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# Comments on Sample Design for Proposed Australian Asthma Survey

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# Comments on Sample Design for Proposed Australian Asthma Survey

## **Abstract**

The proposed design for the Australian Asthma Survey involves: a phone or face-to-face screening interview with approximately 20,000 responding adults, followed by an in-depth interview and objective testing of all asthmatics and 1/10th of nonasthmatics in the screen. This report elaborates on sample design options based on the aims and approaches in the Australian Asthma Survey Proposal. The main requirement affecting the sample design is the need for a relatively small number of objective testing centres to be able to service the whole sample. This report considered a number of options where the sample was clustered in only 25 Statistical Local Areas (SLAs), as well as other options. This will facilitate the objective testing with the penalty of a significant loss of precision for other statistics. The priority and operational process for objective testing should therefore be carefully thought through. In particular, the cost of objective testing should be estimated under different scenarios including selecting 50 SLAs rather than 25. There are a number of options for conducting the screening sample and subselection for the in-depth survey. These include screening all adults or just one adult in each household. One attractive option is to select one adult from each household for the screening interview, then to conduct the selection for the in-depth survey and if possible the in-depth survey interview as part of the same call. Other options exist which are more complex but which give good results with a smaller screening sample. The survey will also include children (at most one child per household) but this report focuses on the adult sample. The major issues to be considered in finalising the sample design are: • clustering of the sample to accommodate the objective testing process (in particular the number of SLAs); • method of conducting screening sample (one adult or all adults per household); • method of selection and conduct of in-depth survey, in particular can this be done by interviewers in one visit or phone call; • whether the screen and in-depth survey will be conducted by face to face or telephone interviewing. Other detailed issues will include: the stratification and selection method for SLAs; the number of CDs to select if face-to-face interviewing is used; the method of selecting CDs, the method of selecting households within CDs; weighting and variance estimation. Section 2 of this report summarises some relevant terms and concepts in comparing sample designs. Section 3 describes three alternative approaches for conducting the screen and in-depth surveys. Section 4 compares six alternative sample designs including alternative approaches to clustering the sample. Appendix 1 contains some detailed comments on the Proposal, Appendix 2 elaborates on one of the sample design options in more detail and Appendix 3 contains some comments on weighting.

## **Disciplines**

Physical Sciences and Mathematics

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# **Comments on Sample Design for Proposed Australian Asthma Survey**

**Robert Graham Clark**  
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**June 2006**

## **1. Summary**

The proposed design for the Australian Asthma Survey involves: a phone or face-to-face screening interview with approximately 20,000 responding adults, followed by an in-depth interview and objective testing of all asthmatics and 1/10<sup>th</sup> of non-asthmatics in the screen. This report elaborates on sample design options based on the aims and approaches in the Australian Asthma Survey Proposal.

The main requirement affecting the sample design is the need for a relatively small number of objective testing centres to be able to service the whole sample. This report considered a number of options where the sample was clustered in only 25 Statistical Local Areas (SLAs), as well as other options. This will facilitate the objective testing with the penalty of a significant loss of precision for other statistics. The priority and operational process for objective testing should therefore be carefully thought through. In particular, the cost of objective testing should be estimated under different scenarios including selecting 50 SLAs rather than 25.

There are a number of options for conducting the screening sample and subselection for the in-depth survey. These include screening all adults or just one adult in each household. One attractive option is to select one adult from each household for the screening interview, then to conduct the selection for the in-depth survey and if possible the in-depth survey interview as part of the same call. Other options exist which are more complex but which give good results with a smaller screening sample.

The survey will also include children (at most one child per household) but this report focuses on the adult sample.

The major issues to be considered in finalising the sample design are:

- clustering of the sample to accommodate the objective testing process (in particular the number of SLAs);
- method of conducting screening sample (one adult or all adults per household);
- method of selection and conduct of in-depth survey, in particular can this be done by interviewers in one visit or phone call;
- whether the screen and in-depth survey will be conducted by face to face or telephone interviewing.

Other detailed issues will include: the stratification and selection method for SLAs; the number of CDs to select if face-to-face interviewing is used; the method of selecting CDs, the method of selecting households within CDs; weighting and variance estimation.

Section 2 of this report summarises some relevant terms and concepts in comparing sample designs. Section 3 describes three alternative approaches for conducting the screen and in-depth surveys. Section 4 compares six alternative sample designs including alternative approaches to clustering the sample. Appendix 1 contains some detailed comments on the Proposal, Appendix 2 elaborates on one of the sample design options in more detail and Appendix 3 contains some comments on weighting.

## **2. Relevant Terms and Concepts**

### *Relevant Concepts*

Section 2.2 will describe six options for the sample design. The options will cluster the sample in different ways, with different strengths and weaknesses for different priorities of the survey. Some relevant concepts in comparing the designs are:

- Standard error and variance are measures of the precision of an estimator. The variance is equal to the standard error squared.
- The design effect is a measure of the effect of a complex sample design on the precision of estimators of interest. It is the ratio of the variance of an estimator to the variance that would be obtained from a simple random sample of the same size. Typically household surveys have design effects between 1.5 and 3, although higher values can be appropriate in some cases.
- Clustering is one of the factors driving the design effect. If a survey is geographically clustered (i.e. concentrated in relatively few areas), and the variable of interest is also geographically clustered (i.e. values from the same area tend to be similar), then the design effect is increased. The intra-class correlation is a measure of the similarity in the values of a variable for people in the same area.
- Another driver of the design effect is the use of one/household sampling. In this type of design, the probability of selection is inversely proportional to the household size. For example, people living alone have much a higher chance of selection than people living in multiple adult households. This variation in selection probabilities leads to variation in estimation weights, which inflates the design effect.
- Disproportionate sampling in different areas also leads to an increase in the design effect. For example if rural statistics were a priority, then a higher probability of selection in the sample might be assigned to rural areas to ensure an adequate sample for this subpopulation. Or if state estimates are a priority, then smaller states are often given a higher probability of selection for the same reason.
- This section will assume that the intra-class correlation within Collector Districts (CDs) is 0.1 for lifestyle variables (e.g. quality of life, management of asthma) and 0.01 for prevalence variables (e.g. asthma, airway hyper-responsiveness). The intra-class correlations within SLAs are assumed to be  $\frac{1}{4}$

of these values. These are very rough estimates and there is considerable uncertainty about the true intra-class correlations.

### *Three Phases of the Survey*

The survey can be considered to have three phases with different data collected from three nested samples:

- The first phase is the screening sample. This will contain approximately 20,000 responding adults. This survey will collect information enabling respondents to be classified as asthmatic or not, which will be used for national prevalence estimates.
- The second phase is the in-depth survey. This will collect quality of life measures, information on the management of asthma, and other information. This second phase sample will consist of all asthmatics and approximately 1/10 of non-asthmatics from the first phase. This will give a responding sample of approximately 1500 asthmatics and 1500 non-asthmatics.
- The third phase is the objective testing. All of the respondents from the second phase will be invited to participate in the objective testing. About 65% participation is expected. The third phase is not a planned phase of sampling. If all respondents agree to participate fully, then the second and third phase samples will be identical.

## **3 Conduct of the Screen Survey and In-Depth Survey**

It the screening survey will involve an interview of approximately 10 minutes for each adult, while the in-depth survey will involve an interview of 40-50 minutes. The screening survey will enable classification of respondents as asthmatics or non-asthmatics. The Proposal indicated that:

- One adult and one child (where available) will be selected for the screening survey.
- All asthmatics in the screening sample and a random sample of 1/10 of non-asthmatics will be selected for the in-depth survey sample.
- The in-depth survey will then be conducted subsequently from main survey. Different modes of collection may be used, for example the screen survey might be by phone and the in-depth survey could be face-to-face. Approximately 30% drop-out is expected between the screening survey and the in-depth survey.

A number of alternative approaches are possible:

The method in the Proposal could be refined to more closely integrate the in-depth survey with the screening survey. Firstly, the selection of 1/10 non-asthmatics should be done live by interviewers, so that respondents can be immediately told to expect a further in-depth interview. The in-depth interview should be scheduled and if possible conducted as part of the same phone call or visit. This should greatly reduce the drop-

out between the screen and the main survey. This approach would be compatible with design options 1 through 4 in the next section.

The screening survey involves 20,000 adult interviews from 20,000 households, of which only 3,000 respondents proceed to the in-depth interview. The remaining screen respondents are selected out due to the 1/10 selection of non-asthmatics. An alternative approach would be to screen the entire household not just a single adult and a single child. This would be particularly efficient if one responding adult could accurately complete the screen interview on behalf of all adults in the household (“proxy reporting”). Designs 5 and 6 in Section 4 are two alternative implementations of this idea.

#### **4 Sample Design Options**

Table 1 summarises six sample design options. Tables 2 and 3 summarise the approximate performance of the designs, in terms of design effects and standard errors for key variables. For the purpose of calculations in these tables, the national asthma prevalence is assumed to be 15%; quality of life is assumed to be a binary variable with roughly equal numbers in each category; management of asthma is assumed to be a binary variable with 30% in one category and 70% in the other; and the prevalence of airway hyper-responsiveness is assumed to be 60% for asthmatics and 2% for non-asthmatics.

The numbers in Table 1 are indicative only. Moreover in multi-stage designs, the sample sizes of people are not fixed and depend on which clusters (for example SLAs and CDs) happen to be selected. Table 1 gives an indication of the average sample sizes that would be expected.

The main features of the designs are as follows:

##### *Design 1: Cluster at CD Level*

The screening sample consists of 20,000 households from 300 CDs. One adult and one child are chosen at random from each household. This design has the lowest design effects and standard errors because the design is not clustered within SLA. However, the 300 CDs would be spread across Australia and objective testing would be more difficult as a result.

##### *Design 2: Cluster at SLA Level*

Objective testing will be carried out by setting up testing centres each of which will service a limited area, for example a Statistical Local Area (SLA). For practical and budget reasons, the sample for the objective testing should be contained in a limited number of localities. We have considered a number of sample designs where the national sample for objective testing is limited to 25 SLAs.

To achieve the required sample sizes for objective testing will essentially require every asthmatic respondent selected in the screen sample to be selected for the objective testing. With non-response, this will give approximately the required number of asthmatics. As a result, the screen sample must also be restricted to 25 SLAs, if this is the requirement for the objective testing sample.

In design 2, the screening sample of 20,000 households is clustered within 25 randomly selected SLAs and 300 CDs in this option. As a result the design effects are very high. This is particularly the case for estimates of asthma prevalence based on the screening sample which have a design effect of 4.88 and a SE of 0.56% (percentage points). The design effects for quality of life statistics are also large, and the SE for these figures are both 3.3%.

National estimates can be calculated using a sample containing only 25 SLAs. However, each state will only have 2-5 SLAs, so that state estimates will not be feasible for small states and possibly not even for large states. This applies to designs 2, 4, 5 and 6.

*Design 3: No Clustering*

This design is based on a national sample of households with no geographic clustering. As a result the design effects and SEs are low. One adult and one child is selected at random from each household in the screening sample. This design could be used if the screen and in-depth survey were conducted by phone, so that interviewer travel costs do not arise. The sample would be spread across Australia and objective testing would be more difficult as a result.

*Design 4: Clustering at SLA Level Only*

This design is based on a national sample of households clustered within 25 SLAs with no further geographic clustering. This design could be used if the screen and in-depth survey were conducted by telephone, so that interviewer travel costs do not arise. The clustering within 25 SLAs would facilitate objective testing.

The design effects are lower than for design 2 but are still quite high. This shows that clustering the sample within 25 SLAs inflates the design effect a lot more than clustering the sample within 300 CDs. The requirement to cluster the sample by SLA to enable objective testing has a high price on the SEs from the screen and in-depth surveys.

If the screening survey was conducted by phone, then it could be difficult to identify SLA for telephone numbers. Alternative approaches could be developed, for example an alternative cluster which approximates SLA.

*Design 5: Screening Whole Households(a): One/Household*

This design is similar to option 2, except that all adults and children in selected households are screened rather than just one of each. As a result, only 12,000 households need to be recruited to give approximately 20,000 adults in the screen sample. This may reduce the cost of screening, particularly if one adult can report on behalf of the whole household (proxy reporting). The use of proxy reporting would need to be validated by testing.

The in-depth sample would be conducted by selecting one adult from each household so that almost all asthmatics and approximately 1/10 of non-asthmatics are selected. This would need to be done in such a way that non-asthmatic adults living with asthmatics adults have a chance of selection. Appendix 2 outlines a possible scheme

for doing this. This selection could in theory be done live by interviewers' computers if computer assisted telephone interviewing (CATI) or computer-assisted personal interviewing (CAPI) is used. However, it is probably safer to conduct the selection in the office. The results from the screening sample would be processed centrally and used to select the in-depth sample which would then be passed back to interviewers.

The selection scheme outlined in Appendix 2 would also give close to equal selection probability to all asthmatics and to all non-asthmatics regardless of their household size, which is why the design effect for option 5 is less than for option 2. The main advantages of design 5 are:

- The use of multiple selections per household rather than one per household would be expected to result in a smaller design effect, as the correlation within households is expected to be low for asthma prevalence.
- Screening whole households should be a less costly way of obtaining 20,000 adults in the screen sample.
- The design effect due to one/household sampling will be reduced for the in-depth survey and objective testing as well as for the screen sample.

If a phone survey is to be used for the screen and in-depth survey, then the CD level of selection should be removed, which will further reduce the design effect to some extent.

*Design 6: Screening Whole Households(b): Multiple Asthmatics per Household for In-Depth Survey*

This is a simplified version of design 5. As for the previous option, all adults and children in 12,000 households are screened to give approximately 20,000 adults in the screen sample. One asthmatic adult and one asthmatic child would be selected from every household in the screen sample containing an asthmatic adult or child. In addition, one non-asthmatic adult and one non-asthmatic child would be selected from 1/10 of households in the screen sample. This could result in multiple adults and children from the same household in the in-depth survey and objective testing. There is a risk the response rate may be affected by the increased burden on these households.

If a phone survey is to be used for the screen and in-depth survey, then the CD level of selection should be removed, which will reduce the design effect to some extent.

*Conclusions*

The requirement for the sample to be clustered enough to support objective testing is the most important factor affecting the design. Options 2, 4, 5 and 6 all support this requirement by clustering the sample in only 25 SLAs. This has the following effects:

- The design effects are high for the national prevalence estimates based on the screening sample. However this sample is large with 20,000 adults, so that the precision may be acceptable in spite of the high design effects.
- The design effects are also high for estimates from the in-depth sample, such as quality of life for asthmatics and for non-asthmatics. **The standard errors are around 3% (percentage points) for the quality of life estimates. This is**

**perhaps the major cost of SLA-level clustering and it needs to be decided whether this level of precision is adequate.**

- The design effects are reasonably low for objective testing statistics, because the intra-class correlation is low for these variables, and because the average number of respondents per SLA is also not too high.
- **State estimates will probably not be feasible with this design, because of the small number of SLAs that will be selected from each state.**

The priority and the process for objective testings needs to be carefully considered, as other statistics from the survey will suffer considerably as a result of the requirement for objective testing. The same precision could be achieved with a much smaller survey for all statistics other than objective testing, and this will be apparent to users of the data. The option of using 50 SLAs rather than 25 should be evaluated and costed. Alternatively, 50 SLAs could be selected, but only 25 of these be selected for the objective testing. This would result in higher SEs (by a factor of 1.4) for airway hyper-responsiveness, but much lower SEs for almost all other variables.

If the objective testing is decided to be a very high priority, and can only be implemented across 25 SLAs, then the decision is which of options 2, 4, 5 or 6 is to be used. This decision would be driven mainly by operational considerations:

- Will the screen and in-depth surveys be by phone or face to face?
- Is it feasible and cost-effective to screen whole households? Is it more important to maximise response rate and simplify operations by closely integrating the screen survey and in-depth survey?
- Can the selection of the in-depth sample be done centrally, or does this need to be done live by interviewers?

**Table 1: Options for Sample Design \***

Option	Selection of Screen Sample	Selection of In-Depth Sample from Screen
1. Cluster at CD Level	<ul style="list-style-type: none"> <li>• Select 300 CDs and 67 households from each</li> <li>• One Adult and one Child from each HH</li> <li>• 20,000 responding adults</li> </ul>	<ul style="list-style-type: none"> <li>• All Asthmatics (-&gt; about 1500)</li> <li>• 1/10 of non-Asthmatics (-&gt; about 1500)</li> </ul>
2. Cluster at SLA Level	<ul style="list-style-type: none"> <li>• select 25 SLAs (2-5 per state)</li> <li>• Select 12 CDs per SLA giving 300 CDs</li> <li>• Approx 67 households in selected CDs</li> <li>• One Adult and one Child from each HH</li> <li>• 20,000 responding adults</li> </ul>	<ul style="list-style-type: none"> <li>• All Asthmatics (-&gt; about 1500)</li> <li>• 1/10 of non-Asthmatics (-&gt; about 1500)</li> </ul>
3. Phone Survey (a): No Clustering	<ul style="list-style-type: none"> <li>• Select households, stratified by region</li> <li>• One Adult and one Child from each HH</li> <li>• 20,000 responding adults</li> </ul>	<ul style="list-style-type: none"> <li>• All Asthmatics (-&gt; about 1500)</li> <li>• 1/10 of non-Asthmatics (-&gt; about 1500)</li> </ul>
4. Phone Survey (b) Clustering at SLA Level	<ul style="list-style-type: none"> <li>• select 25 SLAs (2-5 per state)</li> <li>• select households within SLAs (proportional to SLA population)</li> <li>• One Adult and one Child from each HH</li> <li>• 20,000 responding adults</li> </ul>	<ul style="list-style-type: none"> <li>• All Asthmatics (-&gt; about 1500)</li> <li>• 1/10 of non-Asthmatics (-&gt; about 1500)</li> </ul>
5. Screen Whole Households (a): One/Household	<ul style="list-style-type: none"> <li>• select 25 SLAs (2-5 per state)</li> <li>• select 12 CDs per SLA giving 300 CDs</li> <li>• Approx 40 households in selected CDs</li> <li>• Screen all adults and children</li> <li>• 20,000 responding adults from 12,000 hh's</li> </ul>	<ul style="list-style-type: none"> <li>• Select all asthmatics living alone</li> <li>• Sample of other asthmatics, to give a total of about 1500 asthmatics</li> <li>• Sample of non-asthmatics (approx 1/10) to give 1500 non-asthmatics</li> <li>• This selection method is complex and will need to be conducted in the office not live by interviewers</li> </ul>
6. Screen Whole Households (b): Multiple Asthmatics per Household for In-Depth Survey	<ul style="list-style-type: none"> <li>• select 25 SLAs (2-5 per state)</li> <li>• select 12 CDs per SLA giving 300 CDs</li> <li>• Approx 40 households in selected CDs</li> <li>• Screen all adults and children</li> <li>• 20,000 responding adults from 12,000 households</li> </ul>	<ul style="list-style-type: none"> <li>• Select one asthmatic from all households with one or more asthmatics giving approx 1500 asthmatics</li> <li>• Select one non-asthmatic from 1/10 of households containing a non-asthmatic, giving 1500 non-asthmatics</li> <li>• This selection method can probably be conducted live by interviewers</li> </ul>

**Table 2: Design Effects for Each Design**

Variable	Design					
	1 Cluster at CD Level	2 Cluster at SLA Level	3 Phone(a)	4 Phone(b)	5 Screen Whole HH (a)	6 Screen Whole HH (b)
Asthma Prevalence	2.32	4.88	1.40	4.19	3.49	4.88
Quality of Life for Asthmatics	2.63	6.48	1.34	5.53	4.63	6.48
Quality of Life for Non-Asthmatics	2.63	6.48	1.34	5.53	4.63	6.48
Management of Asthma	2.63	6.48	1.34	5.53	4.63	6.48
Airway Hyper-responsiveness for Asthmatics	1.52	1.91	1.39	1.81	1.36	1.91
Airway Hyper-responsiveness for Non-Asthmatics	1.52	1.91	1.39	1.81	1.36	1.91

**Table 3: Standard Errors (Percentage Points) for Each Design**

Variable	Design					
	1 Cluster at CD Level	2 Cluster at SLA Level	3 Phone(a)	4 Phone(b)	5 Screen Whole HH (a)	6 Screen Whole HH (b)
Asthma Prevalence	0.38%	0.56%	0.30%	0.52%	0.47%	0.56%
Quality of Life for Asthmatics	2.09%	3.29%	1.49%	3.04%	2.78%	3.29%
Quality of Life for Non-Asthmatics	2.09%	3.29%	1.49%	3.04%	2.78%	3.29%
Management of Asthma	1.92%	3.01%	1.37%	2.78%	2.54%	3.01%
Airway Hyper-responsiveness for Asthmatics	1.91%	2.14%	1.83%	2.09%	1.81%	2.14%
Airway Hyper-responsiveness for Non-Asthmatics	0.55%	0.61%	0.52%	0.60%	0.52%	0.61%
Airway Hyper-responsiveness in Total	0.55%	0.61%	0.52%	0.60%	0.52%	0.61%

## **Appendix 1: General Comments on the Australian Asthma Survey Proposal**

- One adult and one child (where available) will be selected from each selected household to participate in the survey. This is a sensible approach, as selecting more adults may reduce the response rate due to the high respondent burden of the survey.
- I agree that option (C) (mail-out survey) is probably not feasible, as suggested in Section 5 of the Proposal. The response rates would be very low from this option given the complexity and length of the survey.
- The calculations of power and precisions in Section 5.4 of the proposal assume simple random sampling of individuals. In reality a more complex sample design will be used, for example:
  - There will be some level of geographic clustering if face-to-face interviewing is used.
  - If only one person per household is selected, then the probability of selection will be inversely proportional to household size.
  - There will be variation in weights due to weighting for differential non-response by age and sex.

The "design effect" is a measure of the effect of a complex sampling design on the variance of estimators. It is defined by the variance for the complex sampling design divided by the variance that would be achieved by a simple random sample of the same size. I suggest assuming a design effect of 2 for planning purposes at this stage. This means that all variances should be multiplied by 2 and all standard errors, relative standard errors and confidence interval widths should be multiplied by the square root of 2. For example, in Table 21 the precision of +/- 0.48% in the first row would change to +/- 0.68%. In reality the design effect will probably be even larger – see Section 2 of this report.

- Figure 2 is a good summary of the proposed design. The in-depth survey and the screen sample are listed as separate steps. I suggest combining these where possible, as the screen will take 5-10 minutes and the in-depth will take 20-30 minutes. The screening sample would be conducted on the first visit. If the selected person is available and willing then the in-depth interview should be conducted at the same time. If not, then a repeat visit should be scheduled.
- The objective testing is asking quite a lot of respondents. They would need to make a separate trip to a testing centre, and go through about 40-50 minutes of testing, including skin pricks and bronchial provocation. The 65% response rate (i.e. 65% of in-depth interviews proceeding to objective testing) might be optimistic, particularly for respondents with no asthma history or symptoms. However a 55% response rate was reported for a 2.5-3 hour biomedical exam in the AusDiab Survey (Table 20 of the Proposal) so maybe this can be achieved. I suggest looking into AusDiab's operations in detail, including their advertising campaign and how they conducted the biomedical exam.

## Appendix 2: Possible Selection Method for Sample Design Option 5

This appendix describes the selection of adults only.

The first phase is a screening sample of approximately 20,000 adults in 12,000 households. These households can be divided into three groups:

### *Group A: Households where All Adult Occupants are Non-Asthmatic*

Members of these households will be ordered by household. The second phase sample will consist of a systematic sample of 1/10 of these adults. The conditional probability of selection is therefore 1/10 (conditional on their household being selected in the first phase sample).

### *Group B: Households containing At Least One Asthmatic Adult*

Members of these households will be ordered by household. There will be both asthmatics and non-asthmatics. A systematic probability proportional to size sample will be selected. Let  $a$  be the number of asthmatics in a given household and  $b$  be the number of non-asthmatics in the household. The conditional probability of selection for asthmatics will be set to

$$0.9 / (0.9a + 0.1b)$$

And the probability of selection for non-asthmatics will be set to

$$0.1 / (0.9a + 0.1b).$$

In most cases there will be only one asthmatic, so that the conditional probabilities of selection will be  $0.9 / (0.9+b)$  for asthmatics and  $0.1 / (0.9+0.1b) = 1 / (9+b)$  for non-asthmatics. Notice that the conditional probabilities of selection are close to 1 for asthmatics and close to 0.1 for non-asthmatics.

In households consisting wholly of asthmatic adults, the conditional probability of selection will be

$$0.9 / 0.9a = 1/a = 1 / (\text{household size}).$$

Households with two or more asthmatic adults are expected to be rare, so in most cases all-asthmatic households will have  $a=1$ , so that the conditional probability of selection will be 1.

This approach gives probabilities of selection which are almost equal for non-asthmatics, and for asthmatics. However the method is sufficiently complex that it is probably not robust to use live in the field even using CAPI or CATI. The selection of the in-depth sample would need to be performed centrally using data from the screen survey.

### **Appendix 3: Comments on Weighting**

At this stage of planning, the weighting method does not need to be developed in any detail. A few broad comments:

- Multi-phase weighting should be used. Estimates based on the screen sample should use two-phase weighting, with the screen sample as the first phase and the in-depth survey as the second phase. This means that weights for the in-depth sample would make use of the information on self-reported asthma collected from the larger screen sample. Similarly, estimates from the objective testing should use three-phase weighting, with the screen sample as the first phase, the in-depth survey as the second phase and the objective testing sample as the third phase. The use of multiphase weighting would complicate the process of calculating weights, but once weights were available, analysis and estimation would proceed as usual. Multi-phase weighting can substantially reduce the standard errors of estimates and the bias due to non-response. The benefit is greatest when the variables from the first phase (i.e. the self-reported asthma collected in the screen) is highly correlated with the variables from subsequent phases (e.g. more accurate measures of asthma from the in-depth survey and objective testing).
- Estimating variances would also be complicated by the use of multi-phase weighting. One approach to this would be to develop replicate weights for use in variance estimation.

One of the purposes of the survey will be analysis, for example regression analysis of asthma against risk factors. There are a range of views and practices on the role of weights in analysis. Some analysts use the weights explicitly in analysis. Other analysts ignore the weights but allow for informative sampling by including explanatory variables related to the survey design in the analysis. Sometimes the complex sampling is completely ignored but this is known to lead to large biases in some cases and is not a good practice