Original Research Communications—surveys

Anthropometry and subsequent mortality in groups of children aged 6–59 months in Guinea-Bissau[1–3]

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ABSTRACT To assess the importance of nutritional status for subsequent survival, 2228 children aged 6–59 mo were followed for 8–12 mo in four different areas of Guinea-Bissau. The overall death rate was 0.62/100 child-months of follow-up (126 deaths) and 0.63 for the 1756 children who were examined on entering the study (109 deaths). Mortality was twice as high in the periurban as in the rural areas due to an outbreak of measles. In a bivariate analysis the relationship between nutritional status indicators and mortality was confounded by the age dependence of both. Using Cox's regression technique, height-for-age but not weight-for-height was positively correlated with survival. The number of children in the household was a better discriminator for death from measles than was nutritional status. Long-term factors, probably of multiple social origin, are likely causes of both relatively short stature and high mortality. *Am J Clin Nutr* 1987;46:369–73.

KEY WORDS Nutritional status, mortality, preschool-aged children, Guinea-Bissau

Introduction

There are few studies that allow anthropometric indicators to be related to subsequent mortality among children in Third World communities (1–5). The discriminatory power of the nutritional status indicators was considerable in the South Asian (1–3, 5) but virtually nil in the African studies (4). A part of the inconsistency may be due to differences between the environments and groups studied. It was suggested that the lesser degree of social stratification in Africa could be an explanation. In Bangladesh, but not in Zaire, nutritional status would be a *proxy* for the parents' socioeconomic position (5). The manner of analysis and presentation of the results may also contribute to the controversy. The interrelationship between the studied variables can be intricate for it reflects complex realities.

Aware that both nutritional status and mortality were strongly age-dependent in this study population, we have analyzed data from a child health and nutrition project in Guinea-Bissau with a multivariate statistical technique. Our primary purpose was to assess the impact of nutritional status on mortality, not to compare different indicators. Weight-for-age (WFA) is a useful single indicator but it is somewhat ambigous (6). Taken together, weight-for-height (WFH) and height-for-age (HFA) provide a conclusive and unambigous description of the measures involved.

Methods

Study population

The children in one urban and three rural areas were studied. Bandim de Cima is a periurban settlement area in the capital, Bissau. Its population is ethnically mixed with the animistic Pepel group dominating. As opposed to the rural villages, most households have at least one wage earner and young families are overrepresented. At the time of this study, there was a dispensary just outside the community. Few children were immunized. A measles outbreak in early 1979 carried a 5% mortality rate among the children < 6 y (7).

The four village communities in the Region of Cacheu belong to the animistic Manjaco group. The group of villages in the Region of Oio consists of three inhabited by the Mandinkas and one village with Peul population. Both these groups are muslims

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TABLE 1
Follow-up status by mode of entering the study for children aged 6–59 mo

Mode of entry	n	Follow-up status: Re-examined	Dead	Moved	Temporarily absent
Examined	1756	1295	109	199	153
Census only	472	304	17	81	70
All	2228	1599	126	280	223

with many animistic features. The country's largest ethnic group, the Balantas, inhabit these northern parts as well. They were studied in six villages in the Sector of Catió in their heartland Tombali in the South.

The rural communities all consisted of traditional subsistence farmers of rice, millet, and cassava who kept animals and fished in the salt-water estuaries or in the paddy fields. Village health units did not exist and children were not immunized. In all the areas, breast-feeding was prolonged beyond the child's first year; among the Balantas often it was prolonged into the fourth year. The weaning food was paps of rice or millet introduced around age 6 mo, earlier in the animistic and later in the muslim groups. Falciparum malaria is endemic with local and seasonal variations. It rains from the end of May through October, more in the South than in the North, where drought had been a problem in the past years.

The villages were chosen for representing major ethnical and ecological entities in the country and they constitute a *judgement sample.* Efforts were made to find all the children in the target-age group living in each community. The study identified 2228 children age 6–59 mo either in a field census or in the initial examination during the first half of 1979. Eight to 12 mo later they were classified as reexamined, dead, moved, or temporarily away (**Table 1**). The 20% who were not examined were children on journeys with their mothers. The travelling pattern of the women in the dry season is a feature of traditional life and probably is largely unrelated to child health. On the other hand, moving away often followed the death of a child.

The procedures followed by the study team were ethically approved by the sponsoring agencies.

Dependent variable

The number of days of follow-up were computed for each child (8). When only the month of birth, death, or movement was known, day 15 of that month was used as an approximation. In all, 20 306 child-months (child-days/30) were covered by the study, 17 201 of them pertaining to children who were weighed and measured on entering. One hundred and nine deaths (80 in Bandim and 29 in the rural areas combined) occurred in the latter group. The over-all death rates among the examined and the nonexamined children were thus 109/17201 = 0.0063 and 0.0055/child-month, respectively (**Table 2**). The death rate was higher in Bandim due to the measles epidemic. Anthropometric nutritional status (WFA) was slightly better there than in the rural areas. Considering only these areas, the death rate for dry season months was 0.0038 and for the rainy season 0.0044 (15 and 19 deaths, respectively).

Examinations

Standard techniques were used for measuring weight, length, and height (9). The improvisations applied for measuring standing height and the method of determining ages were described elsewhere (7). Remeasuring during the same session was used to maintain accuracy and standardization between examination sites was achieved by measuring a team member. For children who did not attend the re-examination, follow-up status was determined by an interview with a knowledgeable household member or close neighbor. This procedure and the lay reporting of deaths was found reliable from continued registration and other criteria (8). In connection with the examinations, the mother or other attendant was briefly interviewed on the child's health and related issues (ie, diarrhea, breast-feeding, supplementary food, parity, number of children in household) according to a pre-tested form.

Analysis

For an exploratory multivariate analysis, we used Cox's regression model (10) in the form of the PHGLM program (11). This program was also used to plot survival curves over follow-up time for groups defined by nutritional status intervals while adjusting for the child's age at the outset and for the study area. The assumption of proportional hazards was thus found justified. For the presentation of the results, we choose to plot survival over age for each subcategory (j) of the child's initial nutritional

TABLE 2
Death rate* for all identified children and nutritional status of those examined, by area

Area	Follow-up period	All children: n	All children: Death rate	Examined children only: n	Weight/age†: Mean	Weight/age†: SD	Death rate
Urban							
Bandim	Jan–Jan	1134	0.76	887‡	90	11	0.82
Rural							
Oio	Jun–Feb	373	0.43	316	81	11	0.44
Cacheu	Jul–Apr	326	0.42	287	85	10	0.30
Tombali	Apr–Mar	395	0.39	266	86	10	0.43

* Per 100 child-months of follow-up.
† Weight expressed as a percentage of the median value for the child's age and sex in NCHS/CDC reference material (6).
‡ Nine hundred children aged 6–59 mo children were weighed. Thirteen lacked height measurement.

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TABLE 3
Mortality as given by levels of indicator variable and time period after examination

Indicator	Child-years followed	Deaths	Death rate* < 3 mo	3 to < 6 mo	6–12 mo	Whole follow-up
Weight-for-age†						
< 75	2 128	17	0.84	1.50	(0.13)‡	0.80
75–84	5 216	39	0.66	1.09	0.56	0.75
85–	9 857	53	0.34	0.84	0.48	0.54
Height-for-age†						
< 90	2 112	10	(0.44)	0.75	(0.26)	0.47
90–94	5 353	44	0.64	1.38	0.54	0.82
95–	9 736	55	0.45	0.84	0.46	0.56
Weight-for-height†						
< 85	1 842	17	0.84	1.25	0.73	0.92
85–89	2 855	17	0.66	0.93	(0.28)	0.59
90–	12 504	75	0.42	0.98	0.47	0.60
Age at entering study (mo)						
6–23	6 276	65	0.98	1.61	0.67	1.04
24–35	3 636	26	(0.36)	1.33	0.54	0.72
36–59	7 289	18	(0.18)	0.33	0.24	0.25

* Deaths per 100 child-months of follow-up.
† Percent of NCHS/CDC median value for age and sex (6).
‡ Parentheses indicate value is from fewer than five deaths.

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status by use of the current life-table technique. The probability of survival (p) through the i:th age interval was calculated from

$$p_{ij} = \exp(-D_{ij}n_i/P_{ij}) \quad (1)$$

where D is number of deaths, n is length of age interval, and P is number of child-days followed. The estimated proportion of survivors (l) to the end of the i:th age interval in the j:th nutritional status subcategory is hence

$$l_{ij} = \prod_{1}^{i} p_{ij} \quad (2)$$

Results

Table 3 relates the death rate to levels of nutritional status in the initial examination. With the number of follow-up months as the denominator for each interval, one rate has been computed for the first 3 mo of the follow-up, one for the 4th–6th mo and one for the remaining 6 mo. For WFA and WFH, a higher death rate seems associated with subnormality. The gradient in terms of death rate is greatest in the beginning of the follow-up period. The corresponding tabulation of age at entering the study, however, shows the same pattern, making this an obvious confounding variable. The higher death rate and the better nutritional status in Bandim also confound this bivariate analysis (Table 3).

Controlling for these effects by means of blocking (11) over the areas (Bandim and rural, respectively) the multivariate analysis showed that age on entering the study was the supreme determinant of survival. Keeping age under control by means of entering it into the model, we found the following: *1*) HFA had a significant statistical effect on survival in the expected direction ($p = 0.03$). *2*) A corresponding tendency for WFH was not statistically significant ($p = 0.12$). *3*) Considering only measles death in Bandim ($n = 49$) as the event variable, neither HFA nor WFH had any statistical effect (**Table 4**). For death from all causes other than measles, on the other hand, HFA was a significant discriminator ($n = 58$, $p = 0.02$). *4*) As regards the deaths from measles in Bandim, a large number of children in the household was associated with poor survival ($p = 0.04$) (Table 4).

The other independent variables did not contribute to explain time to death.

TABLE 4
Three models for the hazard of death from measles* ($n = 49$) in Bandim

Model	Explanatory variables	$\beta \pm$ standard error	Relative risk $= \exp(\beta)$	$p <$
I	Age	0.036 ± 0.011	0.96/mo	0.001
	Weight-for-height	0.010 ± 0.017		NS
II	Age	0.036 ± 0.011	0.96/mo	0.001
	Height-for-age	0.035 ± 0.034		NS
III	Age	0.038 ± 0.010	0.96/mo	0.001
	Number of children in the household	0.155 ± 0.075	1.17/child	0.05

* Multiple regression technique of Cox (10). Death from other causes treated as withdrawal from study.

The graphs (**Figs 1 and 2**) represent the estimated survival of imaginary groups of children (*synthetic cohorts*), each exposed to the observed age-specific and nutritional-status-specific death rates from all causes. No adjustment is made for the effect of area as referred to above. As concerns WFH > and < 90% of the reference median value (Fig 1), the difference between the two survival curves stems mostly from the first age interval (6–11 mo, 11 deaths recorded). The graphs representing HFA > and < 95% (Fig 2) diverge steadily, at least up to age 36 mo. On average, a 6-mo old who remained < 95% of reference HFA would run a 44% risk of dying before age 48 mo whereas the risk for a child > 95% would be 26%. This difference would be due to the nonmeasles rather than to the measles mortality. The lower survival probability of the relatively short children is in apparent contrast to the mortality rates in Table 3.

Discussion

The relationship between anthropometric nutritional status and subsequent mortality in groups of young children in one urban and three rural areas in Guinea-Bissau were studied using a multivariate technique. The most important heterogeneities could thus be kept under control. The analysis revealed an association between a comparatively low height-for-age and subsequent mortality which was entirely hidden in the bivariate presentation (Table 3). For diverse reasons, young age was connected to good nutritional status and with high mortality. Hence, age confounds the bivariate presentation in Table 3 and this explains the seeming inconsistency with the results of the multivariate analysis.

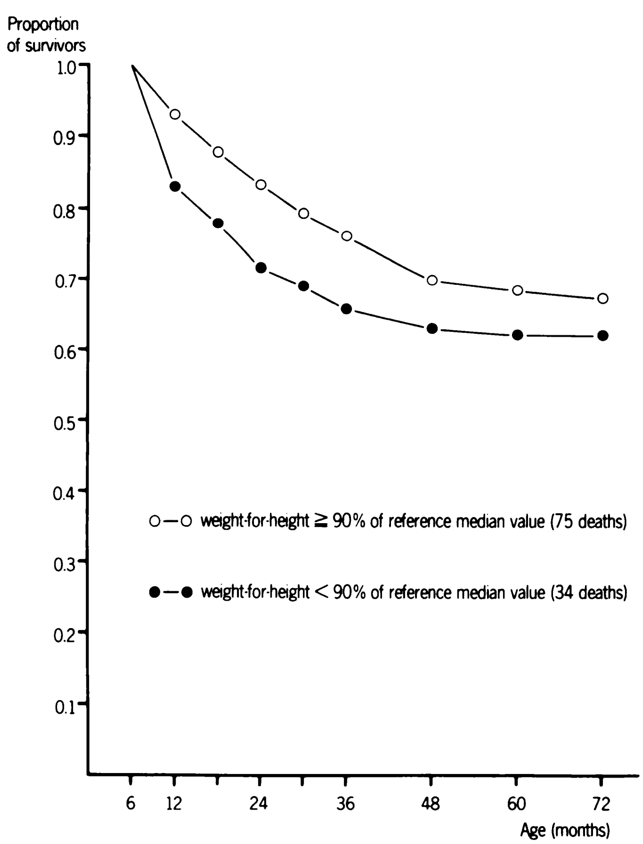

FIG 1. Estimated proportion of survivors among children > and < 90% of reference weight-for-height.

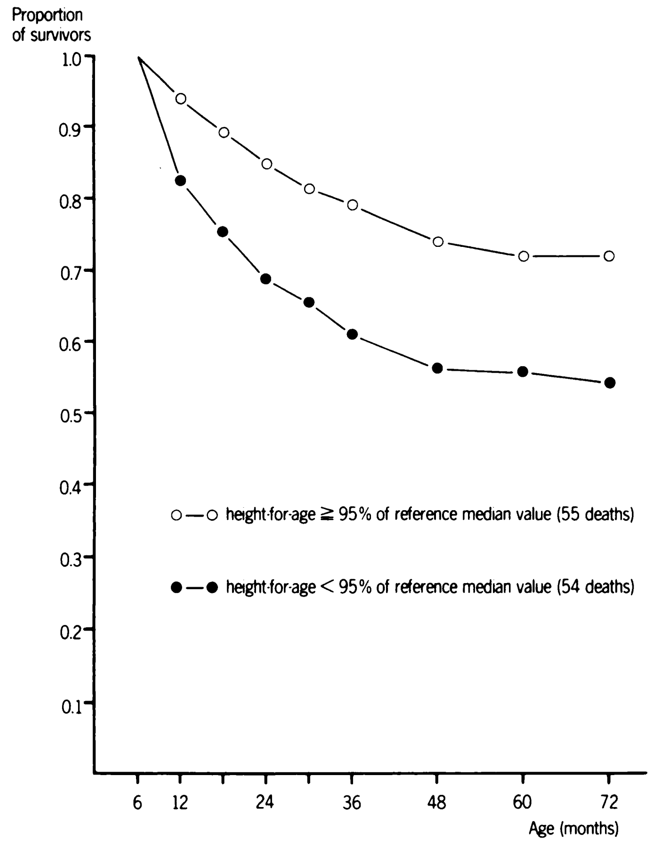

FIG 2. Estimated proportion of survivors among children > and < 95% of reference height-for-age.

The survival curves (Figs 1 and 2) level out at about age 48 mo (which corresponds to 36 mo at the beginning of the study). This makes the children < 3 y the priority group for growth monitoring rather than those < 5 y.

The discriminatory power of anthropometry in this study was less than that reported from the Punjab (2) and Bangladesh (1, 3) but greater than in Kasongo, Zaire (4). Kielman and McCord (2) also used a life-table technique and age is unlikely to have any hidden influence on their results. Chen et al (3), on the other hand, present their findings in a manner similar to our Table 3, but the study group had a narrow age-range with all the children being in their second year at the beginning of the follow-up; age could still have a confounding effect but it should be minor. The Kasongo team in Zaire (4) found no association between nutritional status and subsequent mortality in their large and well-controlled data material. The data

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include ages 6 mo–4 y but the presentation does not account for age differences. The better nutritional status of the African children is likely to make its impact on survival smaller there than in the Asian samples.

Our findings seem to contradict the existence of a threshold of nutritional status, above which any observed difference would be without serious functional consequences (3). However, the severity of past malnutrition mirrored in a certain level of subnormal HFA depends on age. Severely deficient nutriture will compromise linear growth at younger ages than will a mild deficiency (12). Both pairs of survival curves (Figs 1 and 2) fit in with serious malnutrition at an early age being especially consequential for mortality.

We found a significant discriminatory effect on survival from nutriture in the past but not from actual nutritional status. This points to long-term causes of high mortality being active in a West African environment just as in the previously studied South Asian settings (5). Aaby et al (13) demonstrated the importance of ethnic affiliation for death from measles in Bandim. The ethnic group most at risk there was not studied in the rural setting. Thus, we cannot separate the effects of area and ethnic group in this analysis. Such limitations, as well as others mentioned above, may explain the absence of a statistical impact by ethnic group. We observed different growth patterns in the different ethnic groups (14), but these patterns are more likely to reflect social factors than genetic differences. The same determinants could influence mortality independently of nutritional status. Such factors could be, for example, household hygiene, crowding, patterns of breast-feeding, and care in illness, all with an impact on the exposure or resistance to infections. The statistical effect of the number of children in the household on measles mortality and the absence of any important influence from nutritional status (Table 4) can be interpreted in this way.

Data were collected by members of an interdisciplinary team: Jette Bukh, Peter Aaby (anthropology), Arjon Smits (nutrition), and Lars Smedman (pediatrics) in collaboration with Joaquim Gomes, Mariano Soares da Gama, Fransisco Indi, Manuel Fernandes, Flora Có, Maria-Rosa Fernandes, and Juana Lopes. We gratefully acknowledge the advice of John Carstensen on the use of the PHGLM program.

References

1. Sommer AS, Loewenstein MS. Nutritional status and mortality: a prospective validation of the QUAC stick. Am J Clin Nutr 1975;28:287–92.
2. Kielmann AA, McCord C. Weight-for-age as an index of risk of death in children. Lancet 1978;ii:1247–50.
3. Chen LC, Chowdhury A, Huffman SL. Anthropometric assessment of energy-protein malnutrition and subsequent risk of mortality among preschool-aged children. Am J Clin Nutr 1980;33:1836–45.
4. The Kasongo Project Team. Anthropometric assessment of young children's nutritional status as an indicator of subsequent risk of dying. J Trop Pediatr 1983;29:69–75.
5. Bairagi R, Chowdhury MK, Kim YJ, Curlin GTC. Alternative anthropometric indicators of mortality. Am J Clin Nutr 1985;42:296–306.
6. World Health Organization. Measuring change in nutritional status. Geneva: WHO, 1983.
7. Smedman L, Lindeberg A, Jeppsson O, Zetterström R. Nutritional status and measles: a community study in Guinea-Bissau. Ann Trop Paediatr 1983;3:169–76.
8. Smedman L, Aaby P, Lindeberg A, Zetterström R. Survival 0–6 years of age in a periurban area in Guinea-Bissau—a longitudinal assessment. Ann Trop Paediatr 1986;6:67–72.
9. Jelliffe DB. The assessment of the nutritional status of the community. Geneva: WHO, 1966.
10. Lee ET. Statistical methods for survival data analysis. Belmont: Lifetime Learning Publications, 1980.
11. Harrel FE Jr. The PHGLM procedure. In: SAS Institute. Supplemental library user's guide. Cary, NC: SAS Institute Inc, 1983:267–94.
12. Soysa PE, Waterlow JC. Stunting and the prevalence of malnutrition. Lancet 1981;i:1430.
13. Aaby P, Bukh J, Lisse IM, Smits AJ. Measles mortality, state of nutrition and family structure: a community study from Guinea-Bissau. J Infect Dis 1983;147:693–701.
14. Smedman L. The survival and growth of the children: a community study in Guinea-Bissau. Stockholm: Karolinska Institutet, 1986.

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