A guide to choosing sample sizes for M&E practitioners

27 May 2021
Learning objectives

● Choose a sample size for:
  ○ Snapshots: a KAP or Needs Assessment survey
  ○ Change over time: a baseline/final surveys

● Account for costs for stratified and clustered samples
Learning objectives: Key concepts

» Population
» Sample
» Sampling method
» Sample estimate
» Population parameter
» Error
» Sampling error
» Non-sampling error
» Population standard deviation
» Sample standard deviation

» Effect size
» Type 1 and Type 2 Error
» Simple Random Sample
» Complex Sample
» Intra-cluster Correlation Coefficient
» Design Effect
Samples sizes for KAP Surveys and Needs Assessments
Knowledge Attitude and Practices (KAP)

Provide a quantitative **snapshot** of the **knowledge**, **attitudes**, and **practices** of a population.

Results can be used to design interventions.

For more information:
KAP survey example

**Goal:** Increase COVID-19 vaccination rates in a rural population

**KAP Survey:**

- **Only 15%** of respondents knew that the vaccine was available for free
- **5%** of respondents said they could not afford to travel to the vaccination site.

**Conclusion:** focusing on awareness raising will have a high impact on vaccination rates (because … )
**KAP survey example**

**Goal:** Increase COVID-19 vaccination rates in a rural population

**KAP Survey:**

- 95% of respondents knew that the vaccine was available for free
- 50% of respondents said they could not afford to travel to the vaccination site.

**Conclusion:** funding mobile vaccination sites will increase vaccination rates
Needs assessment surveys

Provide a quantitative *snapshot* of the needs of a large population.

Results can be used to *design* interventions to address the most pressing vulnerabilities.
Needs assessments: Example

**Goal:** Reduce morbidity and mortality and preserve dignity among a large group of newly-displaced IDPs.

**Needs assessment:**

- What % have adequate shelter?
- What % experienced diarrhea in last 7 days?
Key concepts

**Population** is the entire group of people* about whom we want to draw conclusions.

A **sample** is the specific group that you will collect data from.

The **sampling method** is the process of choosing which members of the population are included in the sample.
Key concepts - applied to IDP Needs Assessment

**Population** is the entire 20,000 IDP **households** about which we are concerned.

A **sample** is the specific 200 households we will interview.
How can draw conclusions about a population of 20,000 households based on a sample of 200 households ??
Key concepts: Estimates and Error

The **Sample estimate** is the result we get from our survey.

**Error** is the difference between our **sample estimate** and the **population parameter**, or the “true” value.
Key concepts: Applied

**Population parameter:** 7% of households had at least one case of diarrhea in last 7 days.

**Sample estimate:** 15% of responding households had at least one case of diarrhea in last 7 days.

**Error** = Population parameter - Sample Estimate

= 7% - 15%

= -8%
Key concepts: Types of Error

**Sampling Error**

Error resulting from the difference between the population and our sample.

Can be estimated using mathematics.

**Non-Sampling Errors**

Other error, not related to sampling, including:

» Non-response error

» Interviewer error

» Social desirability bias

Difficult or impossible to estimate non-sampling error using mathematics.
Probability theory: example

If the probability of flipping a coin and getting “heads” is ½, then what is the probability of getting three heads in a row?

\[ P(3 \text{ heads}) = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8} = 12\% \]
How can we draw conclusions about a **population** of 20,000 households based on a **sample** of 200?

What is the probability of getting a **sample estimate** that has an **error** of 10% or more compared to the population value?
Probability theory

Sampling error can be estimated using tools from **probability theory**, a branch of mathematics.

Probability theory gives us tools to estimate how likely or unlikely events are.
Sampling error

Sampling error ($\sigma_{\bar{x}}$) depends on:

- Sample size ($n$)
- Population size ($N$)
- Population std. deviation ($\sigma$)
- Confidence level ($t_{\alpha/2}$)
- Sample design*

$\sigma_{\bar{x}} = t_{\alpha/2} \frac{\sigma}{\sqrt{n}} \sqrt{\frac{N - n}{N - 1}}$

Don’t panic! We have a calculator.
Calculating required sample size

If we know:

- Population size \((N)\)
- Population std. deviation \((\sigma)\)

And we choose:

- Confidence level \((t_{\alpha/2})\) and Sampling error \((\sigma_{\bar{x}})\)

We can solve for Sample Size \((n)\) algebraically

\[
t_{\alpha/2} \frac{\sigma}{\sqrt{n}} \leq \frac{\sqrt{N - n}}{\sqrt{N - 1}}
\]
Population standard deviation

- Measure of how diverse or how much variance there is in the population in our measurement

=> The more diversity, the larger a sample we need.

- Estimate using the Sample Standard Deviation ($s$)
Standard deviation - Percentages

Formula: \( s = (p)(1-p) \)  Where \( p \) is the percentage as a fraction

10% had diarrhea
\[ s = (.10)(.90) = .09 \]
Low stdev

50% had diarrhea
\[ s = (.5)(.5) = .25 \]
Highest stdev

90% had diarrhea
\[ s = (.90)(.10) = .09 \]
Low stdev
Examples: percentages

- **Gender**: usually split 50/50% (high standard deviation). We will need a larger sample to measure % of women precisely.

- **Left-handed**: about 10% (low standard deviation). We can use a smaller sample.
Standard deviation strategies

No information
Plan for the largest standard deviation to be safe.

Information available
Use previous surveys, census, etc, to estimate and save resources by planning for a smaller sample.
Recap: Calculating required sample size

If we know:
- Population size \( (N) \)
- Population std. deviation \( (\sigma) \)

And we choose:
- Confidence level \( (t_{\alpha/2}) \)
- Sampling error \( (\sigma_{\bar{x}}) \)

\[
t_{\alpha/2} \frac{\sigma}{\sqrt{n}} \leq \sqrt{\frac{N - n}{N - 1}}
\]
Sampling Error

Often communicated as:

- **Margin of error**: 25% ± 5% of IDPs have access to shelter.
- **Confidence intervals**: 20% - 30% of IDPs have access to shelter.

You should think of surveys as giving a range rather than an exact result.
Revisited: KAP survey example

Goal: Increase COVID-19 vaccination rates in a rural population

KAP Survey:

● Only 15% of respondents knew that the vaccine was available for free
● 5% of respondents said they could not afford to travel to the vaccination site.

Conclusion: focusing on awareness raising will have a high impact on vaccination rates
Revisited: KAP survey example

Goal: Increase COVID-19 vaccination rates in a rural population

KAP Survey:
- Between 10% and 20% of the population knows that the vaccine was available for free
- Between 0 and 10% of the population cannot afford to travel to the vaccination site.

Conclusion: focusing on awareness raising will have a high impact on vaccination rates
Revisited: KAP survey example

Goal: Increase COVID-19 vaccination rates in a rural population

KAP Survey:

- Between 5% and 25% of the population knows that the vaccine was available for free
- Between 0 and 15% of population cannot afford to travel to the vaccination site.

Conclusion: focusing on awareness raising will have a high impact on vaccination rates
Revisited: KAP survey example

Goal: Increase COVID-19 vaccination rates in a rural population

KAP Survey:
- Between 0% and 35% of the population knows that the vaccine was available for free
- Between 0 and 25% of population cannot afford to travel to the vaccination site.

Conclusion: focusing on awareness raising will have a high impact on vaccination rates
Using the calculator

https://www.activityinfo.org/support/docs/sampling/index.html
Samples sizes for Comparisons
Example

**Program:** Three year program to increase women’s meaningful participation in the security sector in a Middle Income Country (MIC)

**Indicator:** Percentage of security sector staff holding a positive perception of women’s entry, advancement and leadership in the security sector.

**Population:** All persons employed on January 1st, 2018 in the Army, Navy, or Police.
Measuring impact

Baseline survey, final survey after 3 years.

How large of a sample do we need?
Confidence intervals, n = 100

Probability theory gives us the tools to estimate the difference in percentages:

Difference is between -10% and +6%
Key concepts: Effect size

**Effect size**  the magnitude of difference between populations.

\[ ES = \frac{p_1 - p_0}{\sqrt{p_1(1-p_1)}} \]
Key concepts

**Type 1 Error:** False positive. Survey says there is a difference, but there is not in reality.

**Type 2 Error:** False negative: Survey says there is no difference, but there is a difference in reality.
Measuring impact

Baseline survey, final survey after 3 years.

How large of a sample do we need?

What is the smallest change we want to reliably detect?
Using the sample calculator

https://www.activityinfo.org/support/docs/sampling/baseline-and-endline.html
Accounting for Sample Design
Key concepts

The **sampling method** is the process of choosing which members of the population are included in the sample.
Key concepts - sampling methods

Random sampling
Sample is selected randomly, without bias.
Every member of the population has a well-defined probability of being selected.
Error and design effect can be estimated mathematically.

Convenience Sampling
Sample is selected at the interviewer or respondent’s convenience.
Examples: Interviewing people in the market, web surveys on social media.
# Key concepts - random samples

<table>
<thead>
<tr>
<th>Simple Random Sample (SRS)</th>
<th>Complex Sample</th>
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<tbody>
<tr>
<td>Every member of the population has an <strong>equal</strong> and <strong>independent</strong> chance of being selected.</td>
<td>Every member of the population has a <strong>known chance</strong> of being selected.</td>
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<tr>
<td></td>
<td>Design includes:</td>
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<tr>
<td></td>
<td>- Stratification</td>
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<tr>
<td></td>
<td>- Clustering</td>
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<td>- Multiple stages</td>
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Problem: transportation costs

If we select a SRS, we might have to travel to many different places.
Cluster Sample, \( n = 16 \)
Number of villages = 15
Simple Random Sample, n = 16
Number of villages = 4
Cluster sampling

- First select clusters randomly
- Then select individuals within the cluster randomly
- Sample is no longer independently selected
Key concepts

**Intra-cluster correlation (ICC):** The degree to which members of the same cluster resemble each other.

**Effective sample size:** the sample size of a Simple Random Sample (SRS) with the same precision.

**Design effect:** The ratio between the actual sample size and the effective sample size.
Example: % of population under 25
Low intra-cluster correlation
Example: % of population with access to an elementary school
Very high intra-cluster correlation
Using Design Effect

If you are planning on a survey with a Design Effect of 2.0, **double** your required sample size.

If you are planning on a survey with a Design Effect of 3.0, **triple** your required sample size.
Using the ICC and Design Effect Calculator

https://www.activityinfo.org/support/docs/sampling/cluster.html
Thank you!
Please try
www.activityinfo.org
and join us for our next webinar!