International Journal of Community Medicine and Public Health
Raut MK et al. Int J Community Med Public Health. 2026 Mar;13(3):1497-1506
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040
DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20260712

Short Communication

SCoPE toolkit: a comprehensive tool to estimate survey sample size, cost, population projection and estimation of denominators for nutrition and health program implementers, researchers and program evaluators

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Received: 25 April 2025
Revised: 30 January 2026
Accepted: 31 January 2026

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ABSTRACT

Prioritization and optimization of budgets for research and program implementation is an important aspect of program conceptualization and management in a world, where there are resource constraints. Estimating budgets for health and nutrition surveys embedded in a program becomes a regular exercise for program implementers and managers. But this becomes difficult due to absence of any estimates or coefficients to benchmark surveys and survey data quality assessments. In addition, estimation of denominators for program monitoring and forecasting of micronutrients and health supplies is requirement, which is regular requirement. A survey sample size, cost, population projection and estimation (SCoPE) toolkit has been developed keeping in mind the needs of the fraternity of program managers, researchers and program evaluators. This could be used to estimate sample size with different absolute and relative precision levels adjusting for design effects and response rates, tentative costs for upcoming surveys, population projections, age specific denominators for forecasting of supplies and monitoring. It has population proportions for the 1,000 days, under five years, 10-19 years for adolescents for weekly iron and folic acid (IFA) supplementation, 15 to 49 years of age for WRA for daily IFA and calcium supplementation, annual and monthly births and pregnancies, assessment of data quality of age data using Whipple's index for digit preference for terminal digits of 0 and 5, assessment of age-sex structure of a population by using a population pyramid, converting five year population to single year age population for groups. It also includes data metrics and a statistical calculator.

Keywords: SCoPE tool, Programs, Surveys, Sample size, Cost of surveys, Population proportion estimation, Precision, DEFF, ICC

INTRODUCTION

Designing, sampling surveys and estimating budgets for health and nutrition surveys embedded in a program becomes a regular exercise for program implementers and managers. But this becomes difficult due to absence of any estimates to benchmark surveys and survey data quality assessments. In addition, estimation of denominators for program monitoring and forecasting of micronutrients and health supplies is a regular requirement. This toolkit assists in this whole process.[1]

METHODS

Objectives

The objective of this paper is to demonstrate a user-friendly excel based toolkit with user friendly buttons to

systematically cost and design programs, surveys, estimate sample size, project population for denominators for program monitoring and tracking. The analyses for the study were undertaken between 2018 and 2025. This toolkit that we developed contains 100+ excel sheets in a workbook which are connected to each other through hyperlinks. The main landing dashboard page, contents of the toolkit and the excel sheets to help in various stages of the program implementation and program evaluation is presented below: The five modules are as follows: program and survey design and methodology module, survey cost module, survey sample size estimation module, population projection and estimation module and statistical calculator and data metrics module (Figures 1 and 2).

Figure 1: The Home landing page of the dashboard of the SCoPE toolkit.

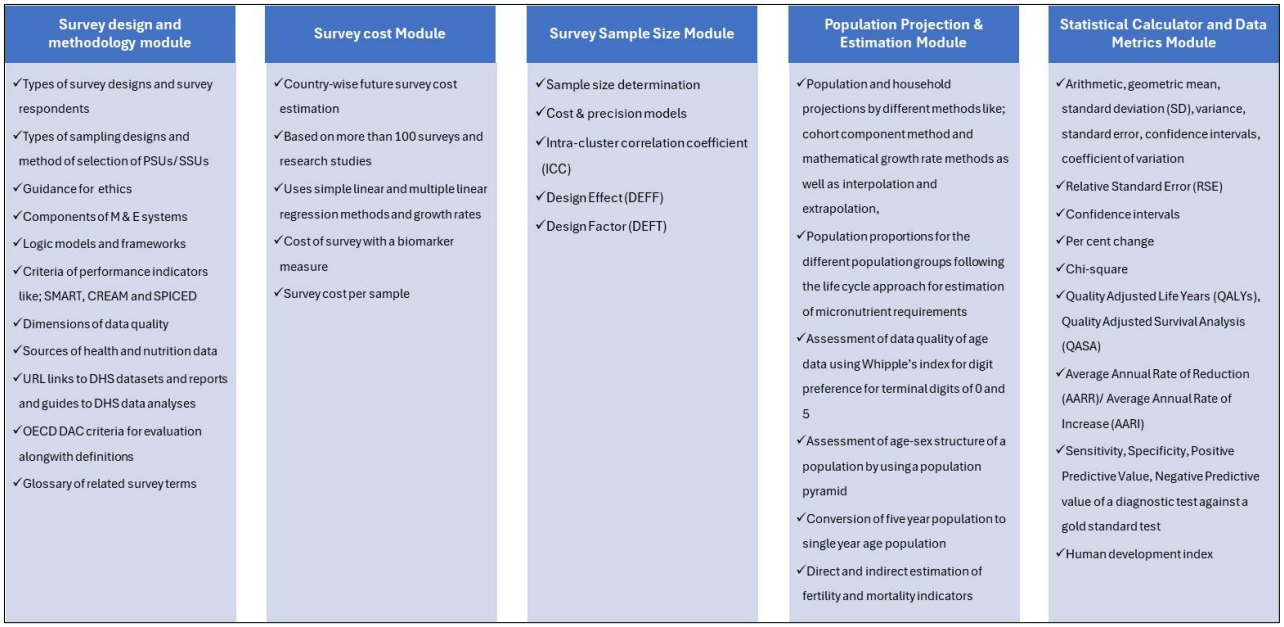

Figure 2: Contents of the SCoPE toolkit.

Program and survey design and methodology module

It includes different types of survey designs, survey respondents, sampling designs, method of selection of PSUs/ SSUs, guidance for ethical conduct for research involving humans, Logic models and frameworks, dimensions of data quality, components of M and E systems, criteria of performance indicators, sources of health and nutrition data, URL links to DHS datasets and reports, guides to DHS data analyses and OECD DAC criteria for evaluation along with definitions and a glossary of related survey terms. This module presents the journey

of a survey design and program design and implementation as mentioned in the following sections: Any survey journey traverses through three phases; a survey design phase, a survey implementation phase and a survey dissemination phase (Figure 3). The journey of program design, program implementation and implementation research design is presented as follows.

Program and survey design phase

The initial process starts with a needs assessment, understanding the program impact pathways, development of a theory of change, development of logical framework, logic model, performance measurement framework, logic model, formulation of research objectives and research questions, development of study design, methodology, estimation of sample size and sampling plan (Figure 4).

Needs assessment

Needs assessments serve as incredibly powerful tools for decision making, resource allocation, and ultimately reaching programmatic goals. They can be utilized across a range of settings to shed light on a variety of topics and identify potential gaps, such as programmatic actions needed to improve breastfeeding rates in a hospital.

It is important to conduct a needs assessment at the onset of the project, to ensure programs are appropriately tailored to the individuals and communities that are being served.

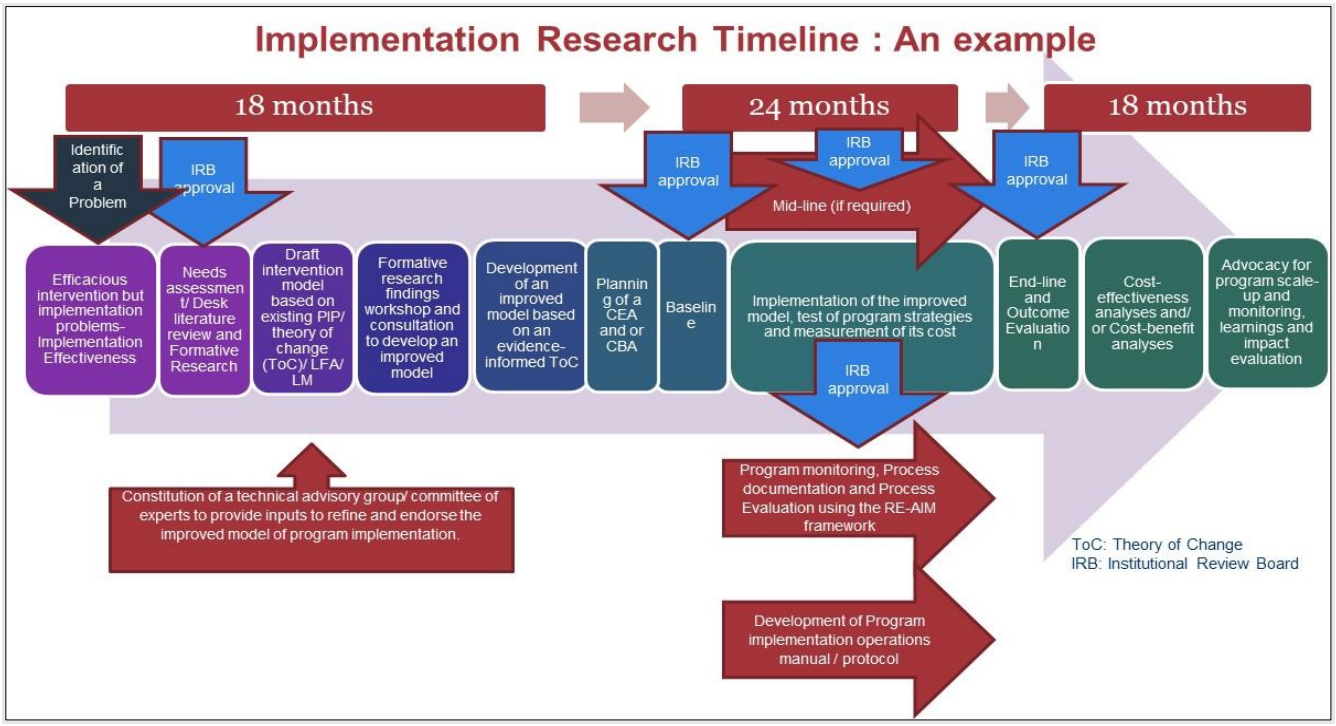

Figure 3: Conceptual framework diagram of the program design, implementation and implementation research with tentative timelines for six years (60 months).

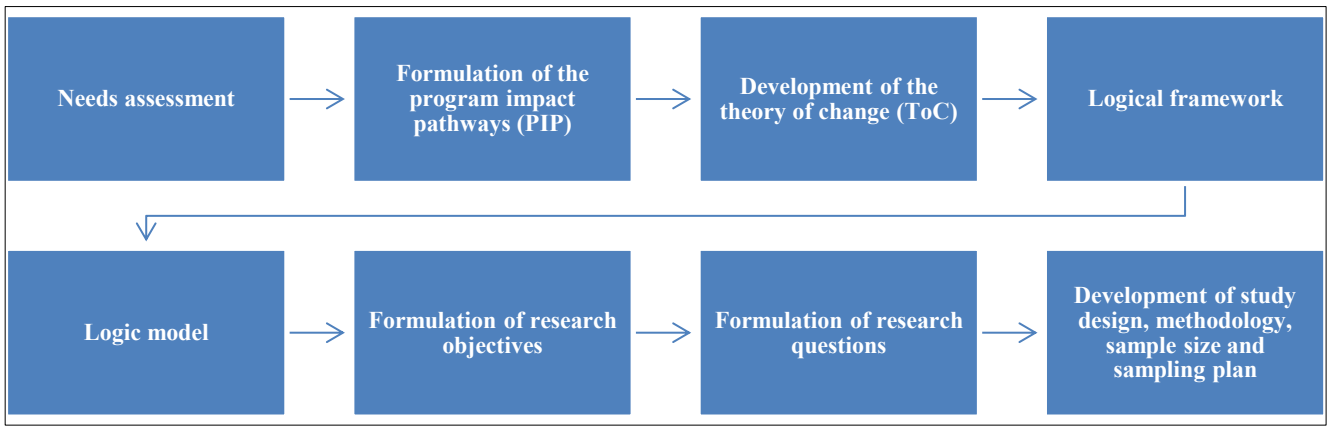

Figure 4: Survey design phase processes.

Program impact pathways (PIP)

A program impact pathway diagram involves translating the logic model narrative into a diagram that describes the activities that the program performs to achieve its stated goals using a causal logic. In other words, the PIP diagram is a representation of the road map that is expected to be followed for the inputs and activities to lead to the expected outcomes. In the PIP diagram, the roads that lead from one activity to the next are referred to as "processes".

Theory of change (ToC)

A theory of change is a method that explains how a given intervention, or set of interventions, are expected to lead to a specific development change, drawing on a causal analysis based on available evidence.

Logical framework

A log frame is a tool for improving the planning, implementation, management, monitoring and evaluation of projects. The log frame is a way of structuring the main elements in a project and highlighting the logical linkages between them.

Logic model

A logic model is a graphic depiction (road map) that presents the shared relationships among the resources, activities, outputs, outcomes, and impact for your program. It depicts the relationship between your program's activities and its intended effects.

Formulation of research objectives and research questions

In order to formulate research objectives and questions, needs assessment, logical framework, logic model, theory of change and PIP can be utilized. The Child Health and Nutrition Research Initiative (CHNRI) method may be employed to determine research priorities and questions. The CHNRI method measures collective optimism of a larger number of researchers toward various components of many proposed research ideas, within an agreed context and using the agreed criteria.

Study design

The study and methods should be fit-to-purpose design, flexible, responsive, quality assured and standardized collection, curation and analysis, based on available budgets (usually a key consideration). Based on the research questions, the study design may be observational assessments, either descriptive or analytical studies.

Analytical studies could be ecological or correlational studies, cross-sectional or prevalence studies: Demographic and Health Surveys (DHS), Multi-Indicator Cluster Surveys (MICS), SMART Surveys, National Nutrition Surveys (NNS), case-control or case-reference studies of cohort or follow-up studies.

They may also utilize experimental studies such as randomized control trials or clinical trials: individual RCTs, C-RCTs: phase-in, cross-over, parallel, pretest-post-test control-group design, post-test-only control-group design, field trials, Community trials or community intervention studies or quasi-experimental studies like; non-equivalent comparison group pretest-post-test or time-series quasi-experimental design/interrupted time-series.

Study tool development

Tool development and guides for developing indicators for program performance measurement could consider the following principles of indicator development.

Principles of indicator development

Principles of Indicator development includes SMART: specific, measurable, achievable and attributable, relevant and time bound, CREAM: clear, relevant, economic, adequate and monitorable and SPICED: subjective, participatory, interpreted, cross-checked, empowering and diverse

IRB approval procedures

A research protocol including study tools, informed consent forms for different age groups, assent forms for children need to be developed to be submitted to an IRB. IRB approval could be obtained from institutional ethics committee (IEC), Research Ethics Committee, Institutional Review Board (IRB).

Ethical and government approvals and no objection certificates (NOC)

This involves the survey team submitting relevant documentation and obtaining approval from appropriate internationally recognized ethical review committee and local government officials prior to implementing the survey. Informed consent is obtained from adult respondents and in research with children (individuals under 18 years of age), assent of the child and parental permission are standard requirements.

The study team should also adhere to any national Government's personal data privacy acts like; the General Data Protection Regulation (GDPR), The India Digital Personal Data Protection Act, 2023 (DPDP Act), Government of Canada's The Personal Information Protection and Electronic Documents Act (PIPEDA) 2000 while collecting, processing, analyzing, storing, retrieving and deleting digital personal data.

All data in research studies should be de-identified of any personally identifiable information (PII).

Methods of sampling

Probability sampling

A probability sampling method is any method of sampling that utilizes some form of random selection. In order to have a random selection method, we must set up some process or procedure that assures that the different units in your population have equal probabilities of being chosen. The examples are; simple random sampling, stratified random sampling, systematic random sampling, cluster sampling and multi-stage sampling.

Non-probability sampling

The difference between non-probability and probability sampling is that nonprobability sampling does not involve random selection and probability sampling does. In general, researchers prefer probabilistic or random sampling methods over non-probabilistic ones and consider them to be more accurate and rigorous. However, in applied social research there may be circumstances where it is not feasible, practical or theoretically sensible to do random sampling. The examples are; convenience sampling, purposive sampling and snowball sampling.

Respondent selection by systematic random sampling (SysRS)

Systematic sampling is the ordered sampling at fixed intervals from a list, starting from a randomly chosen point. Typically, systematic sampling is not used at the first stage of sampling (selection of PSUs) because it renders the estimation of sampling error difficult. Systematic sampling is recommended at the SSU, TSU, and household selection stages of sampling. Systematic sampling may be linear or circular.

Survey implementation phase

The following steps could be carried out to implement the assessment (Figure 5).

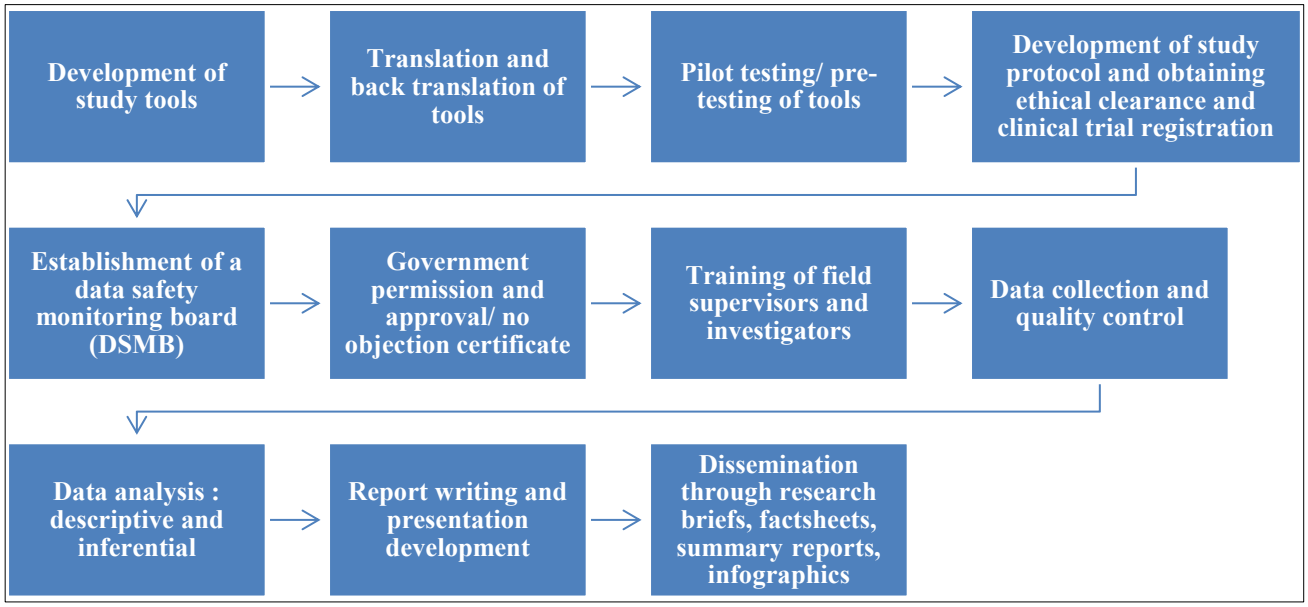

Figure 5: Steps to conduct a study.

PSU and SSU cluster selection procedure

In order to select subpopulations for the surveys, the population needs to be divided into a complete set of non-overlapping groups, known as clusters, which are usually defined by geographic or political boundaries. However, a complete listing of clusters that are very large may not necessarily be feasible for the survey.

Instead, the larger clusters should be subdivided into several smaller segments, of which only one will be included in the survey and listed. In the first stage, primary sampling units (PSU) or clusters are sampled with probability proportionate to the size (PPS) of the population; larger clusters have a higher probability of being sampled.

The second stage involves sampling exactly the same number of individuals per cluster with individuals in large clusters having a lower probability of being sampled. This method allows for the second stage to compensate for first stage, so that ultimately, each individual within the population has the same probability of being sampled.

Households and respondents' selection procedure

The study participants in the households can be selected using systematic random sampling.

Data collection methods

Based on the research questions, there can be different modes of data collection; this could be either quantitative or qualitative or a mixed-methods study. The quantitative methods could include semi-structured interviews and the qualitative methods of data collection could include FGDs, IDIs, methods of participatory rural appraisal like; social mapping, well-being map, resource map, Venn diagram, transect walk, pile sorting, preference ranking, problem tree analysis, case studies, ethnographic methods of enquiry, documentary analyses, qualitative observation, Structured observation, Implementer interviews, Participant interviews and most significant change (MSC) stories.

Data safety monitoring board (DSMB)

A data safety monitoring board may be established for clinical trials as needed. The Data and Safety Monitoring Board (DSMB) is an independent group of experts that advises the study. It comprises of a committee of research experts, such as physicians and statisticians, and general community members, who monitor the progress of a study and review safety and effectiveness data throughout the study.

The members of the DSMB serve in an individual capacity and provide their expertise and recommendations. Their primary responsibilities are to: periodically review and evaluate the accumulated study data for participant safety, study conduct and progress, and, when appropriate, efficacy, and make recommendations to the study team concerning the continuation, modification, or termination of the study.

Quality assurance and control during data collection

It is recommended to provide for and assure quality assurance mechanisms for a pre-test and post-test of training of investigators and supervisors, supervising teams during training and data collection, checking of data regularly, while it is being collected, cleaning of the data to ensure quality and reliability of the data and quality of the main report and presentation. Some high frequency checks (HFCs), back checks (BCs) and spot checks (SPs) could be built in.

Data quality assessment

Data quality assessment could consider the dimensions of data quality: accuracy, reliability, completeness, timeliness, precision, integrity, confidentiality and ensure plausibility checks from SMART methodology.

The accuracy of age and sex data in the survey data could be assessed with the application of Whipple's index, Myer's blended index, UN joint accuracy index, age-sex pyramid, age ratio score, sex ratio score.

Weighting of the survey data

The data could be weighted, which should include generated survey weights including all the different probabilities of selection of PSU, household, respondent selection, and non-response rate adjustment, the inverse of the overall probabilities and normalization of the weights, as necessary. The survey team must compute the sampling errors for the key indicators using complex samples procedure in a statistical software accounting for the survey design and cluster sampling method being used.

Data analyses

The data analysis plan is based on the research questions and objectives and methods of data collection adopted in the study. Qualitative method of data collection generates qualitative data and quantitative methods of data collection generates quantitative data. Qualitative methods of data analyses are used to analyse qualitative data. Quantitative methods data analysis is used to analyse quantitative data. A statistical data analysis software like could be used to conduct descriptive and inferential statistics based on the requirements of the study. The relative standard errors could be computed to assess the reliability of the indicators. Qualitative methods of data analyses include content analyses and thematic analyses. Quantitative methods of data analyses include univariate analyses like; frequencies, central tendencies like mean, median mode, bivariate analyses like; cross-tabulations and multi-variate analyses like; multiple regression analyses among others.

Survey dissemination phase

Report writing, dissemination and knowledge translation

The report should be concise to facilitate its readability by program managers. Policy makers may also be offered the opportunity to read the research and policy briefs as part of the knowledge products developed for dissemination. The report should include in its outline: an executive summary, background/introduction, methods and materials including the study design, sampling design, sample size, key findings, discussion, conclusion and recommendations, annexes of any supplementary information, tables, documentation, ethical approval certificate, study tools, and references.

Manuscript development and publication

The plan for a manuscript to publish insights from the study findings should start with the determination of the research question, data analysis methods, the choice of journals, and the determination of authors and the sequence of authorship. The authorship policy principles set out by the International Committee of Medical Journal Editors (ICMJE) (2010), considering adaptations proposed by Clement (2013) to quantify relative contributions, confirm eligibility as an author and assign order of authorship (Figure 6).[2,3]

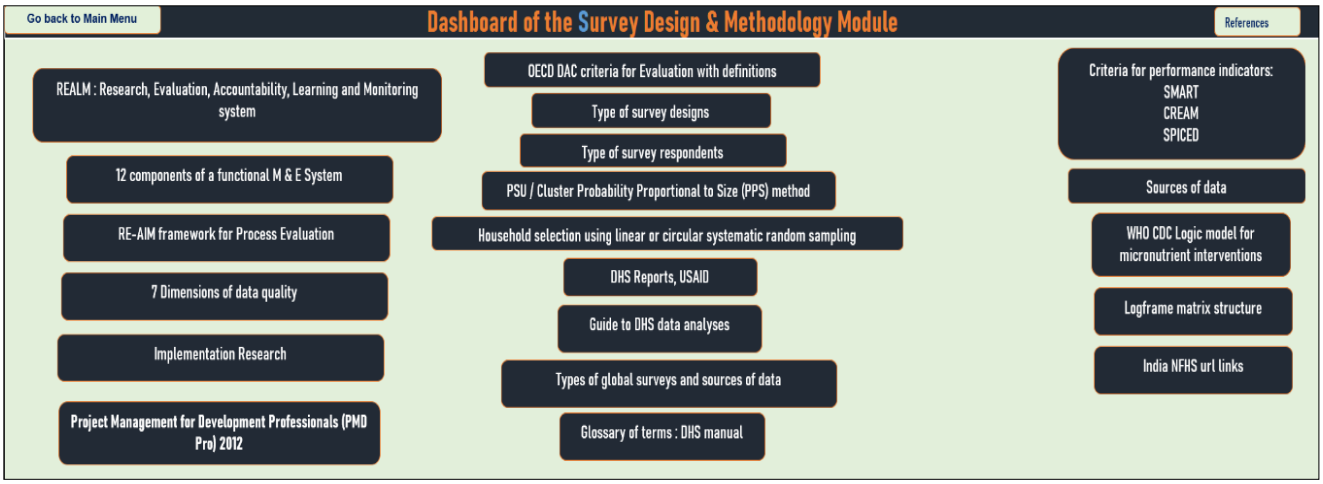

Figure 6: Dashboard of the survey design and methodology module.

Survey cost module

The excel spreadsheet uses regression to estimate costs based on data of historical survey costs of 100+ implementation research, impact evaluations, surveys, qualitative and quantitative research from 2008-25 adjusted for inflation. The sample size calculator is directly linked to the cost with visualization of the cost and precision. The excel spreadsheet uses regression to estimate cost based on data on historical survey costs from 2008-25 adjusting for inflation. The sample size calculator is directly linked to the cost with visualization of the cost and precision. It incorporates computation of survey cost using different methods of simple linear and multiple linear regression methods as well as other methods for selected countries. The cost and sample size data of multiple research studies, surveys, impact evaluations conducted in different countries were entered and a computation spreadsheet was developed to estimate the cost of future research studies accounting for the country-wise inflation (Figure 7). These are presented in the local and international currency for ease of use.

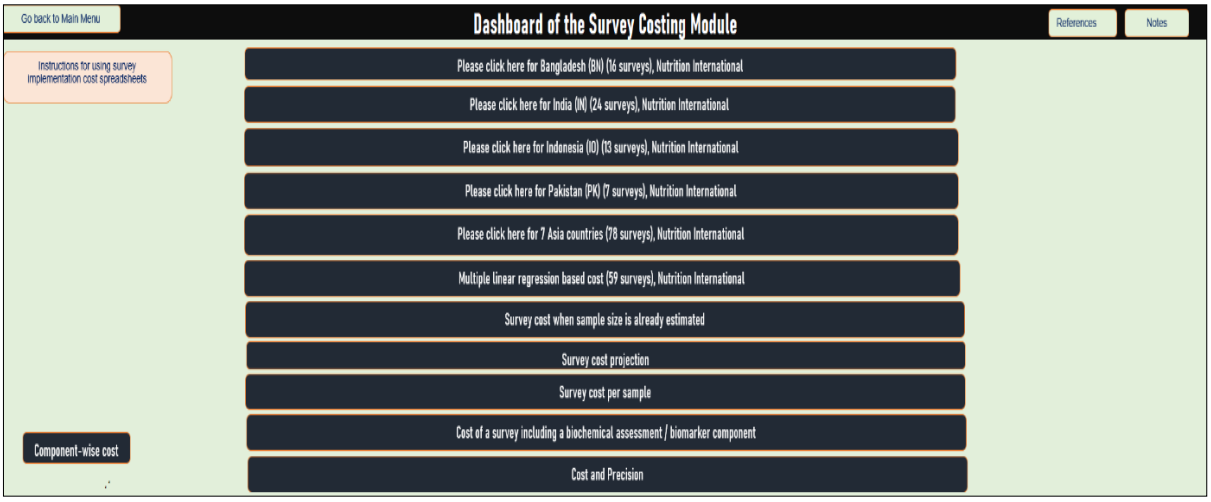

Figure 7: Dashboard of the survey cost module.

The formula used to estimate the regression is as follows, where Y_i is dependent variable, β_0 is constant or intercept, β_1 is slope or coefficient, and X_i is independent variable.

$$Y_i = \beta_0 + \beta_1 X_i$$

Survey sample size module

It has simulations of sample size for multiple scenarios employing different methods using absolute and relative precision assumptions and different parameters of sample size, computation of intra-cluster correlation coefficient (ICC), and design effect (DEFT).

Sample size determination

This is determined by the design, cost and precision of the study. If the survey is intended to measure many indicators among different population groups, a choice must be made as to which indicator will drive the sample size.[1] The major

factors that influence sample size decisions are related to the survey purpose and design and include: stratification and proposed number of survey strata; key indicators, population groups of interest, and whether estimates are required at the stratum or national level; precision and level of statistical confidence required for the indicator of interest in the specific population group at the stratum and national levels; and available budget. The confidence level describes the confidence interval (CI) around the measurement derived from the survey. The CI is presented as a range of values within which the true value is likely to fall. A 95% CI is used as the standard in most surveys and is used in the sample size calculations in this module. The width of the CI around the estimate, for example ±0.05 (±5%) or ±0.10 (±10%) is a measure of the level of precision.

Intra-cluster correlation coefficient (ICC)

The intraclass correlation coefficient is a measure of the correlation between individuals clustered within the same context. It is the proportion of the total unexplained variation in an outcome that is attributable to differences between the contexts. The ρ or ICC of a given variable is typically determined by looking at pilot or baseline data for your population of interest. Should you not have the data, another way of estimating the ρ is to look at other studies examining similar outcomes amongst similar populations. Given the inherent uncertainty with this, it is useful to consider a range of ρs when conducting your power calculations (a sensitivity analysis) to see how sensitive they are to changes in ρ. While the ρ can vary widely depending on what you are looking at, values of less than 0.05 are typically considered low, values between 0.05-0.20 are considered to be of moderate size, and values above 0.20 are considered fairly high.

Design effect (DEFT)

Deft is a measure of efficiency of cluster sampling compared to a direct simple random sampling of individuals, defined as the ratio between the standard error using the given sample design and the standard error that would result if a simple random sample had been used (Figure 8).

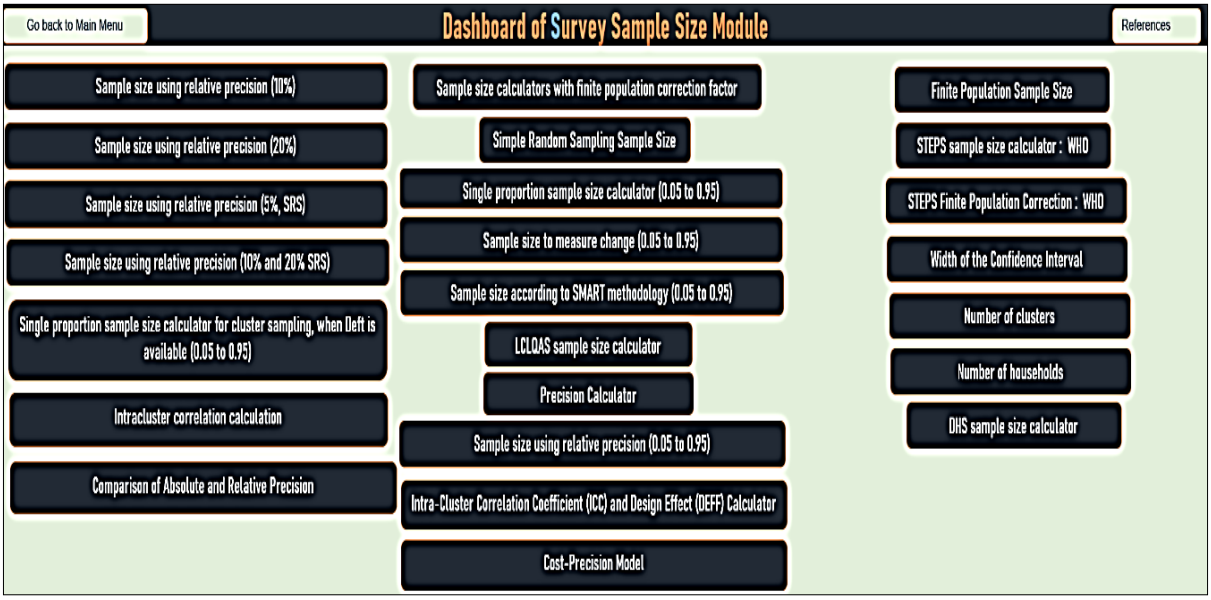

Figure 8: Dashboard of the survey sample size module.

Population projection and estimation module

The toolkit includes population data of all countries in the world from UN ESA estimates and population projections by different methods like; cohort component method and mathematical growth rate methods like arithmetic, geometric and exponential as well as interpolation and extrapolation, population proportions and denominators for the different population groups in the life cycle approach; number of pregnancies, first 1,000 days of life (-270 days to 730 days), for under five years, and within it for 0 to 5 months for exclusive breastfeeding (EBF), 6 to 23 months for IYCN, 6 to 59 months/9 to 59 months (India)/6 to 11 months and 12 to 59 months for vitamin A supplementation and 0 to 59 months for zinc/ORS for diarrhoea management, 10-19 years adolescents for weekly IFA supplementation, 15 to 49 years of age for WRA for daily IFA and calcium supplementation, annual and monthly estimates of births and pregnancies.[4-10]

It also includes computation sheets for assessment of data quality of age data using Whipple's index for digit preference for terminal digits of 0 and 5, assessment of age-sex structure of a population by using a population pyramid, converting five-year population to single year age population for groups, which cannot be estimated using available population at five-year age intervals. It also incorporates tables of country-wise data on age-wise projected population (Figure 9).

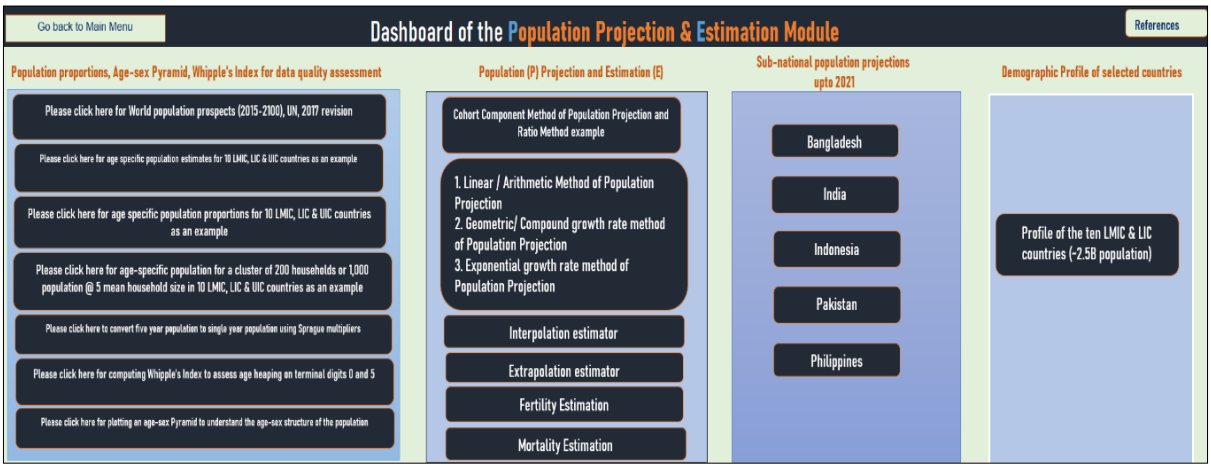

Figure 9: Dashboard of population projection and estimation module.

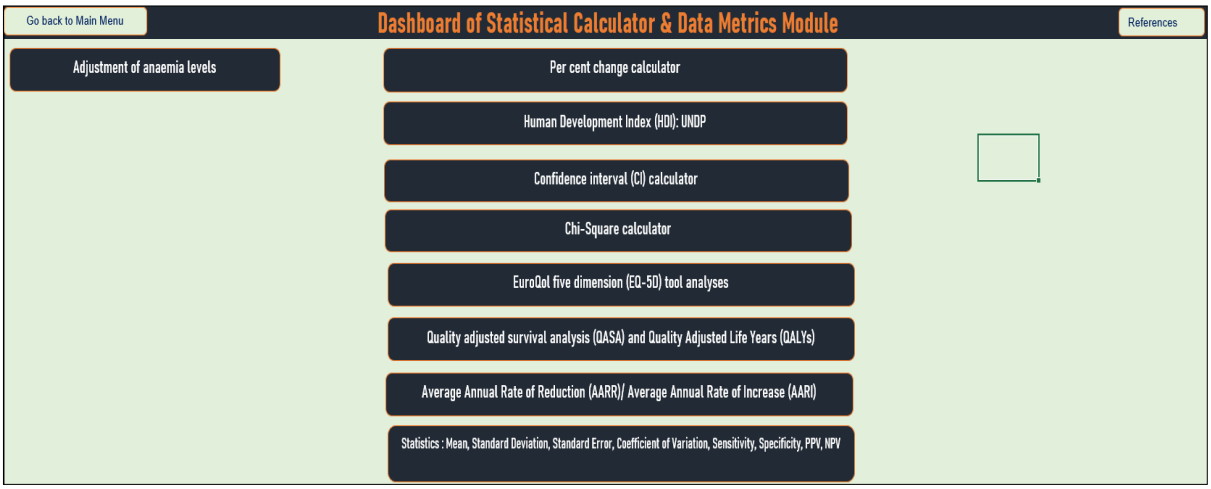

Figure 10: Statistical calculator and data metrics module.

Statistical calculator and data metrics module

It incorporates computation of per cent change, Human development index, chi-square, quality adjusted life years (QALYs), quality adjusted survival analysis (QASA), average annual rate of reduction (AARR)/average annual rate of increase (AARI), sensitivity, specificity, positive predictive value, negative predictive value of a test, arithmetic, geometric mean, standard deviation (SD), variance, standard error, confidence intervals, coefficient of variation and relative standard error (RSE).

Results of the regression analyses

The results of the regression analyses for the estimation of survey cost based on sample sizes of surveys are presented below: The regression equations for the different countries are as follows: The regression equation is given as follows.

$$y = a + bx$$

Bangladesh surveys: estimated cost (y)=13,188.4(a) + 9.88(b)x, where x=sample size, India surveys: Estimated Cost (y)=63,968.1(a) + 1.8 (b)x, where x=sample size, Indonesia surveys: estimated cost (y)=66,877.7.4(a) + 29.7x, where x=sample size and Pakistan surveys: estimated cost (y)=59,692.3(a) + 4.0x, where x=sample size.

DISCUSSION

In the development sector literature, there is a dearth of this kind of holistic toolkits to manage monitoring, evaluation, research and learning for program improvement influencing policy and practice.[10]

This toolkit aims to fill this gap and act as an aid for the academic and programmatic fraternity to manage the full suite of design, cost, estimate sample size, DEFT, ICC, project population, population denominators for health and nutrition program improvement.

CONCLUSION

Authors sincerely hope that this tool will be quite useful for program implementers to design, implement, budget,

analyse data and estimate population denominators for computation of indicators using the numerators generated through program monitoring through HMIS and DHIS to track the progress of health and nutrition indicators.

ACKNOWLEDGEMENTS

Authors would like to acknowledge the extensive review and valuable suggestions given by Colin Beckworth, MEAL consultant, Red Kite consulting.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Raut MK, Rai R, Kapoor M, Bera D, Walters D, Wuehler S. SCoPE toolkit: a comprehensive tool to estimate survey sample size, cost, population projection and estimation of denominators for nutrition and health program implementers, researchers and program evaluators. Int J Community Med Public Health 2026;13:1497-506.