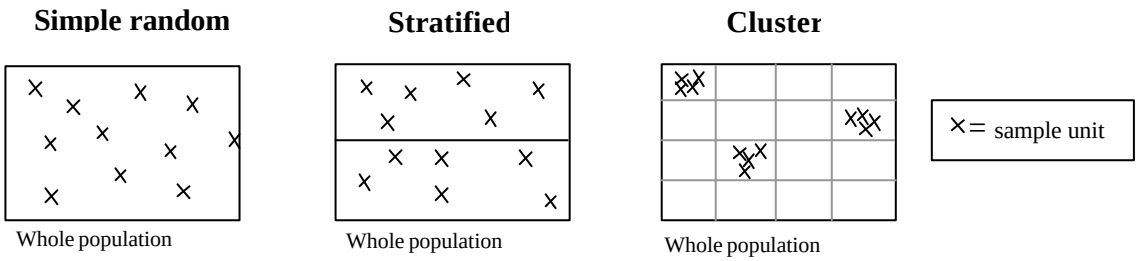
SAMPLING TECHNIQUES

Appendix 2

1. Types of sampling

Three types of sampling are particularly relevant when collecting information for the juvenile justice indicators.

Figure A2.1 – Types of sampling



Simple random sampling involves sampling items (or units) at random from the whole population.

Stratified sampling requires that the whole population is split into a number of smaller populations or 'strata' (two, in Figure A2.1), and simple random sampling is carried out in each strata. This has the effect of increasing the accuracy of the result. For instance, urban police stations (that arrest large numbers of children) may make up one strata, whilst rural police stations (that arrest only a few children) may constitute a second strata.

Cluster sampling describes a sample that is made of units that are grouped together rather than taken randomly from throughout the entire population. Clusters may consist, for instance, of groups of children where each group is held in a different place of detention. Together, all of the clusters make up the complete sample.

2. Confidence limits

When information is gathered from a sample, it is only possible to *estimate* the result for the total population. In other words, it is not possible to be 100% certain that the result obtained for the sample is exactly representative of the total population.

A sample can, however, be used to generate a *range* within which it is possible to be *reasonably confident* that the true population figure lies. This is done through the statistical calculation of confidence limits. Confidence limits are based on the *standard error* of a sample, which is a measurement of how much individual values deviate from the average.

For example, if '95% confidence limits' are used, it can be said that there is only a 5% chance that the true population value lies outside of the range that is encompassed.

Confidence limits show the range within which it is possible to have a reasonable degree of confidence that the true population value lies.

Example: In a sample of 100 children from a population of 500 detained children, 37% were found to have received a visit from their parents in the previous 3 months. The standard error of the sample was calculated to be 0.0434.

Using a value from statistical tables (1.96), we can say that the 95% confidence limit for the population proportion is 37% +/- (1.96 x 0.0434) = 37% +/- 9.

In other words, there is only a 5% chance that the actual population proportion of detained children who have received a visit from their parents in the previous 3 months is outside the range of 28% (37% - 9) to 46% (37% + 9).

3. What is being measured

When sampling in order to estimate true values for the indicators, it is important to be aware of exactly what is being measured. There are two possibilities. Some indicators measure a *population total*. Others measure a population *proportion*.

For example, Indicator 2 measures the *total number* of children in detention in a country. Indicator 3, on the other hand, measures the *proportion* of children leaving detention during a 12 month period who fall into a particular 'time spent in detention' category.

It is also necessary to consider the nature of the population that is being measured. The subject of 'child populations' is discussed in the manual on pages 32 and 33. For ease of reference however, Table A2.1 below shows the total population (from which a sample will be taken) for each indicator, together with what is being measured.

Table A2.1 – The total population and what is measured for each indicator

Indicator		Total population	What is measured
Quantitative Indicators			
1	**Children in conflict with the law**	▪ All children arrested in the country within a 12 month period	▪ **The population total**
2	**Children in detention**	▪ All children in the country detained on a specified date	▪ **The population total**
3	**Children in pre-sentence detention**	▪ All children in the country detained pre-sentence on a specified date	▪ **The population total**
4	**Duration of pre-sentence detention**	▪ All children completing a period of pre-sentence detention within a specified period	▪ **A population proportion** (those children within the population falling within a particular detention-time category)
5	**Duration of sentenced detention**	▪ All children completing a period of sentenced detention within a specified period	▪ **A population proportion** (those children within the population falling within a particular detention-time category)
6	**Child deaths in detention**	▪ All child deaths in detention during a 12 month period	▪ The population total
7	**Separation from adults**	▪ All children detained on a specified date	▪ **A population proportion** (those children within the population not wholly separated from adults)
8	**Contacts with parents and family**	▪ All children detained on a specified date	▪ **A population proportion** (those children within the population who have received a visit in the previous 3 months)
9	**Custodial sentencing**	▪ All children sentenced by a competent authority during a 12 month period	▪ **A population proportion** (those children within the population who receive a custodial sentence)
10	**Pre-sentence diversion**	▪ All children diverted during a 12 month period	▪ **A population total**
11	**Aftercare**	▪ All children released from detention during a 12 month period	▪ **A population proportion** (those children within the population who receive structured aftercare)
Policy/Implementation Indicators that can also be measured in a quantitative form			
12	**Regular independent inspections**	▪ All places of detention in the country on a specified date	▪ **A population proportion** (those places of detention within the population that have received a visit in the previous 12 months)
13	**Complaints mechanism**	▪ All places of detention in the country on a specified date	▪ **A population proportion** (those places of detention within the population that operate a complaints procedure)

Indicator 6 (Child deaths in detention) is the only indicator that is not recommended for measurement by sampling. This is because the number of child deaths in detention is likely to be very small and correspondingly extremely difficult to estimate to a reasonable degree of accuracy by sampling.

4. Estimation of sample size when sampling for a population proportion

The size of a sample taken is connected to the degree of precision required for the estimation of the true population value.

For those indicators that measure a *population proportion*, the sample size, *n*, can be calculated from the degree of precision required, the *estimated* proportion present in the population, and the total population number, *N*, by the use of a mathematical equation.

Equation A2.1 – For use with simple random sampling for proportions

This equation is: $n = \frac{n_0}{1 + \frac{n_0}{N}}$ where $n_0 = \frac{(1.96)^2 pq}{(0.05)^2}$ for a 5% limit of error with 95% confidence.

p = the estimated proportion present in the population (expressed as a fraction) and $q = (1 - p)$.

According to this equation, the sample is required to be largest where p is nearest to 50% (0.5) of the total population. In other words, if 50% of children in detention on a particular date have received a visit from an adult family member in the last 3 months, then a larger sample will be required in order to estimate the true population proportion to the same degree of accuracy as where, say, 20% or 80% of children in detention had received a visit in the last three months.

Hence, in the absence of any information that suggests an estimate for p, it is safest to use a value of 0.5 for p (although this will, of course, require a sample size that may be larger than necessary). Table A2.2 below provides sample sizes calculated using Equation A2.1 for different values of N and p.

Table A2.2 – Sample sizes required when simple random sampling for a population proportion

		Total population number (N)													
		100	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**1000**	**1500**	**2000**	**3000**	**4000**	**>4000**
Estimated proportion in population (p)	**0.05**	66	99	119	132	109	113	116	118	122	127	129	132	134	138
	0.1	66	99	119	132	109	113	116	118	122	127	129	132	134	138
	0.15	66	99	119	132	141	148	153	158	164	173	179	184	187	196
	0.2	71	111	135	153	165	175	182	188	198	211	219	227	232	246
	0.25	74	118	147	168	183	195	204	212	224	242	252	263	269	288
	0.3	77	124	156	179	196	210	221	230	244	266	278	291	299	323
	0.35	78	127	162	187	206	221	233	243	259	284	298	313	322	350
	0.4	79	130	166	192	212	229	242	253	270	296	312	329	338	369
	0.45	79	131	168	195	216	233	247	258	276	304	320	338	347	380
	0.5	80	132	169	196	217	234	248	260	278	306	322	341	351	384
	0.55	79	131	168	195	216	233	247	258	276	304	320	338	347	380
	0.6	79	130	166	192	212	229	242	253	270	296	312	329	338	369
	0.65	78	127	162	187	206	221	233	243	259	284	298	313	322	350
	0.7	77	124	156	179	196	210	221	230	244	266	278	291	299	323
	0.75	74	118	147	168	183	195	204	212	224	242	252	263	269	288
	0.8	71	111	135	153	165	175	182	188	198	211	219	227	232	246
	0.85	66	99	119	132	141	148	153	158	164	173	179	184	187	196
	0.9	58	82	95	103	109	113	116	118	122	127	129	132	134	138
	0.95	42	54	59	62	64	65	66	67	68	70	70	71	72	73

Thus, for a population of 600 children in detention with an estimated 20% being not wholly separated from adults, a sample size of **175** would be required to estimate the true population proportion +/- 5% with 95% confidence.

As noted above, where an estimate for *p* is unavailable, a value of 0.5 should be used and sample size found accordingly.

The above technique is for use where an indicator measures a population *proportion*. The calculation of sample size for indicators that measure the population *total* is discussed in Section 6 below.

It must also be remembered that the table above is to be used for the calculation of sample size when *simple random sampling*, either alone, or when sampling *within* one strata. If cluster sampling is used, the situation is a little more complex.

5. The choice of sample

The sampling techniques and mathematical equations contained in this appendix are, strictly speaking, for use with *random* sampling. That is, individual sample units (e.g. children) or clusters of units, should be chosen truly randomly from the whole relevant population.

It may be the case, however, that as part of an information collection strategy, the units making up a sample may not be truly random. This could be the case, for example, where only certain places of detention record information about the children for which they are responsible, and it would be expedient to collect information from just these places of detention as a 'sample' of the whole population. Caution must be exercised in such cases to ensure that the sample is in fact representative of the whole population. The fact of recording information is likely to be linked, for instance, to good management of the place of detention. Children held in such places of detention may receive more visits on average than children held in other places of detention, or may even spend a shorter average period of time in detention.

As long as the management team is satisfied that the sample is representative with respect to the indicator being measured, then the techniques and calculations contained in this Appendix may still be used. Guidance should be sought, however, from a local statistician wherever a sample is chosen other than on a truly random basis.

6. Choice of sample technique

This section provides guidance as to which sampling technique might be most suitable for each of the indicators measurable by sampling. The appropriate calculations for estimating the population value and calculating confidence limits vary for each technique, and these are also provided.

(A) INDICATORS 1, 2 and 3 – Measuring population totals

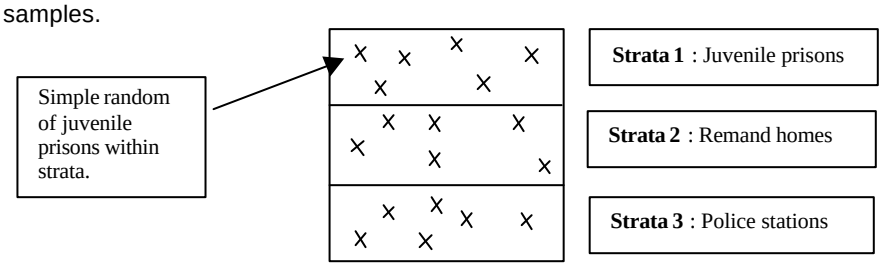
Indicators 1, 2 and 3 measure population totals. Indicator 1 requires that information is available from a completed 12 month period, whilst Indicators 2 and 3 are 'snapshot' indicators.

The technique described below can be used for Indicator 1, 2 or 3. It assumes that the information sources sampled are police stations (for Indicator 1) and places of detention, including police stations (for Indicators 2 and 3).

The total population of arrested or detained children is held within the total number of police stations and places of detention in a country. The difficulty to be overcome is that, within a country as a whole, individual police stations and places of detention arrest and detain (respectively) vastly different numbers of children. A juvenile prison for example may hold 400 children. The cells in a police station, on the other hand, may hold only 2 or 3 children. Assume that a simple random sample of places of detention is carried out to survey how many children are held in each place of detention selected. The risk is that the simple random sample of places of detention will produce an estimate of the total population of child detainees that has such large confidence limits as to make it virtually worthless (due to the fact that the number of children held in each place of detention is so varied).

The answer is to use stratified sampling. In stratified sampling, the population as a whole is divided into sub-groups, and simple random sampling is carried out within each sub-group. When sampling for Indicators 2 for instance, three strata (sub-groups) might be defined. Places of detention which hold large numbers of children (such as juvenile prisons) could make up one strata, places of detention which

hold fewer children (such as remand homes) could make up a second strata, whilst places of detention that hold very few children (such as police stations) may constitute the third strata. Each strata would then be sampled separately. If the *total number* of places of detention in each strata is known then the total population of children in detention can be estimated (with confidence limits) from the separate strata samples.



By way of example, Box A2.1 below shows how this technique might be used for Indicator 1.

Box A2.1 – Stratified random sampling for Indicator 1

Example:

Children in a large country can be arrested by a law enforcement authority operating from 200 police stations. 130 (N_1) police stations are rural and 70 (N_2) are urban. On average, urban police stations arrest six or seven times as many children as rural police stations. Hence rural and urban police stations are chosen as two separate strata.

Not all police stations systematically record details of the children that they arrest. However, 20 police stations in total are identified that do have recorded information available for the previous 12 months. These police stations are considered representative of the population of police stations. They consist of 10 rural police stations (n_1) and 10 urban police stations (n_2).

	Rural police stations	**Urban police stations**
Number of children arrested during 12 month period	3	34
	7	50
	12	44
	6	51
	2	30
	5	39
	8	35
	8	48
	10	56
	7	49
Strata total	68	436
Estimated population total = $\frac{Sx_1}{n_1}(N_1) + \frac{Sx_2}{n_2}(N_2)$	3936	
Strata $s^2 = \frac{1}{n-1}[Sx^2 - \frac{(Sx)^2}{n}]$	9.067	74.489
Population standard error = $v\left[\frac{N_1(N_1-n_1)(s^2_1)}{n_1} + \frac{N_2(N_2-n_2)(s^2_2)}{n_2}\right]$	295.8	
90% Confidence limits = Total +/- 1.64 x standard error	3478 < **3936** < 4421	

In other words, after sampling and completion of this calculation, we can be 90% sure that the total number of children arrested in the country as a whole during 12 months is between 3478 and 4421.

The size of error limits in stratified sampling can be reduced by careful choice of the sample size for each strata. In Box A2.1 above, a sample of 10 was taken from each strata, as these were the information sources that had recorded information available. However, where true random sampling within each strata can take place, then more thought can be given to the sample size for each.

As a rule of thumb, a larger sample should be taken within a particular strata if: (i) the stratum is larger, (ii) the stratum is more variable internally, or (iii) sampling is cheaper in the stratum.

In particular, much can be done to improve accuracy if an estimate of the variance, s^2, (the internal variability) of strata, and an approximate idea of the total population, are available. These may be derived from a small pilot survey, older data on the population of interest, or a mathematical estimator. $s^2 = 0.083h^2$, for example, is often used for estimating the variance within a stratum, where h is equal to the range within that stratum.

Where an estimate of s^2 for each stratum, and an approximation of the population total are available, Equation A2.2 below can be used to find the ideal total sample size, and the individual sample size for each strata:

Equation A2.2

$$\text{Total sample size, } n = \frac{(\Sigma N_h s_h)^2}{V + \Sigma N_h s_h^2}$$

Where N_h = The total population of each strata, s_h = the estimated standard error for each strata, and V = the required overall variance.

Box A2.2 shows how Equation A2.2 is used in practice:

Box A2.2 – Calculation of sample size for measuring Indicator 2 by stratified sampling

Example:

Children in a large country can be detained in either juvenile prisons, detention centres, remand homes or police cells. There are 3 juvenile prisons, 8 detention centres, 5 remand homes and 50 police stations with cells. The management team decide that each will be sampled in its own strata, as the number of children held in each is quite different.

The management team estimate s^2 (the variance) for each strata using $s^2 = 0.083h^2$. This equation can be used when the number of children held in each type of place of detention is relatively constant. The management team find, for example, that the smallest detention centre holds 40 children, whilst the largest holds 54. The value of s^2 for the detention centre strata is therefore estimated as $0.083 \times (54-40)^2 = 16.27$. Accordingly, $s_{detention\ centre} = \sqrt{16.27} = 4.03$. The same technique is used for each other strata.

Two years ago, the total population of detained children was known to be around 900. The management team want to estimate the current total population to within 5%. The value of V (the required overall variance) is therefore calculated using the value from 2 years ago: $(0.05 \times 900)^2 = 2025$.

The management team carry out the calculations below:

Strata	N_h	s_h	$N_h s_h$	$N_h(s_h^2)$	n_h
1 Juvenile prisons	3	14.40	43.2	622.08	**3**
2 Detention centres	8	4.03	32.24	129.93	**2**
3 Remand homes	5	3.46	17.3	59.86	**1**
4 Police stations	50	2.30	115	264.5	**8**
			$\Sigma N_h s_h$ = 207.74	$\Sigma N_h(s_h^2)$ = 1076.37	**14**
			$\Sigma (N_h s_h)^2$ = 43155.91		

The overall sample size is calculated using Equation A2.2: $\frac{43155.91}{2025 + 1076.37} = \mathbf{14}$

Each strata sample size is calculated using $\frac{14}{\Sigma N_h s_h} \times N_h s_h$

Hence, a total sample size of **14** can be used, consisting of all of the juvenile prisons (a "100% sample" for this strata), 2 of the 8 detention centres, 1 of the 5 remand homes and 8 of the 50 police stations. All of the children held in detention at each of these sample sites will be counted on the census date.

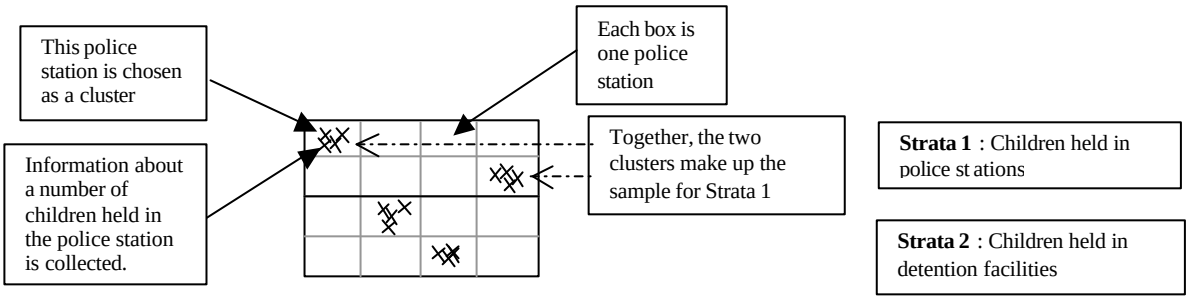
Once the information has been collected, the method contained in Box A2.1 can be used to estimate the current total population of detained children, together with confidence limits.

(B) INDICATORS 4, 5, 7, 8, 9 and 11 – Measuring population proportions

Indicators 4, 5, 7, 8, 9 and 11 measure population proportions. Only one of these indicators, however - Indicator 7 (Separation from adults) - can be measured as a 'snapshot'. All of the other indicators require that information is available from a completed period of 12 months (Indicators 4, 5, 9 and 11), or 3 months (Indicator 8). As such, sampling for these indicators is likely to be carried out when only some information sources have recorded information available, or when recorded information is available but is in a form that is not quickly and easily accessible for all information sources.

The total child population for each indicator will either be contained within individual places of detention, or will have been sentenced by individual courts. As a result, sampling for measurement of these indicators is, in effect, cluster sampling.

Suppose, for instance, that sampling is required to be carried out for Indicator 7 (Separation from adults). Suppose also that children are detained in two types of places of detention: police stations and juvenile detention facilities. As in the examples above, each of these could make up one strata. However, this time, when individual police stations or detention facilities are chosen for sampling, information is collected at each site about a *characteristic* of individual children who are all held within that individual centre. In other words, at each place of detention we have a *cluster* of children about whom we will collect information. Added together, the clusters make up the sample as a whole.



At each place of detention, we might collect information about all of the children held there, or decide to collect information about only a certain number, such that the cluster sizes were constant. Information about just twenty children, for instance, might be collected at each site. Accuracy is much improved where a large number of small clusters are used, rather than a small number of big clusters.

Box A2.3 below provides an example for the measurement of Indicator 4 (Duration of pre-sentence detention) by cluster sampling.

Box A2.3 – Cluster sampling in strata for Indicator 4

Example:

Children in a large country can be detained prior to sentencing in either remand homes or police stations. There are 16 remand homes and 100 police stations that hold children in pre-sentence detention. The management team decide that each will be sampled in its own strata, as the number of children held in each is quite different.

All places of detention record and keep information about children who completed a period of pre-sentence detention during the previous 12 months. However, the information is stored in bulky paper box files. The management team decide that, in the first instance, it would be quicker to take a sample from the places of detention whilst the paper information is transferred to electronic format. The total population of children will effectively be cluster sampled in two strata; remand homes and police stations.

The management team do not know what proportion of children will fall into each time pre-sentence detention time category. However, it is estimated that, during the 12 month period, 500 children in total completed pre-sentence detention in police stations, and 1000 children in total completed pre-sentence detention in the remand homes. The management team therefore commence by using Table A2.2 as a very rough estimate of total sample sizes.

	Police stations – 500 estimated total children	**Remand homes** – 1000 estimated total children
Estimated sample size from table A2.2, using $p = 0.5$	217	278

Box A2.3 continued

Using the estimated total numbers of children and places of detention, the management team calculate that, on average, 5 children (500/100) will have completed pre-sentence detention in each police station during the 12 month period, and that 63 children (1000/16) will have completed pre-sentence detention in each remand home. To make up the total sample, the management team therefore decide to sample from 43 police stations (217/5), and 5 remand homes (278/63).

The management team randomly choose the places of detention that will be sampled and, at each site, record the proportion of children who left pre-sentence detention during the 12 month period which fall into each of the time categories used for Indicator 4.

The table below shows the management team's calculations for children who spent < 1 month in pre-sentence detention. Note that the calculations required are different to those in Box A2.1.

	43/100 Police stations					**5/16 Remand homes**
	1/5	2/4	3/5	0/5	1/5	8/66
	0/5	1/4	2/4	3/5	2/5	12/60
Proportion of children	2/4	1/6	1/4	2/5	3/6	15/69
who left pre-sentence detention	4/4	0/4	0/3	2/5		15/61
during the 12 month period	3/6	1/4	3/4	1/4		11/64
that spent < 1 month	2/5	2/4	2/7	2/5		
in pre-sentence detention	0/3	2/5	1/3	1/3		
(*a* / *m*)	1/5	3/5	0/2	2/4		
	2/5	0/6	2/4	4/4		
	1/3	1/4	3/4	1/3		
Strata proportions (p) = Sa / Sm	70 / 190 = 0.368					61 / 320 = 0.191
Sample proportion = $p_1(n_1/N_1) + p_2(n_2/N_2)$	0.22					
Strata s^2 = $\frac{Sa^2 - 2pSam + p^2Sm^2(1-f)(1+0.05(m_{av}-1))}{n(n-1)(m)^2}$	0.000879					0.001293
Population standard error = $v[\frac{1}{N^2}((N_1(N_1-n_1)(s^2_1)/n_1) + (N_2(N_2-n_2)(s^2_2)/n_2))]$	0.00347					
95% confidence interval = Population proportion +/- 1.96 x standard error	21.3% < **22%** < 22.7%					

The calculations show that from the cluster samples using 43 police stations and 5 remand homes, **22%** of children spent less than 1 month in pre-sentence detention. The management team can be 95% sure that this value lies between 21.3% and 22.7%.

The management team will carry out the same calculation in order to measure the proportion falling in each other time category.

7. Summary of sampling strategies for each indicator

The table on the following page summarises the suggested sampling strategy for each of the Quantitative Indicators and the two Policy/Implementation Indicators that may also be measured in a quantitative form (Indicators 12 and 13).

As mentioned previously, Indicator 6 (Child deaths in detention) is not considered appropriate for measurement by sampling.

Table A2.3 – Suggested sampling strategy for each indicator

Indicator		Suggested sampling strategy
Quantitative Indicators		
1	**Children in conflict with the law**	▪ Identify appropriate strata for information sources that arrest children/are responsible for the detention of children, such as urban police stations and rural police stations, or remand homes, police stations, detention centres and juvenile prisons ▪ Identify appropriate sample sizes for each strata using Equation A2.2 where possible ▪ Ensure that information sources making up the sample have information available for the previous 12 months ▪ Collect sample information for each sample ▪ Calculate estimated population total and confidence limits using the method in Box A2.1
2	**Children in detention**	
3	**Children in pre-sentence detention**	
4	**Duration of pre-sentence detention**	▪ Identify appropriate strata for information sources that are responsible for the detention of children, such as police stations, remand homes, educational establishments, juvenile detention centres ▪ Identify appropriate total sample sizes for each strata and appropriate cluster sizes with guidance from a local statistician on the calculation of sample size in the particular country context ▪ Ensure that information sources making up the sample have information available for the previous 12 months or 3 months where necessary ▪ Collect sample information from cluster sites ▪ Calculate estimated population proportion(s) and confidence limits using the method in Box A2.3
5	**Duration of sentenced detention**	
7	**Separation from adults**	
8	**Contacts with parents and family**	
11	**Aftercare**	
9	**Custodial sentencing**	▪ Identify appropriate strata for information sources that issue sentences, such as magistrate's courts, district courts, regional courts or other competent authorities ▪ Identify appropriate total sample sizes for each strata and appropriate cluster sizes with guidance from a local statistician on the calculation of sample size in the particular context ▪ Ensure that information sources making up the sample have information available for the previous 12 months ▪ Collect sample information from cluster sites ▪ Calculate estimated population proportion receiving a custodial sentence and confidence limits using the method in Box A2.3 ▪ Where possible, use the same sample to estimate the total number of children sentenced to any measure (for Indicator 10 below) using the method in Box A2.1
10	**Pre-sentence diversion**	▪ Identify appropriate strata for information sources that register children for diversion programmes, such as police stations, magistrate's court or social welfare services ▪ Identify appropriate sample sizes for each strata using Equation A2.2 where possible ▪ Ensure that information sources making up the sample have information available for the previous 12 months ▪ Collect sample information for each sample ▪ Calculate estimated population total and confidence limits using the method in Box A2.1 ▪ Use this estimated population total, together with the estimated total number of children sentenced to any measure (see box above) to calculate the indicator value
Policy/Implementation Indicators that can also be measured in a quantitative form		
12	**Regular independent inspections**	▪ Identify appropriate strata for information sources that are responsible for the detention of children, such as police stations, remand homes, detention centres and juvenile prisons ▪ Use Table A2.2 to estimate sample sizes for each strata (the total population is the total places of detention, not total children) ▪ Collect sample information for each sample ▪ Calculate estimated population proportion and confidence limits using appropriate equations of stratified sampling for proportions
13	**Complaints mechanism**	