

## Appendix A. Sample Design

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The major features of the sample design are described in this appendix. Sample design features include target sample size, sample allocation, sampling frame and listing, choice of domains, sampling stages, stratification, and the calculation of sample weights.

The primary objective of the sample design for the Belize Multiple Indicator Cluster Survey was to produce statistically reliable estimates of most indicators, at the national level, for urban and rural areas, and for the seven regions Corozal, Orange Walk, Belize City South Side, Belize Other, Cayo, Stann Creek and Toledo of the country. Urban and rural areas in each of the seven regions were defined as the sampling strata.

A multi-stage, stratified cluster sampling approach was used for the selection of the survey sample.

### Sample Size and Sample Allocation

The target sample size for the Belize MICS was calculated as 4,900 households. For the calculation of the sample size, the key indicator used was the vitamin A supplementation prevalence among children aged 0-4 years. The following formula was used to estimate the required sample size for this indicator:

$$n = \frac{[4(r)(1-r)(f)(1.1)]}{[(0.12r)^2(p)(\bar{n})]}$$

where

- $n$  is the required sample size, expressed as number of households
- 4 is a factor to achieve the 95 percent level of confidence
- $r$  is the predicted or anticipated value of the indicator, expressed in the form of a proportion
- 1.1 is the factor necessary to raise the sample size by 10 per cent for the expected non-response [the actual factor will be based on the non-response level experienced in previous surveys in the country]
- $f$  is the shortened symbol for *deff* (design effect)
- $0.12r$  is the margin of error to be tolerated at the 95 percent level of confidence, defined as 12 per cent of  $r$  (relative margin of error of  $r$ )
- $p$  is the proportion of the total population upon which the indicator,  $r$ , is based
- $\bar{n}$  is the average household size (number of persons per household).

For the calculation,  $r$  (vitamin A supplementation prevalence) was obtained for the national and district levels from the Census 2000 (Table SD.1). The value of *deff* (design effect) was taken as 1.5 based on estimates from previous surveys,  $p$  (percentage of children aged 6 – 59 months in the total population) and  $\bar{n}$  (average household size) were obtained for the national and district levels and presented in Table SD.1, and the response rate was assumed to be 90%.

**Table SD.1. Determining sample size for MICS 4:  
the example of Vitamin A supplementation for children**

	Prevalence r	Design effect deff	Relevant group as % of total population p	Average household size, nh	Relative margin of error	Required sample size n
<b>National estimate only</b>	<b>0.238</b>	<b>1.5</b>	<b>0.129</b>	<b>4.3</b>	<b>0.09</b>	<b>4,900</b>
Urban	0.295	1.5	0.117	3.9	0.12	2,493
Rural	0.189	1.5	0.140	5.0	0.13	2,483
<b>National estimate &amp; U/R</b>						<b>4,976</b>
Corozal	0.149	1.5	0.118	4.7	0.31	699
Orange Walk	0.223	1.5	0.124	5.1	0.23	701
Belize(Excluding Belize City South Side)	0.374	1.5	0.118	3.5	0.19	730
Belize City South Side	0.374	1.5	0.118	3.6	0.19	708
Cayo	0.220	1.5	0.137	5.2	0.22	699
Stann Creek	0.264	1.5	0.141	4.1	0.21	701
Toledo	0.087	1.5	0.160	5.2	0.34	702
<b>District estimates</b>						<b>4,940</b>

Equal allocation of the total sample size to the seven regions was used. The resulting number of households from this exercise was 700 households which is the sample size needed in each region – thus yielding about 4,900 households in total. The average number of households selected per cluster for the Belize MICS was determined as 25 households, based on a number of considerations, including the design effect, the budget available, and the time that would be needed per team to complete one cluster. Dividing the total number of households by the number of sample households per cluster, it was calculated that 28 sample clusters (enumeration districts or EDs) would need to be selected in each region.

Therefore, 28 clusters (EDs) were allocated to each region, with the final sample size calculated at 4,900 households (28 clusters \* 7 regions \* 25 sample households per cluster). In each region, the clusters (primary sampling units) were distributed to urban and rural domains, proportional to the number of households in the urban and rural areas of that region. The table below shows the allocation of clusters to the sampling strata.

**Table SD.2. Allocation of Sample Clusters (Primary Sampling Units) to Sampling Strata**

Region	Households (2010 Estimates)			Number of Clusters (Enumeration Districts)		
	Total	Urban	Rural	Urban	Rural	Total
Corozal	9,247	2,699	6,548	8	20	28
Orange Walk	10,394	3,361	7,033	10	18	28
Belize (Excluding Belize City South Side)	16,083	8,852	7,231	15	13	28
Belize City South Side	10,078	10,078	0	28	0	28
Cayo	16,897	9,221	7,676	15	13	28
Stann Creek	9,057	2,562	6,495	8	20	28
Toledo	6,516	1,358	5,158	6	22	28
<b>Total</b>	<b>78,272</b>	<b>38,131</b>	<b>40,141</b>	<b>90</b>	<b>106</b>	<b>196</b>

## Sampling Frame and Selection of Clusters

The 2010 census frame was used for the selection of clusters. Census enumeration districts (ED) were defined as primary sampling units (PSUs), and were selected from each of the sampling strata by using systematic pps (probability proportional to size) sampling procedures, based on the estimated sizes of the enumeration areas from the 2010 Population Census. The first stage of sampling was thus completed by selecting the required number of enumeration areas from each of the 7 regions, separately by urban and rural strata.

## Listing Activities

A new listing of households was conducted in all the sample enumeration districts prior to the selection of households. For this purpose, listing teams were formed, who visited each selected enumeration district, and listed the occupied households.

Field work: 5<sup>th</sup> to 20<sup>th</sup> May, 2011

Data entry: 23<sup>rd</sup> May, 2011 to 24<sup>th</sup> June, 2011.

Number of ED: 196

Number of interviewers: 98 (one interviewer for two EDs)

Number of supervisors: 6 (one for each district, urban and rural)

## Selection of Households

Lists of households were prepared by the listing teams in the field for each selected enumeration district. The households were then sequentially numbered from 1 to n (the total number of households in each enumeration area) at the Central Statistical Office, where the selection of 25 households in each enumeration area was carried out using random systematic selection procedures.

## Calculation of Sample Weights

The Belize Multiple Indicator Cluster Survey sample is not self-weighting. Essentially, by allocating equal numbers of households to each of the regions, different sampling fractions were used in each region since the size of the regions varied. For this reason, sample weights were calculated and these were used in the subsequent analyses of the survey data.

Thirteen primary sampling units (PSU) were used in producing the sample of households:

Corozal urban,	Corozal rural,	Orange Walk urban ,	Orange Walk rural,
Belize other urban,	Belize Other rural,	Belize City South Side,	Cayo urban,
Cayo rural,	Stann Creek urban,	Stann Creek rural,	Toledo urban,
Toledo rural.			

Seven strata (regions) were used: Corozal, Orange Walk, Belize District (Excluding Belize City South Side), Belize City South Side, Cayo, Stann Creek and Toledo and enumeration districts (ED) constitute the clusters.

It was decided that 28 clusters (ED) would be chosen from each stratum and that 25 households would be chosen from each selected ED.

The major component of the weight is the reciprocal of the sampling fraction employed in selecting the number of sample households in that particular sampling stratum (h) and PSU (i):

$$W_{hi} = \frac{1}{f_{hi}}$$

The term  $f_{hi}$ , the sampling fraction for the  $i$ -th sample PSU (district by urban/rural) in the  $h$ -th stratum (ED), is the product of probabilities of selection at every stage in each sampling stratum:

$$f_{hi} = p_{1hi} \times p_{2hi} \times p_{3hi}$$

where  $p_{shi}$  is the probability of selection of the sampling unit at stage  $s$  for the  $i$ -th sample PSU in the  $h$ -th sampling stratum.

Since the estimated number of households in each enumeration district (PSU) in the sampling frame used for the first stage selection and the updated number of households in the enumeration district from the listing exercise were different, individual sampling fractions for households in each sample enumeration district (cluster) were calculated. The sampling fractions for households in each enumeration district (cluster) therefore included the first stage probability of selection of the enumeration area in that particular sampling stratum and the second stage probability of selection of a household in the sample enumeration area (cluster).

A second component in the calculation of sample weights takes into account the level of non-response for the household and individual interviews. The adjustment for household non-response is equal to the inverse value of:

$$RR_h = \text{Number of interviewed households in stratum } h / \text{Number of occupied households listed in stratum } h$$

After the completion of fieldwork, response rates were calculated for each sampling stratum. These were used to adjust the sample weights calculated for each cluster. Response rates in the Belize Multiple Indicator Cluster Survey are shown in Table HH.1 in this report.

Similarly, the adjustment for non-response at the individual level (women and under-5 children) for each stratum is equal to the inverse value of:

$$RR_h = \text{Completed women's (or under-5's) questionnaires in stratum } h / \text{Eligible women (or under-5s) in stratum } h$$

The non-response adjustment factors for women's and under-5's questionnaires are applied to the adjusted household weights. Numbers of eligible women and under-5 children were obtained from the roster of household members in the Household Questionnaire for households where interviews were completed.

The design weights for the households were calculated by multiplying the above factors for each enumeration area. These weights were then standardized (or normalized), one purpose of which is to make the weighted sum of the interviewed sample units equal the total sample size at the national level. Normalization is achieved by dividing the full sample weights (adjusted for

nonresponse) by the average of these weights across all households at the national level. This is performed by multiplying the sample weights by a constant factor equal to the un-weighted number of households at the national level divided by the weighted total number of households (using the full sample weights adjusted for nonresponse). A similar standardization procedure was followed in obtaining standardized weights for the women's and under-5's questionnaires. Adjusted (normalized) weights varied between 0.452178 and 1.768905 in the 196 sample enumeration districts (clusters).

Sample weights were appended to all data sets and analyses were performed by weighting each household, woman or under-5 with these sample weights.

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