APPENDIX A. SAMPLE DESIGN

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

The primary objective of the sample design for the Mongolia Multiple Indicator Cluster Survey 2010 was to produce statistically reliable estimates of most indicators, at the national level, for urban and rural areas, and for the regions (Western, Khangai, Central, Eastern, and Ulaanbaatar) of the country. Urban and rural areas in each of the five regions were defined as the sampling strata.

A two-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 Mongolia MICS 2010 was calculated as 10500 households at the national level, 2100 households at the regional level. For the calculation of the sample size, the key indicator used was the pre-school attendance among children aged 3-4. The following formula was used to estimate the required sample size for this indicator:

$$n = \frac{[4(r)(1-r)(deff)(1.1)]}{[(0.20r)^2(p)(\bar{n})]}$$

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 key indicator, expressed in the form of a proportion
- *1.1* is the factor necessary to raise the sample size by 10 percent for the expected non-response
- *deff* is the shortened symbol for design effect
- *0.20r* is the margin of error to be tolerated at the 95 percent level of confidence, defined as 20 percent of r (relative margin of error of r) at the regional level
- *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).

From the results of Mongolia MICS 2005, the pre-school attendance among children aged 3-4 was 37 percent at the national level while it is 32 percent in Western region, 32 percent in Khangai region, 33 percent in Central region, 40 percent in Eastern region, and 48 percent in Ulaanbaatar. The value of deff was calculated as 1.7 at the national level, 1.2 in Western region, 2.0 in Khangai region, 2.5 in Central region, 2.0 in Eastern region, and 1.3 in Ulaanbaatar. Also, from the 2009 annual statistics on population, the percentage of children aged 3-4 in the total population was 4.4 and average household size was 4.

The resulting number of households from this exercise was, at the beginning, 1572 households for Western region, 2472 region for Khangai region, 3156 households for Central region, 1839 households for Eastern region and 873 households for Ulaanbaatar, – thus yielding 10183 households in total. The number households for each region vary greatly between regions, from 873 to 3156. Therefore, equal allocation of the total sample size to the regions is used in order to keep sampling errors at similar level for regions. As a result, the number of households needs to be selected from each region rounded up to 2100 households and then the total sample size is determined as 10500 households.

The average number of households selected per cluster for the survey 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 number of households to be selected from each region by the number of sample households per cluster, it was calculated that 84 sample clusters would need to be selected in each region – thus yielding 420 clusters in total.

As mentioned above, equal allocation of the total sample size to the five regions was used. Therefore, 84 clusters were allocated to each region, with the final sample size calculated at 10500 households (84 clusters *5 regions * 25 sample households per cluster). In each region, the clusters (primary sampling units) were distributed to urban and rural domains, proportional to the size of urban and rural populations in that region. The table below shows the allocation of clusters and households to the sampling strata.

Table SD.1: Allocation of Sample Clusters (Primary Sampling Units) and Households to Sampling Strata

	Urban (capital city, aimag center)		**Rural (soum center, rural)**		**TOTAL**	
	Number of Clusters	Number of households	Number of Clusters	Number of households	Number of Clusters	Number of households
Western	24	600	60	1500	84	2100
Khangai	30	750	54	1350	84	2100

Central	32	800	52	1300	84	2100
Eastern	30	750	54	1350	84	2100
Ulaanbaatar	84	2100			84	2100
TOTAL	**200**	**5000**	**220**	**5500**	**420**	**10500**

Sampling Frame and Selection of Clusters

The 2009 annual statistics on population and households frame was used and the khesegs of khoroos of Ulaanbaatar and baghs of soums of provinces are defined as clusters. As first stage of the sampling, the clusters 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 2009 annual statistics on population and households.

Household Listing and Selection

The Statistics Divisions in provinces and districts were responsible for asking the governors of selected baghs and khesegs (PSUs) to update their household listings and for sending the updated listings to the National Statistics Office (NSO). The governors of the selected baghs and khesegs were instructed to include all households locating in the territory of the bagh or kheseg regardless of their registration.

As second stage of the sampling, the households were then sequentially numbered from 1 to n (the total number of households in each cluster) at the NSO, where the selection of 25 households in each cluster was carried out using random systematic selection procedures.

Calculation of Sample Weights

The Mongolia Multiple Indicator Cluster Survey 2010 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.

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):

$$W_{hij} = \frac{1}{p_{1hi}\, p_{2ij}}$$

where

- p_{1hi} – at the sampling stage 1, the probability of selection of the *i*-th sample PSU in the *h*-th sampling stratum or region
- p_{2ij} – at the sampling stage 2, the probability of selection of the *j*-th sample household in the *i*-th sample PSU
- *h* – sampling strata or regions: Western, Khangai, Central, Eastern and Ulaanbaatar
- *i* – 1, … , the total number of clusters or PSUs (for each region)
- *j* – 1, … , the total number of households (for each 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:

$$RR_{hk} = \frac{N_{hk}}{M_{hk}}$$

where

- *k* – target groups for the survey (households, women aged 15-49, children under-5, men aged 15-54, and children aged 2-14)
- *h* – sampling strata or regions: Western, Khangai, Central, Eastern and Ulaanbaatar
- N_{hk} – interviewed numbers (for each target group and region)
- M_{hk} – eligible numbers (for each target group and region)

Finally, the design weights were calculated by multiplying the above factors for each for target group and cluster. 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. As a result, the range of the normalized weights calculated for each target group is shown below and these sample weights were appended to all data sets and analyses were performed by weighting each household, woman aged 15-49, under-5, men aged 15-54, and child aged 2-14 with these sample weights.

- Households – 0.145-3.876
- Women aged 15-49 – 0.138-3.794
- Children under-5 – 0.142-4.042
- Men aged 15-54 – 0.139-3.712
- Children aged 2-14 – 0.149-4.238

The below figure shows the locations of the clusters or PSUs covered by the survey.