PART 7.

Data Analysis

Computer software can be used to make comparisons to the reference standards. The Centers for Disease Control and Prevention (CDC) has developed a free software package called Epi Info that can handle all of these anthropometric calculations (www.cdc.gov/epiinfo). Cooperating Sponsors are strongly encouraged to use available software to analyze nutrition data. Not only will the software enable raw anthropometric survey data to be transformed into the indices and scores described in Part 6, the software will flag outliers which are usually the result of incorrect measurements, coding errors or incorrect ages. Once the anthropometric indices have been calculated, they can be presented in simple tables using specified cut-offs and age categories consistent with the Title II Generic Indicator list.

When using computer software for anthropometry, there are three separate procedures that should be performed. First, the raw measurement data should be entered into the computer. Second, the program should combine the raw data on the variables (age, sex, length, weight) to compute a nutritional status index such as weight-for-age, height-for-age or weight-for-height. Third, the program should transform these data into Z-scores so that the prevalence of nutritional conditions, such as being underweight and stunted, can be calculated.

Another software called ANTHRO analyzes anthropometric data and can be downloaded from the WHO Global Database on Child Growth and Malnutrition (www.who.int/nutgrowthdb).

There is another Windows-based software available from: www.nutrisurvey.de. This software program was designed specifically for nutrition surveys by the Work Group on International Nutrition of the University of Hohenheim/Stuttgart in cooperation with the German Agency for Technical Cooperation (GTZ). The software is based on the *Guidelines for Nutrition Baseline Surveys in Communities* published by GTZ. The purpose of the program is to integrate all steps of a nutrition baseline survey into a single program. The program contains a standard Nutrition Baseline questionnaire which can be easily customized for the specific site, a function for printing out the questionnaire, a data entry unit which controls the data being entered, a specially adapted plausibility check, a report function and a graphics section. The report function produces the full set of descriptive statistics of a baseline survey. The graphics section contains standard graphs and additional graphics for the anthropometric indices with comparison to the NCHS standard. The anthropometric indices (Z-scores of height-for-age, weight-for-height, weight-for-age) and the prevalence of stunting, wasting, underweight and overweight of children are calculated automatically. For further statistical evaluation, the data can be exported to SPSS or other statistical programs.

7.1. Sources of Epi Info Software

Public domain sources of Epi Info software and supporting materials. Epi Info is available from the Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA 30333, USA or downloaded from: www.cdc.gov/epiinfo/.

The Epi Info 2002 package comes with a manual and tutorials to help the user to become familiar with data analysis using Epi Info.

7.2. Recommendation for Analysis and Presentation of Height Data

For evaluation purposes, the presentation of stunting data for children less than 24 months is useful. An intervention among children under 24 months is likely to be more effective than among children 24-59 months. This is because: 1) the determinants of stunting in the older children are more varied; and 2) stunting in older children may reflect historical nutritional or health stress and be 'permanent,' i.e. not responsive to any intervention. A further consideration in the presentation of data on stunting by age groups is the change in measurement technique at 24 months of age.

Prevalence. For use in Title II programs, the prevalence of nutritional status conditions can be calculated using cut-off points for height-for-age and weight-for-age. The cut-off points can be set using Z-scores, percentiles or percentage of the median. For Title II programs, a cut-off of -2 Z-score is recommended and results should be presented for both males and females. An example of a prevalence table for low height-for-age as established by -2 SD for groups of children aged 6 - 59.99 months is given below.

Table 7.1. Prevalence of low height-for-age (stunting) in a sample of 97 children, by sex and age group

Age Group (months)	Sex	Number below cut-off (-2 SD)	Number in age group	Percentage below cut-off
< 6	Boys	0	6	0.0
	Girls	0	4	0.0
	Combined	0	10	0.0
6-11.99	Boys	0	6	0.0
	Girls	0	3	0.0
	Combined	0	9	0.0
12-23.99	Boys	1	6	16.7
	Girls	2	10	20.0
	Combined	3	16	18.8
24-35.99	Boys	0	7	0.0
	Girls	4	13	30.8
	Combined	4	20	20.0
36-47.99	Boys	6	10	60.0
	Girls	3	10	30.0
	Combined	9	20	45.0
48-59.99	Boys	6	15	40.0
	Girls	5	7	71.4
	Combined	11	22	50.0
Total	Boys	13	50	26.0
	Girls	14	47	29.8
	Combined	27	97	27.8

Overall, this table shows that 26.0 percent of the boys had a low height-for-age or were stunted, while 29.8 percent of girls were stunted. Interpretations can also be made about the various age groups or with boys and girls grouped together.

7.3. Examples of Data Analysis

This section covers an analysis of data pertaining to maternal and child nutrition programs using food aimed at vulnerable groups in two populations (countries A and B), simulating situations often encountered in Title II operations. These examples illustrate an analysis that would allow one to reach, at a minimum cost, statistically valid conclusions concerning the nutritional impact of a supplementary feeding program.

The analysis compares the "before intervention" and "after intervention" data according to the following plan going from the general to the specific.

For all ages and sexes combined:

- all ages, both sexes comparison of change in the indicators;
- calculation of general prevalence of malnutrition (stunting and underweight);
- calculation of changes in prevalence.

Examination of data separated by sex (ages combined):

- calculation of general prevalence of malnutrition for each sex;
- calculation of changes in prevalence.

Examination of data by age categories (sexes combined):

- calculation of prevalence of malnutrition by age category;
- calculation of changes in prevalence.

With reference to this plan of analysis, the following assumptions should be noted.

- The final year evaluation measurements were taken after an interval sufficiently long for the program to have produced a nutritional impact (e.g. five years);
- Data were collected from a cross-sectional sample representative of the program population; and
- Baseline data had been collected.

The first example is a comparison of percentage or prevalence changes. Cooperating Sponsors are encouraged to compare changes in the mean Z-scores for statistical and epidemiological rigor.

Example 1

In 1995, a US-supported Cooperating Sponsor in cooperation with the Government of Country A, introduced a community-based health and nutrition program with a supplementary feeding scheme aimed at vulnerable groups. The scheme covered 6 of the 14 administrative districts of the country. Food supplements were distributed through community centers on a year-round basis to infants over six months of age and children up to the age of 3 years and to pregnant women and lactating mothers over an 18-month period (last 6 months of pregnancy and the first 12 months postpartum). In all, 86,000 individuals (21,000 women and 65,000 children) were covered by the program.

In agreement with the USAID Mission and Food for Peace (FFP), the Cooperating Sponsor decided to evaluate the nutritional changes at three intervals (baseline, mid-term and final year). The first collection of data began in the second year following the initiation of operations. By adopting a pre-post or reflexive design, data on sex, age, weight and height were collected from three representative cross-sectional sample surveys of the infant and child beneficiaries in 1996, 1998 and 2000.

Ages of the sample children ranged from 6 months to 5 years. Due to some problems in age estimations and incomplete data, sample sizes of the children varied between 3700 and 2500. No data were collected from the 8 districts in which the program had not been implemented. The population of the 8 districts was not comparable, from the nutritional and socioeconomic standpoints, with the population of the 6 districts covered by the program.

7.3.1. Calculation of Nutrition Levels

The measurement of nutritional impact was based on a comparison of data collected in 1996 and 2000 so that the figures would include the largest possible proportion of children who had participated in the program for one year or more. It was felt that this time interval was necessary to allow for any anticipated impact to manifest itself. The collected data are summarized in Table 7.5.

The results for weight-for-height are presented to illustrate that this indicator is inappropriate to evaluate the program since it reflects short-term changes. The tables also include age ranges that will not be used in the final presentation but Cooperating Sponsors are encouraged to examine the results for different age groups to better understand how the indicator responds.

Table 7.2. Distribution of nutritional indicators (Z-scores) at baseline (all ages)

	Height-for-age HAZ	Weight-for-age WAZ	Height-for-height WHZ
No. examined	2695	2695	2695
No. below -2 **SD**	1294	916	110
% below -2 **SD**	48.0	34.0	4.1

Table 7.3. Prevalence of low levels of nutritional indicators by sex at baseline (all ages)

	HAZ < -2	WAZ < -2	WHZ < -2
Girls	49.5	32.4	3.6
Boys	47.3	35.6	4.6

Table 7.4. Prevalence of stunting or low levels of height-for-age by age categories at baseline

	6-11 months	12-23 months	24-35 months	36-59 months
HAZ < -2	34.5	42.4	48.5	52.7
No. examined	560	523	534	1078

Table 7.5. Prevalence of low levels of nutritional indicators by sex and stage of intervention (for specific age categories)

	HAZ < -2 24-59 months		WAZ < -2 6-35 months		WHZ < -2 6-35 months	
	Baseline	Final year	Baseline	Final year	Baseline	Final year
Girls	49.5	35.5	32.4	23.1	3.6	3.2
Boys	47.3	37.5	35.6	26.5	4.6	4.0
Sexes combined	48.0	36.6	34.0	25.0	4.1	3.8

Tables 7.4 and 7.5 show that over the four years of the intervention, stunting in girls and boys was substantially reduced along with underweight. For sexes combined, the reduction was 11.4 and 9.0 percentage points for stunting and underweight, respectively. The reduction for stunting was more dramatic while wasting (WHZ) was virtually unaffected. Wasting should not be used for evaluation purposes as it is a relatively rare event and very susceptible to seasonal influences.

Note the different age groupings for stunting and wasting in Table 7.5. Some of the children measured for stunting were older than the children in the intervention. The reason for selecting the 24-59 month age group for evaluation was to capture the cumulative and lagged effect that the nutrition project would have on stunting.

There is another reason for the different age groupings. It is not recommended to aggregate data for children under 24 months with those over 24 months (see Part 7.2). Also, the Title II Generic Indicators recommend either stunting or underweight indices but require specific age groupings for underweight.

7.3.2. Comparison of Mean Z-scores

The alternative and preferred approach to evaluating the change in a percentage for a nutritional index is to compare mean Z-score change over the life of the program. Just as in the above calculation of change in prevalence of an index, the data are analyzed at baseline with the mean and standard deviation calculated and compared with the same project area in the final year of the program. The mean Z-score comparison has the advantage of describing the entire population directly, without resorting to a subset of individuals below a set cut-off. Comparing means over prevalences is desired as many of the Title II interventions target whole communities not just the severely malnourished.

A community health and nutrition intervention would expect all children to benefit, whereas a targeted feeding program for the severely malnourished would only benefit these children. Using a -2 SD cut-off and presenting a prevalence change would show a change in the prevalence of those below the cut-off. Therapeutic feeding programs would focus on changes in nutritional status among the severely malnourished but community based programs target all children and their caregivers. A presentation of the mean would reflect all the children and comparing means would reflect the community shift or improvement. The statistical comparison of mean Z-scores over time using the Student's T-test for example, is a more powerful statistical test than comparing prevalences using the Chi-square statistical test. Using the same example from above, Table 7.6 presents the results of the mean Z-scores for height-for-age and weight-for-age.

The evaluation recommendation for Title II programs is to use a comparison of mean Z-scores for statistical testing but the results should be presented with both change in mean Z-score and change in prevalence as the latter is more easily understood by a general audience.

Table 7.6. Mean Z-scores for stunting (HAZ) and underweight (WAZ) by sex and stage of intervention (for specific age groupings)

	HAZ 24-59 months		WAZ 6-35 months	
	Baseline	Final year	Baseline	Final year
Girls	-2.53	-2.33	-1.98	-1.54
Boys	-2.48	-2.45	-1.86	-1.65
Sexes combined	-2.50	-2.36	-1.93	-1.58

Example 2

A Cooperating Sponsor conducted a baseline and final-year survey collecting height and weight data on 24-59 month old children. At both times the sample was randomly drawn from the target communities and did not include the same children in both surveys. The pre-post design enabled a comparison of change in nutritional status (as reflected by height-for-age) in the target communities.

Baseline at time zero:

(t_0): Mean Z-score = -2.05 (sd=1.26); Prevalence (-2SD cut-off) = 40%
Sample size = 940

Final year at time five:

(t_5): Mean Z-score = -1.20 (sd=1.15); Prevalence (-2SD cut-off) = 23%
Sample size = 1056

Using statistical software to conduct the t-test (e.g. SPSS, or STATA; note that Epi Info 2000 or Epi Info 6 does not have this test), the testing of the significance of the change in the sample means is straightforward.

t = (Mean t_0 - Mean t_5) / sq. root (Variance t_0/n_0 + variance t_5/n_5)

where n_0 and n_5 is sample size at baseline and final year.

t = (-2.05 - (-1.20)) / [sq. root ((1.26x1.26)/940)) + ((1.15x1.15)/1056))]
t = (-0.85) /[sq. root (0.0016889) + (0.0012523)]
t = (-0.85) /[0.054233]
t = 15.67

This change in mean Z-scores is highly significant (i.e. well above the critical t-value of 1.96 at 0.05 level).

7.4. Additional Data Analysis Information

In cooperation with Food Aid Management, FANTA developed a workshop for the training of program managers in the calculation and analysis of basic anthropometric data using Epi Info and SPSS (Statistical Package for Social Sciences). The materials from the Data Analysis Workshop are available at: www.fantaproject.org under Monitoring and Evaluation.

Step-by-step instructions on data analysis can be found on the Practical Analysis of Nutritional Data (PANDA) website: www.tulane.edu/~panda2/. PANDA was designed for data analysis instruction using SPSS software.

There are many statistical analysis software packages available, other than Epi Info. The packages listed below are only a few of the commonly used statistical analysis software programs. These packages vary in capability and cost. Information on capability and ordering the packages can be found on their websites.

SPSS (Statistical Package for Social Sciences) www.spss.com
SAS (Statistical Analysis System) www.sas.com
STATA (Statistics/Data Analysis) www.stata.com
SUDAAN (Software for the Statistical Analysis of Correlated Data)