifically, the paper addresses the following:

- the expected precision for design groups varying from 500,000 to one million for a given number of sampled postcodes;
- the impact of varying the number of postcodes per enumeration district on the precision for a given number of sampled postcodes; and
- the expected level of precision and cost for different CCS sample sizes

2. This paper has been jointly prepared with the CCS Project Team to provide information on cost and practicality implications. This includes information on the estimated overall cost of the CCS for different sample sizes.

3. Members of the Steering Committee are asked to:

- **Endorse the recommendation that the size of the design groups should be half a million persons;**
- **Endorse the recommendation that 5 postcodes are to be sampled from each Enumeration District in the Dress Rehearsal;**
- **Provide advice on the Census Coverage Survey overall sample size;**
- **Note the plans for further research; and**
- **Provide comments at the meeting or in writing by 27th November 1998.**

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**October 1998**

# CENSUS COVERAGE SURVEY: THE PRECISION OF POPULATION ESTIMATES FOR DIFFERENT SAMPLE SIZES AND DESIGN AREAS

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## Introduction

The Census Coverage Survey (CCS) is the key component of the One Number Census (ONC) project. Data obtained from this survey will not only be used to produce population estimates, but will also, when combined with matched census counts, form the basis for models that will be used to adjust for differential underenumeration in the 2001 Census. The CCS will involve the re-enumeration of a sample of postcode areas, stratified by Local Authority District (LAD) and by an index measuring the expected level of difficulty associated with enumerating a postcode in the census. Since the main purpose of the CCS will be to estimate the extent of underenumeration in the census, it will be carried out as soon as possible after the census. At this stage it is anticipated that the CCS fieldwork will begin three to four weeks after census day.

It is expected that underenumeration in the 2001 Census will be higher in areas characterised by particular social, economic and demographic characteristics. For example, people in dwellings occupied by more than one household (multi-occupancy) have a relatively high probability of not being enumerated in a census. In order to control for this effect postcodes within each design area will be stratified by a 'Hard to Count' (HtC) index as well as by size (population count at the previous 1991 Census). For the analysis reported below a national HtC index for 1991 Census EDs was calculated by ranking these districts with respect to a series of variables collected in 1991 and then assigning normal scores based on these ranks. All postcodes within an ED were then allocated the HtC score for that district. These scores were divided into quintiles at a national level, with each quintile assigned an index value from 1 (easiest to count) to 5 (hardest to count). Further work will investigate the optimum number of categories but currently it is expected that the sample size will be robust to changes in the number of categories.

The CCS uses a two-stage design. The first stage of the design selects a sample of 1991 Enumeration Districts (EDs), stratified by hard to count, from design group areas formed by grouping LADs. The second stage then samples postcodes within the selected first stage EDs. The two-stage design assumes that the aim of the CCS is to produce population estimates of specified accuracy at design area level for the 24 Age/Sex groups defined by sex (male/female) and the 12 age classes: 0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-79, 80-84, 85+. The ages 45 - 79 have been combined since there was no evidence of any marked underenumeration in this group in 1991. This grouping will be reviewed prior to finalising the CCS design.

Therefore, the design problem for the CCS is to estimate the 24 Age/Sex totals such that each has an expected relative standard error[1] (RSE) of less than $\alpha$ per cent where $\alpha$ is chosen depending on the required accuracy and cost constraints. RSE (also called coefficient of variation) is the estimated standard error of an estimate, expressed as a percentage of the estimate itself.

1 – A description of the RSE is contained in Annex A

As noted earlier, the CCS will be based on a two-stage design. The clustering in this two-stage design has cost advantages for a fixed number of postcodes but efficiency disadvantages when the characteristics of postcodes are positively correlated within enumeration districts. The full design is described in ONS(ONC(SC))98/05.

**Aims of Research**

**This paper aims primarily to give the precision of estimates of population totals for a variety of sample sizes and designs. Specifically it addresses the following:**

**a) For a given number of sampled postcodes what is the expected precision for design groups varying from 500,000 to one million?**
**b) For a given number of sampled postcodes what is the impact of varying the number of postcodes per Enumeration District on the precision? and;**
**c) What overall sample size strikes the best balance between precision and cost?**

**Data used**

Six anonymous Local Authority Districts from the 1991 Census database were used. In total, the population of these six LADs was just over 1 million individuals. The individual population sizes of the LADs varied from approximately 30,000 to 490,000 persons. All six LADs were used in forming a design group of population one million. Three of the LADs formed a three-quarter million group and two LADs made up the half million group. The largest LAD, consisting of 490,000 persons, was included in all three design groups.

Annex B provides details of the formation of the design groups. The LADs provide a representative cross section of the population both in terms of size and characteristics. As can be seen in **Table B1**, the half million group has a smaller proportion of hard to count level 5 Enumeration Districts when compared with the other design groups.

**Methodology**

The methodology used to answer questions (a) and (b) involved simulating both the first and second stages of the CCS design. The CCS design and simulation routines developed at the University of Southampton were revised for this purpose.

For a given design group the first stage of the CCS design is implemented. The strategy was to fix the number of postcodes sampled nationally in order to allow precision calculations through the simulations. Previous research had computed sample size based on a given precision.

Fixing the national postcode sample size and the number of postcodes to be selected within EDs resulted in an estimation of the number of EDs to be sampled nationally. The resulting first stage ED sampling fraction (given that there were approximately 110,000 EDs in 1991) for all sizes of design group was then computed.

For each simulation it was necessary to provide a CCS first stage design that gave a sampling fraction as close to the computed value as possible. To achieve this, the design group RSE

was varied until a solution was reached. **Table C1** in Annex C displays the design group RSEs that were used for each of the simulations. The first stage design meeting the ED sampling fraction criterion was then used in the simulation.

The simulation routines use individual level 1991 Census data to simulate a census and a CCS using the first stage design described above and a fixed number of postcodes per ED. For each CCS, the design group population totals for each age/sex group were estimated through a combined regression and Dual System Estimation approach. Since the true population was known the Relative Root Mean Square Error[1] (RRMSE) was calculated. The variance associated with the estimates of the design group population was estimated by the Mean Square Error[1] (MSE) on the total population estimate from each simulation. One hundred censuses were created, each having ten corresponding CCSs. Across the age/sex groups, the median RRMSE was then computed. In preparing the routines 95% Census Coverage, a perfect, independent CCS and perfect matching algorithms were assumed. It is important to note that for the purpose of this work these assumptions are reasonable as, for example, the dual system estimators account for noncoverage in the CCS.

In order to ensure that the simulations were comparable for each of the options tested, separate simulations were run to produce the achieved CCS postcode sample size for each simulation design. The achieved and target sample sizes are shown in Annex D in **Table D1** and **Table D2** respectively. These results indicated that some of the comparisons were not valid. Therefore, the precision calculations were scaled by the square root of the ratio of the actual achieved sample size by the target sample size. By scaling the results in this way, comparisons can be made.

**Results**

Previous research (ONS(ONC(98))98/05) used four postcodes per ED and a design group size of approximately 450,000 persons. In this paper, simulations are reported for design groups with populations of one million, three quarters of a million and half a million persons. Initially, three, four and five postcodes per ED were tested. However, it became clear that it was necessary to extend the research to include simulating CCSs using six postcodes. Due to time constraints, only five censuses were simulated in these cases to obtain rough estimates and for this reason the results have been excluded. However, these simulations will be run using the usual one hundred censuses to enable inclusion in the table at a later date.

1 – A description of the RRMSE and the MSE are contained in Annex A

**Table 1** shows the scaled median RRMSE for the population estimates of the twenty-four Age/Sex groups within the design group from the simulation results. For example, taking a national sample size of 20,000 postcodes with design groups of size one million and sampling five postcodes per ED, the resulting median RRMSE for all twenty four age/sex groups is 1.35%. It must be noted that the values displayed are the medians rather than the means due to the skewed distribution of the estimated Age/Sex RRMSEs. There is a wide variation in the precision obtained for the different age/sex groups, particularly for the females aged over 85 years. For each of the simulations, the unscaled RRMSE for the 24 Age/Sex groups can be found in Annex E.

**Table 1 – Median precision for 24 Age/Sex groups given fixed national sample size.**

| | | Median RRMSE of 24 age/sex groups for design group population of | | |
|---|---|---|---|---|
| **National Sample Size** | **Postcodes Per ED** | **1 Million** | **0.75 Million** | **0.5 Million** |
| 10,000 | 3 | 1.78% | 2.06% | 2.44% |
| | 4 | 1.77% | 2.06% | 2.49% |
| | 5 | 1.72% | 2.02% | 2.52% |
| 20,000 | 3 | 1.36% | 1.43% | 1.70% |
| | 4 | 1.37% | 1.50% | 1.71% |
| | 5 | 1.35% | 1.49% | 1.74% |
| 30,000 | 3 | 1.14% | 1.25% | 1.43% |
| | 4 | 1.19% | 1.28% | 1.47% |
| | 5 | 1.04% | 1.25% | 1.44% |
| 40,000 | 3 | 1.04% | 1.11% | 1.31% |
| | 4 | 1.03% | 1.15% | 1.28% |
| | 5 | 1.04% | 1.14% | 1.25% |

**Table 2** gives the estimated standard deviation of the total population estimates for the design group for various options. In order to estimate these error levels, an estimate of the variance of the population total is needed. This variance estimate was formed from the Mean Square Error of the design group population estimates. This ensured that the estimate included a measure of the bias, which would indicate whether the regression estimator used in the simulations is producing population estimates that are either consistently too large or too small.

The table gives the information required to form approximate 95% confidence intervals around the design group total population estimates from the census + CCS estimation process. For example, with a national CCS sample size of 20,000 postcodes and design groups containing half a million persons, sampling 5 postcodes per Enumeration District will result in a total population estimate for that design group that has error bounds of ± 4104 persons.

**Table 2 – Estimated error level for design group population estimate.**

| | | **Standard Deviation of design group population estimate for design group population of** | | |
|---|---|---|---|---|
| **Sample Size** | **Postcodes per ED** | **1 Million** | **0.75 Million** | **0.5 Million** |
| 10,000 | 3 | 4582 | 3721 | 3110 |
| | 4 | 4403 | 3794 | 3081 |
| | 5 | 4336 | 3763 | 3389 |
| 20,000 | 3 | 3037 | 2409 | 2044 |
| | 4 | 3016 | 2611 | 2055 |
| | 5 | 3012 | 2686 | 2057 |
| 30,000 | 3 | 2383 | 2127 | 1721 |
| | 4 | 2485 | 2091 | 1777 |
| | 5 | 2205 | 2216 | 1749 |
| 40,000 | 3 | 2150 | 1716 | 1453 |
| | 4 | 2109 | 1857 | 1493 |
| | 5 | 2210 | 1899 | 1424 |

**Table 3** extends the previous results to predict the likely error level for the national population total. These calculations assume the population of England and Wales to be 52 million persons to enable the number of design groups at the national level to be calculated. Since each design group is assumed to be independent of all others, simple summation of the estimated design group variance calculated from **Table 2** results in a national population variance which can then be square rooted to obtain the estimated standard deviation.

The figures presented in the table can, as before, be used to form approximate confidence intervals. For example, the table shows that for a national sample size of 20,000 postcodes, using half million design groups and sampling five postcodes per Enumeration District the estimate of the national population will have error bounds of approximately ± 41948 persons.

**Table 3 – Estimated Standard deviations for England and Wales national population estimate.**

| | | Standard deviation of national population estimate for design group population of | | |
|---|---|---|---|---|
| **Sample Size** | **Postcodes per ED** | **1 Million** | **0.75 Million** | **0.5 Million** |
| 10,000 | 3 | 33040 | 30975 | 31717 |
| | 4 | 31750 | 31582 | 31417 |
| | 5 | 31266 | 31328 | 34565 |
| 20,000 | 3 | 21903 | 20054 | 20849 |
| | 4 | 21749 | 21739 | 20960 |
| | 5 | 21717 | 22360 | 20974 |
| 30,000 | 3 | 17183 | 17709 | 17553 |
| | 4 | 17918 | 17405 | 18123 |
| | 5 | 15901 | 18444 | 17841 |
| 40,000 | 3 | 15507 | 14287 | 14819 |
| | 4 | 15208 | 15455 | 15228 |
| | 5 | 15933 | 15811 | 14519 |

**Table 4** shows the overall cost estimates (to the nearest thousand) for different overall CCS sample sizes. They are presented below for consideration in conjunction with the precision results above.

**Table 4 – Estimated CCS costs by overall sample sizes**

| Sample size (Postcodes) | Sample size (Households) | Estimated overall costs |
|---|---|---|
| 10000 | 150,000 | £2,448,000 |
| 20000 | 300,000 | £4,220,000 |
| 30000 | 450,000 | £5,991,000 |
| 40000 | 600,000 | £7,762,000 |

## Discussion of results

### a) Design group size

**Table 2** clearly shows that any confidence intervals for the design group population total will be narrower for the smaller design groups. However, relative to the population totals being estimated, the intervals are slightly wider for the half million groups, which is as expected given the relative precision results in **Table 1**. It must also be noted that although this is the case, merging two half million groups into a single one million group would mostly provide better estimates of the one million population total than for a one million design group. This can be demonstrated by squaring the standard deviations shown in the half million design group column of **Table 2**, doubling the result and then taking the square root of this value to compare with the one million group estimated error. This demonstrates that using half million groups in the CCS design provides slightly better population estimates.

The assessment of design group size must also take into account the practical and political aspects. Practically, it is easier to form homogenous design groups if their population is smaller. Furthermore, the size of the design group is unlikely to make much difference to the costs of the CCS fieldwork. While different sizes might lead to a different allocation of design groups to regional managers, the costs will remain similar. Smaller design groups would simply be aggregated to form larger areas. The half million groups are also more likely to conform to current Census geography plans for Census Area Manager (CAM) areas.

Politically, it is desirable to have as many LADs as possible as individual design level groups so that they have their own direct population estimate. Furthermore, through the ONC consultation process, some LADs have already expressed a concern that they may be grouped with areas that have completely different characteristics. Once again, this seems to indicate that smaller design groups are the ideal option.

### b) Postcodes within PSUs

The results in **Table 1** show no clear pattern to indicate which strategy should be recommended. Some comparisons show almost no difference, but some indicate some differences between the number of postcodes sampled within EDs. It is therefore difficult to draw any definite conclusions from the data presented without further work.

In practical terms, the number of postcodes sampled within EDs may have an impact on the CCS. It is expected that the workload of an interviewer pair is likely to be between five and ten postcodes. Therefore, cost efficiency gains due to a reduction in costs of travelling between areas can be made if these postcodes are contained within the least number of clusters possible. Although this decrease in travelling costs cannot be quantified, it is unlikely that the reductions will be significant – however they are gains nonetheless.

The allocation of interviewer pairs to a workload will also be made more manageable as the number of postcodes sampled within EDs increases. The size and makeup of workloads for the interviewers will be more adaptable to particular circumstances (such as postcodes with very large populations). This will result in a more efficient allocation of interviewers. Hence it is preferable from a CCS cost and practicality point of view that the number of postcodes sampled per ED is as high as possible.

### c) Overall sample size

**Table 1, Table 2 and Table 3** give indications of the likely overall level of precision for each of the fixed sample sizes used. These tables clearly show diminishing gains in precision as the overall sample size increases. For instance, the difference in precision between sampling 10,000 postcodes and 20,000 postcodes using half million population design groups is approximately 0.8% according to **Table 1**. However, the difference between 20,000 and 30,000 postcodes falls to approximately 0.25%.

**Table 4** presents the estimated CCS costs for the different sample sizes. The costs displayed show a linear relationship with sample size, which is as expected. The marginal cost in sampling an additional 10,000 postcodes is roughly £1.7 million.

Whilst a statistical viewpoint would suggest that 40,000 postcodes is the most desirable sample size, the costs of this particular option are not feasible in view of budgetary constraints. A balance needs to be struck between being able produce an accurate ONC and the cost involved in doing so. This suggests a minimum overall CCS sample size of 20,000 postcodes.

## Conclusions

### a) Design group size

The paper has shown that for smaller design groups there is no loss in precision. However, the levels of precision obtained for different strategies are not the only criteria for assessing the size of design group. Practical and political aspects must also be examined. There is a clear preference both from a statistical and political point of view that the design groups should be as small as possible. Therefore, **it is recommended that design groups of half a million population are the best strategic option**.

### b) Postcodes within PSUs

The results presented in this paper suggest that there is no clear preference as to the number of postcodes to sample from Enumeration Districts. However, it is clear that any increase in clustering of the postcodes within Enumeration Districts will have both beneficial cost and practical implications, although these gains will be small. Provided that further research is not conclusive as to the optimal number to sample from EDs, **it is recommended that five postcodes per Enumeration District be trialled in the 1999 Dress Rehearsal**.

### c) Overall sample size

The results provide an indication of the likely precision for different national sample sizes. Given the estimated costs for the CCS, **the optimum sample size that represents best value for money in terms of precision is around 20,000 postcodes**.

**Further work**

Further work is planned to examine:

- The effect on precision of sampling six postcodes per Enumeration District;
- The likely precision levels of LAD population estimates;
- Development of a strategy for dealing with outlying Enumeration Districts identified in the first stage of the CCS sampling;
- Development of the method used to derive the Hard to Count index for the 1999 Dress Rehearsal;
- The effect on the CCS design of a different number of Hard to Count groups;
- How to group LADs into design groups; and
- Practical sampling issues (e.g. postcodes that cross LAD boundaries etc.).

**ANNEX A – Description of terms used**

**a) Relative Standard Error**

For a given population quantity such as the total T with estimator $\hat{\mathrm{T}}$, one can measure the accuracy of the estimator using the relative standard error (RSE) defined as:

$$\mathrm{RSE}\left(\hat{\mathrm{T}}\right) = \frac{\left\{\mathrm{var}\left(\hat{\mathrm{T}} - \mathrm{T}\right)\right\}^{1/2} \cdot 100}{\mathrm{T}}$$

The RSE is a measure of the variability of the population estimate relative to the population total being estimated.

**b) Relative Root Mean Square Error**

For a given population quantity such as the total T with estimator $\hat{\mathrm{T}}$, one can measure the mean accuracy of the estimator using the relative root mean square error (RRMSE) defined as:

$$\mathrm{RRMSE}\left(\hat{\mathrm{T}}\right) = \frac{1}{\mathrm{T}}\left\{\sqrt{\frac{\sum\left(\hat{T} - T\right)^2}{n}}\right\} \cdot 100$$

where the summation is carried out over all the *n* observations of $\hat{\mathrm{T}}$.

The RRMSE is a measure of the mean level of variability for a population total, relative to the population total being estimated.

**c) Mean Square Error**

For a given population quantity such as the total T with estimator $\hat{\mathrm{T}}$, one can measure the mean accuracy of the estimator using the mean square error (MSE) defined as:

$$\mathrm{MSE}\left(\hat{\mathrm{T}}\right) = \frac{\sum\left(\hat{T} - T\right)^2}{n}$$

where the summation is carried out over all the *n* observations of $\hat{\mathrm{T}}$.

The MSE is a measure of the mean level of variability for a population total. The MSE includes a measure of the bias for the population estimate.

**ANNEX B – Design group details**

**Table B1** provides summary details of the three design groups formed for the simulations, including the number of 1991 Local Authority Districts used, the populations of these LADs and the distribution of the Enumeration District level Hard to Count index for the design groups.

**Table B1 – Details of design groups used**

| Design group | Number of 1991 LADs | LAD Populations (000s) | Hard to Count distribution (EDs) |
|---|---|---|---|
| 1 Million design group | 6 | 1. 191<br>2. 449<br>3. 183<br>4. 64<br>5. 31<br>6. 124 | HtC index 1 – 310 EDs<br>HtC index 2 – 408 EDs<br>HtC index 3 – 409 EDs<br>HtC index 4 – 518 EDs<br>HtC index 5 – 897 EDs |
| 0.75 Million design group | 3 | 1. 191<br>2. 449<br>3. 124 | HtC index 1 – 243 EDs<br>HtC index 2 – 292 EDs<br>HtC index 3 – 252 EDs<br>HtC index 4 – 325 EDs<br>HtC index 5 – 707 EDs |
| 0.5 Million design group | 2 | 1. 449<br>2. 64 | HtC index 1 – 151 EDs<br>HtC index 2 – 233 EDs<br>HtC index 3 – 248 EDs<br>HtC index 4 – 268 EDs<br>HtC index 5 – 219 EDs |

**ANNEX C – RSE constraints used to obtain required Enumeration District sample size**

**Table C1** displays the Relative Standard Error constraints required at the first stage ED sampling to produce a CCS design that selected the target number of Enumeration Districts. The calculation of the target number of EDs assumed that the number of EDs was 110,000 nationally.

**Table C1 – Design group RSEs used to achieve required ED sample fraction**

| Sample Size | Postcodes per ED | National number of EDs | Target ED Sample Fraction | Design RSE | | |
|---|---|---|---|---|---|---|
| | | | | 1.0M design group | 0.75M design group | 0.5M design group |
| 10,000 | 3 | 3333 | 3.0% | 3.4% | 4.5% | 8.0% |
| | 4 | 2500 | 2.3% | 4.3% | 5.9% | 9.3% |
| | 5 | 2000 | 1.8% | 5.7% | 7.2% | 10.5% |
| | 6 | 1667 | 1.5% | 6.5% | 8.5% | 11.5% |
| 20,000 | 3 | 6667 | 6.1% | 2.0% | 2.5% | 3.6% |
| | 4 | 5000 | 4.5% | 2.6% | 3.0% | 4.5% |
| | 5 | 4000 | 3.6% | 3.0% | 3.7% | 6.0% |
| | 6 | 3333 | 3.0% | 3.4% | 4.5% | 8.0% |
| 30,000 | 3 | 10000 | 9.1% | 1.3% | 1.7% | 2.4% |
| | 4 | 7500 | 6.8% | 1.8% | 2.2% | 3.1% |
| | 5 | 6000 | 5.5% | 2.5% | 2.6% | 4.0% |
| | 6 | 5000 | 4.5% | 2.6% | 3.0% | 4.5% |
| 40,000 | 3 | 13333 | 12.1% | 1.0% | 1.3% | 1.9% |
| | 4 | 10000 | 9.1% | 1.3% | 1.7% | 2.4% |
| | 5 | 8000 | 7.3% | 1.7% | 2.1% | 3.0% |
| | 6 | 6667 | 6.1% | 2.0% | 2.5% | 3.6% |

**ANNEX D – Achieved and target postcode sample sizes**

**Table D1** shows the mean achieved postcode sample size for 20 simulations of the CCS sampling using a given first stage design. Sample sizes should be broadly similar when making comparisons. However, the table shows that some simulations achieved a much higher or lower sample. For this reason, the precision estimates were scaled to reflect the relative sample sizes. **Table D2** shows the target number of postcodes, which were calculated to achieve this scaling. This used the target ED sampling fractions in **Table C1**.

**Table D1 – Mean sample size achieved for simulations**

| Planned Sample size | | | Mean Postcode Sample Size[a] | | |
|---|---|---|---|---|---|
| Sample Size | Postcodes per ED | EDs | 1 Million | 0.75 Million | 0.5 Million |
| 10,000 | 3 | 3333 | 228 | 161 | 93 |
| | 4 | 2500 | 231 | 163 | 96 |
| | 5 | 2000 | 229 | 159 | 99 |
| 20,000 | 3 | 6667 | 407 | 317 | 204 |
| | 4 | 5000 | 401 | 322 | 199 |
| | 5 | 4000 | 435 | 325 | 194 |
| 30,000 | 3 | 10000 | 618 | 472 | 293 |
| | 4 | 7500 | 593 | 485 | 295 |
| | 5 | 6000 | 554 | 499 | 288 |
| 40,000 | 3 | 13333 | 819 | 612 | 379 |
| | 4 | 10000 | 821 | 627 | 390 |
| | 5 | 8000 | 811 | 630 | 392 |

a. The estimated number of postcodes was derived from 20 CCS simulations

**Table D2 – Target postcode sample size for the simulations**

| | Target Postcode Sample Size | | |
|---|---|---|---|
| Planned Sample size | 1 Million | 0.75 Million | 0.5 Million |
| 10,000 | 231 | 165 | 102 |
| 20,000 | 462 | 330 | 204 |
| 30,000 | 693 | 495 | 306 |
| 40,000 | 924 | 660 | 408 |

**ANNEX E – Age/Sex group precision levels for each simulation.**

**Tables E1 to E12** show the precision levels obtained for the 24 Age/Sex groups from the simulations. The measures shown are the unscaled results – that is the relative sample sizes have not been taken into account as described in the paper.

**Table E1**

**Half Million Design Group, Fixed Sample size of 40000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 134 | 102 | 81 | 68 |
| **Sample Fraction** | 12.0% | 9.1% | 7.2% | 6.1% |
| **Design RSE** | 1.9% | 2.4% | 3.0% | 3.6% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 1.47% | 1.44% | 1.53% | 1.61% |
| Males aged 5-9 | 1.36% | 1.26% | 1.44% | 1.28% |
| Males aged 10-14 | 1.06% | 1.09% | 1.08% | 1.11% |
| Males aged 15-19 | 1.59% | 1.51% | 1.55% | 1.55% |
| Males aged 20-24 | 2.64% | 2.47% | 2.33% | 2.54% |
| Males aged 25-29 | 2.41% | 2.37% | 2.27% | 2.54% |
| Males aged 30-34 | 1.71% | 1.79% | 1.60% | 1.67% |
| Males aged 35-39 | 1.17% | 1.16% | 1.14% | 0.98% |
| Males aged 40-44 | 1.10% | 1.06% | 1.08% | 1.04% |
| Males aged 45-79 | 0.31% | 0.31% | 0.32% | 0.31% |
| Males aged 80-84 | 2.73% | 2.79% | 2.65% | 2.95% |
| Males aged 85+ | 4.39% | 4.22% | 4.56% | 4.80% |
| | | | | |
| Females aged 0-4 | 1.29% | 1.36% | 1.22% | 1.24% |
| Females aged 5-9 | 1.23% | 1.17% | 1.13% | 1.14% |
| Females aged 10-14 | 0.96% | 0.94% | 0.94% | 1.00% |
| Females aged 15-19 | 1.36% | 1.31% | 1.33% | 1.37% |
| Females aged 20-24 | 1.37% | 1.43% | 1.40% | 1.50% |
| Females aged 25-29 | 1.37% | 1.32% | 1.20% | 1.37% |
| Females aged 30-34 | 0.95% | 0.89% | 0.86% | 0.79% |
| Females aged 35-39 | 0.74% | 0.75% | 0.73% | 0.75% |
| Females aged 40-44 | 0.83% | 0.82% | 0.79% | 0.76% |
| Females aged 45-79 | 0.26% | 0.26% | 0.27% | 0.26% |
| Females aged 80-84 | 3.86% | 3.94% | 3.83% | 3.65% |
| Females aged 85+ | 8.05% | 8.02% | 7.96% | 7.74% |
| | | | | |
| **Mean RRMSE** | **1.84%** | **1.82%** | **1.80%** | **1.83%** |
| **Median RRMSE** | **1.36%** | **1.31%** | **1.27%** | **1.32%** |
| **Design Group RRMSE** | **0.30%** | **0.30%** | **0.29%** | **0.24%** |
| **Design Group Std Dev** | **1507.7** | **1527.3** | **1452.5** | **1222.6** |

**Table E2**
**Half Million Design Group, Fixed Sample size of 30000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 102 | 76 | 60 | 52 |
| **Sample Fraction** | 9.1% | 6.8% | 5.4% | 4.6% |
| **Design RSE** | 2.4% | 3.1% | 4.0% | 4.5% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 1.61% | 1.67% | 1.69% | 1.68% |
| Males aged 5-9 | 1.44% | 1.62% | 1.64% | 1.57% |
| Males aged 10-14 | 1.28% | 1.30% | 1.35% | 1.25% |
| Males aged 15-19 | 1.71% | 1.88% | 1.96% | 1.87% |
| Males aged 20-24 | 2.79% | 2.85% | 2.87% | 2.73% |
| Males aged 25-29 | 2.67% | 2.65% | 2.63% | 2.58% |
| Males aged 30-34 | 1.99% | 2.02% | 2.01% | 1.92% |
| Males aged 35-39 | 1.36% | 1.35% | 1.38% | 1.36% |
| Males aged 40-44 | 1.25% | 1.27% | 1.25% | 1.24% |
| Males aged 45-79 | 0.36% | 0.36% | 0.36% | 0.36% |
| Males aged 80-84 | 3.28% | 3.24% | 3.21% | 3.23% |
| Males aged 85+ | 4.95% | 5.16% | 5.19% | 5.42% |
| | | | | |
| Females aged 0-4 | 1.54% | 1.48% | 1.47% | 1.45% |
| Females aged 5-9 | 1.32% | 1.34% | 1.34% | 1.32% |
| Females aged 10-14 | 1.09% | 1.09% | 1.06% | 1.04% |
| Females aged 15-19 | 1.44% | 1.45% | 1.47% | 1.40% |
| Females aged 20-24 | 1.57% | 1.64% | 1.68% | 1.62% |
| Females aged 25-29 | 1.48% | 1.51% | 1.50% | 1.48% |
| Females aged 30-34 | 0.98% | 1.05% | 1.03% | 1.03% |
| Females aged 35-39 | 0.84% | 0.83% | 0.83% | 0.81% |
| Females aged 40-44 | 0.88% | 0.88% | 0.88% | 0.87% |
| Females aged 45-79 | 0.31% | 0.31% | 0.32% | 0.31% |
| Females aged 80-84 | 4.13% | 4.14% | 4.16% | 3.90% |
| Females aged 85+ | 8.29% | 8.43% | 8.29% | 8.22% |
| | | | | |
| **Mean RRMSE** | **2.02%** | **2.06%** | **2.07%** | **2.03%** |
| **Median RRMSE** | **1.46%** | **1.50%** | **1.48%** | **1.46%** |
| **Design Group RRMSE** | **0.35%** | **0.36%** | **0.35%** | **0.34%** |
| **Design Group Std Dev** | **1758.9** | **1809.9** | **1803.3** | **1752.8** |

**Table E3**
**Half Million Design Group, Fixed Sample size of 20000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 68 | 52 | 41 | 33 |
| **Sample Fraction** | 6.1% | 4.6% | 3.7% | 2.9% |
| **Design RSE** | 3.6% | 4.5% | 6.0% | 8.0% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 1.98% | 2.01% | 2.12% | 2.13% |
| Males aged 5-9 | 1.86% | 1.93% | 1.95% | 2.02% |
| Males aged 10-14 | 1.52% | 1.56% | 1.54% | 1.60% |
| Males aged 15-19 | 2.30% | 2.23% | 2.33% | 2.38% |
| Males aged 20-24 | 3.27% | 3.32% | 3.09% | 3.23% |
| Males aged 25-29 | 3.05% | 3.08% | 2.80% | 3.17% |
| Males aged 30-34 | 2.34% | 2.29% | 2.18% | 2.21% |
| Males aged 35-39 | 1.61% | 1.68% | 1.65% | 1.74% |
| Males aged 40-44 | 1.52% | 1.53% | 1.47% | 1.70% |
| Males aged 45-79 | 0.46% | 0.46% | 0.46% | 0.47% |
| Males aged 80-84 | 3.92% | 3.92% | 4.02% | 3.94% |
| Males aged 85+ | 5.99% | 6.71% | 6.51% | 6.21% |
| | | | | |
| Females aged 0-4 | 1.69% | 1.72% | 1.81% | 1.82% |
| Females aged 5-9 | 1.54% | 1.56% | 1.62% | 1.62% |
| Females aged 10-14 | 1.36% | 1.32% | 1.39% | 1.40% |
| Females aged 15-19 | 1.68% | 1.63% | 1.73% | 1.76% |
| Females aged 20-24 | 1.86% | 1.87% | 1.97% | 2.03% |
| Females aged 25-29 | 1.70% | 1.75% | 1.75% | 1.84% |
| Females aged 30-34 | 1.21% | 1.24% | 1.25% | 1.26% |
| Females aged 35-39 | 0.99% | 0.96% | 0.99% | 1.00% |
| Females aged 40-44 | 0.99% | 1.04% | 1.07% | 1.05% |
| Females aged 45-79 | 0.40% | 0.39% | 0.40% | 0.39% |
| Females aged 80-84 | 4.33% | 4.34% | 4.39% | 4.71% |
| Females aged 85+ | 8.73% | 8.85% | 8.54% | 9.32% |
| | | | | |
| **Mean RRMSE** | **2.35%** | **2.39%** | **2.38%** | **2.46%** |
| **Median RRMSE** | **1.70%** | **1.73%** | **1.78%** | **1.83%** |
| **Design Group RRMSE** | **0.40%** | **0.41%** | **0.41%** | **0.45%** |
| **Design Group Std Dev** | **2044.4** | **2081.0** | **2109.0** | **2272.2** |

**Table E4**
**Half Million Design Group, Fixed Sample size of 10000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 33 | 26 | 20 | 17 |
| **Sample Fraction** | 2.9% | 2.3% | 1.8% | 1.5% |
| **Design RSE** | 8.0% | 9.3% | 10.5% | 11.5% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 2.96% | 2.78% | 2.93% | 2.67% |
| Males aged 5-9 | 2.88% | 2.99% | 2.68% | 2.51% |
| Males aged 10-14 | 2.40% | 2.51% | 2.21% | 1.76% |
| Males aged 15-19 | 3.52% | 3.31% | 3.35% | 2.75% |
| Males aged 20-24 | 4.71% | 4.54% | 4.66% | 2.79% |
| Males aged 25-29 | 4.44% | 4.16% | 4.38% | 6.52% |
| Males aged 30-34 | 3.12% | 3.11% | 3.22% | 3.15% |
| Males aged 35-39 | 2.46% | 2.44% | 2.39% | 1.92% |
| Males aged 40-44 | 2.30% | 2.29% | 2.11% | 1.90% |
| Males aged 45-79 | 0.68% | 0.66% | 0.69% | 0.60% |
| Males aged 80-84 | 5.67% | 5.51% | 5.37% | 4.23% |
| Males aged 85+ | 9.00% | 9.01% | 8.65% | 9.68% |
| Females aged 0-4 | 2.62% | 2.62% | 2.61% | 3.02% |
| Females aged 5-9 | 2.42% | 2.41% | 2.34% | 2.16% |
| Females aged 10-14 | 2.08% | 2.03% | 2.04% | 1.88% |
| Females aged 15-19 | 2.40% | 2.38% | 2.41% | 2.78% |
| Females aged 20-24 | 2.80% | 2.81% | 2.81% | 2.38% |
| Females aged 25-29 | 2.49% | 2.47% | 2.51% | 2.56% |
| Females aged 30-34 | 1.83% | 1.97% | 1.76% | 1.71% |
| Females aged 35-39 | 1.40% | 1.43% | 1.43% | 1.23% |
| Females aged 40-44 | 1.49% | 1.46% | 1.47% | 1.54% |
| Females aged 45-79 | 0.60% | 0.57% | 0.59% | 0.60% |
| Females aged 80-84 | 5.89% | 5.71% | 5.68% | 5.35% |
| Females aged 85+ | 11.09% | 10.22% | 10.80% | 9.88% |
| **Mean RRMSE** | **3.38%** | **3.31%** | **3.30%** | **3.15%** |
| **Median RRMSE** | **2.55%** | **2.57%** | **2.56%** | **2.53%** |
| **Design Group RRMSE** | **0.64%** | **0.62%** | **0.68%** | **0.57%** |
| **Design Group Std Dev** | **3257.1** | **3175.5** | **3440.3** | **2882.8** |

**Table E5**
**Three Quarters Million Design Group, Fixed Sample size of 40000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 221 | 165 | 140 | 114 |
| **Sample Fraction** | 12.1% | 9.1% | 7.7% | 6.3% |
| **Design RSE** | 1.3% | 1.7% | 2.0% | 2.5% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 1.16% | 1.25% | 1.17% | 1.03% |
| Males aged 5-9 | 1.07% | 1.14% | 1.10% | 1.11% |
| Males aged 10-14 | 0.86% | 0.92% | 0.88% | 0.72% |
| Males aged 15-19 | 1.35% | 1.35% | 1.29% | 1.37% |
| Males aged 20-24 | 2.44% | 2.30% | 2.15% | 2.12% |
| Males aged 25-29 | 2.21% | 2.04% | 1.92% | 1.97% |
| Males aged 30-34 | 1.58% | 1.53% | 1.49% | 1.22% |
| Males aged 35-39 | 1.04% | 1.05% | 0.95% | 0.97% |
| Males aged 40-44 | 0.98% | 0.92% | 0.82% | 0.84% |
| Males aged 45-79 | 0.26% | 0.25% | 0.24% | 0.23% |
| Males aged 80-84 | 2.10% | 2.16% | 2.00% | 2.53% |
| Males aged 85+ | 3.39% | 3.45% | 3.32% | 3.59% |
| Females aged 0-4 | 1.24% | 1.22% | 1.21% | 1.34% |
| Females aged 5-9 | 1.15% | 1.10% | 1.10% | 0.94% |
| Females aged 10-14 | 0.95% | 0.95% | 0.96% | 0.98% |
| Females aged 15-19 | 1.36% | 1.33% | 1.35% | 1.42% |
| Females aged 20-24 | 1.27% | 1.30% | 1.36% | 1.16% |
| Females aged 25-29 | 1.08% | 1.14% | 1.16% | 1.41% |
| Females aged 30-34 | 0.86% | 0.85% | 0.85% | 0.95% |
| Females aged 35-39 | 0.64% | 0.67% | 0.66% | 0.57% |
| Females aged 40-44 | 0.74% | 0.73% | 0.74% | 0.64% |
| Females aged 45-79 | 0.21% | 0.20% | 0.21% | 0.24% |
| Females aged 80-84 | 3.78% | 3.78% | 3.64% | 4.08% |
| Females aged 85+ | 7.95% | 8.18% | 7.96% | 8.12% |
| **Mean RRMSE** | **1.65%** | **1.66%** | **1.61%** | **1.65%** |
| **Median RRMSE** | **1.15%** | **1.18%** | **1.16%** | **1.13%** |
| **Design Group RRMSE** | **0.23%** | **0.25%** | **0.26%** | **0.29%** |
| **Design Group Std Dev** | **1782.3** | **1904.8** | **1943.9** | **2176.7** |

**Table E6**
**Three Quarters Million Design Group, Fixed Sample size of 30000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 165 | 124 | 101 | |
| **Sample Fraction** | 9.1% | 6.8% | 5.6% | 0.0% |
| **Design RSE** | 1.7% | 2.2% | 2.6% | |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 1.39% | 1.33% | 1.25% | 1.10% |
| Males aged 5-9 | 1.25% | 1.26% | 1.22% | 1.50% |
| Males aged 10-14 | 1.03% | 1.03% | 1.03% | 0.96% |
| Males aged 15-19 | 1.51% | 1.45% | 1.46% | 1.71% |
| Males aged 20-24 | 2.57% | 2.72% | 2.71% | 2.90% |
| Males aged 25-29 | 2.27% | 2.12% | 2.01% | 1.97% |
| Males aged 30-34 | 1.74% | 1.66% | 1.58% | 1.69% |
| Males aged 35-39 | 1.20% | 1.13% | 1.10% | 1.15% |
| Males aged 40-44 | 1.05% | 1.00% | 0.94% | 1.30% |
| Males aged 45-79 | 0.28% | 0.28% | 0.28% | 0.26% |
| Males aged 80-84 | 2.50% | 2.43% | 2.42% | 2.55% |
| Males aged 85+ | 3.92% | 3.84% | 3.68% | 4.32% |
| | | | | |
| Females aged 0-4 | 1.31% | 1.39% | 1.41% | 1.54% |
| Females aged 5-9 | 1.19% | 1.21% | 1.23% | 1.31% |
| Females aged 10-14 | 1.03% | 1.00% | 1.00% | 0.87% |
| Females aged 15-19 | 1.43% | 1.48% | 1.47% | 1.29% |
| Females aged 20-24 | 1.37% | 1.43% | 1.43% | 1.28% |
| Females aged 25-29 | 1.23% | 1.18% | 1.23% | 1.39% |
| Females aged 30-34 | 0.94% | 0.87% | 0.89% | 0.87% |
| Females aged 35-39 | 0.73% | 0.72% | 0.74% | 0.64% |
| Females aged 40-44 | 0.80% | 0.80% | 0.80% | 0.67% |
| Females aged 45-79 | 0.23% | 0.24% | 0.24% | 0.24% |
| Females aged 80-84 | 3.85% | 3.92% | 3.79% | 3.93% |
| Females aged 85+ | 8.29% | 8.40% | 8.06% | 7.81% |
| | | | | |
| **Mean RRMSE** | **1.80%** | **1.79%** | **1.75%** | **1.80%** |
| **Median RRMSE** | **1.28%** | **1.30%** | **1.24%** | **1.31%** |
| **Design Group RRMSE** | 0.29% | 0.28% | 0.29% | 0.29% |
| **Design Group Std Dev** | **2178.5** | **2112.2** | **2206.7** | **2223.5** |

**Table E7**
**Three Quarters Million Design Group, Fixed Sample size of 20000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 114 | 82 | 67 | 55 |
| **Sample Fraction** | 6.3% | 4.5% | 3.7% | 3.0% |
| **Design RSE** | 2.5% | 3.0% | 3.7% | 4.5% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 1.56% | 1.54% | 1.48% | 1.73% |
| Males aged 5-9 | 1.48% | 1.50% | 1.49% | 1.69% |
| Males aged 10-14 | 1.20% | 1.22% | 1.22% | 1.18% |
| Males aged 15-19 | 1.84% | 1.82% | 1.79% | 1.83% |
| Males aged 20-24 | 3.22% | 2.95% | 3.03% | 3.02% |
| Males aged 25-29 | 2.69% | 2.39% | 2.29% | 2.26% |
| Males aged 30-34 | 1.96% | 1.94% | 1.84% | 1.88% |
| Males aged 35-39 | 1.32% | 1.28% | 1.27% | 1.19% |
| Males aged 40-44 | 1.23% | 1.22% | 1.21% | 1.38% |
| Males aged 45-79 | 0.34% | 0.36% | 0.34% | 0.36% |
| Males aged 80-84 | 2.88% | 2.83% | 2.92% | 2.69% |
| Males aged 85+ | 4.65% | 4.61% | 4.93% | 5.16% |
| | | | | |
| Females aged 0-4 | 1.43% | 1.58% | 1.56% | 1.93% |
| Females aged 5-9 | 1.40% | 1.42% | 1.46% | 1.58% |
| Females aged 10-14 | 1.16% | 1.16% | 1.19% | 1.15% |
| Females aged 15-19 | 1.50% | 1.61% | 1.63% | 1.70% |
| Females aged 20-24 | 1.48% | 1.56% | 1.58% | 2.06% |
| Females aged 25-29 | 1.37% | 1.43% | 1.51% | 1.75% |
| Females aged 30-34 | 0.96% | 1.03% | 1.05% | 1.13% |
| Females aged 35-39 | 0.79% | 0.84% | 0.84% | 0.78% |
| Females aged 40-44 | 0.86% | 0.91% | 0.91% | 0.87% |
| Females aged 45-79 | 0.29% | 0.29% | 0.30% | 0.26% |
| Females aged 80-84 | 4.04% | 4.08% | 4.08% | 3.53% |
| Females aged 85+ | 8.55% | 8.45% | 8.41% | 7.72% |
| | | | | |
| **Mean RRMSE** | **2.01%** | **2.00%** | **2.01%** | **2.03%** |
| **Median RRMSE** | **1.45%** | **1.52%** | **1.50%** | **1.71%** |
| **Design Group RRMSE** | **0.32%** | **0.35%** | **0.36%** | **0.41%** |
| **Design Group Std Dev** | **2457.9** | **2643.7** | **2706.6** | **3110.9** |

**Table E8**
**Three Quarters Million Design Group, Fixed Sample size of 10000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 55 | 42 | 33 | 27 |
| **Sample Fraction** | 3.0% | 2.3% | 1.8% | 1.5% |
| **Design RSE** | 4.5% | 5.9% | 7.2% | 8.5% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 2.26% | 2.24% | 2.16% | 2.39% |
| Males aged 5-9 | 2.13% | 2.13% | 2.15% | 2.10% |
| Males aged 10-14 | 1.73% | 1.80% | 1.84% | 2.24% |
| Males aged 15-19 | 2.50% | 2.52% | 2.56% | 2.67% |
| Males aged 20-24 | 4.18% | 4.43% | 4.45% | 4.00% |
| Males aged 25-29 | 3.45% | 3.43% | 3.33% | 3.05% |
| Males aged 30-34 | 2.68% | 2.64% | 2.63% | 2.22% |
| Males aged 35-39 | 1.82% | 1.89% | 1.80% | 1.78% |
| Males aged 40-44 | 1.76% | 1.75% | 1.77% | 2.15% |
| Males aged 45-79 | 0.50% | 0.50% | 0.49% | 0.52% |
| Males aged 80-84 | 4.01% | 4.18% | 4.25% | 4.87% |
| Males aged 85+ | 6.68% | 6.42% | 6.76% | 6.72% |
| | | | | |
| Females aged 0-4 | 2.14% | 2.11% | 2.05% | 1.88% |
| Females aged 5-9 | 1.97% | 1.97% | 1.98% | 2.06% |
| Females aged 10-14 | 1.63% | 1.63% | 1.61% | 1.17% |
| Females aged 15-19 | 2.05% | 2.03% | 2.04% | 2.31% |
| Females aged 20-24 | 2.11% | 2.16% | 2.30% | 2.45% |
| Females aged 25-29 | 1.99% | 2.02% | 2.07% | 1.98% |
| Females aged 30-34 | 1.42% | 1.46% | 1.48% | 1.34% |
| Females aged 35-39 | 1.10% | 1.10% | 1.12% | 1.10% |
| Females aged 40-44 | 1.21% | 1.22% | 1.22% | 1.15% |
| Females aged 45-79 | 0.41% | 0.42% | 0.43% | 0.46% |
| Females aged 80-84 | 4.59% | 4.61% | 4.58% | 4.82% |
| Females aged 85+ | 9.18% | 9.20% | 8.92% | 8.96% |
| | | | | |
| **Mean RRMSE** | **2.64%** | **2.66%** | **2.67%** | **2.68%** |
| **Median RRMSE** | **2.08%** | **2.07%** | **2.06%** | **2.18%** |
| **Design Group RRMSE** | **0.50%** | **0.50%** | **0.51%** | **0.50%** |
| **Design Group Std Dev** | **3766.8** | **3817.0** | **3833.6** | **3759.4** |

**Table E9**
**One Million Design Group, Fixed Sample size of 40000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 308 | 238 | 187 | 156 |
| **Sample Fraction** | 12.1% | 9.4% | 7.4% | 6.1% |
| **Design RSE** | 1.0% | 1.3% | 1.7% | 2.0% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 1.12% | 1.08% | 1.16% | 1.72% |
| Males aged 5-9 | 1.03% | 1.03% | 1.06% | 1.33% |
| Males aged 10-14 | 0.84% | 0.85% | 0.87% | 0.95% |
| Males aged 15-19 | 1.26% | 1.29% | 1.33% | 1.61% |
| Males aged 20-24 | 2.35% | 2.26% | 2.25% | 2.99% |
| Males aged 25-29 | 2.08% | 2.20% | 1.98% | 2.75% |
| Males aged 30-34 | 1.49% | 1.52% | 1.48% | 2.01% |
| Males aged 35-39 | 1.01% | 1.01% | 0.99% | 1.29% |
| Males aged 40-44 | 0.92% | 0.86% | 0.85% | 0.86% |
| Males aged 45-79 | 0.22% | 0.22% | 0.22% | 0.24% |
| Males aged 80-84 | 1.84% | 1.91% | 1.83% | 2.31% |
| Males aged 85+ | 2.76% | 2.94% | 2.81% | 3.90% |
| Females aged 0-4 | 1.15% | 1.16% | 1.17% | 1.25% |
| Females aged 5-9 | 1.10% | 1.10% | 1.05% | 0.80% |
| Females aged 10-14 | 0.89% | 0.90% | 0.92% | 0.85% |
| Females aged 15-19 | 1.36% | 1.33% | 1.37% | 1.19% |
| Females aged 20-24 | 1.29% | 1.28% | 1.31% | 1.03% |
| Females aged 25-29 | 1.05% | 1.03% | 1.05% | 1.04% |
| Females aged 30-34 | 0.76% | 0.76% | 0.80% | 0.66% |
| Females aged 35-39 | 0.62% | 0.60% | 0.61% | 0.50% |
| Females aged 40-44 | 0.70% | 0.69% | 0.72% | 0.65% |
| Females aged 45-79 | 0.19% | 0.18% | 0.19% | 0.17% |
| Females aged 80-84 | 3.66% | 3.64% | 3.61% | 3.52% |
| Females aged 85+ | 7.80% | 7.59% | 7.63% | 8.56% |
| **Mean RRMSE** | **1.56%** | **1.56%** | **1.55%** | **1.76%** |
| **Median RRMSE** | **1.11%** | **1.09%** | **1.11%** | **1.22%** |
| **Design Group RRMSE** | **0.22%** | **0.22%** | **0.23%** | **0.34%** |
| **Design Group Std Dev** | **2284.1** | **2237.3** | **2358.5** | **3486.8** |

**Table E10**
**One Million Design Group, Fixed Sample size of 30000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 238 | 174 | 134 | 113 |
| **Sample Fraction** | 9.4% | 6.8% | 5.3% | 4.4% |
| **Design RSE** | 1.3% | 1.8% | 2.5% | 2.6% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 1.21% | 1.30% | 1.43% | 1.52% |
| Males aged 5-9 | 1.16% | 1.27% | 1.25% | 1.27% |
| Males aged 10-14 | 0.96% | 1.02% | 0.94% | 0.99% |
| Males aged 15-19 | 1.44% | 1.50% | 1.45% | 1.71% |
| Males aged 20-24 | 2.50% | 2.52% | 2.48% | 2.17% |
| Males aged 25-29 | 2.42% | 2.27% | 2.20% | 2.02% |
| Males aged 30-34 | 1.69% | 1.63% | 1.36% | 1.51% |
| Males aged 35-39 | 1.12% | 1.19% | 0.96% | 0.95% |
| Males aged 40-44 | 0.95% | 1.08% | 0.88% | 1.04% |
| Males aged 45-79 | 0.26% | 0.28% | 0.24% | 0.28% |
| Males aged 80-84 | 2.13% | 2.14% | 2.07% | 1.79% |
| Males aged 85+ | 3.44% | 3.41% | 3.48% | 3.72% |
| Females aged 0-4 | 1.22% | 1.29% | 1.10% | 1.37% |
| Females aged 5-9 | 1.20% | 1.17% | 0.99% | 1.08% |
| Females aged 10-14 | 0.98% | 0.96% | 0.82% | 0.84% |
| Females aged 15-19 | 1.38% | 1.46% | 1.35% | 1.46% |
| Females aged 20-24 | 1.34% | 1.38% | 1.21% | 1.31% |
| Females aged 25-29 | 1.11% | 1.16% | 1.11% | 1.28% |
| Females aged 30-34 | 0.82% | 0.87% | 0.77% | 0.84% |
| Females aged 35-39 | 0.65% | 0.65% | 0.66% | 0.65% |
| Females aged 40-44 | 0.72% | 0.73% | 0.74% | 0.92% |
| Females aged 45-79 | 0.21% | 0.21% | 0.20% | 0.21% |
| Females aged 80-84 | 3.74% | 3.61% | 3.10% | 3.72% |
| Females aged 85+ | 7.68% | 7.71% | 6.74% | 8.56% |
| **Mean RRMSE** | **1.68%** | **1.70%** | **1.56%** | **1.42%** |
| **Median RRMSE** | **1.20%** | **1.28%** | **1.16%** | **1.29%** |
| **Design Group RRMSE** | **0.24%** | **0.26%** | **0.24%** | **0.22%** |
| **Design Group Std Dev** | **2523.3** | **2686.2** | **2466.2** | **2258.4** |

**Table E11**
**One Million Design Group, Fixed Sample size of 20000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 156 | 113 | 89 | 76 |
| **Sample Fraction** | 6.1% | 4.4% | 3.5% | 3.0% |
| **Design RSE** | 2.0% | 2.6% | 3.0% | 3.4% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 1.63% | 1.52% | 1.56% | 1.49% |
| Males aged 5-9 | 1.47% | 1.47% | 1.44% | 1.38% |
| Males aged 10-14 | 1.21% | 1.16% | 1.18% | 1.00% |
| Males aged 15-19 | 1.74% | 1.74% | 1.65% | 1.42% |
| Males aged 20-24 | 3.01% | 2.68% | 3.16% | 3.01% |
| Males aged 25-29 | 2.70% | 2.50% | 2.65% | 2.10% |
| Males aged 30-34 | 2.00% | 1.91% | 1.89% | 1.85% |
| Males aged 35-39 | 1.36% | 1.27% | 1.20% | 1.40% |
| Males aged 40-44 | 1.25% | 1.19% | 1.06% | 0.92% |
| Males aged 45-79 | 0.33% | 0.32% | 0.31% | 0.33% |
| Males aged 80-84 | 2.54% | 2.68% | 2.60% | 2.71% |
| Males aged 85+ | 4.08% | 3.90% | 4.06% | 3.51% |
| Females aged 0-4 | 1.42% | 1.47% | 1.39% | 1.10% |
| Females aged 5-9 | 1.27% | 1.29% | 1.28% | 1.14% |
| Females aged 10-14 | 1.09% | 1.10% | 1.02% | 0.94% |
| Females aged 15-19 | 1.59% | 1.56% | 1.57% | 1.51% |
| Females aged 20-24 | 1.52% | 1.48% | 1.40% | 1.54% |
| Females aged 25-29 | 1.26% | 1.36% | 1.27% | 1.15% |
| Females aged 30-34 | 0.94% | 0.95% | 0.91% | 0.96% |
| Females aged 35-39 | 0.72% | 0.74% | 0.75% | 0.83% |
| Females aged 40-44 | 0.83% | 0.82% | 0.82% | 0.80% |
| Females aged 45-79 | 0.26% | 0.26% | 0.24% | 0.26% |
| Females aged 80-84 | 3.92% | 3.89% | 3.55% | 3.63% |
| Females aged 85+ | 8.24% | 7.95% | 7.78% | 8.06% |
| **Mean RRMSE** | **1.93%** | **1.88%** | **1.87%** | **1.79%** |
| **Median RRMSE** | **1.45%** | **1.47%** | **1.40%** | **1.39%** |
| **Design Group RRMSE** | **0.31%** | **0.31%** | **0.30%** | **0.29%** |
| **Design Group Std Dev** | **3236.1** | **3237.3** | **3103.6** | **2964.2** |

**Table E12**
**One Million Design Group, Fixed Sample size of 10000 postcodes**

| | 3 Postcodes | 4 Postcodes | 5 Postcodes | 6 Postcodes |
|---|---|---|---|---|
| **Sample Size** | 76 | 58 | 46 | 38 |
| **Sample Fraction** | 3.0% | 2.3% | 1.8% | 1.5% |
| **Design RSE** | 3.4% | 4.3% | 5.7% | 6.5% |
| | **RRMSE** | **RRMSE** | **RRMSE** | **RRMSE** |
| Males aged 0-4 | 2.07% | 1.90% | 1.92% | 1.82% |
| Males aged 5-9 | 1.95% | 1.93% | 1.98% | 1.79% |
| Males aged 10-14 | 1.61% | 1.56% | 1.55% | 1.78% |
| Males aged 15-19 | 2.34% | 2.17% | 2.35% | 2.43% |
| Males aged 20-24 | 4.21% | 4.23% | 4.38% | 4.20% |
| Males aged 25-29 | 3.17% | 3.00% | 3.10% | 2.71% |
| Males aged 30-34 | 2.48% | 2.36% | 2.38% | 2.42% |
| Males aged 35-39 | 1.67% | 1.61% | 1.59% | 1.92% |
| Males aged 40-44 | 1.49% | 1.55% | 1.53% | 1.54% |
| Males aged 45-79 | 0.43% | 0.42% | 0.42% | 0.55% |
| Males aged 80-84 | 3.62% | 3.84% | 3.96% | 3.80% |
| Males aged 85+ | 6.17% | 5.97% | 6.52% | 5.73% |
| Females aged 0-4 | 1.77% | 1.77% | 1.67% | 1.65% |
| Females aged 5-9 | 1.59% | 1.59% | 1.57% | 1.50% |
| Females aged 10-14 | 1.37% | 1.35% | 1.31% | 1.37% |
| Females aged 15-19 | 1.90% | 1.87% | 1.89% | 1.79% |
| Females aged 20-24 | 1.82% | 1.77% | 1.78% | 1.94% |
| Females aged 25-29 | 1.75% | 1.68% | 1.67% | 1.84% |
| Females aged 30-34 | 1.26% | 1.21% | 1.22% | 1.69% |
| Females aged 35-39 | 0.99% | 1.01% | 0.99% | 0.91% |
| Females aged 40-44 | 1.02% | 1.05% | 1.07% | 1.11% |
| Females aged 45-79 | 0.34% | 0.36% | 0.35% | 0.33% |
| Females aged 80-84 | 3.99% | 3.81% | 3.66% | 4.01% |
| Females aged 85+ | 8.41% | 8.32% | 8.14% | 8.29% |
| **Mean RRMSE** | **2.39%** | **2.35%** | **2.37%** | **2.38%** |
| **Median RRMSE** | **1.79%** | **1.77%** | **1.72%** | **1.81%** |
| **Design Group RRMSE** | **0.45%** | **0.43%** | **0.42%** | **0.44%** |
| **Design Group Std Dev** | **4611.9** | **4402.9** | **4354.7** | **4587.7** |