1st Report on the World Nutrition Situation – Supplement on Methods and Statistics

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UNITED NATIONS

ADMINISTRATIVE COMMITTEE ON COORDINATION – SUBCOMMITTEE ON NUTRITION (ACC/SCN)

The ACC/SCN is the focal point for harmonizing the policies and activities in nutrition of the United Nations system. The Administrative Committee on Coordination (ACC), which is comprised of the heads of the UN Agencies, recommended the establishment of the Subcommittee on Nutrition in 1977, following the World Food Conference (with particular reference to Resolution V on food and nutrition). This was approved by the Economic and Social Council of the UN (ECOSOC). The role of the SCN is to serve as a coordinating mechanism, for exchange of information and technical guidance, and to act dynamically to help the UN respond to nutritional problems.

The UN members of the SCN are: FAO, IAEA, IBRD, IFAD, ILO, UN, UNDP, UNEP, UNESCO, UNHCR, UNICEF, UNRISD, UNU, WFC, WFP and WHO. From the outset, representatives of bilateral donor agencies have participated actively in SCN activities. The SCN is assisted by the Advisory Group on Nutrition (AGN), with six to eight experienced individuals drawn from relevant disciplines and with wide geographical representation. The Secretariat is hosted by WHO in Geneva.

The SCN undertakes a range of activities too meet its mandate. Annual meetings have representation from the concerned UN agencies, from some 10 to 20 donor agencies, the AGN, as well as invitees on specific topics; these meetings begin with symposia on topics of current importance for policy. The SCN brings certain such matters to the attention of the ACC. The SCN sponsors working groups on inter–sectoral and sector–specific topics. Ten–year programmes to address two major deficiencies, vitamin A and iodine, have been launched.

The SCN compiles and disseminates information on nutrition, reflecting the shared views of the agencies concerned. Regular reports on the world nutrition situation are issued, and flows of external resources to address nutrition problems are assessed. State–of–the–Art papers. are produced to summarize current knowledge on selected topics. As decided by the Subcommittee, initiatives are taken to promote coordinated activities – inter–agency programmes, meetings, publications – aimed at reducing malnutrition, primarily in developing countries.

ACC/SCN
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Publication of material for the ACC/SCN's First Report on the World Nutrition Situation in two sections – as the report itself and this supplement – was originally proposed by the Advisory Group on Nutrition (AGN), to expedite making the results of the review available. The First Report was issued in November 1987, has been widely distributed and is now being reprinted. This Supplement on Methods and Statistics gives details of

methods and data used. For much of the data and advice on analytical methods we are indebted to all those who helped with the First Report, as acknowledged there, notably those in FAO, WHO, and members of the AGN.

This supplement was written by Ms K.Test, based on the work for the First Report. Additional help for the supplement was provided by A.Kelly, M.Lotfi, and P.Stone. Our thanks are due to Ms P.Jamieson and C.Hastings for doing the word processing.

J.B.Mason

1. INTRODUCTION

This supplement to the ACC/SCN's First Report on the World Nutrition Situation (ACC/SCN. Nov. 1987, referred to here as the Report) essentially expands section 4 of that report – the Technical Notes – to give more details, for two main purposes. In the first place, it was felt that an understanding of what is known about the world nutrition situation needs considerable detail on sources of data, assumptions, and analytical methods; in addition, the basic data used are reproduced here[1] for possible further examination or analysis. Second, the methods may be used, no doubt with some development, for future reports on world nutrition. This supplement will provide a source of reference for methodology.

It should be stressed that all estimates used have been based on available data, virtually all published elsewhere – references are given – by the agencies concerned. These are primarily FAO, WHO, and the United Nations Population Division, whose assistance is much appreciated in providing information and advice. In particular, we should emphasize the help of FAO in undertaking many computer calculations from their data base (mainly AGROSTAT) – often rapidly and at short notice.

The basic data given in the Annex Table AI gives the data available from FAO and UN Population Division, as of November 1987, for all countries included, used to estimate underweight prevalences by the methods described below. Table AII gives the anthropometric data used to develop the models. The aggregated data in Table AIII are based on these and thus have the same validity. The data on anthropometric surveys in Table AII, the majority of which were obtained through WHO, were checked for consistency with WHO as of October 1987.

2. DATA AND SOURCES

Two data files were created for the estimates given in the First Report on the World Nutrition Situation (ACC/SCN, Nov. 1987, referred to here as me Report).

(i) A <u>country file</u> of basic data for each of the 94 countries included (given in table 3 of the Report). The data input into mis file is given in Table AI.

(ii) A <u>survey data file</u> containing data from countries with representative anthropometric survey data. The contents of this file are given in Table AIL

The data were processed mainly on IBM–compatible microcomputers, using DBase III and SPSS/PC.

The data used in the panels in the Report (i.e trends in indicators by country group) are given in Table Am. For each country group, data for 1960, 1970, and 1980 are available for most indicators; and yearly estimates from 1980. to 1985 are listed for population, per caput dietary energy supply (DES), and per caput food production indices only. Details of all indicators are discussed below. Distinctions are made between estimates obtained from other UN sources, and those derived by the SCN or the FAO Statistics Division. Sources arc summarized in the footnote to Table AIII. The number of decimal places shown in Table Am should <u>not</u> be taken to suggest undue accuracy. Numbers affected (expressed in millions) were usually reported to two decimal places because of the. very small populations in some country groups, particularly Middle America and the Caribbean.

[1] Annual estimates of dietary energy supply (kcals/caput/day) at country level calculated by

FAO are not published; either group means by year, or country estimates by three year periods are given. Similarly, country level estimates when derived by interpolation methods done by the SCN (i.e. prevalence of underweight children) are not given here, but are aggregated to country group level. This is because margins of error at country level are not known but arc probably substantial.

A complete list of countries used in these calculations is given in Table 3 (p.45) of the Report, by country group. The number of countries with complete information on all indicators varies slightly; for example, not all 94 countries had available information on child deaths. However, this is unlikely to have biased the estimates because only countries with small populations tended to have missing data, and there were very few of these.

2.1 Population data

The estimates of total population and infant mortality rates (IMR) used in the Report were taken primarily from the UN Population Division statistics. These data were available on computer tape in FAO, and were retrieved by the FAO Statistics Division. These figures were then re−entered into the country data file. The data on total populations and IMR were then used exactly as given by the UN Population Division, with no further calculations except for aggregation into country groups.

This section gives a brief description of the origins of and assumptions underlying these figures, and is based on UN (1986), in which further details can be found. **The description in this section therefore refers to calculations done before the data were retrieved, not to analyses done specifically for the Report, and is included as background information.**

By country, the size of the total population and its age and sex structure is first determined for the chosen base year. In most cases, this information is obtained from national censuses (UN, (1986) p.3). The availability of population census data varies by region throughout the world, but during 1975−84, over 95% of me world's population was covered by a population census. Between 1975 and 1984, 50 of the 56 countries of Africa conducted a census; almost all countries of Middle and South America completed a census; and finally, 36 of 43 countries or areas in Asia were covered by population censuses. (Data from North America and Europe were not used in the Report). Where census data for the chosen base year are lacking, information from previous censuses, civil registration, demographic surveys, and other administrative records is used by the UN for population estimation.

Three aspects of population change are considered in making projections of population for a given year: fertility, mortality and migration. The base year population estimates (by age and sex) are adjusted for these as described in UN (1986) p.4. Estimates of age specific fertility and mortality rates are described in UN (1986) p.8. Where these are unreliable for a country, other methods are applied to obtain reasonable estimates. International migration is the most poorly documented; however, except for a few cases, net migration is considered very small and taken to be zero.

One basic underlying assumption in the estimation procedure is that during the projection period, rates of change are reasonably stable; thus catastrophes such as war, famines and epidemics are not considered. This assumption would certainly influence estimates in Africa, where a severe drought affected many countries and contributed to a greater than expected mortality rate. In this instance, mortality statistics might have been adjusted if data were available by country. However, owing to the lag−time in data processing, particularly in times of disaster, the effect of drought was not generally considered in the population and infant mortality estimates given in the Report.

In general, mortality trends assume a gain of 2.5 years in life expectancy for every five year estimation interval, until expectancy reaches 62.5 years when there is a slowdown in the gain. In Sub−Saharan Africa this gain was lowered to 2.0 years for every five year interval in many countries. Both models assume a built−in improvement in mortality rate which, as mentioned above, is assumed to be unaltered by disasters.

From UN (1986) p. 10: "In preparing fertility assumptions, past and current fertility trends for each country are evaluated and placed within me social, economic and political context of the country. Trends and anticipated changes in the socio−economic structure and cultural values of the society as well as policies and programmes directed towards family planning are considered vis−a−vis expected trends in fertility." For a more detailed discussion of assumptions in fertility estimation, including high, medium, and low variants in fertility rates, see UN (1986) p. 10.

International migration was considered to be a significant component of population growth in only a few countries. However, in these cases an accurate estimate is virtually impossible to obtain because migration is affected by many "unpredictable political, economic, and social circumstances" (UN (1986) p.10), which can alter migration patterns in very short periods of time. Caution should be used in considering these cases.

2.2 Food Production Indices

The index numbers of food production compare a volume of agricultural production in a given year with the base period, 1979−81. The definition is given by FAO definition (1987) page **xi:**

"They are based on the sum of price−weighted quantities of different agricultural commodities produced after deductions of quantities used as seed and feed weighted in a similar manner." The commodities included are considered edible and contain nutrients (e.g. coffee and tea are excluded). **These indices are given per caput.**

"The country indices are calculated by the Laspeyres formula. Production quantities of each commodity are weighted by 1979−81 average national producer prices and summed for each year. To obtain the index number, the aggregate for a given year is divided by the average aggregate for the base period 1979−81." (p. xi). National producer prices are expressed as "international commodity prices derived from the Geary−Khamis formula... This method assigns a single 'price' to each commodity (e.g. one ton of wheat has the same price in whatever country it was produced)."

Annual indices of food production by country group are listed in Table AIII for 1980 through 1985, and three year averages for 1960, 1970, 1980, and 1984. Like dietary energy supply (DES, see below), the 1960 value corresponds to 1962 (1961−63, because FAO annual series starts from 1961), the 1970 value to 1969−71, 1980 value to 1979−81, and 1984 value to 1983−85.

2.3 The Food Balance Sheet Method (Dietary Energy Supply − (DES − kcals/caput/day))

The food balance sheet calculated by FAO by country, gives dietary energy supply estimates used in the Report (sections B and C of the panels). "The amount of food potentially available for human consumption is derived after considering the sources of supply, and their utilization. The supply component considers the amount of food produced in a country, imports, and adjustments for changes in stocks. Utilization accounts for food exported, fed to livestock, used for seed, manufacturing for food and non−food uses, and losses during storage and manufacturing." (FAO (1984) p. viii).

Although the food balance sheet method provides estimates for the quantities of food reaching the customer, the amount of food actually consumed may be lower than the quantity shown in the food balance sheet, because losses of edible food and nutrients in the household (e.g. during storage, or in preparation and cooking pets feeding etc.) are not considered.

The Dietary Energy Supply (DES.) is thus an estimate of food availability at the national level. It is derived by applying food composition factors to all food commodities available for human consumption. Only the. total calories available for consumption was of interest. It is expressed on a per caput basis by dividing the total calories available by an estimate of the total population, then per day by dividing by 365, to give the unit kcals/caput/day (FAO, 1984).

The question of accuracy of food balance sheets is addressed thus by FAO (1987), page ix: "The accuracy of food balance sheets, which are in essence derived statistics, is of course dependent on the reliability of the underlying basic statistics of population, supply and utilization of foods and of their nutritive value. These vary a great deal between countries, both in terms of coverage as well as in accuracy. In fact, there are many gaps particularly in the statistics of utilization for non−food purposes, such as feed, seed and manufacture, as well as in those of farm, commercial and even government stocks. To overcome the former difficulty. estimates were prepared in FAO while the effect of the absence of statistics on stocks is considered to be reduced by preparing the food balance sheets as an average for a three−year period." However, it would appear, experience in compilation assures consistency and this permits trend assessment

2.4 Undernourished Population – percent and numbers with DES below 1.2 BMR

[2]Basal Metabolic Rate

The proportion of undernourished population was estimated by the Statistics Division of FAO, and provided by country group only. A discussion of this method of calculating both percent and numbers of undernourished is found in section 4.1.5 of the Report (p. 46) and in FAO's Fifth World Food Survey (FAO (1985) p.l8).

2.5 Underweight Children – percent and numbers below minus 2 SD's weight for age

The proportion of underweight children 0 through 4 years of age was derived by the SCN using an interpolation model, as described in detail in section 3 of this supplement. Briefly, prevalence was predicted from a regression model using the sample of countries shown in Table AII. All factors in the model were taken from the same year as the prevalence estimates. The interpolation model thus derived was applied to the larger set of 94 countries for country group estimates (Table All). This model was based on three year averages for kcals/caput/day and IMR interpolated to the year of interest. Thus, the prevalence estimates listed for 1970 in Table AIII were based on three year average kcals for 1974/75/76 and IMR interpolated to 1975. The 1980 and 1984 estimates were exact midpoints of the three year averages. Numbers of underweight children were derived by country, and aggregated to the country group level as follows:

Number = % prevalence underweight x child population 0 through 4 years/I 00.

Table. All lists the national data (36 countries, 45 surveys) used in the derivation of the inter–polation model. Only country surveys undertaken after 1975 and considered to be nationally representative on prevalence of low weight–for–age (WA) were included. Countries with more than one survey during this period were included, thus some countries were represented more than once. Representativeness was assessed on the basis of the survey design, usually obtained in the survey report, considering the sampling methodology used.

Sources of anthropometric survey data: Sources of anthropometric survey data are listed as part of Table An. The two major sources for survey data on prevalence of below – 2 standard deviations (SD's) WA were WHO, (1987) and Haaga, et al. (1985). Prevalences for five countries were obtained from other sources as follows: Botswana (Spafford Yohannes, 1986), Mauritius (correspondence between WHO Geneva and WHO Mauritius, November 4, 1986), Zimbabwe (K Test personal communication with Ministry of Health, Nutrition Unit), Peru (Rothe, Nieburg, personal communication), Papua New Guinea (correspondence with P Heywood).

Choice of nutritional status outcome measure: Weight–for–age (WA) was chosen as an indicator of nutritional status for primarily practical reasons, in that it was more often reported than either weight–for–height (WH) or height–for–age (HA). It combines both chronic (HA) and acute (WH) malnutrition, a distinction which may be important in individual child growth or for nutrition policies aimed at long–term development. However such a distinction is less crucial for the cross–national comparisons examined here.

The cutoff of –2 SD's WA for estimating prevalence of underweight was chosen because as a standardized measure it is more informative than percent median since it indicates exactly where the case lies relative to the mean. As such it is may be more appropriate for inter–country comparisons. This practice is recommended by WHO (1987).

Derivation of percent below –2 SD's Weight for Age from percent median: In some instances, only the prevalence below 80% median weight–for–age was available, so the prevalence below –2 SD's had to be calculated from this (for about 12 country–year cases). The method used was as follows:

1. From the NCHS data (WHO. 1983) a % median value equivalent to –2.0 SD's was calculated for several ages between 1 and 5 years, and for both sexes. These values were averaged across all ages and sexes to give a value of 78.5% median WA (the range of these values was 77 to 79.4%).

2. The percent below 78.5% (i.e. –2.0 SD's), and the percent below 80% was calculated for several (theoretical) different distributions where only the mean was altered. The standard

deviation was kept constant at 10.0, (in line with the SD observed in many surveys). All distributions were assumed to be normal, Z Tables were used to calculate these percentages (see example below).

3. These two percentages (or prevalences), below −2 SD's and 80% median were graphed for all scenarios. The result was linear with Y−axis = percent < −2 SD's; and X−axis = percent < 80% median WA.

The following is an example in the calculation of one point on the graph. To obtain other points, this method was repeated changing only the sample mean.

Sample mean = 90.0 S.D. = 10.0 % median at −2.0 SD's = 78.5

Z score[3] for 80% median = (80.0 − 90.0)/10 = −1.0.
From Z Table the % < −1.0 = 15.87%.

[3] The z score calculation can be found in most statistical textbooks: z = (XI − X)/SD; where: XI is the value of interest, X is the mean of the sample, and SD is the standard deviation of the population.

Z score for −2.0 S.D. = (78.5 − 90.0)/10 = −1.15.
From Z Table the % < −1.15 = 12.50%.

Choice and sources of independent factors: The independent factors listed in Table AII were selected for the year of the anthropometric survey. These factors were chosen as potentially useful predictors mainly because of their established association with nutritional status (see "purpose of interpolation model" in section 3.1 below). Also important was the availability and consistency of this information for all countries studied since 1975.

All independent factors except DES were obtained from data published by the World Bank (1978−86). DES was extracted from the Food Balance Sheet account in FAO (AGROSTAT). The purpose of restricting sources was to maintain consistency across countries and years. Data from the World Bank (1978−86) are updated and published annually, and are complete for all countries in this sample.

Data for the derivation of country group prevalences of underweight children: Table 3 of the Report lists all 94 countries used in the calculation of country group prevalence of underweight children for 1975, 1980, and 1984. The factors listed in Table AI are those required for the calculation of country level predicted prevalence of low WA for the three years; including kcals/caput/year (as three year averages), and IMR's (interpolated to the year of interest). Child populations of 0 through 4 years of age are needed to calculate the numbers of malnourished children by country. They were derived as described in section 4.1.6 (p. 50) of the Report, from total populations also listed in Table AI. The method used for estimating country group prevalence is discussed below in section 3.

2.6 Infant Mortality Rates and Numbers

Infant Mortality Rate (IMR) is the number of children under 1 year of age who died in a given year, expressed per 1,000 live births. Estimates reported in Table AIII are five year intervals calculated by the UN Population Division, and retrieved from FAO computer files (see section 2.1). In Table AIII, the IMR listed for 1960 is the average of 1960−'65, 1970 is the average of 1970−'75, 1980 is the average of 1980−'85. In the panels these estimates are graphed as the midpoints of the intervals (i.e. 1962.5, 1972.5 and 1982.5). (An additional point is included on the graph but not in this Table AIII, i.e. that for the period 1975−'80, which is plotted as 1977.5 in the panels).

The number of infant deaths was calculated as IMR multiplied by total number of live births per year/I.000. The actual calculation was done by the SCN, using the total number of live births in a given year and IMR's extracted from FAO files. The number of infant deaths are five year interval estimates comparable to IMR.

2.7 Child death rates and number of child deaths

Child death rates are expressed as the number of deaths of children aged 1 through 4 years old, per 1,000 child population (1 through 4 years) in a given year. Child death rates were not readily available, probably because of poor reporting of deaths and child populations. Estimates reported here were taken from the World Bank (1978 – 86), and for some values, from UNICEF (1986).

The number of child deaths is equal to child death rate multiplied by child population of 1 through 4 years of age, in a given year. Basically, the population of 1–4 year olds was obtained by first estimating the proportion of the 0–4 year old age group in the population in question, since the latter is more readily available by country. The procedure is explained in more detail in the Report (section 4.1.8). Additional data listed below are the percentages of 1–4 year olds used in the calculation of child populations, by country group, derived by calculating from UN (1986).

Africa	78.5
Middle America/Caribbean	78.7
South America	80.0
South Asia	80.0
Southeast Asia	78.9
Near East/North Africa	79.7
China	78.0

This proportion was applied to all countries in a country group.

3. THE ESTIMATION OF PREVALENCE OF UNDERWEIGHT CHILDREN

3.1 The calculation of predicted prevalence of underweight

A brief description of the methods used to estimate prevalences of underweight by country groups can be found in section 4.1.6 of the Report (p. 48). These methods are discussed in more detail here, including additional statistical results and a more thorough explanation of the approach used.

Generally the procedure used for obtaining the prevalence of underweight by country group, involved the following steps.

1. Compilation of all available and nationally representative surveys with data on prevalences of underweight in 0 through 4 year old children in developing countries (n=45) from 1975 to present Underweight is defined as below −2 standard deviations weight−for−age (WA) using NCHS standards.

2. Using the prevalence of low weight−for−age data as the dependent variable (outcome), a regression equation was calculated by inserting estimates for a priori chosen independent factors. This is referred to here as the interpolation model.

3. The interpolation model is then applied to a set of developing countries (n=94), grouped by region of the world; by inserting values for the independent factors in the model, a predicted prevalence was calculated for each country.

4. The country group estimates of low WA prevalence were calculated by deriving the number of malnourished children by country, based on the predicted prevalence culated in step 3. totalling these values by country group, and dividing by total regional population of under five year olds.

Purpose of the interpolation method: The use of the regression method for the calculation of an interpolation model was for predictive or interpolation purposes, and not for determining which factors are related to nutritional status. As such, it is not meant to address any questions of causality. With this in mind, the choice of independent factors (discussed below) has little or no bearing on their direct influence on prevalence of malnutrition. This analysis is not concerned with whether they "cause" malnutrition or not. It is concerned to establish whether or not they are "associated" with prevalence.

Calculation of interpolation model – relationship of independent factors with prevalences: The dataset used for the calculation of the regression is listed in Table AII. There are 36 countries with 45 surveys (9 countries had more than one survey) since 1975. The independent factors available for the analysis discussed above are all chosen from the same year as the prevalence data.

The bivariate relationships between the prevalence of malnutrition and the independent factors: kcals/caput/day, log of GNP, and infant mortality rate (IMR), are shown in Figures I–III. The simple regression line of prevalence on log GNP or IMR. respectively, is shown on these graphs, with the appropriate equation listed below the plot The letters represent points (i.e. countries) on the graph designated by different country groups.

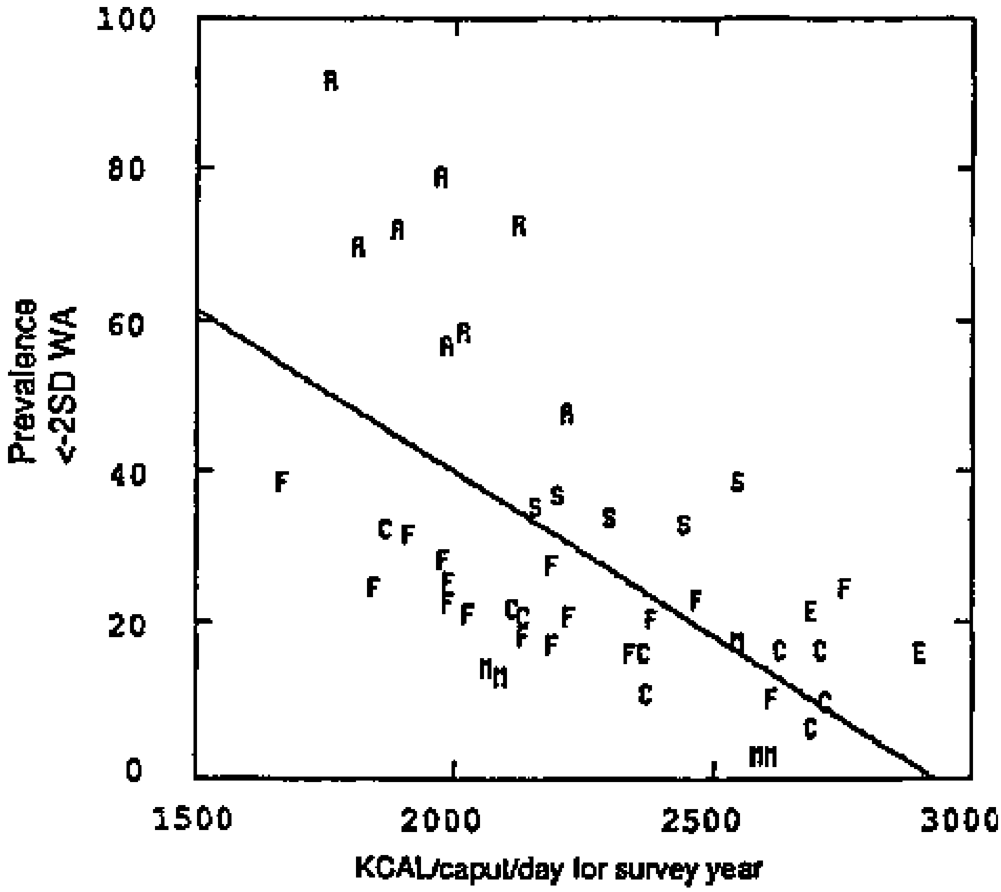


Figure I: Plot of prevalence of low weight–for–age by Kcals/caput/day

KEY

F: Sub Saharan Africa

C: Central America

M: South America

A: South Asia

E: Near East

S: Southest Asia

Regression of PREV2SD (prevalence of under –2SD Weight–for–age) against KCALSY (Kcals/caput/day for survey year):

Correlation = −0.58, R Squared = 0.33, SE of Estimate = 17.2
Significance of regression p<0.0000

Intercept (SE): 126.001 (20.8); Slope (SE): −0.043 (0.009)
45 cases plotted

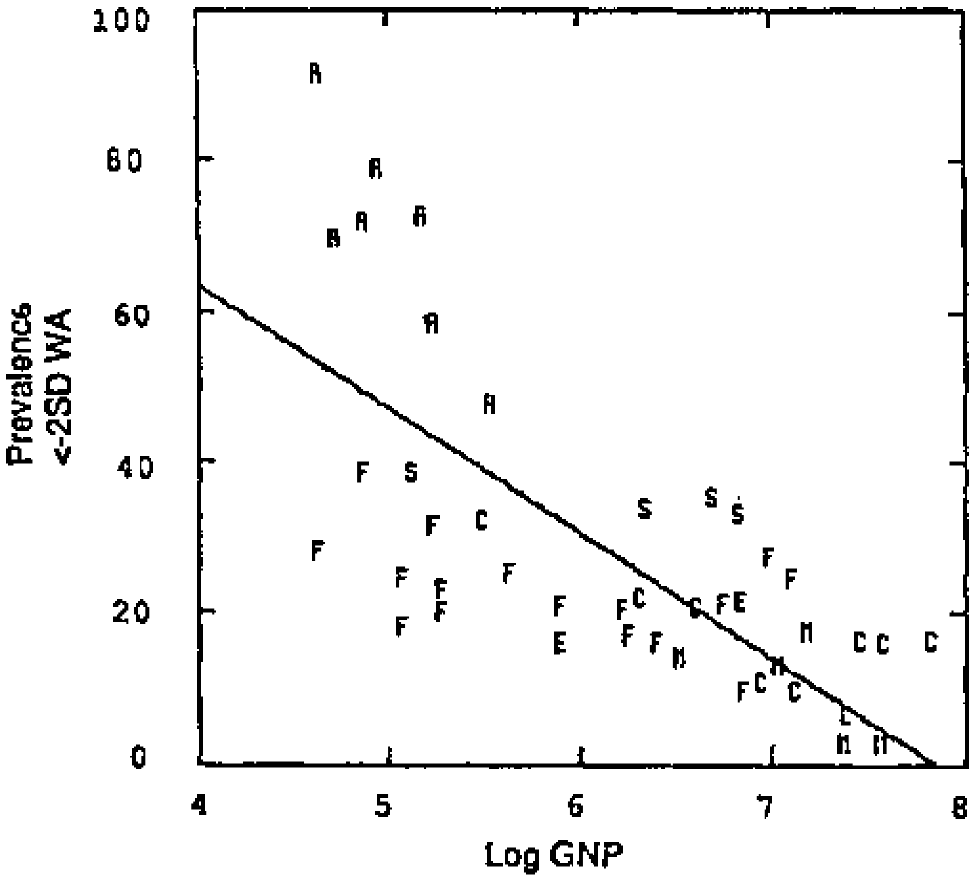


Figure II: Plot of prevalence of low weight−for−age by log GNP

KEY

F: Sub Saharan Africa

C: Central America

M: South America

A: South Asia

E: Near East

S: Southest Asia

Regression of PREV2SD (prevalence of under −2SD Weight−for−age) against LNGNP (log GNP):

Correlation = 0.69. R Squared = 0.48. SE of Estimate = 152 Significance of regression: p<0.0000

Intercept (SE): 129.575 (16.4); Slope (SE): −16.5,7 (2.65) 43 cases plotted

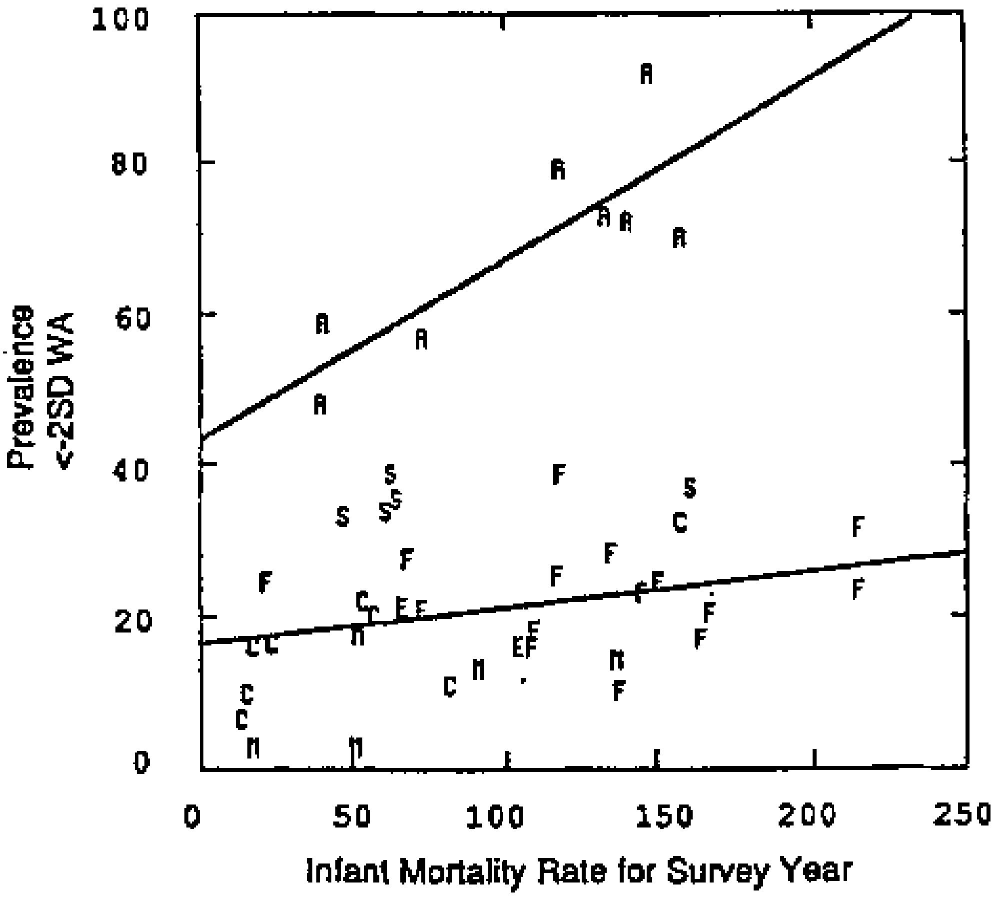


Figure III: Plot of prevalence of low weight–for–age by IMR

<u>KEY</u>

F: Sub Saharan Africa

C: Central America

M: South America

A: South Asia

E: Near East

S: Southest Asia

Regression results from prevalence <–2SD's wt–age by IMR, IMR * DASIA:

R squared = 0.83, significance of regression = 0.000, n = 45

Intercept (SE) = 15.19 (3.01) coefficient for IMR = 0.062 (P = 0.036)
coefficient for IMR * DASIA = 0.205 (P = 0.019)
coefficient for DASIA = 25.03 (P = 0.011)

The lines shown, calculated from this equation, are:

Asia: Prevalence = 40.218 + 0.267 (IMRSY)
Other regions: Prevalence.= 15.188 + 0.062 (IMRSY)

The relationship of both GNP and kcals with prevalence of low WA arc very similar (Figures I and II), and in the expected direction. As GNP increases, the level of malnutrition decreases; likewise as kcals per caput increases, prevalence decreases.

IMR is positively related to prevalence, as expected. The two lines on the graph (Figure III) represent separate relationships for Asia and the rest of the world. The line for Asia clearly shows that prevalence of malnutrition is much higher at a given IMR than the other countries in the sample. In. fact, in all three graphs the prevalence of low WA is higher than expected in Asia; an issue which is discussed in more detail in section 3.4.

Regression analysis – procedure and results: The regression method involved inserting the factors plotted in Figures I–III, and other dervised variables, to best explain the variation in the outcome, i.e. prevalence of low WA. The criteria used for determining the most appropriate model were based on the R–square statistic, the t and p– values for the independent factors, and an analysis for the residuals. All analyses were done using the SPSS/PC statistical package for the IBM PC/XT microcomputer.

Since GNP and kcals showed almost identical relationships with prevalence, two separate models were derived, and both are reported here. All factors in the two models were otherwise identical. The kcal model was used as the best predictive model because it showed the strongest association with prevalence.

Kcal model: Results of the interpolation model including kcals/caput/day are shown in Table I. The adjusted R–square is 0.927, indicating that 92.7% of the variation in prevalence of low WA is explained by the model. The analysis of variance (ANOVA) shows a highly statistically significant model with an F–value of 80.69 (p<0.000). All independent factors are listed in Table I.

Table I: Results of multiple regression analysis (OLS) for prevalence of low wt/age (KCAL model). See text for description of variables.

Multiple R	.96877	Analysis of Variance				
R Square	.93852		DF	Sum of Squares		Mean Square
Adjusted R Square	.92689	Regression	7	18100.97065		2585.85295
Standard Error	5.66101	Residual	37	1185.74135		32.04706
		F – 80.68923		Signif F =.0000		
Variables in the Equation						
	Variable	B	SE B	Beta	T	Sig T
	DASIA	17.30734	6.56822	.31962	2.635	.0122
	IMRSY	−7.88043E−03	.02681	−.01895	−.294	.7705
	DSEASIA	13.63137	3.00127	.20693	4.542	.0001
	DSAMER	−10.85593	3.06321	−.16480	−3.544	.0011
	DCAMCA	−4.19829	2.79055	−.08112	−1.504	.1409
	KCALSY	−.01610 4.	21436E−03	−.21707	−3.821	.0005
	INTERI	.23531	.05482	.49299	4.292	.0001
	(Constant)	59.28480	11.66129		5.084	.0000

The regression equation can be written in the following form:

Predicted Prevalence = 59.285 − 0.0161(KCALSY) − 0.00788(IMRSY)+17.307(DASIA)"
− 4.198(DCAMCA) + 13.631 (DSEASIA) − 10.856(DSAMER)
+ 0.235(INTER1)

Where:

KCALSY is kcals/caput/day for survey year.
IMRSY is Infant Mortality Rate for survey year.
DASIA is a dummy variable for South Asia (1=yes, 0=no).
DCAMCA is a dummy variable for Middle America and Caribbean(0,l).
DSEASIA is a dummy variable for Southeast Asia (0,1).
DSAMER is a dummy variable for South America (0,1).

INTER1 is the interaction term for IMR in Asia (=DASIA x IMRSY).

The slope for KCALSY was statistically significant ($p<0.000$). The coefficient of – 0.0161 means that for every increase of 100 kcals/caput/day (for example), the prevalence estimate will decrease by 1.61%, after accounting for the influence of all other factors in the equation. It should be remembered that this is not assumed to be a causal relationship but simply means that the two factors are changing together by a measurable amount.

Although IMR showed no statistically independent relationship with prevalence it was included in the equation because of its highly significant interaction with the term for Asia.

The independent variables also include:

1. All variables beginning with "D" are dummy variables for country groups, as listed above. A value of "1" is applied for all countries in the country group, and a "0" for all else.

2. INTER1 is the interaction of IMR with DASIA. This term is included to differentiate this relationship from the rest of the country groups, as shown in Figure III.

The significance of the interaction term. INTER1 ($p = 0.0001$ in Table I), indicates that the slope of the line for Asia (i.e. the relationship between prevalence and IMR) is significantly different from that of the other regions. The dummy variables contribute primarily to me constant term, thus the significance of the DASIA term means that Asia is also 17.307 percentage points higher than the prevalence of the overall sample, after all other factors in the equation have been taken into account

The following example demonstrates the use of dummy variables and the interaction terms to calculate separate equations to interpolate national prevalences, in this case, one for Asia, and one for South America, From the regression equation above, a "1" is inserted for DASIA for Asia and the resulting equation is as follows, for Asia:

$$\text{Prevalence} = (59.285 + 17.307) - 0.0161\ (\text{KCALSY}) + (-\ 0.00788 + 0.235)(\text{IMRSY})$$
$$= 76.592 - 0.0161(\text{KCALSY}) + 0.227(\text{IMRSY})$$

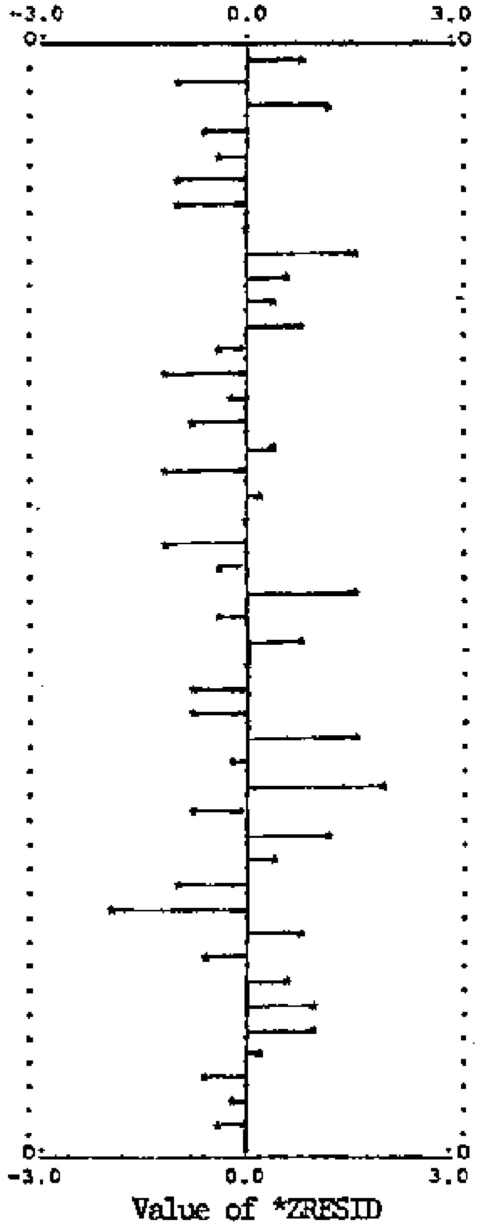
To do me same for a country in South America, a "1" is inserted for DSAMER for all countries in South America (note that there is no interaction term with IMR):

$$\text{Prevalence} = (59.285 - 10.856) - 0.161(\text{KCALSY}) - 0.00788(\text{IMRSY})$$
$$= 48.429 - 0.0161(\text{KCALSY}) - 0.0078\ 8(\text{IMRSY})$$

Notice that the relationship between kcals and prevalence of low WA is the same in both groups. However, both the intercept and the relationship of IMR with prevalence varies by country group.

<u>Analysis of residuals for the kcal model:</u> The residual[4] values from the kcal model are shown in Figure IV. All cases arc listed by country group. The variables given are defined in the figure.

[4]. Residual = observed value residual minus (from model).



CCODE	PREV2SD	*PRED	*RESID	*ZRESID	*SEPRED
bot	27.0	23.0176	3.9824	.7035	1.8948
cmr	16.8	22.3639	-5.5639	-.9828	1.6304
eth	38.1	30.9648	7.1352	1.2604	2.6136
gbs	24.1	27.9814	-3.8814	-.6856	1.8555
ken	20.5	22.4629	-1.9629	-.3467	1.7501
les	17.8	23.6367	-5.8367	-1.0310	1.4100
les	15.6	21.4224	-5.8224	-1.0285	1.3498
lib	20.0	20.3514	-.3514	-.0621	1.8859
mar	24.0	15.3610	8.6390	1.5261	2.5251
mlw	22.6	19.0916	3.5084	.6197	1.7439
rwa	28.0	26.0302	1.9698	.3480	1.6105
sil	31.0	26.4547	4.5453	.8029	2.3494
sil	23.2	25.1342	-1.9342	-.3417	2.3857
swa	9.7	16.8119	-7.1119	-1.2563	2.0668
tog	24.8	25.8842	-1.0842	-.1915	1.6269
zim	20.7	25.6191	-4.9191	-.8689	2.1838
cos	16.0	13.2081	2.7919	.4932	2.0258
cos	6.0	12.3207	-6.3207	-1.1165	2.1206
els	21.6	20.1857	1.4143	.2498	2.1013
els	20.5	20.2021	.2979	.0526	2.0949
nic	10.4	16.8894	-6.4894	-1.1463	2.0537
pan	15.6	17.4904	-1.8904	-.3339	2.1149
hai	32.0	23.4219	8.5781	1.5153	2.9127
jam	9.3	11.8702	-2.5702	-.4540	2.1519
tri	16.1	11.9116	4.1884	.7399	2.1373
bol	13.9	13.7737	.1263	.0223	2.8445
chi	2.5	6.5953	-4.0953	-.7234	2.6303
chi	2.5	7.3223	-4.8223	-.8518	2.7548
col	17.2	7.6341	9.5659	1.6898	2.5790
per	12.8	13.5746	-.7746	-.1368	2.6722
bgd	91.3	79.6725	11.6275	2.0540	2.7256
bgd	71.7	76.0033	-4.3033	-.7602	2.4573
ind	78.7	72.1167	6.5833	1.1629	2.1929
ind	72.3	70.4480	1.8520	.3271	2.4005
mdv	56.1	61.6893	-5.5893	-.9873	2.4387
nep	69.6	81.0773	-11.4773	-2.0274	3.0356
srl	58.2	53.9124	4.2876	.7574	3.6110
srl	47.5	50.4805	-2.9805	-.5265	3.6479
egy	15.8	12.4121	3.3879	.5985	2.7785
tun	21.4	16.1000	5.3000	.9362	2.0237
bur	38.1	32.0025	6.0975	1.0771	2.6196
lao	36.5	35.8497	.6503	.1149	3.0747
phi	33.2	36.0923	-2.8923	-.5109	2.6041
phi	32.5	33.8194	-1.3194	-.2331	2.6177
png	34.7	37.2362	-2.5362	-.4480	2.6521
CCODE	PREV2SD	*PRED	*RESID	*ZRESID	*SEPRED

Figure IV: Case−wise plot of standardized residuals for kcal model

CCODE is the Country code (see Table AII for full names, listed in the same order).
PREV2SD is the actual prevalence of below 2 SD's WA.
*PRED is the predicted value of prevalence of low WA from the model.
*RESID is the residual value. PREV2SD – *PRED.
*ZRESID is the standardized residual (residual/SD of residual) – plotted.
*SEPRED is the standard error of the predicted value.

The plot of residuals shows how well the model predicts the actual country/year value; points which are furthest away from the "0.0" line show the largest discrepancy between actual and predicted prevalences. It is important to note whether a majority of countries in a particular country group show a consistently high or low residual value (me standardized residual is more informative for this purpose). The residuals show an acceptable scatter with no discernible pattern. It should be borne in mind that only two countries in the Near East/North African region were available for interpolation. Further analysis of residuals (from an analogous model) is given in Haaga et al. 1985.

The plot of actual versus predicted prevalence is shown in Figure V. This plot, being an alternative presentation to Figure IV. provides a similar picture as the casewise plot of residuals (Figure IV), showing how far away the actual prevalence in a country is from the predicted value (the line designates a perfect agreement). Agreement is reasonably good, as expected from the high R–squared for the model.

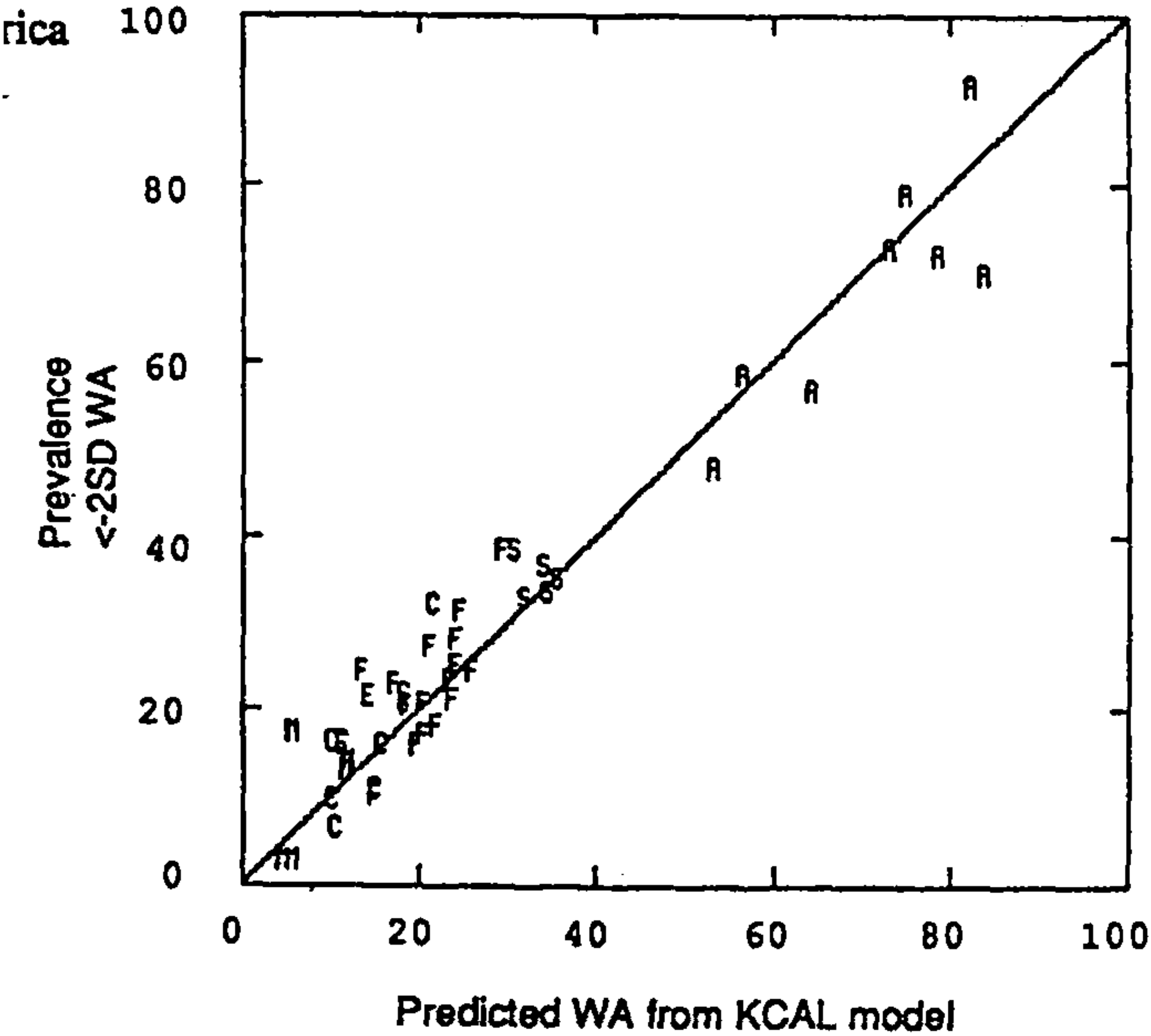


Figure V: Plot of prevalence of low weight–for–age by predicted prevalence from KCAL model

<u>KEY</u>

F: Sub Saharan Africa

C: Central America

M: South America

A: South Asia

E: Near East

S: Southest Asia

Regression of PREV2SD (prevalence of under –2SD Weight–for–age) against PREDWA1 (Predicted WA from KCAL model):

Correlation = 0.96, R Squared = 0.93. SE of Estimate = 5.25
Significance of regression: p< 0.0000

Intercept (SE): −0.019 (1.38); Slope (SE): 1.000 (0.039)
45 cases plotted.

GNP model: Another model was calculated using the natural log of GNP as a predictor of prevalence of low WA, instead of kcals, in order to verify estimates from the kcal model. The log GNP model is expected to be very like the kcal model, given the similarity in their relationships with prevalence (Figures I and II). The natural log of GNP was used because it shows a linear relationship with prevalence (see Haaga, et al. 1985), whereas GNP alone shows an exponential relationship with prevalence. All other independent factors in the kcal model were included in this model (except kcals). The model was calculated for 1980 and 1984 only.

Regression results for the GNP model are shown in Table II. Both the adjusted R−square and the F−value for the regression are lower than the kcal model, (see Table I) albeit still very high. A plot of the actual versus predicted prevalence is shown in Figure VI.

Table II: Results of multiple regression analysis (OLS) for prevalence of low weight−for−age (log GNP model). See text for description of variables.

Multiple R	.96404	Analysis of Variance				
R Square	.92937		DF	Sum of Squares		Mean Square
Adjusted R Square	.91524	Regression	7	17182.93442		2454.70492
Standard Error	6.10823	Residual	35	1305.86465		37.31042
		F = 65.79141		Signif F =.0000		
Variables in the equation						
	Variable	B	SE B	Beta	T	Sig T
	DASIA	17.95794	7.84966	.31972	2.288	.0283
	IMRSY	−9.04543E−03	.03311	−.02183	−.273	.7863
	DSAMER	−6.13377	3.56025	−.09482	−1.723	.0937
	DSEASIA	13.53705	3.72270	.18963	3.636	.0009
	DCAMCA	−.55302	3.07131	−.01085	−.180	.8581
	LNGNP	−6.08339	2.09687	−.25665	−2.901	.0064
	INTER1	.22708	.06183	.47489	3.673	.0008
	(Constant)	59.22568	15.33481		3.862	.0005

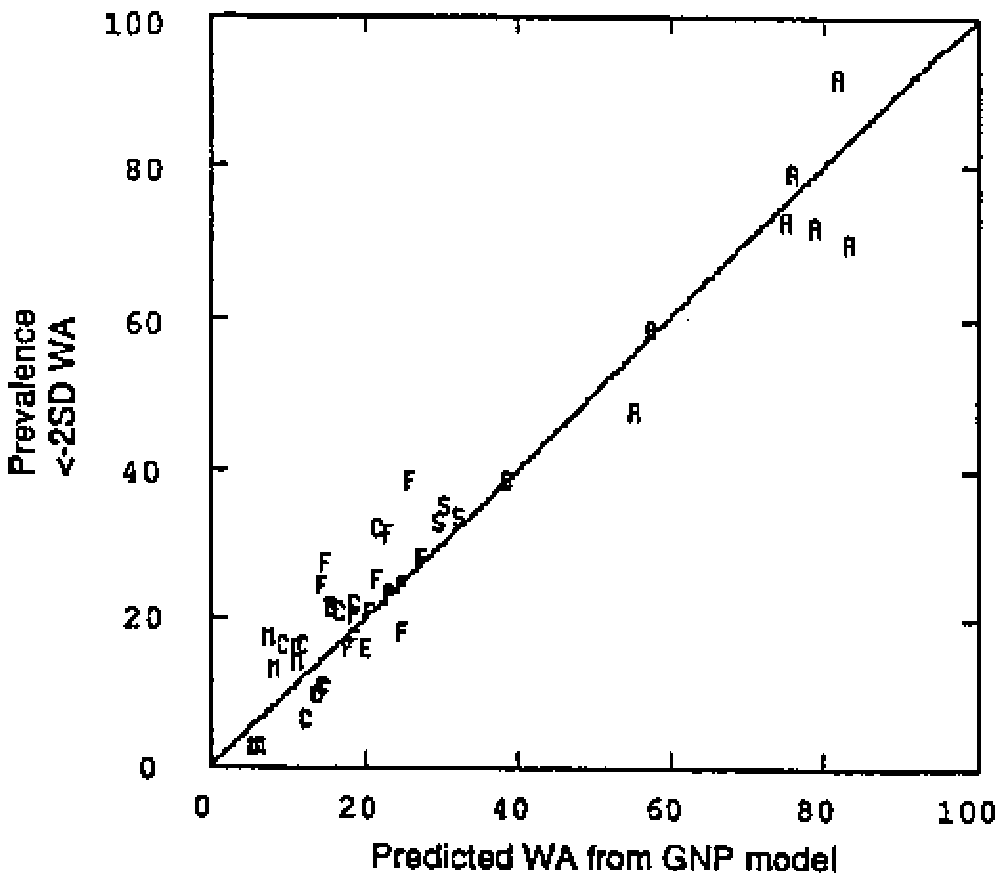


Figure VI: Plot of prevalence of low weight–for–age by predicted from GNP model

KEY

F: Sub Saharan Africa

C: Central America

M: South America

A: South Asia

E: Near East

S: Southest Asia

'Regression of PREV2SD (prevalence of under −2SD Weight−for−age) against PREDWA2 (Predicted WA from GNP model):

Correlation = 0.96, R Squared = 0.92, SE of Estimate = 5.64 Significance of regression: p<0.0000

Intercept (SE): −0.005 (1.49); Slope (SE): 1.000 (0.043) 43 cases plotted.

This model was not used for the interpolation of prevalence, but only to verity results from the kcal model. Comparisons of prevalence estimates from born models are shown in Table III.

Table III: Country group estimates of prevalences and numbers underweight calculated from the KCAL and GNP models (see Tables I and II)

Year		1975		1980		1984	
Country Group	**Model**	**Prev %**	**Numbers (millions)**	**Prev %**	**Numbers (million.)**	**Prev %**	**Numbers (million.)**
Sub–saharan Africa							

	kcal	24.7	14.78	23.6	16.07	25.3	19.45
	gnp			21.8	14.80	23.0	16.53.
Middle America/Caribbean							
	kcal	12.7	1.93	10.2	1.75	8.9	
	gnp			13.8	2.37	13.8	1.69 2.51
South America							
	kcal	7.8	2.25	6.4	2.04	6.4	2.25
	gnp			6.9	2.19	7.5	2.62
South Asia							
	kcal	73.9	89.33	70.0	93.80	66.7	97.70
	gnp			70.0	93.91	67.4	92.08
Near East/North Africa							
	kcal	17.1	4.28	12.3	3.44	10.2	3.20
	gnp			14.5	4.02	14.9	4.17
Southeast Asia							
	kcal	37.1	16.06	34.0	16.37	32.7	17.51
	gnp			34.8	14.19	33.6	14.09
China							
	kcal	25.8	20.64	22.1	19.03	17.7	16.02
	gnp			24.4	20.98	24.0	21.68

Validity of model for interpolation of several time points: Because the purpose of calculating prevalence was to obtain an estimate of trends by country group, one concern was the validity of applying an equation calculated from a combined sample of countries and years (1975 −1985) to three points in time. The major concern was that the effects of time may be confounded by country group if a particular group (or groups) have surveys from only one point in time (e.g. 1982/4). In this case one could not tell if apparent differences over time were in fact due to differences between countries. The sample data was examined for this and was found to have an equal distribution in two time periods, 1975 − 1979. and 1980 − 1985, and most country groups were represented in both periods. Southeast Asia had more surveys in the latter period (N = 1 and 4 respectively). The Near East was only represented in the earlier period, but anyway only data on two countries were available from this region. No information on nutritional status in China existed for this analysis. Thus, because these two regions were under−represented in the original dataset, their predicted prevalence may be less reliable; however, the relationship between prevalence and kcals was so strong and consistent in all other countries, that this is unlikely to affect prediction to a large extent.

To examine whether kcals/caput/day could accurately predict prevalence of low weight−for−age in both time periods, the model was re−calculated separately for both samples. Results showed that kcal was significantly and negatively related to prevalence in both periods; it was a better predictor in the earlier years (as judged by the adjusted R^2), but residuals indicated a poorer fit than in the later period. Thus, the relationship between kcals and prevalence held for both time periods, and the method was used to interpolate prevalences and aggregate them to country group for 1975, 1980 and 1984.

Interpolation of prevalences of low weight−for−age by country: When the calculation of a regression equation for the prediction of prevalence, was completed, the model was applied to a larger set of countries for the calculation of country group estimates of underweight. The intention was to include as many developing countries as possible in this larger set, divided into the following regions: Sub−Saharan Africa, Middle America and Caribbean, South America, South Asia, Near East and North Africa, Southeast Asia and China (not including Mongolia). Inclusion depended on me availability of data, particularly for kcals and population.

Adequate data were available for 92 countries, as listed in Table AI (and Table 3 of the Report[5]). The countries not included were all either industrialized or of relatively low populations.

[5] Two countries (Kuwait and United Arab Emirates) were eventually deleted from the list given in Table 3 of the Report due to unavailability of data.

To estimate trends in prevalence of underweight, the kcal model was applied to three different years. 1975, 1980 and 1984.

The independent factors included in the kcal model were required for every country and for the three years chosen for interpolation of prevalence. Only kcals/caput/year and IMR were required for estimating prevalence: kcals was obtained as three year averages around the year of interest (e.g. the value for 1975 was the average of 1974, 1975, and 1976). Since IMR was only available in five year intervals, estimates for the model (as shown in Table AI) were interpolated from these values as follows:

"IMR 1975" = 172 ((IMR for 1970−75) + (IMR for 1975−80))
"IMR 1980" = 1/2 ((IMR for 1975−80) + (IMR for 1980−85))
"IMR 1984" = 3/5 (IMR for 1980−85) + 2/5 (IMR for 1985−90)

For every country and all three years of interest, a predicted prevalence of under −2 SD's weight−for−age was calculated by inserting the values for all factors into the model.

Calculation of country group estimates of underweight: Country group prevalences of underweight were derived by first calculating the numbers of 0 through 4 year old underweight children at the country level, and then totalling these by country group and dividing by me regional population of children of this age. The population estimates of 0 through 4 year old children for each country were derived by applying a known proportion of 0−5 years of age to the total population of the year of interest These proportions were calculated from 1985 population statistics taken from the UN Population Division database in AGROSTAT, as described in section 2.7 above. The total population estimates used to calculate prevalence over time were three year averages around the years 1975, 1980, and 1984. These were also extracted from data from the UN Population Division.

Country group estimates were obtained for both the kcal model and the GNP model. Prevalence estimates and numbers malnourished for both models arc shown in Table III; but only those from the kcal model were graphed in the panels in the Report.

3.2 Clinic data − Figures 6B to 6E of the Report

Trends in prevalence below 80% weight−for−age (WA) in Figures 6B to 6E are from clinic data compiled by the Catholic Relief Services (CRS) Growth Surveillance System (GSS). In many instances clinic data are the only data available on the level of malnutrition in a country, but the validity of using clinic data for estimating national levels of malnutrition is questionable.

Little work has been done to verify the representativeness of clinic data (see Test, et al. 1987 and Serdula, et al. 1987), i.e. how accurately clinic−based measures estimate the level *of* malnutrition in a population. This section discusses some of the issues concerned with the validity of clinic−based data for this purpose. It is important to distinguish between the use of clinic data for a cross− sectional estimate of prevalence (i.e. one point in time), and its use for comparing estimates over time. In the latter case. as long as the factor(s) which bias these estimates are not changing over time, then although the actual prevalence may be incorrect the trend is likely to be valid. These issues must be borne in mind when interpreting trends shown in Figures 6B to 6E.

Factors biasing clinic−based estimates of malnutrition: There are basically four major sources of bias in clinic data collected by the CRS−GSS, which must be considered when extrapolating to the general population. These are:

1. Self−selection by the mother.
2. Selection (at the clinic level) by age of the child.
3. Selection by nutritional status.
4. Graduation out of the programme (clinic level).

Self−selection by the mother may result in a different population profile of children attending clinics than that of the general population, so that characteristics of these mothers are not typical of the population. This may be related to factors such as education of the mother, or proximity to the clinic. To account for this, characteristics of the mothers, or households, should ideally be compared between different points in time.

Selection at the clinic level by age of the child was practised in some clinics in the CRS programme. This could bias prevalence estimates if the ages selected had very different levels of malnutrition than the rest of the sample. For example, in malnourished populations children under the age of about one year tend to grow normally (i.e. similar to children from healthy populations) (Martorell, 1984). If these children are omitted from a sample of all children under five, then prevalence estimates will increase because the "best" group is being eliminated. The extent of this increase will depend on how large the under one year old population is relative to other age groups, and on how great a difference there is between the prevalence estimates of both groups. As far as could be ascertained, age distributions were unlikely to be changing greatly over time in the data used.

Selection of children at the clinic level based on their nutritional status would have the most drastic effect on estimating prevalence trends. For example, if only weights of children of less than 80% wt/age were recorded, the prevalence would consistently be reported as 100%. whatever the situation in the population. Even if this happened in only some clinics, trends would be obscured. Such selection (known as "medical selection" in some programmes) was looked for carefully, in the data and by enquiry, and suspect results eliminated. Nonetheless, more work on this aspect would be desirable.

Graduation out of the programme is usually based on the child's age; thus, its effects on prevalence estimates are similar to those of selection by age of the child into the programme. Information on prevalence by age of the child and the proportion of all children by age group would help determine to what extent this bias can alter prevalence estimates.

<u>Validity of clinic estimates used in Figures 6B to 6E of the Report:</u> All issues discussed above were addressed in the analysis which derived the estimates used. Details are discussed in Test, <u>et al.</u> (1987). One analytical approach used clinic coverage, calculated as the number of children attending the clinics in a given year divided by an estimate of under five year child population of the region, as a proxy variable reflecting possible changes in the biases discussed above. It was considered that the prevalence estimate based on clinic data may not be accurate at a given point in time, but it is the trend over time that was of concern in the study. Any biases affecting clinic−based estimates would only affect trends if the bias changed over time concomitantly with prevalence. To investigate this. change in coverage was examined. Statistical tests on the change in yearly and monthly prevalences were done after controlling for change in coverage; and results showed that although coverage was significantly related to prevalence in four of the five countries studied, it did <u>not</u> affect estimated trends in prevalence over time.

After examining other potential biases by country, it was concluded that the trends observed over time were likely to be real. This was supported by other available information including: 1) the consistent seasonal trend in prevalence over several years, 2) the impact of the drought in 1983/84 in many Sub−Saharan African countries, 3) associations with annual trends in agricultural production economic indicators.

3.3 Analysis of covariance − Figure 2 of the Report

Figure 2 in the Report shows global trends in mean prevalence (< −2 SD's) weight−for−age over time since 1975. Prevalence was calculated from the actual anthropometric survey data (Table AH) so may not accurately represent regional prevalences. For this reason a more appropriate title would be "Overall National Survey Prevalences of Low Weight−for−age in pre−school Children, 1975−1985, Adjusting for Country Group".

Mean prevalence over time was modeled using an analysis of covariance while controlling for the effect of country group, which if not accounted for could confound yearly trends. Analysis of covariance was chosen because it permits the testing of both categorical (country groups) and continuous (survey year) factors; the dependent variable being prevalence of low weight−for−age. In this case, the trends over time (survey year) was tested <u>after</u> accounting for differences between country groups.

Results of the analysis of covariance are shown in Table IV. There are highly significant differences between regions, as expected, with a highly significant F−value of 49.9 ($p < 0.000$). Survey year as the covariate is significant at the 10% level (F = 2.85, p = 0.099), after controlling for region. The regression coefficient between prevalence of underweight and survey year was −0.739 indicating a negative relationship − in other words, prevalence decreased over time since 1975. Examination of the graph indicates that most of this downward trend was probably during 1975−1980. but this was not examined further by this method.

Table IV: Results of analysis of covariance testing prevalences of low weight−for−age **by** region and over time, using data shown in Table All

Source of Variation	Sum of squares		Mean square	Sig.	
		DF		F Value	of F
Region	16574.72	5	3314.9	49.935	0.000
Year (covariate)*	189.37	1	189.4	2.853	0.099
Residual	2522.63	38	66.4		
Total	19286.71	44	438.3		

* The covariate, survey year, was tested after removing the effects of region. The regression coefficient for prevalence by survey year was − 0.739 (P <0.1).

The mean prevalence estimates graphed in Figure 2 of the Report were adjusted for regional effects obtained from an analysis of variance. This analysis was identical to the analysis of covariance except survey year was entered as a categorical variable and not a covariate (i.e. continuous), grouped by year as indicated on the graph. A Multiple Classification Analysis (MCA. from SPSS/PC for the IBM PC/XT) table gave the adjusted mean prevalence.

It must be emphasized that the downward trend in global prevalence observed over time. as shown in Figure 2 of the Report, must be interpreted with caution because mean prevalence was only based on available survey data, and the significance of the trend was fairly small after accounting for region.

3.4 Interactions in estimating underweight prevalence for Asia

It has been observed that prevalence of malnutrition, particularly wasting, is much higher than expected in South Asia when compared to populations in other developing countries. This is not thought to be an ethnic difference since well−nourished children from India for example, grow in height and weight like children from industrialized countries.

This phenomenon has been observed here, in the relationships of prevalence of low weight−forage with kcals/caput/day, IMR, and GNP, shown in Figures I − III. At a given level of the independent factor (X−axis), prevalences in the South Asian countries (designated by an 'A' on the graph) are much higher than all other countries in the sample. The most striking was with IMR (see Figure *HI),* where prevalence at a given IMR value in the South Asian countries was not only higher than all other country groups, but also increased much more rapidly as IMR increased. In this case, a separate relationship with prevalence was drawn for the Asian countries, as seen in Figure III.

This phenomenon has not been studied in sufficient detail to suggest a feasible explanation for the markedly higher prevalence of underweight in the Asian countries. For this reason, as mentioned in the Report, estimates of underweight prevalences in the South Asian region should be interpreted with caution in so far as the causes and consequences of malnutrition are concerned.

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APPENDICES

TABLE AI: Data used In the calculation of country group prevalences of below 2 S,D. weight–for–age (by country).

Country	Total Pop'n 1974/76	Child Pop'n 1974/76	Kcals/caput/day 1974/76	IMR 1975	Total Pop'n 1979/81	Child Pop' n 1979/81	Kcals/caput/day 1979/81	IMR 1980	Tota Pop'r 1983/
Sub Saharan Africa									
angola	6.74	1.21	1972	166	7.72	1.39	2158	154	8.54
benin	3.13	0.62	2019	140	3.50	0.69	2138	125	3.93

botswana	0.79	0.17	2117	88	0.92	0.19	2140	79	1.07	0.22
burundi	3.80	0.71	2277	132	4.12	0.77	2345	127	4.59	0.86
burkina faso	5.64	1.00	1961	160	6.17	1.10	2034	154	6.78	1.21
Cameroon	7.75	1.36	2270	115	8.63	1.51	2173	107	9.61	1.68
cehafrirep	2.10	0.35	2239	146	2.30	0.39	2114	144	2.52	0.43
chad	4.09	0.70	1755	160	4.48	0.77	1817	148	4.90	0.84
congopeorp	1.38	0.25	2274	88	1.53	0.28	2443	83	1.70	0.31
coteivoire	6.98	1.31	2310	137	8.17	1.53	2570	116	9.46	1.77
ethiopia	34.81	6.47	1575	155	38.55	7.17	1797	155	42.51	7.91
gafflbia	0.52	0.10	2124	188	0.58	0.11	2177	180	0.63	0.12
gabon	1.00	0.13	2017	127	1.07	0.14	2226	117	1.13	0.15
ghana	10.20	1.94	2164	106	11.56	2.20	1783	100	13.16	2.50
guinea	4.92	0.86	1933	176	5.41	0.95	1767	166	5.94	1.04
kenya	14.29	3.16	2250	93	16.78	3.71	2191	84	19.77	4.37
lesotho	1.21	0.21	2081	126	1.34	0.23	2346	117	1.48	0.26
liberia	1.64	0.31	2281	149	1.87	0.36	2381	138	2.12	0.40
madagascar	7.79	1.39	2533	80	8.71	1.56	2511	71	9.74	1.74
malawi	5.29	1.02	2479	184	5.96	1.15	2473	170	6.74	1.30
mall	6.40	1.22	1767	197	7.04	1.34	1752	185	7.86	1.50
mauritius	0.90	0.10	2556	46	0.96	0.10	2723	33	1.03	0.11
mauritania	1.45	0.27	1803	153	1.63	0.31	2000	143	1.83	0.35
mozambique	10.29	1.76	1937	166	12.06	2.06	1804	159	13.58	2.32
niger	4.76	0.91	1958	162	5.31	1.02	2364	152	5.94	1.14
nigeria	70.00	13.93	2084	136	80.57	16.03	2245	119	92.09	18.3
rwanda	4.48	0.90	1926	140	5.15	1.04	2073	136	5.87	1.19
senegal	4.91	0.88	2269	158	5.66	1.02	2389	148	6.28	1.13
sierraleon	3.07	0.52	1941	197	3.30	0.56	2049	185	3.54	0.60
somalia	3.40	0.62	1977	155	4.00	0.72	2054	155	4.52	0.82
sudan	16.42	2.99	2104	138	18.68	3.40	2320	124	20.95	3.81
swaziland	0.48	0.08	2457	142	0.56	0.10	2498	134	0.63	0.11
tanzania	16.46	3.32	2260	128	18.88	3.81	2428	120	21.72	4.39
togo	2.30	0.41	2084	116	2.56	0.46	2218	106	2.88	0.52
uganda–	11.55	2.30	2252	115	13.12	2.61	2171	113	14.98	2.98
zaire	22.86	4.16	2291	122	25.86	4.71	2128	112	29.08	5.29
zambia	4.96	0.96	2321	97	5.65	1.09	2203	91	6.45	1.24
zimbabwe	6.43	1.25	2104	90	7.37	1.43	2110	83	8.48	1.65

South Asia									
afghanistan	14.90	2.46	2207	194	16.05	2.65	2221	194	16.43
bangladesh	78.09	13.82	1861	138	88.24	15.62	1850	132	98.48
india	624.81	81.85	1987	130	688.61	90.21	2104	11B	744.46
iranisimrp	33.89	5.52	2768	124	38.64	6.30	2883	118	43.37
nepal	13.15	2.14	1926	150	14.67	2.39	1975	143	16.11
pakistan	76.51	13.31	2113	135	86.23	15.00	2222	125	97.39
srilanka	13.68	1.78	2145	52	14.82	1.93	2227	44	15.92
Near East and North Africa									
algeria	– 16.42	2.89	2169	122	18.67	3.29	2618	100	21.08
Cyprus	0.61	0.06	3007	25	0.63	0.06	3280	20	0.66
egyptarbrp	37.53	5.70	2693	135	41.49	6.31	3029	110	45.79
Iraq	11.50	2.14	2355	90	13.29	2.47	2740	80	15.35
jordan	2.63	0.51	2366	74	2.93	0.57	2764	60	3.39
kuwait		0.00		38		0.00		28	
lebanon	2.57	0.32	2577	48	2.67	0.34	2938	48	2.65
libya	2.54	0.47	3471	112	2.98	0.55	3653	102	.3.47
morocco	17.48	2.66	2574	116	19.40	2.95	2727	104	21.41
saudiarabi	7.79	1.40	1992	95	9.35	1.68	2827	73	11;08
syrianabrp	7.64	1.51	2498	79	8.81	1.74	2883	64	10.14
turkey	40.17	5.18	2952	129	44.46	5.74	3104	106	48.29
tunisia	5.78	0.80	2609	111'	6.38	0.88	2772	.94	6.94
uniarabemi		0.00		52		0.00		42	
yemen pdr	1.69	0.31	1974	159	1.86	0.34	2212	142	2.08
yemenarbrp	5.45	1.02	1974	159	5.99	1.13	2198	142	6.67
Southeast Asia									
burma	30.52	4.00	2134	80	33.71	4.42	2376	72	36.44
Indonesia	136.14	18.52	2191	100	150.96	20.53	2441	90	163.24
kampcheadm		0.00		222		0.00		212	7.09
lao pdr	3.37	0.55	1807	140	3.69	0.60	2086	128	4.03
malaysia	12.41	1.74	2536	38	13.78	1.93	2596	32	15.18
papuanguin	2.70	0.43	2085	95	3.09	0.49	3377	80	3.42
Philippine	43.26	6.32	2136	59	48.31	7.05	2355	52	53.21
thailand	41.70	5.21	2378	60	46.47	5.81	2404	52	50.40
Vietnam	48.05	6.49	2007	105	54.10	7.30	2116	83	58.57
China	908.99	79.99	2055	51	977.89	86.05	2289	40	1027.7

Middle America and Caribbean										
cost a rica	2.03	0.28	2562	40	2.28	0.31	2621	25	2.54	0.35
cuba	9.19	0.74	2647	30	9.73	0.79	2834	20	9.97	0.81
domincanrp	4.97	0.72	2234	89	5.56	0.81	2316	80	6.10	0.88
elsalvador	4.23	0.72	2059	90	4.80	0.82	2153	76	5.40	0.92
guatemala	6.15	1.10	2159	88	6.92	1.24	2221	76	7.74	1.39
haiti	5.24	0.89	1940	147	5.81	0.99	1903	134	6.42	1.09
honduras	3.21	0.58	2110	103	3.69	0.67	2197	88	4.23	0.77
Jamaica	2.03	0.27	2662	30	2.18	0.29	2572	23	2.30	0.31
mexico	61.09	9.10	2827	65	69.40	10.34	3054	57	77.05	11.4
nicaragua	2.43	0.44	2382	96	2.77	0.50	2326	84	3.16	0.58
panama	1.76	0.22	2341	38	1.96	0.25	2322	29	2.13	0.27
trindadttob	1.03	0.12	2631	28	1.10	0.13	2853	25	1.17	0.14
South America										
argentina	26.22	2.96	3263	45	28.24	3.19	3252	38	30.09	3.40
bolivia	5.00	0.87	2016	144	5.57	0.96	2085	131	6.20	1.07
brazil	109.46	14.56	2497	85	121.30	16.13	2623	75	132.66	17.6
Chile	10.33	1.09	2582	58	11.13	1.18	2642	34	11.85	1.26
Colombia	23.38	3.20	2347	60	25.80	3.53	2506	52	28.11	3.85
ecuador	7.15	1.12	2035	88	8.13	1.28	2063	76	9.12	1.43
guyana	0.78	0.09	2305	52	0.87	0.10	2412	42	0.94	0.11
Paraguay	2.77	0.44	2730	51	3.17	0.50	2780	47	3.58	0.57
peru	15.38	2.34	2272	108	17.30	2.63	2179	102	19.20	2.92
Uruguay	2.86	0.27	2931	46	2.91	0.27	2832	37	2.10	0.20
Venezuela	12.98	1.92	2447	46	15.00	2.22	2665	41	16.84	2.49

Sources of data: see notes to table A III.

TABLE AII: Data from Nationally Representative Surveys of Prevalences of low Height-for-Age

Country Group	Country	Year of survey	Infant Mortality Rate	Child Death Rate	DES kcals/caput/day.	GNP	Total Population (millions)	Prevalence < 2 SD weight-for-age
Africa	Botswana	84	72	11	2217	960	1.0	27.0
	Cameroon	78	157	27	2216	460	8.1	16.8
	Ethiopia	82	122	25	1699	140	32.9	38.1
	Guinea-Bissau	80	143		1874	170	.8	24.1
	Kenya	82	77	13	2249	390	18.1	20.5

	Lesotho	76 81	114 113	21 22	2158 2296	170 540	1.2 1.4	17.8 15.6
	Liberia	76	159	17	2340	450	1.6	20.0
	Mauritius	85	26	1	2715	1090	1.0	24.0
	Malawi	82	137	29	2429	210	6.5	22.6
	Rwanda	76	127	27	2003	110	4.2	28.0
	Sierra Leone	75 78	208 208	27 27	1937 2019	200 210	3.1 3.3	31.0 23.2
	Swaziland	84	130		2574	890		9.7
	Togo	77	121	27	2015	300	2.4	24.8
	Zimbabwe	84	77	7	2053	760	8.1	20.7
Middle America & Caribbean	Costa Rica	78	28	3	2587	1540	2.1	16.0
		82	18	1	2647	1430	2.3	6.0
	El Salvador	75	58	7	2139	490	4.1	21.6
		78	60	8	2137	660	4.3	20.5
	Nicaragua	82	86	9	2330	920	2.9	10.4
	Panama	80	22	1	2324	1730	1.8	15.6
	Haiti	78	150	23	1893	260	4.8	32.0
	Jamaica	78	20	3	2674	1110	2.1	9.3
	Trinida & Tobago	76	27	3	2668	2240	1.1	16.1
South America	Bolivia	81	129	23	2089	600	5.7	13.9
	Chile	78	55	5	2571	1410	10.7	2.5
		85	22	1	2542	1700	11.8	2.5
	Colombia	80	56	4	2506	1180	26.7	17.2
	Peru	84	95	11	2118	1000	18.2	12.8
South Asia	Bangladesh	75	140	23	1786	110	80.4	91.3
		82	133	19	1915	140	92.9	71.7
	Indonesia	76	122	18	2001	150	620.4	78.7
		79	125	15	2147	190	659.2	72.3
	Maldives	81	77	–	2013	–	.2	56.1
	Nepal	75	150	23	1840	120	12.9	69.6
	Sri Lanka	76	45	2	2044	200	13.8	58.2
		80	44	3	2243	270	14.7	47.5
Near East	Egypt	78	108	18	2858	390	39.9	15.8

	Tunisia	75	63	15	2651	840	5.7	21.4
South East Asia	Burma Laos	85	67	7	2508	180	36.1	38.1
		84	153	24	2227		3.5	36.5
	Philippines	78	65	7	2255	510	45.6	33.2
		82	51	4	2403	820	50.7	32.5
	Papua New Guinea	84	69	7	2182	710	3.4	34.7

Sources: See next page

List of sources of Anthropometric Survey Data shown in Table MI.

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Table AIII: Indicators by country group (Sources and Notes given at end)

		POPULATION	DIETARY ENERGY SUPPLY		FOOD PRODUCTION		INFANT MORTALITY		CHILD DEAT	
			Per caput DES (Kcal/caput/day)		Index numbers of per caput food production (1979/81–100)					
Country Group	Year (1)	Total Population	(Annual)	(3–year average)	(Annual)	(3–year avergae)	Number deaths per 1000 live births	Average number deaths per year	Number child deaths per 1000 child population	A n d p
		(millions)						(millions)		(m
Sub–Saharan Africa	1960	205.2		2045 (61–63)		115.3 (61–63)	164.8 (60–65)	1.77 (60–65)	34.0	0.8
	1970	265.6		2096 (69–71)		111.0 (69–71)	141.1 (70–75)	1.97 (70–75)		
	1980	357.6	2157	2150 (79–1)	100.0	100.0 (79–11)	129.9 (75–10)	2.10 (75–80)	25.7	1.3
	1981	368.7	2155		100.3					
	1982	310.0	2115		99.2					
	1983	391.8	2035		94.6		121.5 (80–85)	2.28 (80–85)		
	1984	403.9	2025	2051 (83–15)	91.2	94.1 (13–15)			23.1	1.4
	1985	416.5	2086		96.6					
Middle America and Caribbean	1960	65.9		2341 (61–63)		88.0 (61–63)	96.1 (60–65)	0.30 (60–65)	12.6	0.0
	1970	88.2		2509 (69–71)		96.4 (69–71).	76.6 (70–75)	0.30 (70–75)		

	1980	116.2	2782	2780 (79–81)	98.9	100.0 (79–81)	68.2 (75–80)	0.27 (75–80)	6.1
	1981	119.1	2824		101.1				
	1982	122.1	2845		97.8				
	1983	125.1	2859		98.9		59.6 (80–85)	0.25 (80–85)	
	1984	128.2	2894	2872 (13–15)	98.7	97.8 (83–85)			4.5
	1985	131.3	2863		96.0				
South America	1960	146.5		2402 (61–63)		89.6 (61–63)	103.1 (60–65)	0.64 (60–65)	13.2
	1970	190.0		2521 (69–71)		92.6 (69–71)	83.6 (70–75)	0.56 (70–75)	
	1980	239.4	2634	2628 (79–81)	99.7	100.0 (79–81)	72.7 (75–80)	0.52 (75–80)	6.3
	1981	244.8	2630		101.6				
	1982	250.3	2629		103.3				
	1983	255.9	2605		98.6		65.0 (80–85)	0.50 (80–85)	
	1984	261.5	2622	2616 (83–85)	100.7	100.7 (83–85)			5.4
	1985	267.3	2622		102. 6				
South Asia	1960	594.4		1999 (61–63)		98.0 (61–63)	156.8 (60–65)	4.30 (60–65)	23.7
	1970	753.3		2036 (69–71)		98.8 (69–71)	136.5 (70–75)	4.39 (70–75)	
	1980	947.4	2060	2125 (79–81)	99.0	100.0 (79–81)	128.4 (75–80)	4.28 (75–80)	17.6
	1981	967.9	2143		103.4				
	1982	988.8	2125		100.5				
	1983	1010:2	2185		108.4		115.2 (80–85)	4.01 (80–85)	
	1984	1032.0	2197	2176 (83–85)	107.3	107.8 (83–85)			12.5
	1985	1054.3	2143		107.9				
Near East and north Africa	1960	106.7		2274 (61–63)		88.5 (61–63)	162.3 (60–65)	0.85 (60–65)	28.1
	1970	138. 6		2423 (69–71)		90.7 (69–71)	128.1 (70–75)	0.79 (70–75)	
	1980	181.3	2902	2893 (79–81)	101.1	100.0 (79–81))	107.6 (75–10)	0.73 (75–80)	16.4
	1981	186.2	2940		101.3				

	1982	191.3	3000		103.5					
	1983	196.5	3004		102.6		89.0 (80–85)	0.65 (80–85)		
	1984	201.9	3019	3021 (83–85)	103.6	104.3 (83–83)			9.7	0.2
	1985	207.5	3073		106.6					
Southeast Asia	1969	225.4		1832 (61–63)		81.8 (61–63)	121.7 (60–65)	1.24 (60–65)	15.7	0.3
	1970	287.3		2082 (69–71)		84.9 (69–71)	95.7 (70–75)	1.13 (70–75)		
	1980	360.6	2337	2417 (79–81)	101.0	100.0 (79–81)	83.6 (75–80)	1.02 (75–80)	8.3	0.3
	1981	368.1	2401		104.5					
	1982	375.1	2378		104.6					
	1983	383.6	2406		106.5		73.2 (80–85)	0.88 (80–85)		
	1984	391.5	2431	2467 (83–85)	110.2	109.4 (83–85)			7.6	0.3
	1985	399.7	2435		111.6					
China	1960	657.5		1713 (61–63)		68.7 (61–63)	121.0 (60–65)	3.16 (60–65)	11.0	0.5
	1970	830.7		1976 (69–71)		86.5 (69–71)	61.0 (70–75)	1.64 (70–75)		
	1980	996.1	2291	2219 (79–81)	99.3	100.0 (79–81)	41.0 (75–80)	0.86 (75–10)	5.0	0.3
	1981	1001.5	2309		100.5					
	1982	1021.0	2434		107.1					
	1983	1033.7	2549		113.1		39.0 (10–85)	0.77 (80–85)		
	1984	1046.5	2586	2564 (83–85)	119.3	117.0 (83–85)			2.0	0.1
	1915	1059.5	2557		111.5					

(1) The year refer* to value, for population, annual DES. annual food production, and child deaths; I.e. thoes with no year range given In brackets Otherwise the Interval is given In bracket, under the value. For ease of reading the interval values are as far as possible lined up with the nearest year.

Sources and Notes for Table AIII

Population and Infant Mortality Rates

From the United Nations Population Division, UN (1986) as given in the reference section, retrieved from FAO Information System of Food and Agriculture (AEROSTAT). Total population values are point estimates from the UN Population Division (retrieved from AGROSTAT). Child population: estimates for 0 through 4 years of age child populations were calculated by multiplying three year averages for total population by a known proportion of this age group calculated from 1985 population estimates (UN Population Division – retrieved from AGROSTAT).

Infant mortality rates: number of deaths of children 0–1 year/1,000 live births in a given year. Estimates are five year intervals from the UN Population Division (retrieved from AGROSTAT). Number of infant deaths: IMR x total number of live births per year/1,000. Based on five year intervals for IMR. Number of live births were retrieved directly from AGROSTAT, originally from UN Population Division data.

Child Death Rates

From the World Bank (1978–1986) and a few missing values from UNICEF (1986), both given in the reference section. Numbers of deaths of children 1 through 4 years of age/1,000 child population (1 through 4 years) per year. Number of child deaths: child death rate x 1 through 4 year child population (as above).

Dietary Energy Supply

Compiled from FAO Data Bank, FAO Information System of Food and Agriculture (AGROSTAT). Kcals/caput/day were obtained from the Supply Utilization Account in AGROSTAT> These may not match annual data exactly because a slightly different sample of countries was used to calculate each.

Food Production Indices

From FAO Production Year–book (e.g. PAO 1987) and data bank for relevant years. Values in parentheses are three year averages; 1960 – 1961/63, 1970 – 1969/71. 1980 – 1979/81, 1984 – 1983/B5. The sample of countries used to calculate three year averages were identical to the annual data. Estimates were provided by the FAO Statistics Division (retrieved from AGROSTAT).

Undernourished Population

Calculated by FAO on the basis of the methodology given in the 5th World Food Survey (FAO 1985), given in the reference section. See also section 4.1.5 of "First Report" for details.

Underweight

Calculated by ACC/SCN based on the methodology given in Section 3 of this Supplement. Prevalences were estimated, initially by country, using the regression modes derived from the sample of countries given in Table AII, using the independent variable values listed in Table AI. Prevalences were from a regression model derived using the sample of countries listed in Table AII. Numbers underweight – prevalence underweight x child population 1 through 4 years/100. Prevalences by country group were then calculated as total underweight/total child population.