PN-AAQ-393
ISN: 35346

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.

TRENDS IN NUTRITIONAL STATUS OF CHILDREN IN RURAL KENYA: REVIEW AND POLICY IMPLICATIONS[1/]

Paper presented at National Workshop on
Nutrition and Planning in Kenya
Kisumu, Kenya, 6 January 1984

Cornell Nutritional Surveillance Program

January 1984 **No: 30**

1/ Original title: **RECENT ADVANCES IN NUTRITIONAL SURVEILLANCE: REVIEW AND POLICY IMPLICATIONS**

I. DEVELOPMENT OF NUTRITIONAL SURVEILLANCE WORLD-WIDE

The concept of nutritional surveillance stemmed from the success in surveillance of infectious diseases, for which one notable achievement has been the recent eradication of smallpox. At the World Food Conference of 1974, it was proposed that nutritional surveillance be established to "monitor the food and nutrition conditions of the population at risk". In a meeting convened by WHO in 1975, a clear decision was made that the focus of nutritional surveillance should be at national level, and that the primary purpose should be to support decisions aimed at improving nutrition on a national or sub-national basis. A metholodogy for nutritional surveillance was proposed by this meeting (ref. 1), although at this stage there was rather little experience in applying concepts of surveillance to the problem of malnutrition. The characteristics of surveillance in a general sense are, first and foremost, that information is only made available insofar as it is needed to make decisions on actions to tackle the problem being monitored; and that data are derived from sourves that are as far as possible already available, and these may be both administrative (e.g. from clinic or school records) as well as deliberately collected (e.g. through sample surveys). Central to the concept is a mechanism for producing information and using it for decision-making in a timely manner. The actions which nutritional surveillance information can support can range from national development planning throught to clinic level interventions: in other words, these depend on opportunities for improving nutrition, more often than not through introducing nutrition considerations into government policies and programs that may already be planned or in operation even if not primarily for nutritional purposes.

In the period from 1975 on, many countries began to develop systems which approximated to the concepts of nutritional surveillance put forward at the World Food Conference and the subsequent meeting at WHO. Of course, these derived from national priorities, and were usually not specifically labelled "nutritional surveillance" - nonetheless, they involved regular information generation coupled to decision-making with respect to nutrition. When in 1979 reviews of progress were initiated both by the UN system (ACC-Subcommittee on Nutrition) and by the National Academy of Sciences of the U.S., some twenty or so programs involving regular collection of nutritional information were identified. It became clear that more emphasis was needed on decision-making: a number of operations were attempting to reach a range of objectives at the same time, and some prioritization of these objectives was needed. We suggested therefore that the different characteristics of nutritional surveillance systems should be defined by their purposes, and this definition of nutritional surveillance by purpose was accepted at a UN-sponsored meeting in Cali, Columbia in 1981 (ref. 2). This meeting also agreed that nutritional surveillance should be defined as "to watch over nutrition in order to make decisions that lead to improvement in nutrition in populations". The three types of nutritional surveillance, defined by purpose, were: (a) to support long-term plannning; (b) for program management and evaluation; (c) for timely warning and intervention to prevent short-term food crises. These objectives are not mutually exclusive, but do however aid in setting priorities for nutritional surveillance systems. By far the most common form of nutritional surveillance is the first, to support long-term plannning. Based on the experience of different national programs, and further research (not least through our collaboration with the government of Kenya) we have described the theory and practice of nutritional surveillance in a book shortly to be published by WHO (ref. 3).

Kenya has taken an important lead in developing techniques of regular collection and analysis of nutritional data, with reference to government decision-making. We are most grateful and privileged to have been associated with these developments, and hope very much to continue to be involved. Before giving some of our interpretations of the recent progress made in Kenya, it may be useful to set the more general context by describing nutritional

surveillance activities in a number of other countries throughout the world. (Some of these descriptions are available in working papers from the Cornell Nutritional Surveillance Program, and a list of publications is available; in particular two working papers entitled "Surveillance Summaries" describe activities in many of the countries involved). The nutritional surveillance activities depend, as they should, on the priorities seen by national governments in terms of nutrition; and these in turn tend to vary by region of the world. Therefore we will briefly describe what is happening by region first in Southern and Southeastern Asia, then in Latin America, and then in Africa.

In Asia, systems being developed in Indonesia, Philippines and India illustrate different aspects of nutritional surveillance. In Indonesia, the government has given priority to developing locally-based systems (at the administrative level approximating to the district) to prevent the nutritional effects of periodic acute food shortages. Here, agricultural information at critical times of the year is compiled at the local government level and a series of decision-making meetings are held prior to the annual period of greatest risk, to identify whether and where food shortages are to be expected later in the year. Research from historical data has shown that the indicator most sensitive and specific for predicting food shortages later in the year is the area of rice harvested, in relation to that planted. For areas where there is risk of food shortage, additional indicators are then collected, including through rapid surveys, and subsequently through the health system. The interventions which are put in place where needed to prevent suffering from food shortage are staged, beginning with emergency public works to generate income, if necessary moving on to food distribution. In India, a number of different aspects of nutritional surveillance are in operation. The best known procedures which date back several decades involve mechanisms for preventing acute food scarcity: these involve legislation, movement of food stocks, and emergency public works. The information used to trigger these is again a compilation of agricultural data, observation, local knowledge, etc. Beyond this, there is an extensive nutrition monitoring system whose uses are aimed at long-term planning. These are based on annual sample surveys, both specifically nutritional (through the National Nutrition Monitoring Board), and through the National Sample Survey Organization. These are now to be merged to some

extent, such that nutritional status information is collected through the National Sample Survey procedures, and indeed there is an analogy here with the procedures used in Kenya. The population of India is orders of magnitude greater than that of African countries, and consequently the extent of the data is enormous. The familiar constraints of dealing with large volumes of data exist here too, but nonetheless regular reports are made available to the government on nutrition conditions, changes in these, and correlates of these changes. In the Philippines, there are a number of complementary systems producing regular information for different purposes, for government planning. In general in nutritional surveillance there are trade-offs between using administrative data sources, which allow for very large sample sizes and hence a high degree of disaggregation (but with representativeness of the data not well defined), and representative sample surveys where the possibility for disaggregation is less, but integrated data becomes available. This is illustrated well in the Philippines, where regular (approximately every three years) sample surveys give reliable estimates of prevalences of malnutrition by broad area of the country, and some information on food consumption. There is then a national weighing program of pre-school children, which gives information primarily for local targetting of programs and local planning, and which can be used to monitor trends in nutritional status. A third method has recently been tried whereby data already collected on the heights and weights of school entrants are retrieved, together with certain characteristics of the schools, and used to give a more representative picture of nutritional status by disaggregated administrative area. This method of school survey is promising where there is a high level of school enrollment. A combination of these data sources has given a reasonably clear picture of the evolution of nutrition problems in the country, defining who is most affected, and giving indications of causes of malnutrition and hence implications for policy and program planning.

In certain Latin American countries, large-scale nutrition and social welfare programs have been set up (for example in Costa Rica and Colombia), and these have incorporated nutritional surveillance within the programs for purposes primarily of planning and monitoring of the programs. The nutrition information system in Costa Rica is a good example. Here again, a combination

of administrative and sample survey data sources is used. The technique of school entrants survey was first tried here, and reporting of child nutrition through the health system is extensive. These data have been used for allocating resources to needy areas, and for beginning to evaluate the effect of these resources on nutritional status. In Colombia, a pilot scheme has been in operation for a number of years, mainly using data from health centers to give a rapid assessment of health and nutrition.

Many countries in Africa are at the stage of beginning to use their resources for nutrition to develop nutritional surveillance. Very valuable experience is being gained in Kenya, as will be discussed later. A second development which seems well worth briefly describing is in Botswana, which in contrast to the approach taken in Kenya relies on reports of prevalences of malnutrition from health centers. The major purpose here is also different to that in Kenya since the major immediate problem of nutrition is the effect of drought, and the distribution of food assistance to mitigate these effects. In Botswana, weights and ages of children attending clinics are recorded, summarized and tallied, and reported up to the central office on a monthly basis; an effective data handling system provides reports within the same month on changes in prevalences of malnutrition by clinic and districts, and these data can be used to direct food resources in times of drought. Analysis of historical data is showing that certain agricultural indicators (for example water satisfaction indices) for certain crops are highly related to subsequent changes of nutrition, and there exists an excellent chance that these agricultural indicators may be sufficiently precise to predict when and where nutrition is likely to deteriorate.

The system in Kenya needs no description from us, except to emphasize that the innovative work undertaken by the Central Bureau of Statistics since 1977 is now beginning to bear fruit in terms of much better knowledge of what is happening in terms of nutrition in Kenya, and to some extent why it is happening. The priority now is to come up with realistic recommendations as to what to do about the situation. Some of these topics are discussed in the second section of this report. It is very much to be hoped that this experience

will be communicated to other countries in Africa, and it seems very likely that this experience will be of great benefit in guiding development of activities elsewhere within this region.

In general, the stage of development of nutritional surveillance is moving ahead from problems of acquiring the necessary data and processing it, to interpreting the results in a way relevant to policy, and then effectively inserting the conclusions into decision-making. Everywhere, this is the key factor, and indeed one of the most difficult to deal with. There are many facets of this - effective communication with decision-makers, and renewed efforts on the part of those concerned with nutrition to make recommendations that are realistically in line with government possibilities for actions to tackle the situation. We of course know less about this than most people present at this meeting - after all, the people present here are those with responsibility for making decisions, in terms of allocating resources to different activities, that can affect the nutritional situation. We hope we shall be able to learn from these experiences, and where possible help to suggest what needs to be done. The next section of this paper gives a brief review of what we do know about the nutritional situation in Kenya, based on the extensive information on nutrition that has been gathered since 1977; we hope this may be useful, not only to observe the situation, but to take action to reverse deteriorating trends and bring about improvement in nutrition throughout the country.

II. RECENT RESULTS FROM NUTRITIONAL SURVEILLANCE IN KENYA AND THEIR IMPLICATIONS

Results from the nutrition surveys carried out in 1977 (NS1), 1978/9 (NS2), and in 1982 (NS3) can be interpreted in the following ways.

1. Changes in nutritional status over the five year period, by province, can be described.
2. Certain explanations for these changes can be proposed.
3. From the more detailed NS3, targetting priorities for programs can be established.
4. Correlates of nutritional status, again from NS3, give indications of possible policy implications.

Changes in nutrition from 1977-1982. Prevalences of stunting by province are shown in Table 1. Overall, there has been an increase in the prevalence of stunting over this period, from about 24% in 1977, through 27% in 1979, to 28% in 1982. However, these changes were not the same in all provinces. In general, Central and Rift Valley provinces showed a slight improvement during this period, and remained among the best off in the country. Eastern Province showed a dramatic improvement from 1977, when it had the highest prevalence at 34%, to 24% prevalence in 1979 and 27% in 1982. In the West however, in Western and Nyanza provinces, there has been a substantial deterioration over this period, such that these two provinces are, with Coast, the worst-off in the country.

Before discussing the likely causes of these changes, it is important to examine the data further in order to gain confidence that these changes are in fact real, and are not due to sampling differences, or for example to a particular age group of children being stunted in one survey becoming too old to be included in a later survey. Several techniques have been used to test these possibilities (so far for NS1 and NS2) two of which will be discussed here.

The first was to compare the nutritional status of cohorts of children - that is children born during the same six-month (in this case) time periods, and to trace their progress between the surveys. Examples are given for Eastern and Nyanza provinces in Figure 1 (a and b). In Eastern Province (Figure 1a) it can be seen that the substantial improvement shown between NS1 and NS2 is reflected in most of the cohorts. A similar picture is seen comparing age groups cross sectionally between the two surveys (Figure 2). Similarly, the deteriorating trend in Nyanza Province is observed in almost all cohorts (Figure 1b); and indeed the same result is again seen when examining age groups cross sectionally. Thus the explanation for the improvement in Eastern Province is not that one particularly stunted group of children got to the age where it was not included in the second survey - on the contrary, the improvement is seen amongst all the age-groups included in the 1977 survey. In the worst-affected provinces, the 2-3 year old children are generally the worst-off - that is in Nyanza, Western, and Coast Provinces (see Figure 2). Nonetheless, in all of the provinces examined in this way, a consistent trend of improvement, deterioration, or maintenance of the position was seen when comparing cohorts.

One possible explanation for these trends is that the observed changes in prevalence of malnutrition between 1977 and 1979 were due to differences in the composition of the sample, for example, if the earlier sample contained more landless or very poor families, than the later sample. However, the changes in nutritional status are seen even if we allow for any changes in sample composition by landholding size, water supply, household sanitation etc. This can be seen in Table 2a. A regression equation relating nutritional status to these household factors in the 1979 data was estimated (Table 2b). Then, if values for the same independent variables from the households in the 1977 data set are entered into this equation, we can calculate the mean height-for-age by province that would have been seen in 1977, if nothing had changed in the sample between 1977 and 1979 except these factors. The differences between the hypothetical means for 1977 and the actual for 1977 (Table 2a, cols. 1 and 2) are just as great as the differences between actual means in 1977 and 1979 (Table 2a, cols. 1 and 3). Therefore the improvement in Eastern Province and the deterioration in Nyanza and Western cannot be explained solely by changes in the sample composition, as least as far as we can tell from the household-level variable included in the nutrition surveys.

We conclude that, so far as we are able to check with the data at hand, the general picture for 1977 to 1979 of improvement in Eastern Province, little change in Central and Rift Valley provinces, and deterioration in Western and Nyanza provinces, is likely to be accurate. Similar checks can be run for 1979 to 1982. The trend in Coast Province is less clear, because the sample in 1977 was known to be biased. However, it is fairly certain that the nutritional situation in Coast is the worst in the country, and attention is needed to this province.

Some possible explanations for observed changes in nutritional status. Eastern Province, and to a lesser extent parts of Central Province, are known to have suffered a severe drought in 1976. Data on maize production and rainfall are given in Table 3, which emphasize the extent to which production was reduced in Eastern Province in 1976, and returned to stable levels in 1977 and thereafter. It seems likely that in non-drought years, Eastern Province is not particularly badly affected by malnutrition - it is about average for the

country. On the other hand, nutrition clearly suffers badly in times of drought. There is a clear implication here that alleviating the effects of drought on nutrition would be likely to prevent not only the acute wasting of malnutrition, but also the longer term effects manifested as chronic malnutrition or stunting.

Western and Nyanza provinces, on the other hand, have not suffered severe drought during the last six years or so. However, very rapid changes seem to have taken place in the distribution of land; moreover these provinces have the highest population densities in the country. According to the data from the 1977 and 1979 integrated rural surveys (IRS2 and IRS4) the cultivated land is highly fragmented, with the majority of farmers having very small (less than 1.5 hectares) landholdings. Moreover the trend toward smaller landholdings is rapid. Table 4 shows the distribution of households into four categories of landholdings for 1977 and 1979 for the six provinces with estimates of children's nutritional status. In Central, Rift, and Eastern provinces, no substantial change in this distribution is noticeable. On the other hand, the distribution in Western and Nyanza provinces shows a marked snift to smaller landholdings between these two time periods: for example, the proportion of farmers with 0.1 to 1.5 hectare landholdings increased from 44 to 72% in Western Province, and from 47 to 70% in Nyanza Province during this time period. Even allowing for some uncertainty in the sample, this shift, and its contrast with the rest of the country, is dramatic. The relationship of landholding with nutritional status varies in different parts of the country and by cropping pattern (as we have discussed in a separate paper) and in most provinces there is no clear trend such that smaller landholders always have higher prevalences of malnutrition. The clearest case for a relationship between nutritional status and landholding area is in Nyanza Province, certainly in 1979 (see Table 4 Figure 3). In Western Province it does not appear simply that smaller landholders have worse nutrition, and the number of smaller landholders is increasing; in fact the major changes in nutritional status tend to be <u>within</u> landholding categories, and nutrition in the 1.5 to 5.0 hectare group deteriorated sharply. In Nyanza Province, possibly both effects are occurring - there are more smaller landholders in the later year, and these tend to be worse off. However, the major influence may be that the fragmentation of

landholdings is itself related to changes in farming patterns, and also that the individual holdings are needed to support more people (the data given in Table 4 are landholding area per household). Nonetheless, it is most likely that these data reflect a rapid change in living conditions in Western and Nyanza provinces which is responsible for the deterioration in nutritional status.

A characteristic of nutritional surveillance is that it provides clues as to changing conditions and their likely effects on nutrition and level of living, and point to where to look next. It is sure that conditions are deteriorating in Western and Nyanza provinces, and likely that pressure on land, changing cultivating patterns, and associated effects should now be examined for their influence on nutritional status.

Targetting priorities in terms of nutrition. The survey in 1982 (NS3) for the first time was designated to produce valid estimates of nutritional status at the district level. The relative prevalences, and total numbers of malnourished children by district are shown in Table 5. This shows a considerable degree of concentration of the malnourished in eight districts (given in order of total numbers stunted): (1) Kilifi/Tana River/Lemu (2) Siaya (3) Nakuru (4) Kisii (5) Kakamega (6) South Nyanza (7) Muranga (8) Machakos. In fact, 54% of all the malnourished children are to be found in these 8 priority districts, which argues strongly for focussing programs on these 8 (out of the 27 surveyed) districts. The relative numbers of malnourished children in these 8 districts compared with the other 19, and hence targetting implications, are shown in Table 6. These data show, for example, that a 30% increase in efficiency of reaching malnourished children (or households) would be achieved by concentrating resources on these districts, rather than spreading resources evenly throughout the country. This is because the prevalence of malnutrition in these districts is a factor of 1.3 higher than in the overall sample. Obviously, this is only one presentation of such data, but it is given to illustrate there does now exist an important tool for assessing the efficiency of targetting of a whole range of programs likely to have an effect on nutritional status.

Correlates of malnutrition at district level. Table 5 gives a number of other indicators of living conditions by district. One striking observation is that

nutritional status is highly correlated with estimated mortality rates (either from the census or the survey) in those districts where the level of infection is average or less. This is illustrated in Figure 4. Here the districts are divided into two categories, those with high rates of infection) and those with lower rates of infection, defined as above or below the median percent sick in a district (or 46). In those districts where the infection rate is high, there is little correlation (at least at the aggregate level) between nutritional status and mortality. However, in the other half of the districts the correlation is high, such that about half the variation is mortality rate is accounted for by nutritional status (R^2 ,50, Figure 4). This has two obvious implications. The first is that in the high mortality districts, efforts to control the rate of infection are likely to be of overriding importance. On the other hand, where infection is less extensive, there is likely to be an important role for interventions that improve food consumption. However, this dichotomy between high and low infection rates is primarily useful for purposes of presentation. The more general conclusion would be that health interventions and those affecting food availability need to be considered together.

The data available at this stage at district level from the 1982 survey are restricted to only a few variables, but these nevertheless have wide implications. Just three variables are effective in discriminating between better and worse-off districts in terms of nutrition: these variables measure infection rate, education of mothers, and population density, and are also shown in Table 5. These variables themselves may well be proxies for other factors affecting nutrition and level of living - for example education may be highly related to income, environmental conditions, and so on. It certainly cannot be concluded at this stage that improved education itself would reduce malnutrition. Of these three variables at district level, sickness and education account for a considerable amount of the variation in nutritional status at the district level (see Table 7). Analyzed like this (without taking interactions into account), population density is less important. However, it appears likely that a combination of these factors accounts for differences between better and worse-off districts.

We classified districts, in a simple exercise, as better or worse than average in terms of these three variables. The eight worst-affected districts

(by prevalence) fall into two distinct groups: they are either the worse than average in terms of all three indicators (generally the worst-affected districts in the west); or they have low population density, relatively low sickness rates, but a very high proportion of mothers with no education (in lower rainfall areas). This classification is shown in Table 8a. All but one of the worst-affected districts fell into these two categories. It should be noted that education alone also discriminates well (Table 8b). However, it seems likely that the worst-off areas are of two distinct types: the highly populated, sickness-affected, less developed areas in the west; and the more sparsely populated, higher altitude, more arid areas with a lower degree of development in other parts of the country.

These preliminary results indicate that at least three causes of either persistently or intermittently deteriorating nutrition should be of concern. First, efforts to eliminate the effects of drought on nutrition are evidently needed. Secondly, programs to improve health (possibly with emphasis on malaria, since malaria is highly correlated with the sickness variable) are likely to have important effects on nutrition. Thirdly, there are a complex of factors relating to landholding areas and cropping patterns which require further investigation, but which may well be connected with the deteriorating trends seen in the west of Kenya.

Policy implications. As this brief review illustrates, Kenya's nutritional surveys provide a picture of trends and patterns of children's nutritional status that could be very useful in planning the efforts of Kenya's government to alleviate poverty and monitoring their progress. One implication that emerges from analysis of these data is that programs designed to alleviate poverty and to improve children's health and nutritional status could have a greater impact if resources are concentrated on the worst-off areas, since malnutrition is not a problem to the same extent in all parts of the country. There is considerable diversity within Kenya in both trends and correlates of malnutrition, suggesting the need to adapt programs to local conditions and problems as much as possible.

Long-term malnutrition in the arid parts of Eastern Kenya seems especially bad following the drought years. Thus in these areas measures to raise family incomes and reduce dependence on agricultural activities likely to fail in drought years would have, besides their payoff to the local economy, a justification as investments in the health and welfare of Kenya's children. During severe droughts, emergency measures to increase food availability to families would still seem to be necessary.

In the Western part of the country, the worsening of children's nutritional status in recent years seems to be associated, not so much with intermittent factors like drought, but with high rates of infectious diseases in childhood. Malnutrition and infection interact and reinforce each other, and are reflected in high mortality rates in the early years of life. Measures to attack this complex of problems would include health sector and water supply interventions aimed at controlling diarrheal diseases, malarial, and other infectious, and these could usefully be targetted to the areas shown by the nutrition surveys to be worst off. The association between the size of the family landholding and child malnutrition, at least in Nyanza Province, suggests that living conditions for the landless and smallholders will worsen unless alternative sources of employment and income are generated.

The results of the nutrition surveys also have implications for nutrition interventions more narrowly defined, for example, child feeding programs, programs to promote breastfeeding and good weaning practices, and the like. These have not been emphasized here, even though in some form they might be useful adjuncts to Kenya's strategy to eliminate malnutrition. The surveys show, for example, that breastfeeding is nearly universal in rural Kenya, which is a valuable practice and ought to be encouraged. The distinguishing characteristics of the areas with relatively high malnutrition, however, are social and economic factors that should be of primary concern to planners and administrators in the sectors of health, food and agriculture, finance and planning, education, and human resources.

It seems clear from the data of successive surveys that long-term malnutrition is a serious problem in Western Kenya and that the problem is getting worse. The aggregate-level and household-level associations that have emerged so far from analyses give policy makers a glimpse into the reasons for

the problem. More could be done to provide useful information on priorities for interventions to improve nutritional status, both with follow-up studies of the survey data already available from the IRS and the NS3 particularly, and with careful detailed investigations in the areas where nutritional status appears to be worsening. This would appear to be an urgent task, if the effort of producing the survey results is to bear fruit in assisting Kenya's policy makers to achieve their goals.

The survey results, of course, have primary interest to those in Kenya responsible for the development of the country and the improvement of its people's welfare. As is evident at this workshop though, the results have meaning to an international audience, as well. Those concerned with producing information on nutritional status that can be used in a multisectoral approach to alleviate malnutrition will learn a great deal from Kenya's experience both in producing information and in translating information into action.

References

1. Methodology of Nutritional Surveillance, Report of a joint FAO/UNICEF/WHO Expert Committee, World Health Organization Technical Report Series no. 593, Geneva: 1976.

2. ACC-SCN. 1982. Report of the International Workshop on Nutritional Surveillance held in Cali, Colombia, 14-17 July, 1981. SCN 82/10. Rome: ACC-SCN.

3. J.B. Mason, J-P. Habicht, H. Tabatabai, and V. Valverde, Nutritional Surveillance - Theory and Practice, World Health Organization, Geneva: 1984 (forthcoming).

TABLE 1

CHANGES IN NUTRITIONAL STATUS OF CHILDREN 1-4 YEARS OLD BETWEEN 1977-1982 BY PROVINCE

	1977 (NS1)		1979 (NS2)		1982 (NS3)	
	Prevalence (% < 90% HA)	Mean HA	Prevalence (% < 90% HA)	Mean HA	Prevalence (% < 90% HA)	Mean HA
CENTRAL	26	93.6	21	94.5	24	94.0
RIFT VALLEY	25	94.0	24	94.2	22	94.9
WESTERN	16	95.0	24	94.0	30	92.9
NYANZA	21	94.7	34	93.6	33	93.4
EASTERN	34	92.8	24	94.6	27	93.3
COAST	(14)*	96.3	40	92.9	39	92.2
TOTAL SAMPLE	**24**	**94.1**	**27**	**94.5**	**28**	**93.6**

* Data unreliable due to sampling error

TABLE 2A

Actual and Predicted Mean Height for Age by Province, NS1 and NS2

Province	1977 Actual	1977 Predicted*	1979 Actual
Central	93.6	94.5	94.5
Rift	94.0	94.0	94.2
Western	95.0	93.4	94.0
Nyanza	94.7	93.7	93.6
Eastern	92.8	94.0	94.6
Coast	96.3	92.4	92.9

*Based on the regression equation in TABLE 2B. From 1979 models using 1977 parameters.

TABLE 2B

Regression Coefficients- Height for Age as Dependent Factor, NS2

Variable	Coefficient(B)	s.e. B	p value
Intercept	94.7355		
Age	.00066	.0176	.9700
Dsew (pit,none)	-.5960	.3658	.1035
Dwat1 (stream+spring)	-.4812	.4433	.2779
Dwat2 (well)	-1.244	.5912	.0355
Dwat3 (piped)	.2487	.6554	.7044
HDA	.4471	.2881	.1209
Dprov1 (Coast)	-1.500	.9438	.1120
Dprov2 (Eastern)	-.3065	.7356	.6770
Dprov3 (Nyanza)	-.3106	.8039	.6993
Dprov4 (Rift)	.4695	.7585	.5360
Dprov5 (Western)	.7332	.9242	.4277
HDA*Dprov1	-.6565	.4062	.1063
HDA*Dprov2	-.2802	.2985	.3480
HDA*Dprov3	-.3911	.3899	.3160
HDA*Dprov4	-.3122	.3067	.3089
HDA*Dprov5	-.5466	.4331	.2071

Adjusted R^2= .0127

TABLE 3

MAIZE PRODUCTION AND RAINFALL, BY PROVINCE, 1976-1979

Province	Total Maize Production ('000 Tonnes)[a]			Rainfall (in mm)[b]			
	IRS1 (1977)	IRS4 (1979)	%Increase	1976	%Average	1977	%Average
Coast	40.5	94.5	133	837	88	1111	117
Eastern	36.9	251.1	580	671	74	956	106
Central	245.7	297.0	21	834	81	1464	142
Rift	396.9	409.5	3	858	90	1218	128
Nyanza	172.8	283.5	64	2173	90	2636	109
Western	175.5	206.1	17	1856	95	2489	127
Total	1068.3	1541.7	44				

[a] The Integrated Rural Surveys 1976-1979, Basic Report. Table 11.9, p. 120

[b] Statistical Abstract 1979 and 1982, Central Bureau of Statistics, Nairobi, Kenya

TABLE 4

Distributions, Mean Height for Age, and Prevalences < 90% Height for Age, by Province and Holding Area- NS1 and NS2

Province	Area Groups	1977 %Total Sample	1977 Prev. <90% HA	1977 Mean HA	1977 N	1979 %Total Sample	1979 Prev. <90% HA	1979 Mean HA	1979 N
Central	0-.10	10.2	22.2	95.1	18	11.6	25.0	92.9	20
	.1-1.5	62.1	23.6	93.7	110	60.7	22.9	94.2	105
	1.5-5.0	21.5	31.6	93.0	38	24.9	23.3	95.6	43
	>5.0	6.2	18.2	96.2	11	2.9	0	96.5	5
Rift	0-.10	15.9	13.9	95.6	36	21.6	17.5	95.5	80
	.1-1.5	56.4	30.5	93.4	128	39.1	22.8	94.4	145
	1.5-5.0	21.1	22.9	94.6	48	25.9	15.6	94.2	96
	>5.0	6.6	26.7	94.2	15	13.5	20.0	96.3	50
Western	0-.10	6.4	15.4	95.6	13	5.3	9.1	96.5	11
	.1-1.5	44.3	18.9	94.6	90	71.8	23.9	94.5	92
	1.5-5.0	40.4	14.6	95.0	82	17.7	29.7	92.5	37
	>5.0	8.9	11.1	95.5	18	3.8	25.0	95.4	8
Nyanza	0-.10	13.7	21.9	94.4	32	10.7	47.6	92.1	21
	.1-1.5	46.6	22.0	94.0	109	69.9	30.7	93.8	150
	1.5-5.0	28.6	25.4	94.5	67	15.8	19.4	94.2	31
	>5.0	11.1	7.7	98.3	26	3.6	28.6	94.9	7
Eastern	0-.10	4.6	33.0	92.4	12	14.1	32.8	93.4	58
	.1-1.5	49.4	30.0	93.6	130	51.9	28.0	93.3	214
	1.5-5.0	29.7	42.3	91.7	78	23.1	25.3	95.4	95
	>5.0	16.3	37.2	91.8	43	10.9	11.1	95.8	45
Coast	0-.10	25.6	9.5	95.5	21	17.4	33.0	93.2	27
	.1-1.5	22.0	5.6	96.1	18	44.5	46.4	91.9	69
	1.5-5.0	36.6	13.3	98.1	30	32.3	34.0	93.5	50
	>5.0	15.9	23.1	94.4	13	5.8	55.6	89.3	9

TABLE 5
DISTRICT LEVEL INDICATORS

District	Province	% 90% HA	Mean HA	Census[1]	Survey[2]	% Sick[3]	% No.Educ.	% Malaria cases	Pop. Density[4]	0-4 Pop. (x 10^3)	Number Children Stunted
Kilifi, Tana River,											
Lamu	Coast	42.1	91.9	200	15.7	64.1	85.8	24.0	20	180	76
Kwale	Coast	38.5	92.1	190	19.4	43.4	83.0	23.8	34	60	23
Siaya	Nyanza	36.6	93.2	210	20.4	61.1	51.5	32.6	188	110	40
Nakuru	Rift Valley	34.5	92.2	97	8.2	43.6	54.9	9.2	90	120	41
Kisii	Nyanza	31.1	93.4	101	9.5	57.7	51.6	20.9	395	240	75
Kitui	Eastern	30.0	92.9	148	10.2	37.9	70.9	25.0	15	100	30
Kakamega	Western	26.7	93.7	143	14.0	56.2	46.2	31.0	294	125	33
S. Nyanza	Nyanza	25.3	94.2	216	16.1	58.4	56.9	31.6	143	190	48
Muranga	Central	24.8	94.3	68	7.3	42.1	28.1	11.3	261	160	40
Bungoma	Western	24.7	94.1	140	9.8	49.6	35.1	30.4	163	130	32
Kirinyaga	Central	24.5	93.1	82	7.9	35.3	43.3	14.4	202	70	17
Machekos	Eastern	23.1	94.0	98	7.9	46.9	38.3	19.6	72	230	53
Embu	Eastern	22.3	93.7	83	8.8	45.0	34.9	16.7	96	60	13
Busia	Western	21.1	93.3	198	17.5	72.6	68.4	27.6	183	70	15
Narok, Kajiado	Rift Valley	19.8	94.9	85	4.9	32.1	72.6	16.2	10	90	18
Kisumu	Nyanza	19.8	94.9	200	20.0	60.7	36.5	34.7	230	110	22
Baringo, Laikipia	Rift Valley	19.4	95.8	124	12.7	47.7	55.4	11.1	17	80	16
Transnzoia	Rivt Falley	19.1	95.2	114	12.1	41.8	44.5	17.5	124	70	
El Marakwet,											
W. Pokot	Rift Valley	18.6	95.5	180	11.6	49.3	53.8	18.4	11	70	13
Nyeri	Central	18.5	94.9	50	3.2	44.9	13.4	1.4	148	110	20
Kericho	Rift Valley	18.1	96.0	91	7.2	28.4	64.8	14.9	161	160	29
Uasin Gishu	Rift Valley	17.8	95.6	92	9.9	24.7	41.6	19.8	89	70	12
Kiambu	Central		95.3	70	7.7	30.6	40.1	4.5	280	150	26
Meru	Eastern	16.8	94.8	68	7.3	41.0	43.9	15.7	83	200	34
Taita Taveta	Coast	14.7	95.8	116	10.1	46.4	40.9	23.9	8	30	4
Nyandurua	Central	12.4	95.3	64	5.5	25.4	35.2	1.7	66	60	7
Nandi	Rift Valley	12.0	96.3	110	9.8	48.1	46.1	13.8	109	70	8

[1] From 1979 Census

[2] Calculated as number died/number ever born

[3] Sick within past two weeks

[4] From Statistical Abstract 1982, CBS Nairobi, Kenya

TABLE 6

IMPLICATIONS OF TARGETTING EIGHT PRIORITY DISTRICTS

		# MALNOURISHED HOUSEHOLDS (THOUSANDS)		
		MALNOURISHED	NON-MALNOURISHED	
Districts	Top 8 Priority	406	849	1255
	Bottom 19	352	1408	1760
		758	2257	3015

Coverage = 0.54

Focussing (F) = 0.32

Population Prevalence (PP) = 0.25

F/PP = 1.28

TABLE 7

DISTRICT LEVEL REGRESSION ANALYSIS: MEAN HEIGHT-FOR-AGE AS DEPENDENT FACTOR (n = 27)

	Regression Results			
	1	2	3	4
Sickness (%)	-.043 (.044)*		-.034 (.071)	-.029 (.150)
Population Density	.00032 (.897)	-.0033 (.181)		-.002 (.415)
% No education		-.040 (.010)	-.028 (.043)	-.033 (.033)
Adj. R^2	.094	.189	.238	.228

* B (p value)

TABLE 8a

SENSITIVITY AND SPECIFICITY USING EDUCATION, SICKNESS AND POPULATION DENSITY AS PREDICTORS OF NUTRITIONAL STATUS (KENYA DISTRICT)

PREVALENCE < 90% HEIGHT-FOR-AGE

	≥ 25	< 25	
*Predicted/worst	7	3	10
Other	1	16	17
	8	19	27

Sensitivity (Se) = 7/8 = 0.88

Specificity (Sp) = 16/19 = 0.84

Se + Sp = 1.72

*Worst category includes the following two groups:

(1) Poor education + high sickness + high population density

(2) Poor education + low sickness + low population density

TABLE 8b

SENSITIVITY AND SPECIFICITY USING EDUCATION AS PREDICTOR OF NUTRITIONAL STATUS (KENYA DISTRICT)

PREVALENCE < 90% HEIGHT-FOR-AGE

	≥ 25	< 25	
Low Education (≥46)	8	6	14
High Education (<46)	0	13	13
	8	19	27

Sensitivity (Se) = 1.00

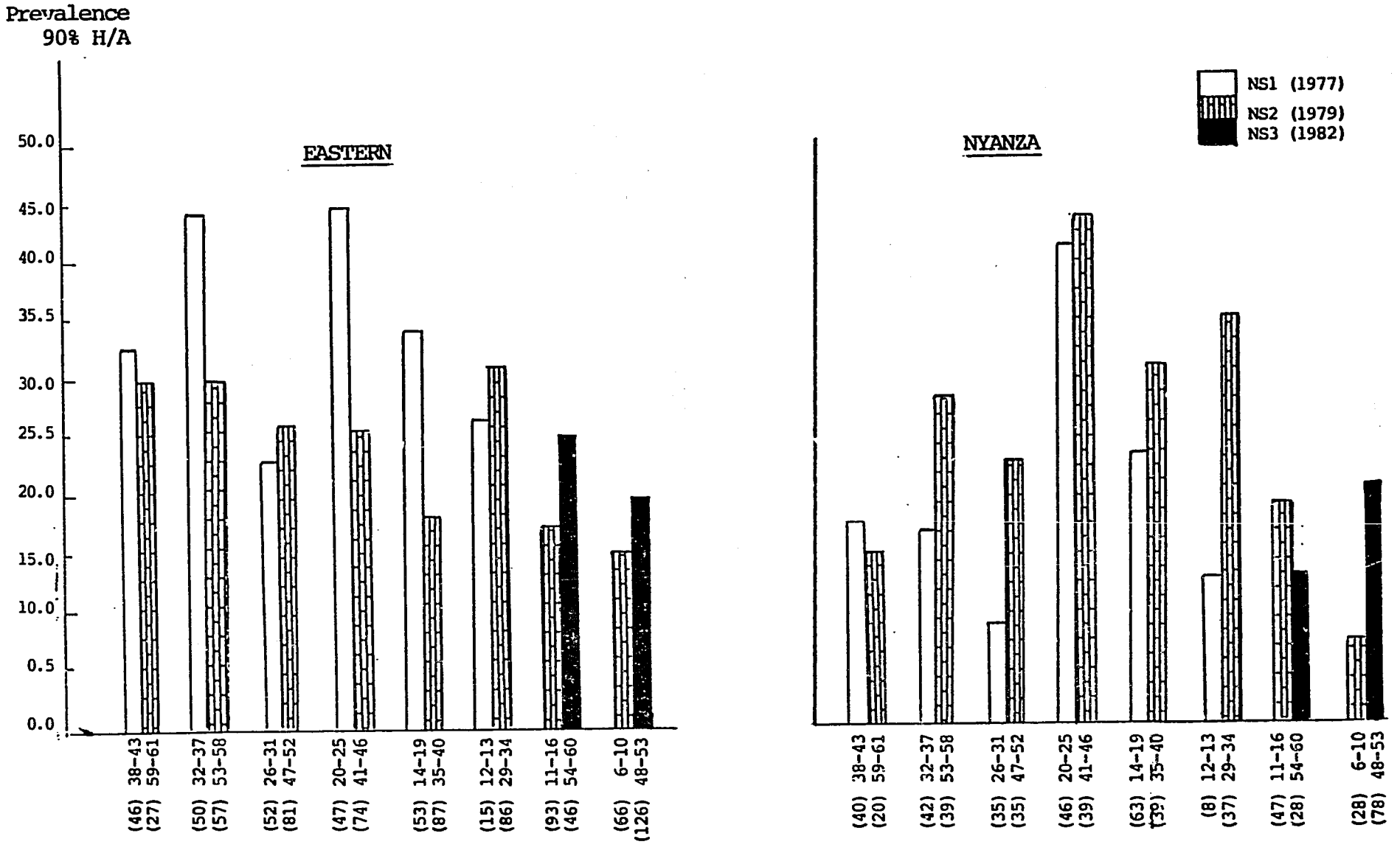
Specificity (Sp) = 13/19 = 0.68

Se + Sp = 1.68

FIGURES 1 a) and b)

PREVALENCE OF STUNTING (< 90% HEIGHT FOR AGE) BY COHORT FOR EASTERN AND NYANZA PROVINCES

(NS1, NS2 and NS3)



Age in months (numbers in parantheses indicate total for cohort)

a) b)

FIGURE 2

PREVALENCE OF STUNTING (< 90% Height-for-age) BY PROVINCE AND AGES (NS1 - 1977, NS2 - 1979, NS3 - 1982)

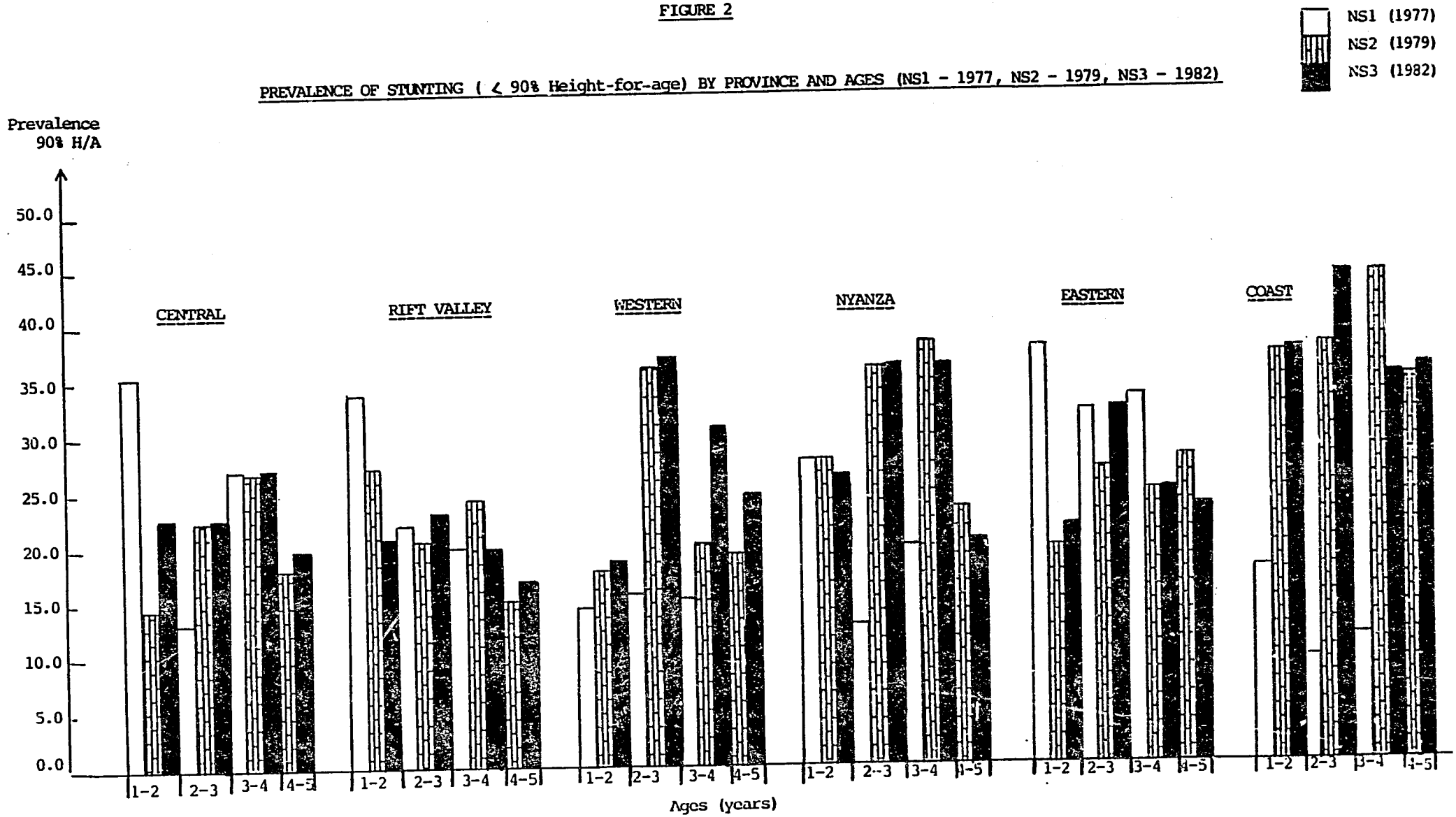


FIGURE 3

DISTRIBUTION OF PREVALENCES < 90% H/A BY LANDHOLDING AREA, NS1 and NS2

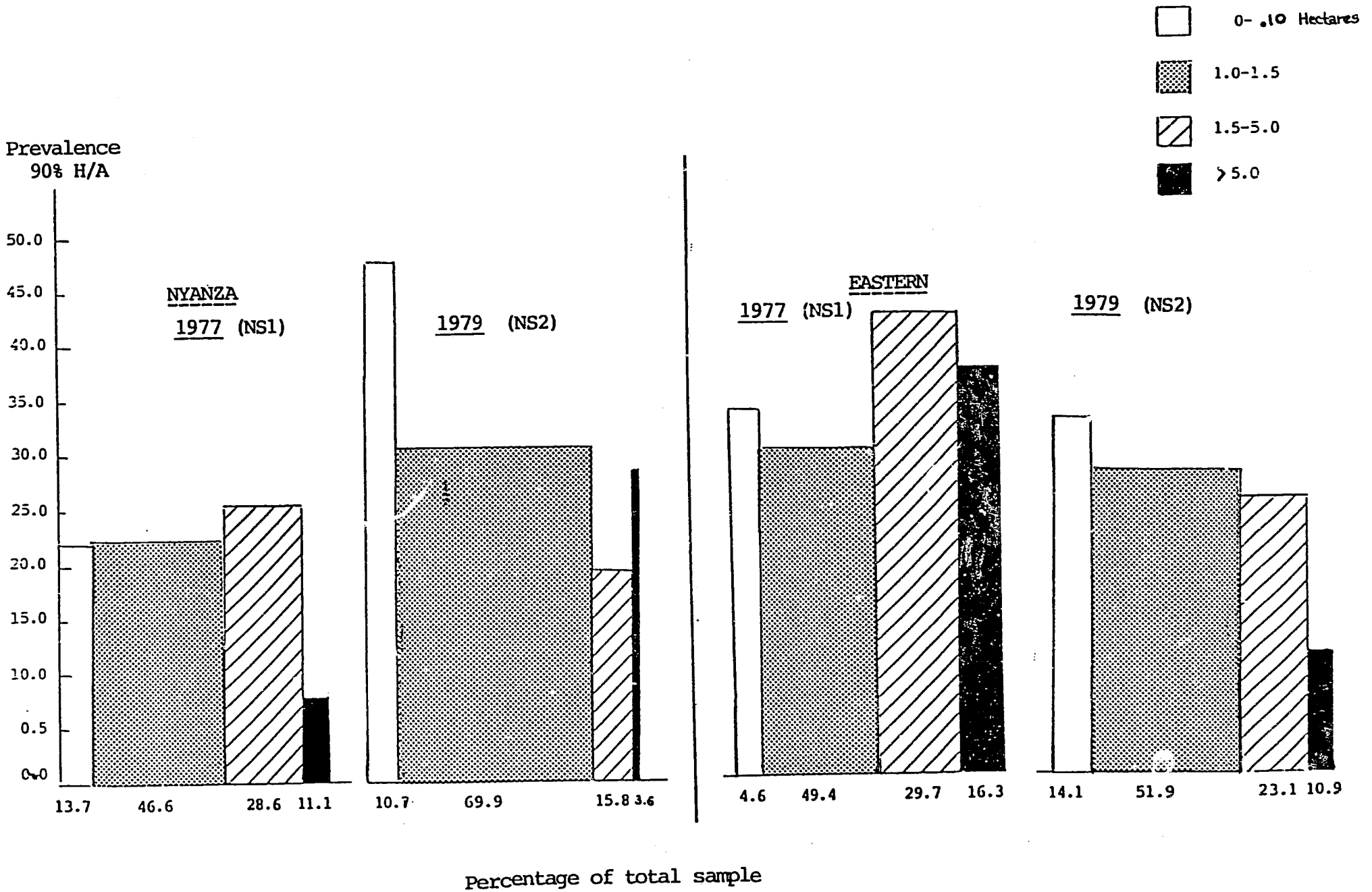
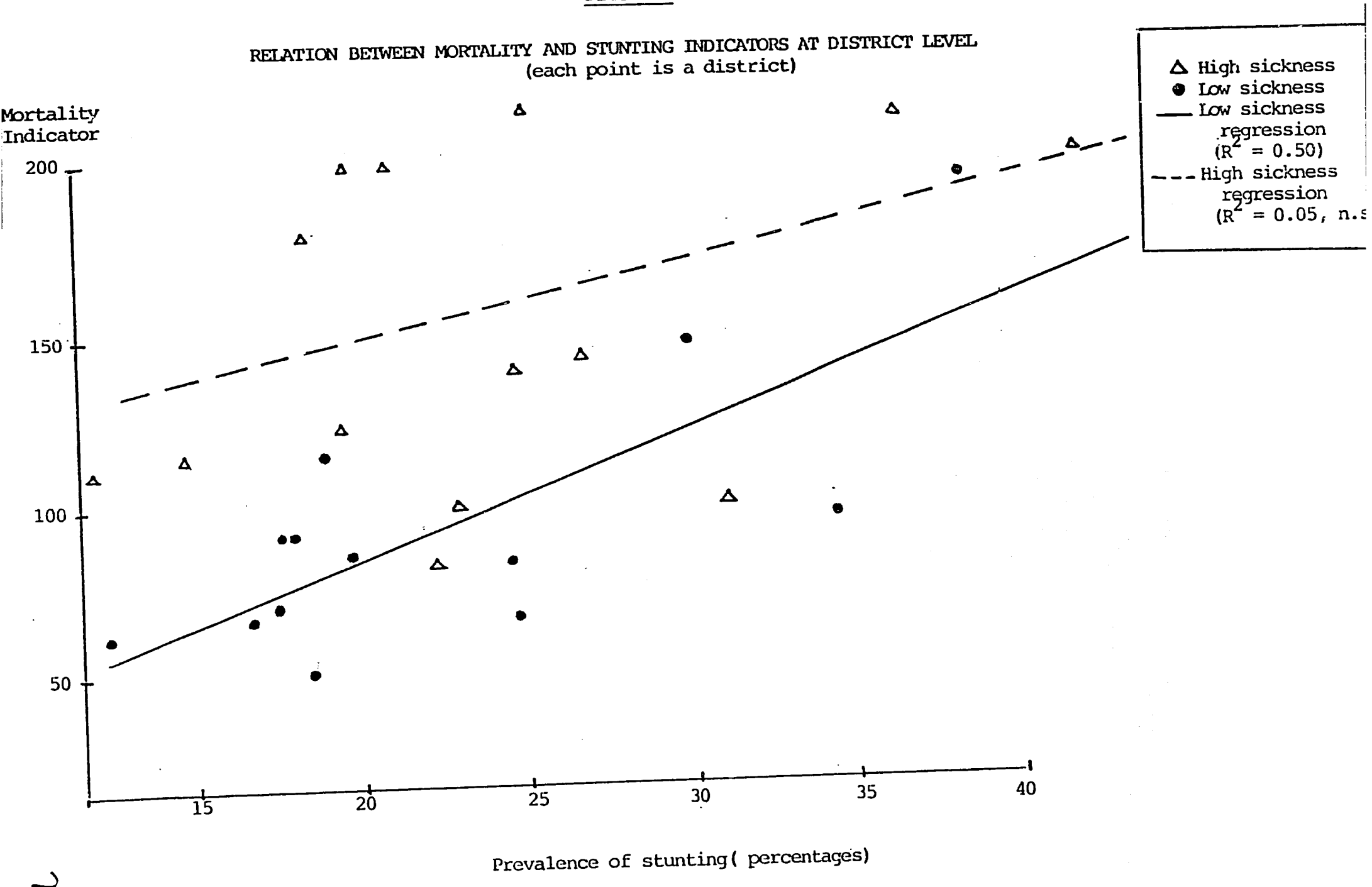


FIGURE 4

RELATION BETWEEN MORTALITY AND STUNTING INDICATORS AT DISTRICT LEVEL
(each point is a district)



28