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A Survey of Nutritional Status in Children Under Four and Their Mothers in Four Villages in the Regions of Brakna, Guidimaka and Gorgol, Mauritania

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I. INTRODUCTION

This report summarizes the results of a nutritional status survey carried out from January 31 to February 10, 1988 in four villages on the Mauritanian side of the Senegal River. The information was collected to provide baseline quantitative data on nutritional status during the winter months for children under age four and their mothers, the two groups most vulnerable to undernutrition in most populations. Surveys were carried out in villages within the Agricultural Research II (AgResII) Project area, and will be used as an aid to assessing the impact of AgResII agricultural intervention methods. This was the first nutritional status survey conducted in connection with AgResII; however, two food consumption surveys were completed in 1986 (Frankenberger et al, 1986; Stone et al, 1986). This nutritional status survey was performed at the same time as a household food consumption survey (Patricia O'Brien-Place, OICD/USDA) and a survey of women's roles in agricultural production (Helen Henderson, University of Arizona).

A. Health in Mauritania

Adult life expectancy in Mauritania is approximately 46 years, with an infant mortality rate of about 102/1000 (United States Department of State 1987). Rates among persons living according to different subsistence modes may vary from this average. For example, among nomads, average life expectancy at birth is about 43.6 years with an infant mortality rate of 160/1000 (Traore, 1985). However, Warrick-Goldman, Brown and Binkin (1986) found that settled peoples, whether at an oases or in agricultural villages, had higher rates of malnutrition than did more nomadic peoples.

Approximately 45% of the population is under 15 years of age (RIM, 1984). The three most common diseases reported from Guidimaka and Gorgol in 1984 were conjunctivitis, the diarrheas, and malaria; followed by influenza, helminthic infections, syphilis, and bilharzia. Diarrhea is common among children but only about 1.5% of reported cases result in death, in contrast to about 12% case fatality rate for children with measles.

The health care delivery system of Mauritania is urban-oriented and curative in focus (RIM, 1984). The countryside is served by several means. Traveling vaccination teams visit villages on a rotating schedule to provide immunizations (BCG, DPT, polio and measles); these teams may also make emergency tours when circumstances warrant as they did during a yellow fever epidemic in the fall of 1987. Villages are also served by traditional midwives (accoucheuses traditionelles), and/or village health workers; many of these village-level specialists have completed a limited training course offered by the government of Mauritania.

B. Nutritional Status in Mauritania

Besides that reported here, several other nutritional status surveys have been carried out in Mauritania. Most have had as their goal the identification of malnourished preschoolers, especially in connection with the drought that began in 1969; as a result very little is known of the

usual growth patterns of Mauritanian children or of the nutritional status of women. Table 1 summarizes data from several of these surveys.

The earliest survey with semi-quantitative data (Ferro-Luzzi 1962) suggests what may have been the typical pattern before the drought: the youngest children were adequately fed, while weaned children presumably still learning the intricacies of self-feeding (ages 3-6 in that survey) were most at risk of malnutrition.

The remaining surveys in Table 1 were all carried out during or near drought years. The quality of the sampling and the sample sizes vary considerably. Different reference standards and different indicators were used by the various authors to estimate rates of undernutrition. Examinations were made in different parts of the country. Nevertheless, there are some consistencies in the resulting data. First, it appears that girls and boys do not experience malnutrition at significantly different frequencies. Second, peak ages for malnutrition are between 12 and 36 months, earlier than recorded in the 1961/62 survey. Third, rates of malnutrition, recorded by whatever method, are strikingly high, averaging from about 25% to 45% of the preschool samples surveyed. Finally, the Gorgol/Guidimaka Regions (the "breadbasket" of Mauritania) may demonstrate rates of malnutrition that are lower than those recorded for other regions of the country.

TABLE 1

Reports on Nutritional Status of Children 0-5 in Mauritania

Reference	Sample & Indicator	Findings
Ferro-Luzzi, 1962in RAMS, 1981:26	Food Disappearance Data & Clinical Survey	Children 0-2 "have sufficient & well-balanced diets, weaning is not a problem as milk is available almost everywhere...diets of children 3-6 years suffer from the marginal availability of food in the nation".
Kloth, 1974/5 in RAMS, 1981	35 village survey, 25 6mos-6yrs/village: N=875 Serious Malnutrition = W/H < 80% Stuart- Meredith Standards	1974: 20.8% < 85 cm malnourished; 3.2% > 85 cm. 1975: 10.7% < 85 cm; 6.1% > 85 cm. 1974: 10.9% sedentary villagers; 12% government workers; 8.7% nomads.
RAMS, 1981	Files of PMI, 5th arrondissement, Nouakchott; children < 24 mos: N = 450 Malnutrition = W/A < 80% Harvard Standards	16.5% chronic malnutrition 18.5% acute malnutrition 35% malnourished, especially ages 12-16 mos. Growth good to 6 mos; slows thereafter.
Aliou, nd	Sample not stated. Indicator not stated; probably W/A < 80% Harvard Standards	Trarza Region: 46% global malnutrition; 8% grave. Brakna Region: 44% global malnutrition; 11% grave.
Warrick-Goldman et al 1986	52 Clusters of 30 children 0-5 in Trarza, Tagant & Adnar Regions. Malnutrition = W/H < 80%, and H/A < 90% of NCHS-WHO Standards	Low H/A: Trarza 25%, Tagant 32.2%, Adnar 35.8%. Low W/H: Trarza 8.2%, Tanant 17.1%, Adnar 14.0% Rates in girls and boys not different.
Mundschenk & Sapathy, 1987	480 children 0-5 in 30 sites in Assaba Region Malnutrition = Values < 10th% of NCHS standards	W/H: 27.3% < 10th% W/A: 55% < 10th% H/A: 56% < 10th% Rates in girls and boys not different. Elevated levels wasting and stunting.

Catholic Relief Services in FEWS Report, 1/1988	Children 0-5 attending CRS-run feeding centers in selected Regions. Malnutrition = W/A < 80% Harvard Standards	Guidimaka levels in first four 1987 18%; mean for all 7 regions: 33.4%. Guidimaka levels June-Sept 21.6%; mean for all 7 regions: 35.9%.

Findings in the present survey concur with several of these earlier findings: boys and girls do not demonstrate different rates of malnutrition, rates peak after 12 months, and about 35% of the children are currently undernourished or show growth patterns indicating earlier undernourishment. This high rate does not support the hypothesis that the "breadbasket" regions of Mauritania have better-fed children. The observed undernourishment expresses itself mainly in stunting and in wasting, rather than in more severe clinical syndromes.

II. SURVEY METHODS

The nutrition survey had as its primary goal to survey a sample of children ages 0-4 years (0-48 months) and their mothers in the assigned villages. Sample size was limited by the field time available. A secondary goal was to test instruments and techniques for appropriateness in Mauritanian villages.

A. Choice of Villages

Four villages were selected by AgResII personnel for the nutritional status survey, including one each of the four major ethnic groups[1]: Doubel Doubai in Brankna is Black Maure; Ganki in the Gorgol is Pulaar; Seyenne in the Gorgol is Peul; and Solou in Guidimaka is Soninke. Although each village was primarily of the designated ethnic group, most also contained persons and families who self-identified as belonging to other ethnic groups. Racially, all were black Africans.

Ganki is distinctive in that it consisted of a central village which was primarily Pulaar plus two outlying hamlets, one Black Maure and the other Peul. At the request and with the arrangement of the village chief, children were measured from both outlying hamlets as well as from the central village. No differences in health or growth status distinguished children of the suburbs from those of central Ganki.

The villages differed in terms of their major means of agricultural production. Doubel Doubai depends on rainfall agriculture and had experienced a virtual total failure of harvest in 1987. Ganki depends both on regularly flooded river bottom lands and rainfed agriculture and had had a good agricultural year. Seyenne depends primarily on herding, with agricultural inputs from both regularly flooded river land and rainfed lands; it was also the only one of the four villages to have received food

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[1] For an explanation of ethnicity in Mauritania, see Grayzel, 1980

aid in 1987. Solou has both rainfed and floodland agriculture, and had experienced a good harvest in 1987.

All four villages are served by traditional midwives. They proved very helpful to the survey not only because they encouraged women to participate, but even more importantly because they shared their birth records with us. In a country where few villagers know their children's ages, the midwives' willing cooperation allowed us to ascertain accurate birthdates on a generous 62% of the children.

In addition to its midwife, Ganki village had a village health worker. None of the villages was the site of a dispensary or other established biomedical health facility.

B. Sampling Procedure

Two days were spent in each village. After the survey had been discussed with the chief and town elders, a crier was sent to call the mothers of the children under age four to a central measuring area or clinic. At Doubel Doubai the clinic was held in the central plaza, outdoors under a thatch sunroof. At the remaining villages, houses or their porches were loaned to serve as the clinic. Large numbers of women responded at each village.

Children and their mothers were measured on a first-come first-served basis. However, because villagers showed some tendency to present male children ahead of female children for measuring, after the second village measurers (Cassidy and Daoula) established a policy of measuring the sexes alternately. Numbers of girls and boys are still not equivalent because we measured all children under four of a given family at one sitting, but final female/male sample sizes are not significantly different.

Not every mother of measured children was also measured. This is because some mothers were unavailable (out of town, or deceased), and also because with our limited time it was judged more important to have large samples of children than of women. Final sample sizes of children and of women are listed in Table 2. These are relatively small, but generally adequate for statistical analysis and the purposes of the survey. The proportion of the village under-fours accessed by the sampling method is unknown except for Seyenne, where the sample represents 96% of the children in the appropriate age category.

TABLE 2

Number of Children and Mothers Studied by Village

	Village				
	Doubel (Brankna)	Ganki (Gorgol)	Seyenne (Gorgol)	Solou (Guidimaka)	Total
Children					
Girls	16	15	19	18	68
Boys	13	25	24	19	81
Total	29	40	43	37	149
Mothers	16	18	22	29	85
Total Sample	45	58	65	66	23

C. Survey Procedure

The survey form (in French) is presented in Appendix 1. Detailed discussion of accuracy issues is presented in Appendix 2. The survey was directed toward

- accurately identifying individuals within their families;
- accurately assessing ages of children under 4 years;
- gathering mothers' reports of the diet of the child (breastmilk only, breastmilk supplemented, or weaned), and of ages at which supplementary foods had been introduced or weaning was completed;
- assessing the current health status of children on the basis of brief examination and of mothers' reports;
- noting the vaccination status of the children;
- gathering measurement data on height/length, weight, mid-arm circumference and triceps fatfold, head circumference (children), and handgrip strength (women);
- collecting a finger-prick blood sample for the assessment of iron status from mothers.

Questionnaires required from 15-30 minutes to administer per child, of which most of the time was spent simply collecting data on name, age, and feeding pattern. Questionnaires took about 10 minutes to administer to women.

The questionnaire was administered in a setting that was crowded, noisy, and often windy and dusty as well. In most cases, despite our and the mother's efforts to establish calm, the children were very resistant to measurement. They expressed their distress by struggling, screaming, and withdrawing. Despite this fact, we believe our measurement data are accurate. The major adjustment made to respond to the children's struggles was the decision to take recumbent length on all children, instead of only those under age two. The bias potentially introduced by this decision is to somewhat overestimate child height for children over 2 years of age. Children were "rewarded" with an orange candy after submitting to measurement.

The collection of names and of ages was the most time consuming part of the survey procedure. Names were important to know because the concurrent surveys of household consumption and women's productivity were designed to include a sub-sample of families from whom nutritional status measurements had been taken. At the same time naming procedures in the villages differ from those current in the United States in ways that make it necessary to collect not only the child's name, but also that if its mother, father, and often grandfather as well. For example, relatively few first or surnames are used, so many individuals have almost identical names. Boys and girls may have the same first names. Women typically do not change their names at marriage. Surnames are used variably. Among the Black Maures, no surnames are used, but both girls and boys are named after their father and grandfather in the format [Jane daughter of Hank daughter of John]. The other ethnic groups do use surnames, but report them variably so that the same child can seem to have two different names. These points are issues mainly where the same child must be identified not in person but from a written record, as from a survey form, a health card, or a birth record, as was true here.

Mothers typically had no initial idea of their own ages, but following discussion with neighbors, their mothers and the midwife, could usually narrow the age to within a decade (teen, 20s, 30s...). With the active Mauritania program to train traditional midwives to keep birth records, the problem of estimating ages for young children was greatly reduced in those villages where the midwife had succeeded. In the absence of a midwife's record, we estimated the age of the child on the basis of a combination of indicators including: mother's report from memory or from reference to the Islamic calendar or agricultural calendar, the RIM government's Vaccination Program age estimate as recorded on the child's Health Card (example, Appendix 3), and from a combination of observational factors such as tooth eruption status and developmental status. Comparison of rates of undernutrition among children with ages established from birth records and those established by other means indicates no bias toward either health or ill-health among those with less precise ages, suggesting that estimated ages are, in general, adequately accurate for the purpose of growth assessment.

Gathering accurate data on ages of breastmilk supplementation and of weaning faced the same problems as did that of ascertaining accurate birthdates. Specifically, these village mothers are not concerned with measuring time in the same way as urban people. In a few cases mothers threw up their hands and said "I don't know!" when we pressed for details of the feeding history; in most cases mothers provided estimates. The latter were sometimes belied by the age of the child (eg. a child weaned "at two years a year ago" who is only 30 months old), but are probably accurate enough for general assessment of the relationship of diet to nutritional status, as in this survey.

Children were weighed barefoot and lightly clothed to the nearest tenth kilogram using a suspended Salter Balance Scale Model MP-25. Women were weighed barefoot and lightly clothed to the nearest tenth kilogram using a Heathkit Digital Scale Model GD-1186.
Length of children was determined to the nearest centimeter using a folding measuring board with adjustable headpiece designed at the University of Arizona.

As noted above, because of problems of cooperation, recumbent length was measured on all children. Women's heights were measured barefoot to the nearest tenth centimeter using a wooden anthropometer designed to usual specifications and constructed by a carpenter in the central town of the Gorgol, Kaedi.

Head circumference of children was measured as the maximum occipitofrontal circumference to the nearest tenth centimeter, using a fiberglass measuring tape. The same tape was used to measure left mid-arm circumference in mothers and children to the nearest tenth centimeter where mid-arm was defined as halfway between the tips of the acromion and olecranon processes. Left triceps fatfold was measured in mothers and children to the nearest millimeter using a Lange Skinfold Caliper. The arm was bent 90 degrees at the elbow and relaxed, and held in the same position, for both measurements.

Hand grip strength was measured to the nearest half kilogram using a TEC Dynamometer. Grip strength provides a measure of muscle strength. Maximum strength, and rate of fatigue, both vary with nutritional status and muscle mass, with undernourished women showing comparatively low strength and rapid fatiguability (Mathiowetz, el al. 1984). In this survey two trials were allowed to learn the technique. Then six trials were recorded. The mean of the first three was considered to represent peak strength, while the sixth was taken to represent the fatigue measure. Efforts at squeezing the handle were made with the right elbow bent at a 90 degree angle, and the dynamometer supported on its underside, as illustrated in Mathiowetz, et al. 1984. Because this measure was difficult for respondents to understand and perform, took considerable time to administer, and provided results that did not resemble those predicted, it was dropped from use after the first village; no results of this measure will be reported herein.

A fingerprick blood sample was drawn from the small sample of women who agreed to the procedure. The method involved pricking the finger using a sterile Autolet system with disposable needles, then removing on drop of blood to each of two circles of chromatographic paper set on the tops of pins as described in Feraudi and Mejia, 1987. Samples were labeled as assembled on styrofoam trays, and were stored in a sealable plastic box for twenty-four hours (until dry) before being transferred to individual envelopes for storage and subsequent analysis. The goal of this collection was to assess iron status in mothers. With the exception of Solou village, few women agreed to the fingerprick sample, giving as reasons for refusal that the hurt finger would slow their work, that they might have an infection, that they were pregnant and couldn't afford to lose blood, that their diet and their blood was poor, or, most often, that they were afraid.

Children were given a brief health examination, consisting of observations for signs of respiratory infection, skin infection or other abnormality, eye infection or other dysfunction, kwashiorkor (swollen feet, legs, belly, moonface, irritability with withdrawal, abnormal hair and skin, etc.), and severe anemia (pale eye mucosae, tongue). Mothers were asked if the child had been ill that day or within the last two weeks. Mother's answers often did not reflect the abnormalities researchers identified, suggesting either that the mother did not notice the illness in her child, or did not deem it important enough to comment on. Appendix 4 presents a complete list of all abnormalities noted in the four villages among the children surveyed.

A majority of children owned a Health Card (Appendix 3) on which was recorded their vaccination history. Village children are vaccinated in groups periodically as a vaccination team of the PEV (Programme Elargee des Vaccinations) rotates through their village. The four vaccinations normally recorded are BCG (given soon after birth), DPT and polio (given within the first 12 months), and measles (given after 12 months). BCG is typically given in the right forearm near the elbow and leaves a scar. DPT and Polio are given in the upper arm, and measles is given over the scapula on either the right or left sides. For those children who did not have a health card, we sought scars as evidence of the BCG, and asked mothers if the child had received shots in the locations specific to the various vaccinations.

D. Interpretive Methods

Explanation of Indicators. The adequacy of child growth is typically determined by comparing the growth of an individual repeatedly or of a population sample to a reference standard which has been developed on a large healthy population. In 1978, the US National Center for Health Statistics (NCHS) weight and height distributions of healthy American children was designated by the World Health Organization as the height and weight reference standard for the world (WHO, 1978). The use of an American standard to consider growth adequacy in Mauritanian children is appropriate because studies have generally shown that size variation in young children is more closely liked to socio-economic status than to race or genetics. Among healthy American children, black and white girls and boys do not grow significantly differently either as to pacing or as to final size; only poverty is associated with lower weights and statures (Unsigned, 1975). Similarly, well-off Kenyan children grow more like their American counterparts than like poor rural Kenyan children (Stephenson, Latham and Jansen, 1983).

A population characterized by low height-for-age (H/A) may be one of genetically low average height compared to the reference population, or, more commonly, is one that has experienced chronic undernutrition (from whatever cause) and is stunted. A population characterized by low weight-for-age (W/A) may be one adapted to particular environmental pressures such as extreme dry heat (Roberts, 1953), or one that is experiencing current underfeeding and is wasted, or one in which stunting is the major manifestation and weight is appropriate for height. The ability to distinguish among these causes requires additional information, including data on climate, height and weight characteristics of adults in the population, socio-economic status, food availability in general and to vulnerable sub-populations, and disease burden.

In a population in which age is not accurately known, useful age-independent indicators of current nutritional status include weight-for-height (W/H) in children and body mass index (Weight(kg)/Height(m)^2 x 100) in adults. However, it is often valuable to consider other measures, such as arm circumference as well.

The designation of cut-off points beyond which abnormality is presumed is always somewhat arbitrary. Chen, Chowdhury and Huffman (1980) found that among children with weights less than 70% of the median of the standard for age mortality rose

sharply in the year following measurement in contrast to children with more normal weights. Applying a degree of conservatism to this finding, common practice is to define H/A of less than 90% of the median (= -2 SD, or Z Score of -2 or more), and W/A, W/H, and BMI of less than 80% (= -2 SD) of the median as abnormal, or "dangerous." If the frequency of such values rises above about 10% of the population, intervention is highly recommended (Himes, 1987). The "caution" zone falls between 80 and 90% of the median for W/A, W/H, and BMI. In each of the above cases, cut-offs correspond to approximately the first to third percentile of the reference population, i.e., in a normally distributed population, one to three percent of persons are expected to fall below these values. Because most published reference standards expressed as percentiles do not detail values less than the fifth percentile, when using percentile standards it is necessary to designate "abnormality" as less than or equal to the fifth percentile; this slightly overestimates frequencies as derived from the other two methods.

Reference data also exist for tricep fatfold thickness, midarm circumference, midarm nonfat (muscle and bone) area, and head circumference. Where distributions are provided in terms of standard deviations, undernutrition can again be defined as -2 SD from the population mean or median; in several cases standard deviations are not designated, and abnormality must be designated as <=5th percentile. As with height and weight, it is sometimes useful to estimate undernutrition on the basis of a ratio; Kanawati and McLaren (1970) suggest reference values for children for the arm circumference: head circumference ratio.

In previous surveys, the government of Mauritania and Catholic Relief Services [which was a major observer of rates of undernutrition among Mauritanian preschoolers until it closed its feeding center program in October 1987; (Unsigned, 1988)], have measured W/A alone and designated undernutrition as <80% of the Harvard Growth Standard. The Harvard Growth Standard differs by only about 1% from the NCHS/WHO standards (Stephenson, Latham, Jansen, 1983).

Choice of Indicators for this Survey. In this report the following indicators of undernutrition are used:

--H/A, W/A, and W/H: -2SD of NCHS/WHO reference standards (Z Score of -2 or more.) Calculations were performed by Centers for Disease Control Anthropometric Software Package (CASP V3.0). Calculations for children are age-accurate; the program does not include values for persons over 18 years, so height and weight for women in this survey were calculated as if the women were 17.9 years old. The effect on height calculation is insignificant; since women gain weight with age, the effect is to underestimate the actual frequency of low body weights.

--BMI: <=5th percentile of standard for nonreproducing black women derived from the US first National Health and Nutrition Examination Survey, 1971-1974 (Cronk and Roche, 1982). Reference standards for pregnant and lactating women are not available; the use of standards for nonreproducing women will tend to underestimate the true frequency of low BMI.

--Head Circumference: (children only) <=5th percentile of NCHS/WHO) reference standards (Nellhaus 1968).

--Mid-arm circumference, arm nonfat area, and tricep fatfolds: For children: <=5th percentile of standard derived from white children in US Ten State Nutrition Survey of 1968-1970 (Frisancho, 1974). For women: Triceps fatfolds <=10th percentile of black standard as reported in Cronk & Roche (1982); arm circumference and arm nonfat area <=15th percentile of white sample as reported in Frisancho (1974). Arm nonfat area was calculated using nomogram given in Gurney & Jelliffe (1973).

--Arm Circumference: Head Circumference Ratio: < 0.310. The cutoff is derived from a study of Lebanese children of low socioeconomic status (Kanawati & McLaren, 1970).

III. RESULTS

A. Body Size Distributions of Children and Mothers.

The goal of this section is to compare the sample body size distributions for the sampled Mauritanian villagers with the reference populations, to give an overall perspective on body size. Desert-adapted populations are expected to be relatively linear, that is, to have relatively low W/H or BMI (Roberts, 1953). Additionally, in healthy heat-adapted populations, growth is typically somewhat delayed (Weiner, 1977). These causes of low weight and slow growth are normal and must be counted as a factor even when underfeeding is known to be the primary cause of small size.

Tables 3 and 4 compare the height and weight distributions of the sampled children with the height and weight distributions of the reference population. The Mauritanian children are about one full standard deviation shorter on average than the reference children; 17.3% fall below 2 SD from the median. The discrepancy is greater for weight, amounting to about 1.5 SD, with 31.4% less than 2 SD from the median.

TABLE 3

Height Distributions (Z Scores)* of Children by Village (%)

Z Score	Expected Distribution (Reference) %	Village: Doubel (N=30)	Ganki (N=40)	Seyenne (N=43)	Solou (N=37)	All (N=150)
+3 - +4			2.5			0.6
+2 - +3	<2.5					0.0
+1 - +2	14.0	6.7	5.0	2.3	2.7	4.0
0 - +1	33.5	10.0	17.5	20.9	16.2	16.7
0 - -1	33.5	23.3	32.5	30.2	35.1	30.7
-1 - -2	14.0	30.0	32.5	39.5	18.9	30.7
-2 - -3	<2.5	13.3	7.5	7.0	21.6	12.0
-3 - -4		16.7	2.5		5.4	5.3

*Reference Population: U.S. National Center for Health Statistics

TABLE 4

Weight Distributions (Z Scores)* of Children by Village (%)

Z Score	Expected Distribution (Reference) %	Village: Doubel (N=30)	Ganki (N=40)	Seyenne (N=43)	Solou (N=37)	All (N=150)
+3 - +4						
+2 - +3	<2.5					
+1 - +2	14.0	3.4			5.4	2.0
0 - +1	33.5		17.5	7.0	8.1	8.7
0 - -1	33.5	27.6	32.5	23.3	16.2	24.8
-1 - -2	14.0	31.0	35.0	34.9	29.7	32.9
-2 - -3	<2.5	24.1	10.0	27.9	32.4	23.5
-3 - -4		13.8	2.5	7.0	8.1	7.3
-4 - -5			2.5			0.6

*Reference Population: U.S. National Center for Health Statistics

Tables 5 and 6 compare the heights and weights of village mothers with reference values for women 17.9 years old (for explanation see under Interpretive Methods). For height, the Mauritanian women approximate the reference distribution, with only a mild skew toward shorter statures. For weight, the distribution is at least one full SD below the reference populations; 8.2% are below 2 SD from the median. The eight teenage mothers in the sample, who were born at the beginning of the drought, have heights and weights no different from those of women born in the pre-drought period. Table 7 summarizes mean height and weight values for women in the four villages.

TABLE 5

Height Distributions (Z Scores)* of Mothers by Village (%)

Z Score	Expected Distribution (Reference) %	Village				
		Doubel (N=16)	Ganki (N=18)	Seyenne (N=22)	Solou (N=29)	All (N=85)
+2 - +3	<2.5			9.1	6.7	4.7
+1 - +2	14.0	6.3	16.7	4.5	13.8	10.6
0 - +1	33.5	31.3	16.7	36.4	27.6	28.2
0 - -1	33.5	31.3	55.6	40.9	27.6	37.6
-1 - -2	14.0	25.0	11.1	9.1	20.7	16.5
-2 - -3	<2.5	6.3			3.4	2.4

*Reference Population: U.S. National Center for Health Statistics (for women age 17.9 years).

TABLE 6

Weight Distributions (Z Scores)* of Mothers by Village (%)

Z Score	Expected Distribution (Reference) %	Village				
		Doubel (N=16)	Ganki (N=18)	Seyenne (N=22)	Solou (N=29)	All (N=85)
+2 - +3	<2.5				3.4	1.2
+1 - +2	14.0		5.6			1.2
0 - +1	33.5		11.1	13.6	6.9	8.2
0 - -1	33.5	37.5	50.0	40.9	62.1	49.4
-1 - -2	14.0	43.8	33.3	31.8	24.1	31.8
-2 - -3	<2.5	18.8		13.6	3.4	8.2

*Reference Population: U.S. National Center for Health Statistics (for women age 17.9 years).

TABLE 7

Height and Weight of Village Mothers*

	Village			
	Doubel (N=16)	Ganki (N=18)	Seyenne (N=22)	Solou (N=29)
HEIGHT (cm)				
Mean	160.4	163.4	164.7	163.6
Range	150.0-170.0	155.5-174.5	154.4-178.0	151.51-179.0
WEIGHT (kg)				
Mean	48.1	52.7	49.4	52.8
Range	36.3-56.2	43.1-73.4	38.4-59.1	42.0-86.0

Together these data indicate that both mothers and children are relatively linear but that children are proportionately shorter and thinner than their mothers. This suggests two interpretations: 1) that while heat adaptation is probably acting to increase linearity and slow growth, under-feeding and hunger are significant additional factors in preschool children; and 2) either the nutritional situation has deteriorated in the last generation, or late in childhood (beyond the age sampled in this survey), the children manifest some compensatory growth.

Head circumference provides an indirect measure of brain growth during the first two years of extrauterine life. Undernutrition during this period is often correlated with slow neurological development (Adair 1987; Engsner, et. al., 1974). Table 8 shows distribution of head circumference among village children compared to NCHS/WHO standards. In a normally distributed population, only 5% would be expected to have circumferences below the fifth percentile; here nearly 50% of the sampled children do.

TABLE 8

Head Circumference Distribution* (%) of Children by Village

	Village				
Percentile	Doubel (N=29)	Ganki (N=40)	Seyenne (N=43)	Solou (N=37)	All (N=149)
>85	3.4		2.3		1.3
50-85	17.2	7.5	11.6	5.4	10.1
15-50	24.1	32.5	18.6	24.3	24.8
5-15	20.7	17.5	18.6	8.1	16.1
<5	34.5	42.5	48.8	62.2	47.7

*NCHS/WHO Standards (Nellhaus 1968).

Tables 9 and 10 show central tendency statistics for fatfolds and arm circumference for village children and mothers, respectively. Fatfold thickness is an estimator of energy stores while arm circumference reflects adequacy of body muscle mass. Fatfold thickness among children was generally normal at Ganki and Seyenne, and below normal at Doubel Doubai and Solou, which also show higher than expected frequencies of low fatfolds. For women, fatfolds are generally low normal except at Doubel Doubai where nearly 50% of women had thicknesses < 10th percentile for age. Arm circumference averages were low among children in all villages except Ganki, and among women in all villages.

TABLE 9

Tricep Fatfolds and Upper Arm Circumference of Village Children*

	Village			
	Doubel (N=30)	Ganki (N=40)	Seyenne (N=43)	Solou (N=37)
Triceps Fatfold				
Mean	8.0	10.0	9.6	8.4
Range	6.0-22.0	3.0-15.0	5.0-16.0	4.0-12.0
Mean Percentile Range	<=15th	>=50th	<=50th	15-50th
% < 5th percentile	23.3	5.0	7.0	13.5
Upper Arm Circumference				
Mean	12.9	14.4	14.0	13.1
Range	11.5-18.0	9.0-17.5	10.9-16.0	7.3-16.0
Mean Percentile Range	<5th	5-15th	5-15th	5-15th
% < 5tn percentile	53.3	10.0	39.5	48.6

*Reference Population: White American Children in U.S. Ten-State Nutrition Survey of 1968-1970 (Frisancho 1974).

TABLE 10

Triceps Fatfolds and Upper Arm Circumferences of Village Mothers*

	Village				
	Doubel (N=16)	Ganki (N=18)	Seyenne (N=22)	Solou (N=29)	All (N=85)
Triceps Fatfold					
Mean (mm)	10.2	18.3	15.4	19.6	15.9
Range	3.5-15.0	12.0-31.0	5.0-23.0	13.0-31.0	
Mean Percentile Range	10th	25-50th	15-35th	25-50th	
% <=10th percentile	50.0	5.6	4.5	0.0	
Upper Arm Circumference					
Mean (cm)	23.7	25.9	24.0	25.3	24.7
Range	19.9-29.5	22.0-33.5	20.8-27.5	22.2-31.5	
Mean Percentile Range	5-15th	25th	<=15th	25th	
% <=15th percentile	31.3	22.2	36.4	24.1	

*Reference Population for Triceps Fatfold is black women in first U.S. Health and Nutrition Survey, 1971-1974 (Cronk and Roche 1982). Reference population for Arm Circumference is white women in U.S. Ten-State Nutrition Survey 1968-1970 (Frisancho 1974).

Table 11 shows the distribution of upper arm nonfat area for village children and mothers. Non fat area represents lean body mass, and especially, muscle mass and protein stores. Among children, as expected from the low arm circumferences combined with relatively normal fatfolds, lean mass is skewed to lower values, with 25% of the children showing values in the "danger" zone. A milder skew toward lower values characterizes the mothers.

In sum, fat stores are relatively adequate in both children and mothers (except at Doubel Doubai), while protein stores are adequate to marginal for mothers and low for children.

TABLE 11

Upper Arm Nonfat Area (%) Village Children and Mothers*

Percentile	Village				
	Doubel	Ganki	Seyenne	Solou	All
Children	N=30	N=40	N=43	N=37	N=150
>85			2.3		0.6
50-85	10.0	15.0	23.3	18.9	17.3
15-50	46.7	50.0	18.6	32.4	36.0
5-15	20.0	20.0	18.6	24.3	20.7
<5	23.3	15.0	37.2	24.3	25.7
Mothers	N=16	N=18	N=22	N=29	N=85
>85	6.3	16.7		3.4	8.8
50-85	56.3	27.8	18.2	20.7	30.8
15-50	6.3	33.3	45.5	51.7	34.2
5-15	25.0	22.2	36.4	17.2	25.2
<5	6.3			6.9	6.6

*Nomogram: Gurney and Jelliffe 1973. Reference Standards Frisancho 1974.

B. Growth Patterns of the Sampled Children

Table 12 shows the relationships between age and distributions of height, weight and head circumference. Table 13 summarizes the data by age on a village by village basis.

TABLE 12

Height, Weight and Head Circumference of Children, Villages Combined
(Percentage)

Percentiles	Age in Months 0 < 12 (N=43)	12 < 24 (N=47)	24 < 36 (N=47)	36 < 48 (N=13)
Height				
>=50th	37.2	12.8	29.8	7.6
<10th	16.3	59.6	31.9	42.6
< 5th	11.6	46.8	23.4	30.8
Weight				
>=50th	20.9	6.4	8.5	0.0
<10th	25.6	72.3	61.7	84.6
< 5th	20.9	53.2	51.1	61.5
Head Circumference				
>=50th	32.6	12.3	10.6	7.7
<10th	30.2	55.3	70.2	92.3
< 5th	16.3	38.3	59.6	76.9

In the first year of life, more children are growing close to NCHS mid-range values for height, weight and head circumference than in any of the subsequent years. There are, however, a considerable portion who are small even in the first year. For weight and for head circumference, deficits are apparent by the sixth month.

By the twelfth month, slow growth in all parameters is well established--virtually the norm--in all villages. All villages continue to show growth deficits through the fourth year (36-48 months). The sample sizes are small and the observations cross-sectional, but the patterns are relatively consistent and similar to those found in other studies (e.g., Dagan et al., 1983, Warrick-Goldman, Brown & Binkin, 1986; Mundschenk & Sapathy, 1987), so it is likely that they are representative.

Table 13 shows that slowing in length gain occurs by twelve months in all villages except Doubel Doubai, where it is apparent by nine months. Ganki shows a bimodal distribution, with growth deficits in the second (12-24) months) and fourth (36-48 months) years, with 24-36 month old children doing apparently better. For weight, slowing is apparent by the eighth month at Seyenne, the ninth at Doubel Doubai, and the twelfth for both Ganki and Solou. Ganki again shows a bimodal curve with poor weight at 12-20 months, and again over 30 months. Deficits in weight are more marked than those in length. Head circumference is low by 12 months at Ganki and Solou, by 18 months at Seyenne, and by 20 months at Doubel Boubai.

TABLE 13

Prevalence of Low Height, Weight and Head Circumference by Age and by Village*

Village	Low Height	Low Weight	Low Head Circumference
Doubel	100% > 9 mos	93% > 12 mos	90% > 20 mos
Ganki	56% 12-24 mos 33% > 36 mos	20% 12-20 mos 58% > 30 mos	93% > 12 mos
Seyenne	100% > 12 mos	95% > 8 mos	84% > 18 mos
Solou	82% > 12 mos	79% > 12 mos	78% > 12 mos
Combined	88% > 12 mos	86% > 12 mos	82% > 18 mos

*"Low" Height, Weight or Head Circumference equals sizes less than the 5th percentile for the NCHS Reference Population.

In sum, deficits in weight occur earliest and in head circumference latest, but all villages show a striking pattern of slowed growth past early infancy, which continues through the fourth year. The bimodal curve at Ganki may be an accident of sampling or may indicate a distinctive pattern that cannot be explained at this time.

Table 14 shows an index of lean body mass (nonfat upper arm area) by village. Well-fed and healthy children show a progressive increase in lean body mass with age, and remain within the growth channel established early in life. This pattern emerged only at Ganki where sampled children showed a increase with age in nonfat upper arm area, and remained within a low-normal channel. Seyenne and Solou, and Doubel Dobai show a pattern of inadequate lean body mass, with a progressive decline from normal values near birth to mean values below the 15th percentile after age 30 months.

TABLE 14

Nonfat Upper Arm Area (cm^2) by Age for Children by Village*

	Village			
Age in Months	Doubel (N=29)	Ganki (N=40)	Seyenne (N=43)	Solou (N=37)
0 < 6	8.1	8.1	8.1	8.1
6 < 18	10.2	9.9	10.6	9.5
18 < 30	10.1	10.6	9.6	9.6
30 < 48	9.5	11.9	10.0	9.1

*Nomogram: Gurney and Jelliffe 1973; Reference population Frisancho 1974. V = Variance, %R = Percent Refer?

C. Further Evidence for Undernutrition Among the Sampled Children.

Proportions of children with H/A, W/A and W/H more than 2 SD below the reference population median are given in Table 15. These data indicate again that the children lag more in weight than in height. Low height indicates stunting; low weight indicates wasting and low W/H indicates a child who is thin for length. Low H/A is usually taken as an indicator of chronic undernutrition, while low W/H indicates acute undernutrition. Where ages are uncertain, the age-independent measure of W/H is the preferred estimator of acute undernutrition. By this measure, about 19% of the sampled children are acutely undernourished.

TABLE 15

Frequency (%) of Child Undernutrition Estimated from Height and Weight Z Scores

	Village				
Z Score	Doubel (N=29)	Ganki (N=40)	Seyenne (N=43)	Solou (N=37)	All (N=149)
Height-for-Age					
> - 2	69	90	93	73	83
< - 2	31	10	7	27	17
Weight-for-Age					
> - 2	62	85	65	60	68
< - 2	38	15	35	40	32
Weight-for-Height					
> - 2	86	88	77	76	81
< - 2	14	12	23	24	19

Table 16 shows estimates of the frequency of undernutrition on the basis of the mid-arm circumference: head circumference ratio (Kanawati and McLaren, 1970), another estimator of chronic undernutrition. In contrast to the height and weight measures that are compared with norms derived from middle-class American children, these reference data are derived from a sample of over 1000 preschool Lebanese children of low socio-economic status. Because the ratio was derived from a population of poor children, it could function as a more conservative measure of undernutrition; in fact, by this measure the Mauritanian village children demonstrate more growth deficit than by the previous global measures. Thus only 39.4% have normal ratio values, while 48.9% demonstrate values indicative of mild undernutrition and 11.7% values indicative of moderate to severe undernutrition.

TABLE 16

Frequency of Child Undernutrition Estimated Using the Mid-arm Circumference: Head Circumference Ratio.*

AC:HC Ratio	Village					
	Doubel	Ganki	Seyenne	Solou	All	(%)
> 0.310	5	22	16	11	54	(39.4)
0.310-0.280	14	15	23	15	67	(48.9)
< 0.280	6	2	3	5	16	(11.7)

*Ratio values over 0.310 correspond to normal, 0.310-0.280 mild malnutrition, and < 0.280 moderate to severe malnutrition. Appropriate for use in children over 3 months of age. Ref: Kanawati & McLaren 1970.

Together the data suggest that while villagers have a typically linear body build (an adaptation to dry heat stress), undernutrition is also common among both children and mothers. Acute undernutrition is somewhat less common than chronic undernutrition, but both are common.

D. Pattern of Undernutrition Among Village Children

It is possible to derive some estimate of the pattern of undernutrition by simultaneously comparing H/A, W/A, and W/H in a three-way matrix (WHO 1983: 25-27). The results of such an analysis are shown in Table 17. A child with normal height and weight for age and normal W/H is accounted normal; 96 or 64.4% of the children (villages combined) are normal by this measure. The distribution of body size even for this group is small in comparison to reference children, perhaps are a result of earlier undernutrition, but they are within, the normal range.

TABLE 17

Distribution of Types of Malnutrition by Village Using Three-way Matrix*

Anthropometric Classification	Village: Doubel (N=29)	Ganki (N=40)	Seyenne (N=43)	Solou (N=37)	All (N=149)	%
Normal	17	31	27	21	96	64.4
Stunted	8	3	2	6	19	12.8
Wasted	3	5	13	6	27	18.1
Wasted & Stunted	1	1	1	4	7	4.7

* Matrix simultaneously compares H/A, W/A, and W/H.
Normal = Height-for-Age, Weight-for-Age, Weight-for-Height values all normal, where normal is defined as > -2 SD of median, or Z Score over -2.
Stunted = Weight-for-Height is normal, Weight-for-Age is either low or normal, and Height-for-Age is low, where low is defined as Z Score < -2.
Wasting = Weight-for-Height low, Height-for-Age normal, and Weight-for-Age normal or low.
Chronic Growth Failure (Stunting and Wasting) = Weight-for-Height, Height-for-Age, and Weight-for-Age all low.

Children with normal W/H but low H/A show evidence of having experienced chronic undernutrition which may be continuing or from which incomplete recovery has been made. The age distribution of stunting may give a clue to some causes of undernutrition. Seven percent of infants under six months were short for age; they very likely were low birthweight infants.

Recent weight loss in a previously well-nourished child (wasting) is signaled by normal H/A, low W/A, and W/H. Finally, children with all three measures abnormally low are demonstrating the most severe form of undernutrition, wasting with stunting, or chronic growth failure.

In the sampled villages, both wasting (14.1%) and stunting (12.8%) were observed. About 5% of the children showed growth failure. The overall pattern suggests acute nutritional stress superimposed on a population in which chronic malnutrition is not uncommon.

Table 18 summarizes status of the village children on the basis of the 3-way matrix; 35.6% show evidence of malnutrition. The great majority of these are cases of marasmic undernutrition; only one case of frank kwashiorkor was seen (in Doubel Doubai), with several suspicious cases in Seyenne and Solou.

TABLE 18

Summary of Growth Status of Village Children

Normal Growth	64.4%
All Abnormal Growth	35.6%
Stunted	35.8%
Wasted	50.9%
Wasted and Stunted	13.2%

E. Factors Associated with Undernutrition Among the Sampled Children

Sex was not predictive of malnutrition in any of the villages sampled (Table 19).

TABLE 19
Prevalence of Malnourished Children by Sex* and Village

	Doubel	Ganki	Seyenne	Solou	All (%)
Sex					
Girls	7/16	4/15	5/19	10/18	26/68 (38.2)
Boys	5/13	5/25	11/24	6/19	27/81 (33.3)

*Chi-square not significant.

Village Membership and Ethnicity. Table 20 indicates that village membership was associated with risk of malnutrition. Specifically, Ganki village had a significantly lower prevalence of malnutrition than the other three villages combined (Chi-square significant at .05 level). The other three villages experienced approximately equal prevalences of malnutrition.

TABLE 20

Number of Children by Village and Nutritional Status

Nutritional Status	Village			
	Doubel	Ganki	Seyenne	Solou
Normal	17	31	27	21
Undernutrition* (Wasting and Stunting)	12	9	16	16

*Village frequency differences not significant using Chi-square test on a village by village basis, but significant at .05 level if Ganki is compared to merged samples of the other three.

Ganki village actually consists of a central village which is mainly Pulaar, and two outlying hamlets, one of which is Black Maure and the other of which is Peul. Measurements were made in all three locations. Sample sizes were too small for statistical analysis, but it was clear that most malnutrition in Ganki was affecting the Pulaar in the central village. Thus while village membership affects the frequency of undernutrition, ethnicity does not seem to be the explanatory factor in this distribution. A likely explanatory factor is agricultural productivity. Ganki is fortunate in splitting its agricultural dependence among both rainfed and annually flooded lands; in 1987 there was a good harvest on the latter despite the failure of the rains. In contrast, Doubel Doubai, dependent primarily on rainfed agriculture, harvested little in 1987 and by January 1988 there was little food of any kind in the village (personal communication, Patricia O'Brien-Place).

TABLE 21

Prevalence of Malnourished Children by Age and Village

Months of Age	Village					
	Doubel	Ganki	Seyenne	Solou	All	(%)
0 < 12	2/10	1/8	2/8	3/16	8/43	(18.6)
12 < 24	6/10	4/13	3/14	7/10	20/47	(42.6)
24 < 48*	4/9	4/18	11/21	6/11	25/59	(42.4)

*Difference between first and subsequent years of life significant at the .05 level using Chi-square test.

A second explanatory factor could be cultural, specifically related to food distribution habits as they affect access to food among small children. Differing habits by ethnic group could explain village-level differences in hunger experience among children; however, this survey collected rather little evidence that they do (see below).

Age Distribution of Malnutrition. Table 22 shows the distribution of undernutrition by feeding status. Five children receiving only breastmilk were malnourished; two of these were twin girls aged three weeks of extreme small size, and it is possible that the remainder are also secondary to low birth weight. About 28.6% of children receiving both breast milk and supplementary food (milk, rice and milk bouilli, millet porridge, family food) showed abnormal growth, while 40.2% of completely weaned children were malnourished. These patterns parallel the age distribution of malnutrition, although there were no statistically significant differences in prevalence of malnutrition by feeding status.

TABLE 22

Prevalence of Malnutrition by Feeding Status

Feeding Stunting	Village					
	Doubel	Ganki	Seyenne	Solou	All	(%)
Breastmilk only	1/6	0/2	2/4	2**/10	5/22	(22.7)
Breastmilk + Supplement*	4/9	5/14	1/9	4/10	12/42	(28.6)
Weaned	7/14	4/24	13/29	9/15	33/82	(40.2)

*Supplement may be liquid milk, cereal, or other; see text.
**Premature twin girls.

Table 23 displays the patterns of supplementation and weaning as reported by mothers in the survey. Considerable time was necessary to elicit child feeding information from mothers. Some women did not consider the use of cow's or goat's milk as supplementary while others did. Dates given by mothers are subject to errors of memory and of calendrical ignorance. I consider accuracy to be adequate because the results both make sense, and resemble those collected by other observers (below).

TABLE 23

Village Patterns by Age in Months of Breast Milk Supplementation and Weaning

		Supplementation			Weaning		
Village	N	$\bar{X}$ age Begins	Mode	Range	$\bar{X}$ age Severage	Mode	Range
Doubel	25	6.0	3	3-18	17.4	18,24	7-24
Ganki	32	7.4	6	2-20	17.8	16,19	5-25
Seyenne	35	2.8	1	1-7	19.0	24	2-26
Solou	31	6.9	1,4,6	1-19	19.0	19,20	12-24

At the three farming villages supplementation began on the average between the 6th and 7th months but showed a remarkably wide range. At Seyenne, the herding village, supplementation began much earlier, with a mode in the first month. Indeed, many Seyenne mothers told us that they began supplementation at birth.

Breast feeding, according to the Koran, should be extended to the age of 24 months (Mundshenk and Sapathy 1987). Sampled women completed weaning much earlier, averaging between the 17th and 19th month, with an upper range just reaching 24 months. The few instances of very early weaning were due either to the mother's subsequent pregnancy or to her death.

Peul children, at Seyenne, experience the longest period of supplementation before weaning. Soninke are reputed to practice abrupt weaning (this is "received" anecdotal evidence repeated to me by several persons interviewed in Nouakchott and Kaedi); this survey does not bear out this perception, for a majority of Solou children reportedly received supplements from a relatively early age.

Overall, supplementation appears to begin at recommended ages, but both breastmilk and supplementation may be inadequate based on the relatively high rates of malnutrition.

Birth Spacing. Of 149 children measured, 50 formed one of a sibling pair. Average time between these births for all villages was 25.1 months, with a range of 10-41 months, and a range between villages means of 23.7 to 28.4 months (not significant). Samples are very small, but the evidence suggests that children closer in age to their siblings did not show higher rates of poor growth than those spaced further apart or without siblings.

Morbidity. A list of all symptoms of infectious disease, malformation, and other nutritional disease is given in Appendix 4. The most common disease problems reported by mothers and observed by researchers included conjunctivitis, colds and other respiratory system infections, diarrhea,

and anemia. Seyenne had the largest number of children with no symptoms of illness, while Doubel Doubai had the fewest. Doubel Doubai suffered more than any of the other villages from conjunctivitis, diarrhea, and anemia, and had the only case of frank kwashiorkor. Respiratory illness was commonest at Solou, with Ganki and Doubel Doubai coming in second and third respectively.

On the basis of these findings, we might expect Seyenne village to show better growth profiles than the other villages, especially Doubel Doubai. This is not the case, and with no disease is there a clear correlation of poor growth with the presence of disease. Thus, Seyenne and Solou share the highest rates of low W/H, while Doubel Doubai and Ganki both have lower rates though the differences are not statistically significant.

One possible interpretation of these data is that poor growth at Seyenne is linked rather directly to food availability. Poor growth at Solou and Ganki, however, may relate more to crowding and problems of cleanliness associated with long settlement. Doubel Doubai is in the worst position because it suffers both from lack of food and from problems of cleanliness exacerbated by their distance from water during the most recent drought period.

Measles Vaccination. Some evidence suggests that children without measles vaccination are more likely to experience undernutrition than those vaccinated (Koster, et. al., 1981). In the present survey that does not seem to be the case. Table 24 shows that children who have received measles vaccine are no less likely to experience undernutrition that those who have not received the vaccine. More generally, vaccination status does not seem to be a predictor of nutritional status.

TABLE 24

Distribution of Vaccination (%) by Village

	Village			
	Doubel	Ganki*	Seyenne	Solou
Proportion of Sample Ever Vaccinated	66.7	71.0	90.5	66.7
Proportion Ever Vaccinated with Measles Vaccine	70.0	44.7	55.3	21.2
Proportion of Measles Vaccinated	50.0	40.0	50.0	20.0

*Ganki Central village 92% ever vaccinated; Ganki suburbs 23% ever vaccinated.

Twinning. Table 25 displays growth adequacy data from three sets of twins measured at Solou village. With the exception of fatfold thickness, every measure indicates that these children are small. Five of the six children fall into the most severe category of malnutrition; one boy of nearly 33 months had normal weight for height but was extremely stunted.

TABLE 25

Growth Status of Twins at Solou Village

	Girls	Girls	Boys
Age in Months	0.76	28.39	32.85
Height-for-Age Z Score	-3.61	-0.17	-2.27
	-2.29	0.47	-1.31
Weight-for-Age Z Score	-2.96	-3.17	-2.45
	-2.27	-2.40	-2.91
Weight-for Height Z Score	*	-3.45	-1.45
	*	-2.89	-2.71
Head Circumference	<2 SD**	<2 SD	<2 SD
	<2 SD	<2 SD	<2 SD
Percentile Score			
Arm Circumference	<5	<5	<5
	<5	<5	<5
Tricep Fatfold	15th	5th	50th
	15th	5th	50th
Ratio AC:HC[x]	.242	.291	.294
	.252	.290	.272

* CDC Anthropometric Software Package does not compute weight-for-age for these height and weight values.

**Source curves show -2 SD curve only, exact Z Score not known. (Nellhaus, 1968.)

x Arm Circumference: Head Circumference Ratio. Values under .310 indicate mild malnutrition; those under .280 indicate moderate to severe undernutrition. Values applicable for children over 3 months; calculated here for 3 week infants to emphasize their smallness. Ref: Kanawati and McLaren 1970.

F. Evidence for Undernutrition among the Sampled Mothers.

Table 26 shows the distribution of body mass index, an age-independent indicator of relative body weight, for mothers in the sample. Values tend toward the lower end of the distribution of the reference population, meaning that weights are relatively low in proportion to height. Thirty-four percent had BMIs in the "danger" zone, or lower than the fifth

percentile, and an additional 27% have BMIs in the "caution" zone. Differences between villages and by age are insignificant. Even accepting that the women are naturally linear as a climatic adaptation, this strong skew to the lowest values indicates that these women are underfed.

TABLE 26

Distribution (%) of Body Mass Index Values of Village Mothers*

Percentiles of reference population	Village				
	Doubel (N=66)	Ganki (N=18)	Seyenne (N=22)	Solou (N=29)	All (N=85)
50-75		11.1		3.4	3.5
25-50			4.5	6.9	3.5
10-25	37.5	27.8	31.8	31.0	31.8
5-10	37.5	33.3	13.6	27.6	27.1
<5	25.0	27.8	50.0	31.0	34.1

*Reference Population: American Black Women who formed part of the First U.S. Health and Nutrition Examination Survey (HANES), 1971-1974, in Cronk and Roche 1982.

The BMI reference population does not adjust for pregnancy or for lactation, both associated in a well-fed population with increased body weight. The low values among these village women are all the more striking because 20.2% were pregnant and another 61.9% lactating at the time of the survey. Table 27 shows the distribution of BMI, and Table 28 shows average weights, by reproductive status for these mothers.

Interviewers asked mothers if they were pregnant or lactating; culturally, the latter is a matter of pride but the former more one of embarrassment. Most mothers who claimed pregnancy were either obviously so (5th month and beyond), or "admitted" to pregnancy when explaining why they were not lactating. Thus, although researchers did not attempt to estimate month of pregnancy, a majority of women claiming pregnancy in this survey were far enough along to have experienced (in a well-fed population), weight gain. The tables indicate, however, that these mothers gained very little additional weight with pregnancy. Similar observations have been made among other underfed populations of women (Allen, 1984; Adair, 1987; Chowdhury, 1987).

TABLE 27

Body Mass Index of Village Mothers by Reproductive Status, Villages Combined

Percentiles of reference population	Reproductive Status		
	Pregnant (N=17)	Lactating (N=52)	Neither (N=15)
50-75		3.8	13.3
25-50	11.8	15.4	
10-25	41.2	28.8	13.3
5-10	17.6	30.8	40.0
< 5	29.4	36.5	33.3

TABLE 28

Average Weights (kg) of Women by Different Reproductive Status

Reproductive Status	N	Village									
		Doubel (N=30)		Ganki (N=40)		Seyenne (N=43)		Solou (N=37)		All (N=150)	
Pregnant	2	55.4	5	51.8	7	50.3	3	57.9	18	52.7	
Lactating	12	45.9	10	52.2	10	48.5	21	50.8	52	49.5	
Neither	2	53.9	3	55.6	5	49.7	5	58.0	15	54.2	

In a well-fed pregnancy, some 30,000 kcal of energy are stored in the form of fat, which is subsequently used during lactation (Adair, 1987). A well-fed woman begins the post-pregnancy period at a higher fat weight than usual in nonreproductive status. BMI values and body weight for lactating village women are low; previous data on fat stores indicated low normal were characteristic except at Doubel Doubai (50% "low").

Interestingly, nonreproducing women were not better off than reproducing women.

In sum, lactating mothers have the lowest average BMI and body weights, while pregnant and nonreproducing mothers have only moderately higher, and similar, values.

G. Comparison of Mothers with their Children.

Table 29 shows the frequencies of "low" BMI and W/H values for all mothers and children at the four villages. "Low" values are almost twice as common in mothers as in children.

TABLE 29

Frequency (%) of Women's "Low" BMI and Children's W/H Values by Village

	Village				
	Doubel	Ganki	Seyenne	Solou	All
Children w/low W/H	14.0 (N=29)	12.0 (N=40)	23.0 (N=43)	24.0 (N=37)	19.0 (N=149)
Women w/low BMI	25.0 (N=16)	27.8 (N=18)	50.0 (N=22)	31.0 (N=29)	34.1 (N=83)

Table 30 shows mothers compared with their own children. The pattern of relationship between mother's and childrens' status gives clues to the primary cause of undernutrition among the villagers. Thus, if a major cause of undernutrition in the villages is lack of food, then mothers and children can be expected to show similar rates of undernutrition. If, in the situation of food scarcity, mothers are diverting food to their children, mothers may be underfed while their children are adequately nourished.

TABLE 30

Frequency (%) of Normal and Low Mother's BMI's Compared with Own Children's W/H*

	Village				
	Doubel	Ganki	Seyenne	Solou	All
Mo Norm & Child Norm	5.0	20.0	14.3	22.9	16.7
Mo Norm & Child Low	25.0	12.0	10.7	14.3	14.8
Mo Low & Child Norm	30.0	40.0	32.1	31.4	33.3
Mo Low & Child Low	40.0	28.0	42.9	31.4	35.2

*On this table, "low" for mothers and children is defined as values under the tenth percentile. Mothers were counted once for each child measured, thus the sample N equals the number of mother-child dyads. Sample sizes: Total: not 149 (total # children) because not all mothers were available; Doubel 20, Ganki 25, Seyenne 28, Solou 35 (includes three pairs of twins).

If, however, a major cause of hunger is the practice that underfeeds only children, than we can expect mothers to be better nourished than their children. The examination of the latter possibility is important because many intervention projects attempt to alleviate child malnutrition by educating mothers in appropriate child feeding practices. In addition, there is a judgmental issue at hand. While in Nouakchott in the pre-survey period, I spoke with several people familiar with children in the city refeeding centers. I was repeatedly told that mothers attending these centers are typically well-fed, while their children are hungry. The pattern was explained as being a result of mothers "not caring," of being fatalistic about child survival, or of being "ignorant" of appropriate child feeding practices. There was a tendency to attribute this pattern especially to white Maure mothers; black mothers (Maure and non-Maure) were reputedly less likely to present this pattern. These data are anecdotal, but resemble reports for white Maures by Abeille (1979), and for noble black Malians by Hilderbrand, et. al. (1985).

In the present case, the data clearly indicate that lack of food is the basic problem in these villages. A majority of undernourished villagers show either the pattern of both mother and own child being underfed, or of mother being underfed while her child is better fed. The next largest proportion are mother-child dyads that are adequately fed with only a minority having a better fed mother than child.

IV. DISCUSSION

The costs of undernutrition are high. Undernourished mothers gain less weight during pregnancy, produce smaller and fewer placental cells, store less fat, and produce more low birthweight infants after shorter gestational periods (Allen, 1984). Afterwards, these mothers produce less milk to feed their infants. They have less energy to work or to interact with their children. The infants themselves, besides being typically small, also commonly show decreased head circumference and impaired neuro-behavioral development and immune systems. Such infants get sick and die more often than infants of better fed mothers (Allen, 1984). Undernourished children grow more slowly, show retarded neuro-behavioral maturation, and increased morbidity and mortality.

Studies in Third World settings indicate that both mothers and children can partially accommodate to undernutrition (Adair, 1987; Chowdhury, 1987). In undernourished mothers there may be an increase in metabolic and protein utilization efficiency; intakes that are much lower than those typical in the industrialized west (Adair, 1987). However, there is a limit to accommodation: chronic undernutrition coupled with frequent reproduction leads to a decrease in maternal efficiency, with weight loss and decreasing reproductive success.

Children can recover from undernutrition to a considerable extent, but chronic undernutrition becomes permanently fixed as low stature, low body mass, and often, mild neurobehavioral deficit.

Results of this survey suggest that a majority of both mothers and children are at least mildly chronically undernourished in the sampled villages. Less is known of women, but for the children surveyed, these findings closely resemble results gathered from other studies in Warrick-Goldman, Brown and Binkin (1986) which identified acute undernutrition in 8.2-17.1%, and chronic undernutrition in 25.0-35.8% of preschool children in their sample from the Trarza, Adnar and Tagant Regions of Mauritania, while Mundschenk and Sapathy (1987) noted high rates of both wasting and stunting, with 50% of their sample from the Assaba Region having sizes less than the tenth percentile for height and weight. Both these surveys were done during relatively food-rich times of the year, as was ours. Wagenaar-Brower (1985) and Hilderbrand (1985), both working in Central Mali, emphasize seasonal effects, noting that growth slows during rainy periods, and is also slower among children living in the wetter delta area of the Niger River than among those living in drier zones. Seasonal effects relate both the food unavailability before the harvest and the peaking of debilitating diarrhea and malaria during the wet months. However, conjunctivitis is a serious problem in the drier months, especially January (Hildebrand, 1985), as noted also in this study.

Warrick-Goldman, Brown and Binkin (1986) found a slightly narrower interval for greatest prevalence of malnutrition (12-36 months) than was found in this study (12-48 months). Mundschenk and Sapathy (1987) found the same pattern of supplementation (average 4-6 months) and severage (19-24 months) as recorded here.

In an important study with results that closely parallel those reported here, Dagan et al. (1983) compared growth in Bedouin and Jewish children living in the Negev Desert. They found that while the Jewish children grew much like the reference population, the Bedouin children showed deficits in weight, length and head circumference, with means at the fifth percentile. The W/H ratio was adequate for 88% of the children, but the AC:HC ratio located most of the Bedouin children in the mild malnutrition range. Dagan, et. al. describe the Bedouin children as demonstrating high levels of stunting accompanied by only mild malnutrition, and attribute this pattern to not-well-specified factors associated with the cultural and genetic backgrounds of the Bedouins in contrast to the Jews.

The results of a food consumption survey done in conjunction with this nutritional status survey (O'Brien-Place, 1988) provide some further insight into the probable causes of undernutrition among the villagers. According to this survey, stored food levels in all of the villages was too low to last until the next harvest. Doubel Doubai had the lowest foodgrain consumption levels of only 0.7 kg per adult equivalent per day; the others averaged 1.0 kg per adult equivalent per day. Either of these levels is barely adequate. Other foods were available but also in low quantities. Milk was at a dry season low, and meat was used only about once per week in Ganki and Solou, and essentially not at all in Seyenne and Doubel Doubai. Some green leaves were included in mixed dishes, but fruits were not eaten at all except at Solou. The three better off villages averaged three meals per day, but Doubel Doubai averaged 2.7.

These food circumstances go a long way toward explaining the low weights of mothers and the malnutrition among children. Specifically, the data are consistent with lack of food rather than typical results of high disease loads, harmful feeding habits, or other stressors. The fact that mothers show normal heights while children are increasingly stunted, suggests that the present food situation is relatively new, no doubt a result of the drought that began in 1969 and has continued with brief breaks to the present time.

The components of the diet also help explain why the signs of undernutrition are primarily those of simple hunger--marasmus. Specifically the diet, while of low variability and low quantity, appears reasonably nutrient dense and balanced. The weak areas seem to be less in the area of protein than for vitamin A and iron. Simple clinical observations were consistent with relatively common anemia among these children. Skin condition was not good in any of the villages but Seyenne; the kinds of skin abnormalities we found were a result of infection (especially fungal), but may have been exacerbated by mild or moderate vitamin A deficiency. No cases of clinical vitamin A deficiency (e.g., Bitot's spots) were seen, though they have been reported from more arid parts of Mauritania (Warrich-Goldman, Brown and Binkin, 1986; Numdschenk and Sapathy, 1987).

O'Brien-Place's (1988) findings on average ages of food supplementation and weaning, gathered in her household survey, are similar to those in during the present survey. The only striking difference in responses occurred in Solou, where the nutrition survey found mothers supplementing at usual ages (4-6 months) and only a few using abrupt weaning techniques, while the food consumption survey reported abrupt weaning to be common and suggested it helps explain the high rates of child death recorded for that village. Solou village is in other respects as well somewhat anomalous. Although the village appears to have adequate food supplies, the children are strikingly small and rates of illness are second only to the far worse off Doubel Doubai. This pattern does indicate that stress is high at Soulou, possibly from unidentified environmental factors (e.g., proximity to the river); possibly from child feeding habits, but most likely from a combination of these and other factors. Causality in this pattern cannot be illuminated with currently available data, but would require a more focused and in-depth analysis.

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

On the basis of this survey we may draw the following conclusions about nutritional status of children under four years of age and their mothers in the four villages surveyed (also see Table 31):

TABLE 31

Summary of "Low" Frequencies (%) of Indicators by Village for Mothers and Children*

	Village				
	Doubel	Ganki	Seyenne	Solou	All
Children					
(N)	(29)	(40)	(43)	(37)	(149)
H/A Z Score <2	30.0	10.0	7.0	27.0	17.0
W/A Z Score <2	37.9	15.0	34.9	40.5	32.0
W/H Z Score <2	14.0	12.0	23.0	24.0	19.0
Head Circ <5th	34.5	42.5	48.8	62.2	47.7
Triceps <5th	23.3	5.0	7.0	13.5	14.1
Arm Circ <5th	53.3	10.0	39.5	48.6	36.9
Arm Nonfat Area <5th	23.3	15.0	37.2	24.3	25.7
AC:HC Mild	58.3	59.0	35.7	48.4	48.9
Mothers					
(N)	(16)	(18)	(22)	(29)	(85)
H/A Z Score <2	6.3	0.0	0.0	3.4	2.4
W/A Z Score <2	18.8	0.0	13.6	3.4	8.2
BMI <5th	25.0	27.8	50.0	31.0	34.1
Triceps <10th	50.0	5.6	4.5	0.0	11.8
Arm Circ <10th	31.3	22.2	36.4	24.1	28.2
Arm Nonfat Area <15th	6.3	0.0	0.0	6.9	6.6

*H/A, W/A, W/H: NCHS/WHO Standards, CASP Anthropometric Program; children by exact age, women by age 17.9 (see text for explanation). Z Score <=2 = Standard Deviation -2 or more below reference population median.

<5th, 10th, 15th + <=5th, <=10th, <=15th percentile of standard population values.

W/A = Weight-for-Age
H/A = Height-for-Age
W/H = Weight-for-Height (age independent indicator)
BMI = Body Mass Index (age independent indicator); reference population Cronk & Roche, 1982.
Head Circ = **Head Circ**umference; reference population Nellhaus, 1968.
Triceps = **Triceps** Fatfold; reference population Frisancho, 1974.
Arm Circ = Upper Mid**Arm Circ**umference; reference population Frisancho, 1974.
Arm Nonfat Area = Upper **Arm Nonfat Area**; reference population Frisancho, 1974.
AC:HC = Arm Circumference : Head Circumference Ratio. 'Mild' = Mild Malnutrition. 'Worse' = Moderate to Severe Malnutrition. Reference Population Kanawati & McLaren, 1970.

--Surveyed children were both significantly shorter and lighter than reference population children.

--Height and weight were similar to the reference population until the second six months of life, when they begin to differ; lag in growth of head circumference begins somewhat later but is severe. Fat stores are adequate to low adequate, but lean body mass appears low.

--Both linearity and slow growth are adaptations to dry heat, and therefore probably a considerable proportion of the smallness noted is a normal and appropriate adaptation to the desert (Roberts, 1953). Nevertheless, levels of undernutrition among the children are high.

--About 50% of the children show signs of chronic undernutrition, while 19-22% of these also suffer from acute undernutrition. The signs include short stature, low body weight, small head circumference, and reduced body muscle mass.

--This marasmic response indicates that the diet, while insufficient, is broadly adequate qualitatively. On the basis of limited observation, both vitamin A and iron appear to be in low supply in the diet, and protein supply could be enhanced. Most important, however, is to increase the energy (total food) supply.

--Risk factors for the development of undernutrition in the children include birthsize (low birth weight infants at greater risk), age (12-48 months at greater risk), village membership (likely linked to agricultural productivity), feeding status (supplemented and recently weaned children at greater risk), and being a twin. Factors that do not differentiate risk include sex, ethnicity, and vaccination status.

--Sampled village mothers average both shorter and thinner than reference population women, but not to as great an extent as do the children.

--Undernutrition is also common among the mothers. Thirty-four percent of the mothers had body mass index values in the "danger" zone, while another 27% had values in the "caution" zone. Mothers gain little weight with pregnancy, and lactating mothers have the lowest average body weights. Fat and nonfat arm area average in the low adequate range.

--Children and their mothers tend to match in terms of adequacy or inadequacy of body mass, or mothers are less well fed than their own children, indicating that the primary cause of hunger in these villages is food scarcity rather than maladaptive child feeding habits.

--Ganki village was better off than the other three villages while Doubel Doubai had relatively the worst nutritional status for both children and mothers. Solou and Seyenne were only marginally better off than Doubel Doubai. It is important to note that even at Ganki, frequencies of "low" values are often over 10% of the population, the "trigger point" for

intervention (Himes, 1987). All of the villages could profit from a good agricultural intervention project.
--These findings indicate that even during the winter months, a time traditionally considered food-adequate with relatively low stress from ill-health (especially diarrhea and malaria), hunger and poor growth are commonplace.

--These findings closely resemble findings made in other parts of Mauritania, suggesting that even though these regions near the Senegal are popularly termed the "breadbasket" of Mauritania, any local abundance is not reaching the children or their mothers.

--The pattern of malnutrition is consistent with the primary cause being lack of food associated with the ongoing drought. Other causes, such as poverty, limited knowledge of farming techniques and limited variety of agricultural production, exposure to environmental stressors (heat, dusty winds, infectious agents), and child feeding habits may be contributory.

--In sum, this is a naturally linear desert-adapted population, with a considerable degree of underfeeding superimposed to yield an abnormally thin and susceptible population. Intervention trigger points (10% of the population showing anthropometric indicator values of <=5th percentile of the reference population) are passed in every village for both women and children. Appropriate intervention should focus on improving the food supply of the whole population, and in particular that of mothers and preschool children.

<u>The following RECOMMENDATIONS apply to the design of future AgResII nutrition surveys, and to the use of the present data:</u>

--It is recommended that in future nutritional surveys, AgResII personnel work through their contract contacts in the RIM Ministry of Agriculture to make a diplomatic channel approach to personnel in the RIM Ministry of Health and Social Services to inform them of the goals of the nutrition surveys, and to solicit their input and cooperation.

--It is recommended that future surveyors continue to solicit the cooperation of the traditional midwife in each village; her help in this survey was pivotal to gaining cooperation from mother, and accurate birthdates for children. Traditional midwives may be offered a small gift to thank the for their help (1000 UM, or replenishment of parts of the midwives' kit).

--It is recommended that a future survey attempt to remeasure women and children reached in this survey. A longitudinal survey (or cross-sectional/longitudinal survey) is the surest way to identify positive nutritional response to agricultural intervention. Since accurate names and ages exist identifying persons who participated in this survey, it would be relatively easy to construct a longitudinal or cross-sectional/longitudinal protocol for a follow-up survey.

--A follow-up study in the rainy season would appropriately complement these data collected in the dry winter season.

--It is recommended that the questionnaire be modified to include questions on child death, more detailed observations for vitamin A and iron deficiency, poverty, and diet, and that detailed observations for kwashiorkor be dropped. Questions about feeding habits and health need modification to improve their comprehensibility in the village setting. A sample improved questionnaire is given as Appendix 5.

--It is recommended that weight, height, age, sex, fatfold thickness, head circumference, and arm circumference continue to be collected on the children.

--It is recommended that measurements be extended to include children up to age five. Children under six months could be deleted unless there is interest in the issue of pregnancy efficiency and low birthweight infants.

--It is recommended that weight, height fatfold and arm circumference continue to be collected on the mothers. Blood samples may continue to be drawn, but large samples will be difficult to obtain because women are reluctant to give blood; problems of maintaining cleanliness in the field are large. It may be helpful to measure head circumferences on adults to help gauge normalcy of measurements among the children.

--If other than survey data are desired, it is recommended that longer periods be spent in each village, so that a more careful assessment of each child can be made. A house-to-house survey technique would decrease sample size but allow more thorough data collection per family.

--Conditions of children and mothers as noted in this survey are similar to those recorded for other parts of the Sahel. Intervention to improve overall food supply is the most needed form of intervention.

--Evidence for malnutrition in early infancy suggests intervention might also profitably be focused on enhancing mothers' prenatal and lactational diets, and on mothers' health during pregnancy and lactation.

--Both mothers and children should be targeted for intervention.

--Data from this survey are accurate and suitable for wider distribution and publication.

REFERENCES CITED

Abeille, B.
1979 A Study of Female Life in Mauritania. Office of Women in Development, U.S. Agency for International Development, Washington, D. C.

Adair, L. S.
1987 Nutrition in the Reproductive Years. In: Nutritional Anthropology, F. E. Johnston, ed., Alan R. Liss, N.Y., p. 119-154.

Aliou, S.
nd Apercu sur la Situation Nutritionalelle dans la Delta du Fleuve Senegal avant et apres barrages. Service National de la Nutrition (Ministry of Health, Mauritania). Mimeo.

Allen, L.
1984 Effects of Nutritional Status on Pregnancy and Lactation. In: Malnutrition: Determinants and Consequences, P. L. White and N. Selvey, eds., Alan R. Liss, N.Y., pp. 101-109.

Bishop, C. W.
1984 Evaluating Upper Arm Anthropometric Measurements. Journal of the American Dietetic Association 84:330-335.

Chen, L. C., A. K. M. Chowdhury, S. L. Huffman
1980 Anthropometric Assessment of Energy-Protein Malnutrition and subsequent Risk of Mortality Among Preschool-aged Children. American Journal of Clinical Nutrition 33:1836-1845.

Chowdhury, A. K. M.
1987 Changes in Maternal Nutritional Status in a Chronically Malnourished Population in Rural Bangladesh. Ecology of Food and Nutrition 19:201-211.

Cole, T. J.
1985 A Critique of the NCHS Weight for Height Standard. Human Biology 57:183-196.

Cronk, C. E. and A. F. Roche
1982 Race- and Sex-Specific Reference Data for Triceps and Subscapular Skinfolds and Weight/Stature2. American Journal of Clinical Nutrition 35:347-354.

Dagan, R., S. Sofer, W. J. Klish, G. Hundet, H. Saltz, S. W. Moses
1983 Growth and Nutritional Status of Bedouin Infants in the Begev Deset, Israel: Evidence for Marked Stunting in the Presence of Only Mild Malnutrition. American Journal of Clinical Nutrition 38:747-756.

Dibley, M. J., J. B. Goldsby, N. W. Staehling, F. L. Trowbridge
1987 Development of Normalized Curves for the International Growth Reference: Historical and Technical Considerations. American Journal of Clinical Nutrition 46:736-748.

Engsner, G., S. Relete, I. Sjorgren, B. Vahiquist
1974 Brain Growth in Children With Marasmus. Uppsala Journal of Medical Science 79:116-128.

Feraudi, M. and L. A. Mejia
1987 Development and Evaluation of Simplified Method to Collect Blood Samples to Determine Hemoglobin and Hematocrit Using Chromatographic Paper Discs. American Journal of Clinical Nutrition 45:790-796.

Ferro-Luzzi, G.
1962 Rapport sur la Situation Alimentaire et Nutritionelle en Mauritanie. (Quoted in RAMS Report).

Frankenberger, T. R., B. Perquin, F. mint H'Malla
1986 Farming Systems Research Along the Senegal River Valley: Food Consumption Survey in Guidimaka, Gorgol, Brakna and Trarza Regions. Mauritania Agricultural Research Project II, University of Arizona.

Frisancho, A. R.
1984 New Standards of Weight and Body Composition by Frame Size and Height for Assessment of Nutritional Status of Adults and the Elderly. American Journal of Clinical Nutrition 40:808-819.

1974 Triceps Skinfold and Upper Arm Muscle Size Norms for Assessment of Nutritional Status. American Journal of Clinical Nutrition 27:1052-1058.

Geissler, C. A. and D. S. Miller
1985 Problems with the Use of "Weight for Height" Tables. Journal of Nutrition 115:1546-1549.

Gurney, J. M. and D. B. Jelliffe
1973 Arm Anthropometry in Nutritional Assessment: Nomogram for Rapid Calculation of Muscle Circumference and Cross-sectional Muscle and Fat Areas. American Journal of Clinical Nutrition 26:912-915.

Grayzel, J.
1980 Introduction to Mauritanian Social Structure. In: Women in Mauritania: The Effects of Drought and Migration on Their Economic Status and Implications for Development. M. Smale. Report prepared for Office of Women in Development, USAID.

Hilderbrand, K.
1985 Assessing the Components of Season Stress Amongst Fulani of the Seno-Mango, Central Mali. Chapter 12 in: Population, Health and Nutrition in the Sahel, A. G. Hill, ed. KPI, London.

Hilderbrand, K., A. G. Hill, S. Randall, M-L. van den Erenbeemt
1985 Child Mortality and Care of Children in Rural Mali. Chapter 9 in: Population, Health and Nutrition in the Sahel, A. G. Hill, ed. KPI, London.

Himes, J. H.
1987 Purposeful Assessment of Nutritional Status. In: Nutritional Anthropology, F. E. Johnston, ed., Alan R. Liss, N.Y., pp. 85-99.

1980 Subcutaneous Fat Thickness as an Indicator of Nutritional Status. In: Social and biological predictors o Nutritional Status, Physical Growth, and Neurological Development, L. S. Greene and F. E. Johnston, eds., Academic Press, N.Y. pp. 9-32.

Kanawati, A. A. and D. S. McLaren
1970 Assessment of Marginal Malnutrition. Nture 228:573-573.

Kloth, T. I., W. A. Burr, J. P. David, G. Eplen, C. A. Koltt, R. A. Rosenbert, H. W. Staehling, T. M. Lang, M. Z. Nichaman
1976 Sahel Nutritional Surveys, 1974. American Journal of Epidemiology 103:383-390.

Koster, F., G. C. Curling, K. M. A. Aziz, A. Haque
1981 Synergistic Impact of Measles and Diarrhea on Nutrition and Mortality in Bangladesh. Bulletin of the World Health Organization 59:901-908.

Mathiowetz, V., K. Weber, G. Volland, N. Kashman
1984 Reliability and Validity of Grip and Pinch Strength Evaluations. Journal of Hand Surgery 9A:222-226.

Mundschenk, C. A. and P. Sapathy
1987 Nutrition Survey of the Departments of Kankossa nd Bomdeid, Assaba Region, Mauritania. World Vision International.

Nellhaus, G.
1968 Head Circumference from Birth to Eighteen Years, Practical Composite International and Interracial Graphs. Pediatrics 41(1):Part I: 106-11".

O'Brien-Place, T.
1988 Preliminary Results, A Dry Season Food consumption Indicator Survey Along the Senegal River in Mauritania: Brakna, Gorgol, and Guidimaka Regions. Mauritania Agricultural Research II Project, and USAID/Nouakchott. Manuscript.

Republique Islamique de Mauritanie.
1984 Rapport Annuel, Statistiques Sanitaries, Ministry of Health and Social Affairs.

1981 The Food and Nutritional Situation in Mauritania. Rural Assessment and Manpower Surveys (RAMS Project).

Roberts, D. F.
1953 Body Weight, Race and climate. American Journal of Physical Anthropology 11:533-558.

Roche, A. F., R. Siervogel, W. C. Chumlea, P. Webb
1981 Grading Body Fatness from Limited Anthropometric Data. American Journal of Clinical Nutrition 34:2831-2838.

Stephanson, L. S., M. C. Latham, A. Jansen
1983 A Comparison of Growth Standards: Similarities Between NCHS, Harvard, Denver and Privileged African Children, and Differences with Kenyan Rural Children. Cornell International Nutrition Monograph Series 12.

Stone, M. P. et al
1986 A Rainy Season Food Consumption Survey in Guidimaka, Gorgol and Brakna Regions. Mauritania Agricultural Research II Project, University of Arizona.

Traore, B.
1985 Demographic Characteristics and Trends Amongst the Nomads of Mauritania. Chapter 5 in: Population Health and Nutrition in the Sahel. A. G. Hill, ed. KPI, London.

United States Department of State
1987 Background Notes: Mauritania.

Unsigned
1988 Famine Early Warning System (FEWS) Country Report, Mauritania. USAID, Mimeo.

Unsigned
1975 Preliminary Findings of the First Health and Nutrition Examination Survey, U. S., 1971-72. Anthropometric and Clinical Findings. DHEW Publ. #75-1229, USDHEW.

Wagenaar-Brouwer, M.
1985 Preliminary Findings on the Diet and Nutritional Status of Sane Tamasheq and Fulani Groups in the Niger Delta of Central Mali. Chapter 11 in: Population Health and Nutrition in the Sahel. A. G. Hill, ed. KPI, London.

Warrick-Goldman, H., B. H. Brown, N. J. Binkin
1986 Nutritional Status of Mauritanian Children During a Drought Emergency. Ecology of Food and Nutrition 18:21-229.

Weiner, J. S.
1977 Human Ecology. In: Human Biology, An Introduction to Human Evolution, Variation, Growth and Ecology, 2nd Edition. G. A. Harrison, J. S. Weiner, J. M. Tanner, N. A. Barnicot. Oxford University Press, London, pp. 389-481.

World Health Organization
1983 Measuring Change in Nutritional Status. Geneva.

1978 A Growth Chart for International Use in Maternal and Child Health Care. Geneva.