PN-AAQ-186
ISN = 34883

9311064

62

CORNELL NUTRITIONAL SURVEILLANCE PROGRAM

Working Paper Series

Division of Nutritional Sciences
New York State Colleges of Human Ecology & Agriculture and Life Sciences
Statutory Colleges of the State University of New York
Cornell University
Ithaca, New York 14853

Cornell University is an equal opportunity, affirmative action employer and educator.

CHANGES IN NUTRITIONAL STATUS IN THE PHILIPPINES FROM 1979 TO 1980

by

Hamid Tabatabai, John Mason, Asuncion Macalalag,
Myra Bondad, Marito Garcia, and Eliot Morrison

October 1982 No. 13

The CNSP is supported by Cooperative Agreement # AID DSAN CA-0240 between the Office of Nutrition, Bureau for Science & Technology, USAID, and the Division of Nutritional Science, New York State Colleges of Human Ecology & Agriculture and Life Sciences, Cornell University, Ithaca, New York 14853.

A report of research of the Cornell University Agricultural Experiment Station

ABSTRACT

This paper examines possible changes in the prevalence of malnutrition in the Philippines from 1979 to 1980. Municipal level information on prevalence of malnutrition comes from a nationwide community weighing program known as Operation Timbang. Results at the national level suggest that an improvement of the order of 2-3 percentage points may have occurred from 1979 to 1980 and that the extent of improvement appears to be only slightly higher for nutritionally least and worst affected municipalities compared to that of municipalities which were moderately affected in 1979. Northern regions of the country improved unevenly but the central and southern regions seem to have done somewhat better than the national average. The implications of imperfect reliability of data on the change at municipal level are also examined.

TABLE OF CONTENTS

	Page
ABSTRACT	
INTRODUCTION	1
METHODS AND RESULTS	2
Data	2
Associations Among Variables	4
Change at National Level	4
Relative Change for Different Municipal Groupings	6
Change at Regional Level	8
Change at Municipal Level	9
DISCUSSION	13
TECHNICAL APPENDIX	14
REFERENCES	16

INTRODUCTION

The recent establishment of the Philippine Nutritional Surveillance System was preceded by an initial assessment phase (see Mason et al. 1982, Chapter 2) which examined, among other things, the geography of malnutrition in the Philippines in 1979. Nutritionally worst affected municipalities were identified and country-wide mappings of malnutrition were produced at municipal and provincial administrative levels (Tabatabai et al. 1982). This paper is a follow-up to the previous analysis. It extends a static picture of malnutrition at one time (1979) to a dynamic picture of possible changes overtime (from 1979 to 1980). These types of analysis would be carried out regularly by a well-established nutritional surveillance system and just as was the case with the analysis of malnutrition in 1979, the present analysis of change is primarily for the purpose of demonstrating potentially useful information that a surveillance system could routinely provide. The major drawback limiting the practical usefulness of the results of such analyses at present is the insufficient reliability of the raw data used. As more suitable and reliable data become available in the future similar analyses will provide outputs useful for planning and evaluation purposes which are the broad objectives of the nutritional surveillance activities in the Philippines.

This paper addresses itself to four specific questions:

(1) Has there been an overall change in the prevalence of malnutrition among preschool children in the Philippines in the 1979-1980 period?

(2) How have groupings of nutritionally worst affected, moderately affected and least affected municipalities in 1979 performed relative to the observed change at the national level?

(3) What changes have occurred at the regional level?

(4) What are the implications of measurement error on the measurement of change at the municipal level?

In answering these questions three issues have to be faced:

(a) The validity of inferences for the country at large when a large non-random sample of municipalities is used;

(b) The effect of regression toward the mean; and

(c) The imperfect reliability of data.

The outline of this paper is as follows. Data are briefly described and municipalities with relatively reliable information are identified. The applicability of inferences based on the resulting sample of municipalities is then examined. Possible change in the prevalence of malnutrition at the national level is studied and followed by an examination of the relative change for groups of municipalities which were, in 1979, nutritionally worst affected, moderately affected and least affected. The question of change at the regional level is addressed next. The implications of a more realistic view of the reliability of raw data are discussed when observed changes at municipal level are contrasted with estimated "true" changes. A simple model of change is used to estimate true change for individual municipalites in the sample from observed values of prevalence in 1979 and 1980. The last section discusses the results.

METHODS AND RESULTS

Data

The nutritional data for this study come from Operation Timbang (OPT), annual community weighing program which collects weight and age data on preschoolers around the nation. OPT is primarily a screening mechanism for the identification of malnourished preschoolers but the data it provides are also used for community-level planning. The use of OPT data for the estimation of prevalence of malnutrition at municipal level may involve substantial biases. The fact that not all preschoolers in a municipality are generally weighed (imperfect coverage) may on the one hand introduce a downward bias as outlying areas where malnutrition is probably more widespread are more likely to be ignored. On the other hand, as a screening mechanism, there is also a possibility that malnourished preschoolers are more heavily represented among those weighed than in the population at large. Overall however it appears that prevalence data from OPT are biased upward (for further discussion see Tabatabai et al. 1982). Apart from the unreliability introduced thus, many municipalities do not report their OPT data to central authorities. Available data are hence incomplete and sometimes unreliable.

As described in an earlier paper (Tabatabai et al. 1982) a 20-98 percent coverage of preschoolers in a municipality is chosen to identify municipalities

with relatively reliable information on prevalence of malnutrition. Coverage refers to the proportion of preschoolers measured in a municipality and the prevalence of malnutrition refers to the percentage of second and third degree malnutrition, i.e. the percentage of weighed preschoolers having a weight for age below 75 percent of Philippine standards. Out of a total of 973 municipalities in 1979 and 1025 in 1980 with prevalence information, 626 municipalities have a coverage of between 20 and 98 percent in both years. These municipalities constitute the sample on which the present analysis relies. It is therefore important to reflect on the applicability of any inferences drawn from this sample for the entire population of 1572 municipalities in the Philippines.

Two extreme positions can be contrasted with regard to the representativeness of this sample. One is that the sample is in no way representative and that the results are valid only for the sample and not for the population of municipalities in the country. The other is that the sample can be assumed to represent the population as well as a random sample of the same size would. Our position is eclectic and falls in between. While no claim is made that the results are necessarily valid for the population at large the sample has characteristics that suggest that it may not be entirely unrepresentative either. The sample is quite large containing about 40 percent of the municipalities in the country. Sample municipalities are geographically scattered around although the northern and central regions of the country are more heavily represented. These two areas were found in the previous analysis to be relatively least and worst affected nutritionally whereas the southern part, which is not as heavily represented in the sample, appears to be moderately affected.

The previous analysis also used five variables pertaining to socio-economic characteristics of municipalities: population density in number of persons per square kilometer, the percentage of palay (rice) area irrigated, the percentage of dwelling units with poor roofing material (cogon and nipa), the percentage of barangays (villages) not served by the local waterworks system and the number of physicians per 10,000 population. Table 2 provides the necessary information for the comparison of the relative availability of information on socio-economic characteristics and their unweighted means in the sample and the population (columns 1-6). In no case is the sample mean different from population mean by

more than twice the standard error of the sampling distribution (column 10), a property that is satisfied by at least 95 percent of random samples of corresponding size drawn from the population. At any rate, while our results strictly speaking apply only to the sample of 626 municipalities whose relatively reliable prevalence data are used we will be talking loosely about results "at national level", "by region," etc. when we mean that either the entire sample is being used or that the sample is broken up by region, etc.

Association among Variables

Table 1 gives correlation matrix of OPT and coverage in both years and the change observed. The correlation coefficient between OPT's is not as high as one might expect due to two factors: first, real change across municipalities is not uniform and second, there are measurement errors. The correlation between the OPT and coverage in each year is highly significant and negative although not very high. If OPT were indeed an unbiased measure of prevalence of malnutrition the association between OPT and coverage would not have existed. That it is negative can probably be explained partly by the fact that in low coverage areas the screening purpose of OPT results in an overestimation of prevalence. The interesting correlation coefficients are however those between change in prevalence and coverage on the one hand and with prevalence on the other. Lack of association with coverage is somewhat reassuring. The negative correlation of change with OPT 79 is expected for a number of potential and real reasons: regression toward the mean, i.e. high values of OPT in 1979 are likely to decline considerably (high negative change) and low values are likely to rise (high positive change); measurement error in OPT 79 is present in the amount of change with opposite sign (change = OPT 80 - OPT 79) and a potential reason that high prevalence municipalities in 1979 may have made more improvement than low prevalence ones. The positive correlation between OPT 80 and change is due to some of the same factors which now work in the opposite direction.

Change at National Level

A preliminary idea of possible change at the national level can be gained from the presentation of data in a format such as that in Table 3. Six prevalence

categories are distinguished in both 1979 and 1980 and each of the 626 municipalities with relatively reliable prevalence figure (OPT) is placed into one of 36 possible cells. The northeast and southwest corners of the table refer to municipalities (cases) where the prevalence of malnutrition changes drastically from 1979 to 1980. For example, there are two municipalities that improve from a 40-50 percent prevalence category in 1979 to a 10-20 percent prevalence category in 1980 implying an improvement of between 20 and 40 percentage points or 20 to 40 children in 100. Such changes are probably more an indication of the unreliability of data in these particular cases than of actual improvement. Hence the fact that very few municipalities are located in these two corners is a reassuring sign that there are probably few outliers in the 626 cases deemed to have reliable OPT. A plot of OPT in 1980 against OPT in 1979 (see Figure 1) reveals only a couple of potential outliers which are nevertheless retained. They do not affect the results in any significant way. There are 292 municipalities (47%) on the diagonal running from top left corner to bottom right corner which remain in the same category. There are 227 cases that show some improvement (below diagonal) and 107 that deteriorate, i.e. twice as many municipalities seem to have improved rather than deteriorated. Note that there is a strong tendency for municipalities in end categories in 1979 to move toward the center of the distribution. For example of the 9 that have a prevalence of less than 10 percent 7 move to higher prevalence categories. This is attributable in large part to the phenomenon of regression toward the mean which would be present even if there were no measurement errors. This regression effect will be discussed more fully in the next section. The conclusion that many more municipalities appear to have improved than deteriorated is unaffected by the existence of regression effect since we are concerned here not with the movement of extreme groups but with that of all municipalities taken together.

Table 4 makes an initial attempt to account for both the regression effect and measurement errors. Municipalities are grouped here by the mean of OPT for both years. This averaging process attenuates the effect of regression toward the mean as the high (or low) initial prevalences are usually combined with lower (or higher) final prevalences attributable mostly to the regression phenomenon. Furthermore, as it is reasonable to expect that higher coverage

generally implies a more reliable measurement of the prevalence of malnutrition three narrower ranges of coverage are also assumed to identify municipalities with progressively more reliable data. The unweighted means of municipal-level changes in prevalence are given in Table 4 for all groupings of municipalities in each range of coverage. All mean changes are negative reflecting improvement across the board regardless of mean prevalence category, range of coverage and number of municipalities. The average reduction in prevalence for all 626 municipalities is 2.5 percentage points which increases somewhat with increasing coverage. A general declining trend can also be detected in the amount of improvement as one moves from high mean prevalence groups down to low mean prevalence groups. This result however may be due to the residual effects of regression towards the mean. A genuine improvement and the regression effect work in the same direction for municipalities with higher mean prevalence and in the opposite direction for those with lower mean prevalence. Hence the pattern of change in these results is to be expected. Later results will show however that when the regression effect is removed the amount of improvement is about the same for both groups of municipalities with initially high or low prevalence.

We saw that the average improvement for all 626 sample municipalities was about 2.5 percentage points. This is an unweighted average although weighting municipal prevalence changes by say, population figures does not result in substantially different estimates of overall change in prevalence of malnutrition. The fact that the sample is large also removes the possibility that a few potential outliers are responsible for this estimated improvement. If it is admissible to assume that this estimate reflects a genuine nationwide change it remains to be explained how this improvement may have come about. This question is now being explored.

Relative Change for Different Municipal Groupings

A question of considerable interest concerns the relative improvement of groups of municipalities that start off with different levels of malnutrition. We are particularly interested in examining whether the worst affected municipalities (those with a prevalence of more than 40 percent in 1979) improve more than those least affected (those with less than 20 percent prevalence in

1979). Regression toward the mean (Furby 1973) is the major confounding factor here. Even in the absence of any genuine change the worst affected municipalities would tend to show an apparent improvement and the least affected ones an apparent deterioriation. Regression toward the mean may be due to errors of measurement. The constellation of factors that lead to an overestimation of prevalence, for example, are in part random and may not be as strong on a repeat measurement. This may not be true for an individual municipality but it is likely to apply when extreme groups are involved. On the other hand even in the absence of measurement error the regression effect may still exist. Extreme values result in part from the influence exerted by random elements which reinforce one another on an initial measurement whereas they often would not work in the same direction on a repeat measurement. The crucial precondition for the existence of regression effect is a remeasurement of extreme cases identified by a premeasurement. Our purpose here is to make an effort to measure real change over and above the change expected due to regression effect. The method of estimation of this real change is adapted from Davis 1976. Details of calculations are given in the Technical Appendix.

Assume that OPT79 (prevalence of malnutrition in 1979) is normally distributed. The X^2 test of goodness of fit was applied (see, e.g. Tabatabai 1982) to the observed distribution of this variable and the hypothesis of normality was not rejected at 5 percent level of significance. The mean and standard deviation of the distribution of OPT79 are 30.82 percent and 10.06 percent respectively. Consider first the worst affected municipalities with OPT79 exceeding 40 percent. The expected mean of the distribution of OPT79 for these municipalities is (Davis 1976):

$$E(OPT79 \mid OPT79 \geqslant 40\%) = 45.4\%$$

Suppose that the second measurement of OPT is carried out in 1980 when no overall change has occurred in the meantime. Despite a lack of overall change, the worst affected municipalities in 1979, being an extreme group, would show an expected mean of OPT in 1980 (OPT80) which is less than their 1979 mean of 45.4. The amount of the regression toward the mean is a function of, among other things, the correlation coefficient between the two measurements. The expected value of the distribution of OPT80 of worst affected municipalities

is :

$$E(OPT80 \mid OPT79 \geq 40\%) = 39.1\%$$

The regression effect is then - 6.3. The observed difference however is -9.9 indicating an improvement of about 3.6 percentage points over and above the effect of regression toward the mean (Table 5, Panel A). This improvement is somewhat larger than the overall improvement of 2.5 percentage points for the entire sample.

The least affected municipalities in 1979 (those with prevalence of below 20 percent) are subject to the regression effect in the same way as were worst affected municipalities. The difference is that their mean OPT would increase as a result of the regression toward the mean. The needed information is provided in Table 5, panel B. The observed deterioration of 3.5 percentage points is lower than the expected deterioration of 6.9 due to regression effect. The difference of 3.4 may be taken to represent change over and above that expected due to regression. Since both the worst affected and least affected municipalities seem to have improved somewhat more than all the sample municipalities put together the moderately affected group must have improved slightly less than the average of 2.5 percentage points. The observed values of OPT79 and OPT80 for this middle group are in fact 29.5 and 27.8 percent indicating an improvement of about 1.7 percentage points.

Change at Regional Level

Table 6 shows the mean change in prevalence of malnutrition by region. The percentage of municipalities with reliable OPT in total number of municipalities is given in column 3 for each region and varies from about 10 percent in Region XII to more than 60 percent in Regions II and V. The mean change (column 4) is consistently negative, i.e. all regions appear to show an improvement albeit at different rates. This statement assumes that the sample of municipalities with reliable OPT is representative of all the municipalities in each region. This assumption would be untenable if the sample proportion is low

but is likely to be more defensible as this proportion increases. It is assumed here that if this proportion is at least 40 percent and if the number of municipalities with reliable OPT in a region is at least 40, the sample of such municipalities can be treated as a simple random sample of all municipalities in the region. With this assumption statistical tests of hypothesis can be applied to the reliable OPT data to infer possible change at the regional level. Two such tests have been applied to the eight regions that satisfy the two restrictions: the t-test for paired samples and its non-parametric equivalent, Wilcoxon matched pairs signed rank test. The results of both are consistent. Regions III, IV, VI, VII and XI show highly significant improvements whereas the other three, II, V and VIII, do not show a significant change. All but one of these eight regions are in the northern and central parts of the country. The relative paucity of reliable data in the southern part of the country prevents any solid statements to be made regarding any changes that may have occurred in the 1979-1980 period but sample mean changes for all southern regions are above average for all sample municipalities.

Change at Municipal Level

Much of the preceeding analysis rested on the assumption that with a coverage of 20-98 percent a municipality would have reliable OPT. If this assumption were valid, the observed change in OPT from 1979 to 1980 would correctly measure true change for each municipality. This assumption is however unrealistic in view of the well-recognized shortcomings of Operation Timbang and the upward bias that appears to exist. There is little that can be done here to compensate for the overall upward bias of OPT except to assume that it is about the same in both years and would not appreciably affect the measurement of change. However, to the extent that the measurement errors are unsystematic, or unbiased, some additional results can be obtained concerning the implications of imperfect reliability for measurement of change at municipal level.

If measurement errors were unbiased the observed mean change which was calculated to be -2.5 percentage points for 626 sample municipalities would be an unbiased estimate of the true mean change. The unbiased measurement

errors however profoundly affect the estimate of change in individual municipalities as the observed change in each is not an unbiased estimate of true change. In this section we attempt to arrive at unbiased estimates of change for individual municipalities in the presence of unbiased measurement errors. A comparison of the results with those obtained with the assumption of perfect measurement reliability provides some useful insights.

A model of change. Social scientists, notably psychologists, have often faced the problem of measuring change when measurements are not fully reliable (see, e.g. Harris 1963). We employ here a model proposed by Lord (1956, 1958 and 1963) to estimate true change in the presence of measurement error. Suppose that x and y represent the observed values of OPT for 1979 and 1980 respectively and X and Y represent their unobserved true values. We have $x = X + e_x$ and $y = Y + e_y$ where e_x and e_y are measurement errors assumed to have zero means and constant variances $S^2_{e_x}$ and $S^2_{e_y}$ respectively. The true change in prevalence G is equal to Y-X and an unbiased estimate of its mean $\bar{G}$, (a bar denotes a mean), is given by $\bar{y}-\bar{x}$, i.e. the difference in the observed means. The model assumes that the estimate of true change in each municipality, $\hat{G}_i$, is a linear function of the observed values x and y, i.e.

$$\hat{G}_i = a + b_1 x_i + b_2 Y_i \qquad i = 1, 2 \ldots, n \quad (1)$$

where i refers to each observation. Summing over all observations 1 to n and dividing by n we have

$$\bar{G} = a + b_1 \bar{x} + b_2 \bar{Y}$$

or

$$a = \bar{G} - b_1 \bar{x} - b_2 \bar{Y}$$

Substituting for 'a' in (1) and dropping 'i' for convenience, we get

$$\hat{G} = \bar{G} + b_1 (x - \bar{x}) + b_2 (Y - \bar{Y}) \qquad (2)$$

where $\bar{G} = \bar{Y} - \bar{x}$

The calculation of b_1, and b_2 involves the standard deviations of x and y, s_x and s_y, their correlation coefficient, r_{xY}, and their reliability

coeffieicnets r_{xx} and r_{yy} (see Lord 1956 and 1963) where $r_{xx} = 1 - S^2_{e_x}/S^2_x$ and $r_{yy} = 1 - S^2_{e_y}/S^2_y$. The reliability coefficient is the correlation coefficient between two replicate measurement of the same variable when the second measurement is repeated on the same entities immediately after the first. The difference between the two measurements arises thus from measurement error alone. With perfect reliability

$$r_{xx} = r_{yy} = 1, \; b_1 = -1 \text{ and } b_2 = 1$$

In this case $\hat{G}_i = \bar{y} - \bar{x} (x_i - \bar{x}) + (y_i - \bar{y}) = y_i - x_i$

i.e. e estimate of the true change is merely the final value minus the initial value. Three other quantities are of interest: r_{gg}, the correlation reliability of the observed change $g = y-x$; r_{gG}, the correlation coefficient between the observed change and true change; and r_{GG}, the correlation coefficient between the estimate of the true change and true change. High values of these coefficients are desired.

In our analysis we have the following:

$$\bar{x} = 30.82 \qquad \bar{y} = 28.32 \qquad \bar{G} = -2.50$$

$$S_x = 10.06 \qquad S_y = 9.53 \qquad r_{xy} = 0.57$$

The reliability coefficients for x and y, r_{xx} and r_{yy}, are of course not available. If they were, b_1, b_2, r_{gg}, r_{gG} and r_{GG} could be readily caluculated. The upper limit of these reliability coefficients is 1 which was implicitly assumed in earlier part of the analysis. In this case the reliability of the observed change would be perfect, i.e. $r_{gg} = 1$. It can also be shown that if $r_{xx} = r_{yy} = r_{xy}$, the reliability of the measured growth r_{gg} would be zero if $s_x = s_y$ and close to zero if r_{xy} is not small and s_x is approximately close to s_y as is the case with the present data.

Considering these limits for the reliability coefficients of the initial and final OPT on the one hand and that of the measured change on the other, it is clear that when the observed OPT figures are unreliable, the observed change is even more unreliable. We lack knowledge of the reliability of OPT measurements but they are known to be less than perfect. For the sake of studying the effect of less than perfect measurement reliability it is assumed

that $r_{xx} = r_{yy} = 0.75$, which fall about in the middle of the reasonable range noted above. This assumed value implies that the standard error of measurement in x and y is one-half of their respective standard deviations. With this assumption, and using formulas given by Lord (1963) the following quantities can be obtained:

$$b_i = 0.43 \qquad b = 0.41$$

$$r_{gg} = 0.42 \qquad r_{gG} = 0.65 \text{ and } r_{\hat{G}G} = 0.65$$

Hence, from (2), we have:

$$\hat{G} = -2.50 - 0.43(x - \bar{x}) + 0.41(y - \bar{y})$$

and substituting for $\bar{x}$ and $\bar{y}$, we obtain:

$$\hat{G} = 0.86 - 0.43x + 0.41y \qquad (3)$$

Equation (3) provides estimates of true change for every one of the 626 municipalities with 1979 and 1980 OPT (x and y respectively). As can be seen the right hand side of the equation is quite different from y-x which would be used when x and y are measured with perfect reliability.

Results. To see the implications of this difference more clearly, Figure 1 plots Equation (3) for several assumed values of estimated true change on a scatter plot of all 626 municipalities. Some of the implications are as follows:

(1) All those municipalities that lie above the 45° line ($g = y - x = 0$) and below line marked by $G = 0$ have a positive observed change (a deterioration as prevalence is observed to have increased) and a negative estimated true change (an improvement). An apparent deterioration in some cases seems to be in fact an improvement.

(2) The range of the estimated change is much narrower than that of the observed change. The observed change varies from about - 50 to + 50 percent but the estimated change has a range of about - 20 to 20 percent.

(3) For all municipalities with a prevalence of more than about 45 percent in 1979 the estimated true change is negative. This is in part a reflection of the regression toward the mean.

(4) The slope of the regression of OPT80 on OPT79 is significantly lower than 1 suggesting that municipalities with higher prevalence in 1979 gained considerably more than those with lower prevalence. This mistaken inference is due to the strong effect of regression towards the mean. The fact that the slopes of the (G = constant) lines is close to one (i.e. the slope of 45° line g - 0) suggests that the extent of improvement is in fact roughly the same regardless of initial prevalence.

(5) The validity of numerical observations in (1) - (4) depends on the accuracy of the assumed values for the reliability of measured OPT in 1979 and 1980.

DISCUSSION

This study has reached two broad conclusions which are however highly tentative. These are (a) that an overall improvement in nutritional situation in 1979-1980 period has taken place and (6) that the extent of improvement appears to be roughly the same whether municipalities are grouped by their nutritional situation in 1979 or regionally. The extent of change in individual municipalities is however very diverse. These conclusions are highly tentative because of incompleteness of data and their insufficient reliability. They must remain so until more thorough investigation of more appropriate data establishes whether these conclusions are valid for the period under consideration, and if so, whether they are part of a trend and the reasons for them. A beginning can be made by examining other indicators such as growth of per capita income, changes in income distribution, in health services, etc. These and similar factors may or may not provide corroborating evidence for the tentative finding of nationwide improvement in nutritional situation and its distribution. Certain other factors need to be investigated as well such as whether seasonal factors may account for the change.

These caveats however need not detract attention from the importance of examining change in nutritional status over time. Under normal circumstances an improvement of 2-3 percentage points appears to be a realistic objective and suggests that if the rate of improvement can be sustained through time, a period of a decade or so may be a realistic and sufficient time horizon to practically eliminate the problem of malnutrition.

TECHNICAL APPENDIX

Assume that x refers to the prevalence of malnutrition in 1979, is normally distributed, has a mean $\bar{x} = 30.82$ and a standard deviation $S_x = 10.06$. The mean prevalence for all municipalities with a prevalence of at least 40 percent is given by :

$$E(x \mid x \geq 40\%) = \bar{x} + c S_x$$

where

$$c = \phi(a) / [1 - \phi(a_1)]$$

$$\phi(a) = \exp(-\tfrac{1}{2} a^2) / \sqrt{2\pi}$$

$$\phi(a) = \int_{-a}^{a} \phi(x)\, dx$$

and a is the cutoff in standard deviation units, i.e.

$$a = \frac{40 - 30.82}{10.06} = 0.7125$$

Hence $\phi(a) = 0.263$, $\phi(a) = 0.8186$, $c = 1.45$ and

$$E(x \mid x \geq 40\%) = 30.82 + 1.45 \times 10.06 = 45.4\%$$

Assume further that if prevalences were measured again in 1980 (x') and that <u>if the correlation coefficient between 1979 and 1980 measurements (in the absence of any true change) were the same as the observed correlation coefficient of r = 0.57 (when there has in fact been some true change for at least some municipalities)</u> then the mean prevalence in 1980 of municipalities with more than 40 percent prevalence in 1979 is given by

$$E(x' \mid x \geq 40\%) = \bar{x} + r c S_x = 39.1\%$$

The assumption regarding the value of correlation coefficient between pre- and post-measurement would be valid if the extent of true change is the same for all municipalities. But true change is likely to be different for individual muncipalities and this assumption may or may not be valid. A similar procedure has been followed to find the mean prevalence of municipalities with less than 20 percent prevalence in 1979 and their mean prevalence following the hypothetical remeasurement in 1980 in the absence of the change.

REFERENCES

Davis, C.E. 1976. "The Effect of Regression to the Mean in Epidemiologic and Clinical Studies." American Journal of Epidemiology, Vol. 104, No. 5, pp. 493-498.

Furby, L. 1973. "Interpreting Regression toward the Mean in Developmental Research." Development Psychology, Vol. 8, No. 2, pp. 172-179.

Harris, C.W. (Ed.) 1963. Problems in Measuring Change. Madison, Wis.: University of Wisconsin Press.

Lord, F.M. 1956. "The Measurement of Growth". Educational and Psychological Measurement, Vol. 16, pp. 421-437.

Lord, F.M. 1958. "Further Problems in the Measurement of Growth." 1958. Educational and Psychological Measurement, Vol. 18, pp. 437-451.

Lord, F.M. 1963. "Elementary Models for Measuring Change." In Harris (Ed.), see above.

Mason, J.B., Habicht, J-P, Tabatabai, H. and Valverde, V. 1982. Nutritional Surveillance. Cornell Nutritional Surveillance Program.

Tabatabai, H. 1982. Analytical Methods for Nutritional and Socio-Economic Data. Cornell Nutritional Surveillance Program Working Paper Series, No. 4.

Tabatabai, H., Mason, J., Garcia, M., Elliott, T. and Mitchell, J. 1982. Methods Used to Identify Priority Municipalities for Intervention Based on Operation Timbang and Socio-Economic Data. Working Paper Series, No. 7.

TABLE 1

CORRELATION MATRIX

(N=626)[a]

	(1)	(2)	(3)	(4)	(5)
OPT 79	1.00				
OPT 80	0.57*	1.00			
COVERAGE 79	-0.15*		1.00		
COVERAGE 80		-0.18*	0.50*	1.00	
CHANGE	-0.51*	0.42*	-0.01	-0.07	1.00

[a] Municipalities with coverage of 20-98 percent in both 1979 and 1980.

* $p < 0.01$

TABLE 2. COMPARISON OF SOCIO-ECONOMIC CHARACTERISTICS OF POPULATION AND SAMPLE OF MUNICIPALITIES

	(1) NO. OF AVAILABLE OBSERVATIONS	(2)	(3) PERCENT OF AVAILABLE OBSERVATIONS	(4)	(5) MEAN OF VARIABLE	(6)	(7) ST. DEV.	(8) DIFF. IN MEANS	(9) ST. ERROR OF MEAN	(10) DIFF. IN MEAN IN UNITS OF ST. ERROR
	P[b]	S[b]	P	S	P	S	P	(6) - (5)	(8) ÷ $\sqrt{(2)}$	(8) ÷ (9)
POPULATION DENSITY (Persons/sq.km)	1492	625	99.6	99.8	195.7	184.8	174.1	-10.9	6.96	1.57
RICE AREA IRRIGATED (Percent)	1461	619	97.5	98.9	39.5	42.0	33.0	2.5	1.33	1.9
HOUSES WITH POOR ROOFING (Percent)	1491	626	99.5	100.0	62.2	64.0	24.5	1.8	0.98	1.8
BARANGAYS WITH WATERWORKS (Percent)	1231	537	82.2	85.8	34.9	34.9	35.2	0.0	1.52	0.0
NO. OF PHYSICIANS (Per 10,000 Population)	610	279	40.7	44.6	2.03	2.00	2.46	-0.03	0.15	0.2

[b] P = Population
S = Sample

TABLE 3. MOVEMENT OF MUNICIPALITIES ACROSS PREVALENCE CATEGORIES IN 1979-80[a, b]

1979 Prevalence Categories (Percent)	1980 Prevalence Categories (Percent)						
	< 10	10-20	20-30	30-40	40-50	≥ 50	Total
< 10	2	5	1	0	0	1	9
10-20	4	31	27	3	0	0	65
20-30	1	47	142	38	5	0	233
30-40	0	14	89	85	22	4	214
40-50	1	2	11	38	27	1	80
≥ 50	0	0	8	5	7	5	25
Total	8	99	278	169	61	11	626

(a) Municipalities with coverage of 20-98% in both 1979 and 1980.

(b) The number in each cell refers to the number of municipalities that have moved from a prevalence group in 1979 (identified in the corresponding row) to a prevalence group in 1980 (identified in the corresponding column). Diagonal cells represent the number of municipalities that have remained in their respective prevalence group in both years.

TABLE 4

CHANGES IN PREVALENCE OF MALNUTRITION IN 79-80
BY MEAN PREVALENCE CATEGORY AND COVERAGE

Mean prevalence of malnutrition in 79 and 80	No. of Municipalities	Mean Change
	Coverage in both 79 and 80 = 20 - 98%	
> 50	11	-0.4
40-50	66	-4.8
30-40	195	-3.1
20-30	283	-1.9
0-20	71	-1.3
Total	626	-2.5
	Coverage in both 79 and 80 = 40 - 98%	
> 50	3	-4.9
40-50	30	-6.8
30-40	95	-4.1
20-30	170	-1.6
0-20	54	-1.6
Total	352	-2.7
	Coverage in both 79 and 80 = 50 - 98%	
> 50	1	-14.8
40-50	14	- 8.4
30-40	50	- 5.7
20-30	99	- 1.3
0-20	37	- 2.4
Total	201	- 3.2
	Coverage in both 79 and 80 = 70 - 98%	
> 50	---	---
40-50	3	-10.6
30-40	12	- 5.4
20-30	17	- 1.3
0-20	9	- 1.3
Total	41	- 3.2

TABLE 5. COMPARISON OF EXPECTED CHANGE DUE TO REGRESSION TOWARD THE MEAN AND OBSERVED CHANGE FOR WORST AND LEAST AFFECTED MUNICIPALITIES

(A) Worst affected municipalities (≥ 40% prevalence of malnutrition)

	Expected mean[a]	Observed mean
OPT 79	45.4	46.9
OPT 80	39.1	37.0
CHANGE (OPT 80 - OPT 79)	-6.3	-9.9

(B) Least affected municipalities (< 20% prevalence of malnutrition)

	Expected mean[a]	Observed mean
OPT 79	14.9	15.6
OPT 80	21.8	19.1
CHANGE (OPT 80 - OPT 79)	6.9	3.5

[a] Expected mean in 1980 assumes "no change" in the prevalence of malnutrition in any municipality hence the difference in expected means are due to regression towards the mean phenomenon alone.

TABLE 6. CHANGE IN PREVALENCE OF MALNUTRITION IN 1979-80 BY REGION

	1	2	3	4	5	6
Region	No.of Muni.	No. of Muni with 20-98% Coverage in Both Years	%	Change	t[a]	z[b]
I	174	67	39	-1.10		
II	111	72	65	-0.07	0.06	-0.19
III	121	62	51	-3.42	-3.30**	-3.03**
IV	217	79	36	-3.20	-3.92**	-4.11**
V	86	55	64	-1.35	-1.01	-0.87
VI	128	76	59	-3.52	-3.93**	-3.97**
VII	132	66	50	-2.63	-3.27**	-3.12**
VIII	137	55	40	-2.73	-1.60	-1.87
IX	90	12	13	-2.61		
X	120	28	23	-5.75		
XI	79	43	54	-2.97	-2.64*	-3.03**
XII	103	11	11	-3.26		
Total	1498	626		-2.50		

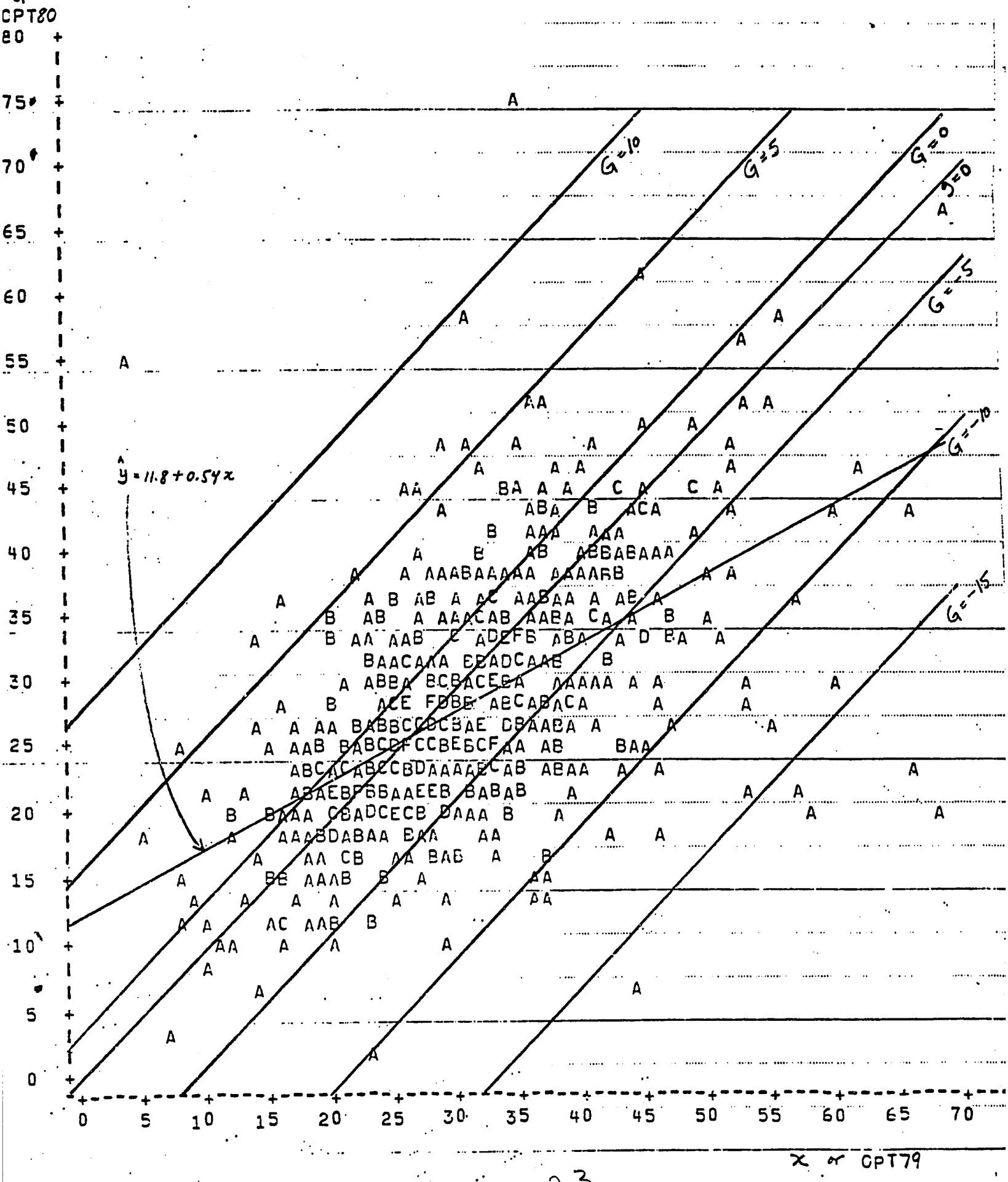
[a] t- value for test of no change in overall prevalence of malnutrition.

[b] Wilcoxon matched-pairs signed- ranks test statistic.

** Significant at 1 percent.

* Significant at 5 percent.

FIGURE 1


y or CPT80
x or CPT79
ŷ = 11.8 + 0.54x
G=10
G=5
G=0
G=0
G=-5
G=-10
G=-15
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80

CNSP WORKING PAPER SERIES

Currently available:

1. Nutritional Surveillance: A synopsis. June 1981.
2. Nutritional Surveillance. August 1981.
3. Surveillance Summaries. January 1982.
4. Analytical Methods for Nutritional and Socio-economic Data. April 1983.
5. Principles for Evaluation of On-going Programs. May 1982.
6. An Outline Plan for Developing a Nutritional Surveillance System in New York State. May 1982.
7. Initial Assessment for Nutritional Surveillance in the Philippines. Forthcoming.
8. Preliminary Analysis of Nutritional and Agricultural Data, Eastern Province, Kenya. August 1982.
9. Static and Dynamic Poverty Indicators: An Indonesian Example. May 1983.
10. Reducing Malnutrition Through Rural Development: A test of Planning Methods in Haiti. June 1983.
12. Malnutrition by Socio-Economic Classification in Palawan, the Philippines. June 1983.
13. Changes in Nutritional Status in the Philippines from 1979 to 1980. Forthcoming.
14. National Health Information Systems and their use in Nutritional Surveillance. January 1983.
15. On Sampling Variance of the Sensitivity of an Indicator. January 1983.
16. Note on a Framework for Monitoring and Evaluation of UNICEF/WHO Nutrition Improvement Programmes. March 1983.

Additional Documents Available from CNSP:

Report of Workshop on Social and Nutritional Surveillance in Eastern & Southern Africa. May 17-19, 1982.

Background Papers for Workshop on Social and Nutritional Surveillance in Eastern & Southern Africa. May 17-19, 1982.

6/83