# **Sample Size Calculation Worksheets for Vaccination Coverage Cluster Surveys**

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Prepared for

World Health Organization  
Measles Rubella SIA Training

Geneva, Switzerland

10-15 November 2014

This document takes the reader through six steps to calculate a cluster survey sample size. The process requires several input parameters, described below. Along the way, the reader uses accompanying tables and formulas to calculate several factors, labeled A-E, which may be multiplied together to calculate the target total number of respondents, number of clusters, and the target number of households to visit in order to achieve the total sample size.

The first few times through the process it may be helpful to use the *long form* that is the first eight or so pages of this document. As the reader becomes familiar with the terms and quantities, they may wish to use the abbreviated forms that appear near the end of the document.

The document is a work-in-progress and we welcome your feedback on it. Contact information for suggestions is listed on the final page.

**Step 1: Calculate the number of strata where the survey will be conducted**

A *stratum* (plural *strata*) is a subgroup of the total population – they might be a subgroup defined by geography, like occupants of the same province, or they might be a demographic subgroup, like women, or children aged 12-23 months. When the survey is finished, a separate coverage estimate will be calculated for each stratum in the survey.

If the survey steering group wishes to calculate results for each district within provinces, and each province within the country, then the survey has three levels of geographic strata, and the entire endeavor may be thought of a survey in each district, repeated across all districts. In that case, the number of districts is the number of strata. E.g., Burkina Faso has 13 regions, and 63 health districts. If a survey were designed to estimate vaccination coverage in every district, it would be like conducting 63 separate surveys. The results from each mini-survey could be combined to estimate coverage in the regions and in the entire nation.

Sometimes results are reported for demographic subgroups within geographic subgroups. If the committee wishes to report results separately for boys and girls within each district, and wishes to design the survey to obtain precise results for boys and girls, then the field staff would conduct two simultaneous surveys in each district – one for boys and one for girls – and results would be reported from 126 separate surveys (63x2=126).

If the total population is to be divided into subgroups and surveys are to be conducted in each sub-group, then calculate the total number of subgroups and write it in box A below. Otherwise, if the results will be reported only in one grand result, and not broken out with precision goals in subgroups, then write 1 in Box A below.  
Table A in the appendix might be helpful. Fill it out, and write the number of strata in Box A below.   
Proceed to Step 2.

1. NStrata = \_\_\_\_\_\_\_\_\_\_

**Step 2: Calculate the effective sample size (ESS)**

Although cluster samples require a larger total sample size than simple random samples, cluster samples are less expensive than simple random samples. This is because they require that field staff visit fewer locations and collect data from several respondents per location.

In this step we pretend for a moment that we might conduct a simple random sample and calculate the number of required respondents to meet our inferential goal. In later steps this so-called *effective sample size* (ESS) will be inflated to account for the clustering effect.

First decide whether you wish to calculate precise results in each stratum, which will require relatively higher sample sizes, or whether less precise results are okay at the lowest level of stratum (e.g., districts) as long as the results are quite precise when rolled up to the regional and national levels.

*Do you require very precise results for each stratum?*

Circle answer: YES / NO

If yes, complete this page. If no, skip the rest of this page and go on to the next page.

If results are to be estimated to within a given precision at the lowest level of strata (e.g., districts), then please specify (1) the expected coverage level and (2) the precision with which the coverage should be estimated. Write the values below:

Expected coverage: \_\_\_\_\_\_\_\_%

Desired precision level: ±\_\_\_\_\_\_\_%

Use Table B1 in the appendix to look up the ESS based on your specified expected coverage and desired precision level. Write the ESS in Box B below. Proceed to Step 3.

For example, if the outcome of interest is DTP3, and expected coverage is 75% and you wish to have precision of ± 5%, then Table B1 indicates that ESS = 340.

(B) ESS = \_\_\_\_\_\_\_\_\_

If sufficient resources are not available to obtain very precise results in every stratum, it can be helpful to select a sample size based on power to classify coverage in those strata as being higher or lower than a fixed programmatic threshold. The results will be a coverage point estimate and confidence region, and coverage will either be:

* Very likely lower than the programmatic threshold
* Very likely higher than the threshold, or
* Not distinguishable from the threshold with high confidence using the sample size in this survey

This design requires four input parameters to be specified in order to look up the corresponding ESS.

1. The programmatic threshold is a coverage level of interest…it might be the coverage target.
2. Delta is a coverage percent defining a distance from the programmatic threshold. If the true coverage is at least delta points away from the programmatic threshold, then we pick a sample size likely to classify those districts as having coverage likely different than delta.

For example, if the programmatic threshold is 80% and delta is 15% then when coverage is 80-15=65% or 80+15=95%, you want the survey results to be very likely to show that coverage is very likely lower or higher than 80%.

1. Alpha (α) is the probability that a stratum with coverage at the programmatic threshold will be mistakenly classified as very likely to be above or below that threshold.
2. Beta (β) is the probability that a stratum with coverage delta points away from the threshold will be mistakenly classified as not different than the threshold. We call the quantity 100%-β the *statistical power* of the classifier.

Write the values below:

Programmatic threshold: \_\_\_\_\_\_\_%

Delta: \_\_\_\_\_\_\_% (choose 1%, 5%, 10%, or 15%)

α \_\_\_\_\_\_% (choose 5% or 10%)

β \_\_\_\_\_\_\_% (choose 10% or 20%)

Power = (100%-β) = \_\_\_\_\_ % (either 80% or 90%)

Use Table B2 in the appendix to look up the ESS based on the programmatic threshold, delta, α, and power inputs. Write the ESS in Box B below. Proceed to Step 3.

(B) ESS = \_\_\_\_\_\_\_\_\_

**Step 3: Calculate the design effect (DEFF)**

When we select a cluster design, we require more respondents to achieve the statistical precision specified in step 2 above. The *design effect* (DEFF) is a factor that tells us how much to inflate the ESS to achieve the precision we want with a cluster sample.

Two input parameters are required to calculate the DEFF. One is largely under your control, and one is not.

1. The target number of respondents per cluster (*m*) will often be between 5 and 15 and is influenced by the number of people in each field data collection team and the length of the survey. For many surveys it may be good to start with a value of 10 and adjust slightly when revising the design. (Consider adjusting *m* to be smaller if the number of households needed to visit per cluster (D x E x *m*) is too many for a single team to accomplish in a day. Consider adjusting *m* to be larger if (D x E x *m*) represents much less than a full day of work for a field team.)
2. Respondents from the same cluster tend to give similar responses to each other. They often come from similar socio-economic conditions, often have the same access to services and the same attitudes toward those services. So the responses within a cluster are likely to be correlated, and the degree of correlation affects statistical power and sample size. The *intracluster correlation coefficient* (ICC) is a measure of correlation of responses with clusters. For survey work it varies from 0 to 1. This figure affects the sample size calculation and is not usually known in the planning stage – the true figure for any survey will only be well estimated after the data have been collected. So for planning purposes we use either a) an observed figure from a recent survey of the same topic in a similar study area, or b) a conservative value that is slightly larger than what is likely to be observed in the field.

The DEFF is a function of the target number of respondents per cluster (m) and the ICC.

For post-campaigns surveys, an ICC between 1/24 and 1/6 is probably appropriate, with 1/6=0.167 being more conservative. For routine immunization surveys, an ICC between 1/6 and 1/3 is probably appropriate, with 1/3 being more conservative.

Specify the average number of eligible children sampled per cluster (m) and the ICC. Write the values below:

m = \_\_\_\_\_\_\_

ICC = \_\_\_\_\_\_\_\_\_

Use Table C in the appendix to look up the DEFF based on the m and ICC just specified or simply calculate it using the following formula:

DEFF = 1 + (m-1)\*ICC

Write the DEFF in Box C. Proceed to Step 4.

(C) DEFF = \_\_\_\_\_\_\_\_\_

**Step 4: Calculate the average number of households to visit to find an eligible child**

Not every household in the cluster will have an eligible child for the survey. The number of households that need to be visited to find an eligible child (NHH to find eligible child) should be estimated before survey work begins. This number will help survey planners know if the cluster (or cluster segment) is big enough to find the number of eligible children needed for the survey as well as to allow appropriate time to complete the work in each cluster.

If NHH to find eligible child is known or easily found from recent census or survey data, then that number should be written in Box D below and the reader can proceed to Step 5. If it is not known, it can be estimated in various ways. Birth rates, infant mortality rates, and household size are some rates that may be easy to obtain from recent census or survey data to help estimate NHH to find eligible child. Consider the following formulae. Equation (1) estimates NSurvived at birth per HH, which is used in Equation (2) to estimate NHH to find eligible child.

(1)

(2)

*YC* is the number of years of eligible children in the cohort, *BR* is the birth rate per 1000 population, *HS* is the average household size, and *IM* is the infant mortality rate. The first term in Equation (1) estimates the number of live births per household and the second term in Equation (1) estimates the proportion of live births that survived. (The multiplier YC assumes everyone survives after their first birthday, so Equation (2) underestimates NHH to find eligible child.) Round the result from Equation (2) up to the nearest whole number.

Example 1: Suppose a measles campaign is scheduled to occur in Ethiopia and a survey estimating the coverage level for a single year cohort (maybe children 12-23 months) is desired. From the 2011 Ethiopia Demographic Health Survey, the birth rate per 1000 population was estimated to be 34.5, the infant mortality rate per 1000 live births was estimated to be 59, and the average household size was estimated to be 4.6. The number of years of eligible children in the cohort is 1. Using Equations (1) and (2) we have

About 1 in every 7 households are estimate to have an eligible child for this survey.

Example 2: In Example 1, if the cohort of interest was for 1-5 year olds, then YC=5-1=4 and Equations (1) and (2) yield

Expanding the birth cohort translates to more households with an eligible child for the survey. In this example, on average 2 households would need to be visited to find an eligible child.

Example 3: In Example 1, if the birth cohort was for 1-15 year olds, then YC=15-1=14 and Equations (1) and (2) yield

Expanding the birth cohort dramatically translates to even more households with an eligible child for the survey. In this example, every household is estimated to have an eligible child.

Using Equations (1) & (2), estimate NHH to find eligible child and write it in Box D below. Consult a statistician or the census bureau if the rates used in Equations (1) and (2) are not known or well estimated and a different way to estimate NHH to find eligible child is needed. Discussions with colleagues who have recently completed national child health surveys may also be helpful (malaria, nutrition, etc.).

(D) NHH to find eligible child = \_\_\_\_\_\_\_\_\_\_

**Step 5: Calculate an inflation factor to account for nonresponse**

Some households that have a child eligible for survey participation may not participate either because the caregiver is not be at home when the data collection team visits, or because the caregiver refuses to participate. So although there might be an eligible respondent in every 7th home, the team may need to visit 8 or 9 homes, on average, per completed survey.

Based on recent survey experience in the same country, specify the percentage of households with an eligible child that are likely to be excluded (PHH eligible and not respond). Write the value below:

PHH eligible and not respond = \_\_\_\_\_\_\_\_\_%

Use Table E in the appendix to look up the appropriate inflation factor (INonresponse), or calculate it using the following formula:

INonresponse = 100/(100 – PHH eligible and not respond)

Write the inflation factor in Box E below. (Do not round this result.) Proceed to Step 6.

(E) INonresponse = \_\_\_\_\_\_\_\_\_\_\_

**Step 6: Use the values above to calculate interesting quantities for survey planning and budgeting**

Copy the quantities A-E and m from the earlier sheets onto this sheet:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
| A.  NStrata | B.  ESS | C.  DEFF | D.  NHH to find eligible child | E.  INonresponse | m  (from Step 3) |

1. Calculate the total completed surveys needed:

Ncs = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(A) (B) (C)

1. Using Ncs just calculated and (D) and (E) in the boxes above, calculate the total number of households to visit to get the necessary completed surveys:

NHH to visit = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(Ncs) (D) (E)

1. Using (B)-(E) in the boxes above, calculate the target number of households to visit in each stratum:

NHH to visit per stratum = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(B) (C) (D) (E)

1. Using (B) (C) and m, calculate the number of clusters needed per stratum:

Nclusters per stratum = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(B) (C) m

1. Calculate the total households to visit per cluster:

NHH per cluster = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(D) (E) m

1. Calculate the total number of clusters in the survey:

Nclusters total = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(A) Nclusters per stratum

**Discussion**

If the quantities calculated in Step 6 are compatible with established budgets and timelines, then stop here and use these values as the sample sizes for the upcoming survey. Congratulations on designing your survey!

If the quantities calculated above would be too expensive or take too long, there are several modifications that can be made to try to reduce the sample size.

1. In Step 1, if the number of strata to survey is large, consider reducing this number. For example if results were desired by region by age group by gender, then consider stratifying only by region. Data analyses can still be summarized by region by age group by gender, but those sub-sub-subgroup results will not have the extremely high precision or high power to classify.
2. In Step 2, was the ESS calculated using estimation with desired precision? If so, consider:
3. Relaxing the level of precision with which the coverage needs to be estimated (e.g., relax from +/- 3% to +/- 5% or 10%).
4. If relaxing the precision still does not produce sample sizes feasible, consider using classification methods in Table B2 instead of estimating with a desired precision level from B1.
5. In Step 2, if the ESS was calculated using classification methods, consider:
   1. Increasing delta (i.e., increasing the difference from the programmatic threshold for which a change is likely to be detected)
   2. Increasing alpha
   3. Increasing beta (i.e., lowering the desired power)
6. In Step 3, consider modifying *m* (the average number of respondents per cluster). Specifically, consider adjusting *m* to be smaller if the number of households needed to visit per cluster (D x E x *m*) is too many for a single team to accomplish in a day. Consider adjusting *m* to be larger if (D x E x *m*) represents much less than a full day of work for a field team. Increasing *m* may result in surveying fewer clusters while decreasing *m* may result in less time (and potentially cost) in a particular cluster.

**Introduction to Worksheets on the Following Pages**

The first few times through this process it will be helpful to use pages 1-8 to understand the inputs and outputs A-E. As you gain familiarity with the process and the quantities, you may wish to move to a single sheet form for doing these calculations. The worksheet on the following page consolidates pages 1-8 considerably. And as your skills progress even farther, you may wish to compare multiple survey designs on a single sheet. In that case, use the quick comparison worksheet on the page after to compare up to ten designs simultaneously.

**Cluster Survey Sample Size**

**Single Page Worksheet**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Step | Letter | Quantity | Inputs | (Specify Inputs) | Output using Table or Formula |
| 1 | (A) | Number of Strata (NStrata) | (no inputs) | |  |
| 2 | (B) | Effective Sample Size (ESS) – Estimation with Desired Precision | Expected coverage |  |  |
| Precision level |  |
| Effective Sample Size (ESS) – Classification | Programmatic threshold |  |
| Delta |  |
| Alpha |  |
| Power |  |
| 3 | (C) | Design Effect (DEFF) | m |  |  |
| ICC |  |
| 4 | (D) | Number of Households to Visit to Find an Eligible Child (NHH to find eligible child) | (no inputs) | |  |
| 5 | (E) | Inflation Factor for Nonrespone (INonresponse) | PHH eligible and not respond |  |  |

1. Calculate the total number of completed surveys needed:

Ncs = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(A) (B) (C)

1. Calculate the total number of households to visit to get the necessary completed surveys:

NHH to visit = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(Ncs) (D) (E)

1. Using (B)-(E) in the boxes above, calculate the target number of households to visit in each stratum:

NHH to visit per stratum = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(B) (C) (D) (E)

1. Using (B) (C) and m, calculate the number of clusters needed per stratum:

Nclusters per stratum = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(B) (C) m

1. Calculate the total households to visit per cluster:

NHH per cluster = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(D) (E) m

1. Calculate the total number of clusters in the survey:

Nclusters total = \_\_\_\_\_\_\_\_ x \_\_\_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

(A) Nclusters per stratum

**Cluster Survey Sample – Quick Comparison Worksheet**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Step 1 | | Step 2  (Choose 1 Method to Calculate ESS) | | | | | | | Step 3 | | | Step 4 | Step 5 | | Step 6 | | | | | |
|  |  | (A) | Estimation | | Classification | | | | (B) |  |  | (C) | (D) |  | (E) | Ncs | NHH to visit | NHH to visit per stratum | Nclusters per stratum | Nhh per cluster | Nclusters total |
| Design # | Description of Strata | NStrata | Expected Threshold | Desired Precision | Programmatic Threshold | Delta | Alpha | Power | ESS | m | ICC | DEFF | NHH to find eligible child | PHH eligible and not respond | INonresponse | (A) X (B) x (C) | (A) x (B) x (C) x (D) x (E) | (B) x (C) x (D) x (E) | (B) x (C) / m | (D) x (E) x m | (A) x Nclusters per stratum |
| 1. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Appendix Tables**

**Table A. Stratification Schemes for Survey**

|  |  |  |  |
| --- | --- | --- | --- |
| Strata at Lowest Level Estimated | Number of Strata | Example: Burkina Faso – 3 age cohorts | Your Results |
| National results – all strata combined | 1 | **1** |  |
| National results – stratified by demographic | # of demographic groups | **3: Under 5, 5-9, 10-14 years** |  |
| Sub-national results - all strata combined | e.g., # of provinces | **13** |  |
| Sub-national results - stratified by demographic | e.g., (# of provinces) x (# of demographic groups) | **39** |  |
| Sub-sub-national results - all strata combined | e.g., # of districts | **63** |  |
| Sub-sub-national results - stratified by demographic | e.g., (# of districts) x (# of demographic groups) | **189** |  |

The following examples parallel the levels outlined in Table 1 and illustrate how to calculate the number of strata.

*Example 1a*: Coverage estimates are needed for Ethiopia. The number of strata for this survey is then 1.

*Example 1b*: Coverage estimates for Kano, Nigeria are needed. The number of strata for this survey is then 1.

*Example 2a*: Coverage estimates by geographic area (urban versus rural) are needed. The number of strata for this survey is then 2.

*Example 2b*: Coverage estimates by age group (<5, 5-9, 10-14 years old) are needed. The number of strata for this survey is then 3.

*Example 2c*: Coverage estimates by gender (female versus male) are needed. The number of strata for this survey is then 2.

*Example 3*: Post measles campaign survey in 13 regions. The number of strata for this survey is then 13.

*Example 4*: Post measles campaign survey in 11 regions with target audience stratified by age: <5, 5-9, 10-14 years old. The number of strata for this survey is then 11\*3=33.

*Example 5*: Coverage estimates by local government areas (LGA) in Kano, Nigeria are needed. The number of strata for this survey is the number of LGAs, which is 44.

*Example 6*: Coverage estimates by zone by geographic region (urban versus rural) in Ethiopia are needed. The number of zones in the survey is 96 (three excluded because of security). The number of strata for this survey is then 96\*2=192.

**Table B1. Effective Sample Size (ESS) by Expected Coverage & Desired Precision for the 95% Confidence Interval (CI)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Expected Coverage | | | | | |
|  |  | 50-70% | 75% | 80% | 85% | 90% | 95% |
| Precision for  95% CI | ±3% | 1,097 | 892 | 788 | 663 | 518 | 354 |
| ±4% | 622 | 517 | 461 | 394 | 315 | 227 |
| ±5% | 401 | 340 | 306 | 265 | 216 | 162 |
| ±6% | 280 | 242 | 220 | 192 | 160 | 132 |
| ±7% | 207 | 182 | 167 | 147 | 125 | 110 |
| ±8% | 159 | 143 | 131 | 117 | 101 | 93 |
| ±9% | 126 | 115 | 106 | 96 | 83 | 81 |
| ±10% | 103 | 95 | 88 | 80 | 70 | 70 |

Note 1. These sample sizes are consistent with sample size formulas on page 35 of Fleiss, Levin, and Paik (2003); *Statistical Methods for Rates and Proportions, 3rd edition*; John Wiley & Sons, Inc.; Hoboken, New Jersey. Note that within any row, the ESS doesn’t change for coverage levels between 50% and 70%. This is not a mistake in the table, but rather a result of using a conservative upper bound of “k=1” in calculations for these values.  As p moves away from 50% then “k” can be scaled down to something <1 and a reduced sample size results.

Note 2. Recall from the 2005 EPI Cluster Survey Guidelines that when the design effect is 2, a sample of 30x7=210 will yield confidence intervals no wider than +/- 10%. The highest entry in this table for a precision of +/- 10% is 103. If we multiple 103 by a design effect of 2, we obtain a total sample size per stratum of 206 which is essentially the same as 210. So Table 1 is consistent with the 2005 WHO EPI Survey Guidelines in that important respect.

Note 3. If the expected coverage is less than 50%, this table can still be used to determine the effective sample size (ESS); subtract 1 from the expected coverage and look up the ESS for that value. For example, if the expected coverage is 15%, look up the ESS for 1-15%=85%. If the coverage is greater than 95%, use the ESS for 95%. For coverage between two values in the table, to be conservative, look up the ESS for the expected coverage that is closer to 50%. For example, if expected coverage is 73%, look up the ESS using 70%. If expected coverage is 23%, then 1-23%=77% and look up the ESS using 75%.

**Table B2. Effective Sample Sizes (ESS) for Surveys to Classify Coverage**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | alpha=10%; power=80% | alpha=5%; power=80% | alpha=10%; power=90% | alpha=5%; power=90% |
| Programmatic Threshold (%) | **Delta (%)** | **ESS** | **ESS** | **ESS** | **ESS** |
| 50 | 1 | 11,368 | 15,555 | 16,521 | 21,506 |
| 55 | 11,273 | 15,421 | 16,389 | 21,330 |
| 60 | 10,953 | 14,978 | 15,929 | 20,725 |
| 65 | 10,407 | 14,226 | 15,141 | 19,692 |
| 70 | 9,636 | 13,165 | 14,024 | 18,230 |
| 75 | 8,640 | 11,795 | 12,579 | 16,341 |
| 80 | 7,418 | 10,115 | 10,804 | 14,023 |
| 85 | 5,970 | 8,126 | 8,701 | 11,276 |
| 90 | 4,296 | 5,827 | 6,269 | 8,100 |
| 95 | 2,396 | 3,217 | 3,506 | 4,494 |
| 50 | 5 | 469 | 637 | 674 | 873 |
| 55 | 468 | 635 | 674 | 872 |
| 60 | 458 | 620 | 661 | 854 |
| 65 | 439 | 593 | 634 | 818 |
| 70 | 411 | 554 | 595 | 766 |
| 75 | 374 | 502 | 542 | 696 |
| 80 | 328 | 438 | 476 | 609 |
| 85 | 272 | 362 | 397 | 504 |
| 90 | 208 | 272 | 304 | 382 |
| 95 | 133 | 169 | 196 | 241 |
| 50 | 10 | 121 | 163 | 171 | 221 |
| 55 | 122 | 163 | 173 | 222 |
| 60 | 120 | 161 | 171 | 220 |
| 65 | 116 | 155 | 166 | 213 |
| 70 | 110 | 146 | 158 | 201 |
| 75 | 102 | 134 | 146 | 186 |
| 80 | 91 | 119 | 131 | 165 |
| 85 | 78 | 101 | 113 | 141 |
| 90 | 62 | 79 | 91 | 111 |
| 95 | 44 | 53 | 64 | 77 |
| 50 | 15 | 55 | 74 | 77 | 98 |
| 55 | 56 | 74 | 78 | 100 |
| 60 | 56 | 74 | 78 | 100 |
| 65 | 54 | 72 | 77 | 97 |
| 70 | 52 | 68 | 74 | 93 |
| 75 | 49 | 63 | 69 | 87 |
| 80 | 44 | 57 | 63 | 79 |
| 85 | 38 | 49 | 55 | 68 |
| 90 | 32 | 40 | 46 | 56 |
| 95 | 24 | 28 | 35 | 41 |

Note 1. Programmatic threshold is the expected coverage level.

Note 2. Delta is the difference (+ or -) from the programmatic threshold from which you want to be well powered to reject the null hypothesis. For example, when ESS = 11,368 a classification based on an upper confidence limit will misclassify strata with true coverage of 50% only 5% of the time, and will have 80% power to correctly classify strata with true coverage of 49% or lower as having low coverage.

Note 3. This table conservatively provides ESS based on testing if coverage is below programmatic threshold (i.e., subtract delta from programmatic threshold). In some cases, the ESS would be slightly smaller if testing if coverage is above programmatic threshold (i.e., adding delta to programmatic threshold).

**Table C. Example Design Effects (DEFF) for Coverage Surveys**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ICC | Average Respondents per Cluster *(m)* | | | | | |  |
| 1 | 5 | 7 | 10 | 15 | 20 | Description |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | Uniform coverage |
| 0.042 | 1 | 1.17 | 1.25 | 1.38 | 1.58 | 1.79 | = 1/24 very little variation in coverage |
| 0.167 | 1 | 1.67 | 2 | 2.50 | 3.33 | 4.17 | = 1/6 conservative choice for SIA surveys |
| 0.333 | 1 | 2.33 | 3 | 4 | 5.67 | 7.33 | = 1/3 conservative choice for RI surveys |
| 1 | 1 | 5 | 7 | 10 | 15 | 20 | Some clusters 100% covered; all others 0% |

Note 1. Design Effect = DEFF = 1 + (m-1) \* ICC

Note 2. ICC = Intracluster Correlation Coefficient (sometimes called Intraclass Correlation Coefficient)

Note 3. ICC=0.042 refers to a plausible ICC value that may result after an excellent campaign.

Note 4. ICC=0.167 refers to a value that is implicit but not stated in the 2005 WHO EPI Cluster Survey Guidelines: a design effect of 2 with 7 respondents per cluster implies that the ICC = 1/6 = 0.167. This is a direct result from the equation in Note 1. This would reflect more variability in coverage than 0.042. This is probably a conservative choice for planning a post-SIA survey.

Note 5. ICC=0.333 refers to a more conservative value that will be listed in the 2015 update to the WHO EPI Cluster Survey Guidelines. In RI surveys we sometimes observe ICCs higher than the 0.167 value that was implicit in the 2005 document, so we recommend a conservative value of 0.333, or a design effect of 4.0 when *m*=10.

**Table E. Inflation Factor to Account for Nonresponse**

|  |  |
| --- | --- |
| Anticipated % of households with an eligible child where no one will be at home or caregiver will refuse to respond | Inflation factor for non-response (INonresponse) |
| 0% | 1 |
| 5% | 1.05 |
| 10% | 1.11 |
| 15% | 1.18 |
| 20% | 1.25 |
| 25% | 1.33 |
| 30% | 1.43 |
| 35% | 1.54 |
| 40% | 1.67 |
| 45% | 1.82 |
| 50% | 2 |
| 55% | 2.22 |
| 60% | 2.5 |
| 65% | 2.86 |
| 70% | 3.33 |
| 75% | 4 |
| 80% | 5 |
| 85% | 6.67 |
| 90% | 10 |
| 95% | 20 |

**Comments & Corrections**

This set of worksheets is still evolving and we welcome your feedback and suggestions; send them to [Dale.Rhoda@biostatglobal.com](mailto:Dale.Rhoda@biostatglobal.com).