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Contents

Comparison of food-frequency and 24-hour-recall instruments for estimating vitamin A intake

Lilian Portocarrero, Julieta Quan de Serrano, Carmen Yolanda Lopez, Elien de Zepeda, Alejandrina Vasquez, Jesus Bulux, and Noel W. Solomons

Abstract

The purpose of the study was to compare the 24-hour-recall method with the seven-day food-frequency questionnaire to estimate the dietary intake of vitamin A. Thirty-three women from a peri-urban neighbourhood in Guatemala City were interviewed using both methods with a seven-day interval. The reproducibility of the results was analysed at both the individual and group levels. The 24-hour-recall method gave consistently higher average values for vitamin A intake, but the median was higher with the frequency method. The correlation coefficients between the repeated interviews were $r = .49$ for food frequency and $r = -.07$ for 24-hour recalls. Diagnostic classification with the two methods was in good agreement at the 750-retinol-equivalents cut-off criterion for adequacy of vitamin A intake, but fell progressively as sequentially lower cut-offs were applied.

Introduction

Guatemala is a country with a long history of hypovitaminosis A [1–3]. For that reason, there is an interest in defining the population's intake of vitamin A. Two of the various approaches to this are the 24-hour-recall method and the food-frequency questionnaire. On a population basis, it is accepted that both can provide a reasonable estimate of central tendency (i.e., mean, median) and of variance (i.e., standard deviation, range) [4–6], but there is serious concern about their ability to provide a reliable estimate for the individual [7, 8]. Dietary intake is not constant from day to day, making a single 24-hour recall subject to being unreliable and non-representative of the person's long-term consumption [7, 8]. In theory, food-frequency assessment would encompass more dietary experience, and its average, expressed on a per day basis, should provide a more stable estimate. In a recent dietary survey conducted in a peri-urban neighbourhood of Guatemala City, we examined the within-individual and inter-method reproducibility of estimates of vitamin A intake, which is believed to be the most variable of all nutrient intakes [9–12].

The authors are affiliated with the Center for Studies of Sensory Impairment, Aging and Metabolism (CeSSIAM), the research centre of the National Committee for the Blind and Deaf of Guatemala, in Guatemala City, Guatemala.

Population and methods

Population

This research was part of a larger inquiry into dietary vitamin A intake, intestinal parasitosis, biochemical indices of vitamin A status, and haematology of pregnant women in the low-income, marginal, peri-urban settlement of Guajitos on the southern edge of Guatemala City. The control group consisted of 46 non-pregnant neighbours, 14–69 years old. All the women spoke Spanish, and their literacy rate was about 77%.

Food-frequency estimate of vitamin A–rich food

The intake of vitamin A from foods rich in this nutrient over the previous seven days was estimated using a food-frequency questionnaire [13]. This instrument listed 39 food and beverage items from the Guatemalan urban diet, and the subjects were asked how many servings of each item they had consumed in the last seven days. These were converted into standard portions and the corresponding value for vitamin A activity, expressed in retinol equivalents (RE), using the Food Composition Tables for Use in Latin America [14] and Central American food tables [15]. A seven-day tabulation of vitamin A intake was derived, and this was divided by 7 to provide an estimate of average daily intake.

24-hour-recall estimate of vitamin A intake

A history of intake of all foods and beverages consumed at meals and snacks in the previous 24 hours was elicited. The field team consisted of two research nutritionists and two research physicians who were trained in the procedure. The recall began with the last meal consumed and proceeded backwards for 24 hours. An estimate of portion sizes in common household measures was requested, and actual recipes were recorded for complex foods such as soups, stews, and casseroles. Portion sizes were converted to volumes and weights in grams and then into multiples of standard units. The corresponding values for vitamin A activity, expressed in RE, from the same food composition tables [14, 15] were applied to portion sizes.

Field procedures

The interviews were conducted from September to November 1987. Our intention was to apply both instruments to a given subject on the first day of study, and then again seven days later. This would have generated two 24-hour recalls and two food-frequency estimates at a seven-day interval. In practice, it was possible to obtain the full complement of data from only 33 subjects. The same research interviewer worked with the same subject throughout the study.

Data analysis

Descriptive statistics—arithmetic means, standard deviations, medians, and ranges—were calculated.

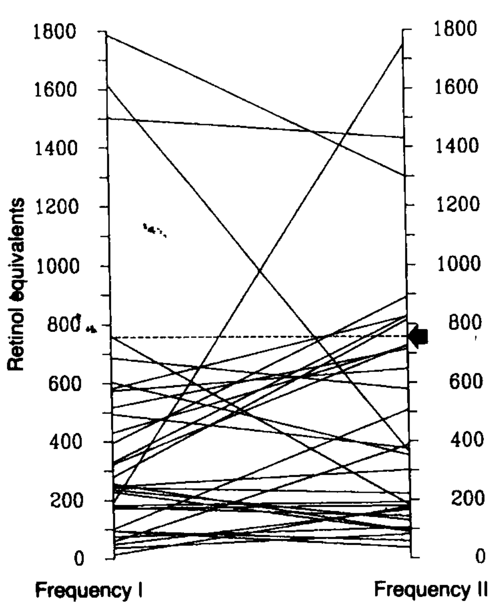

FIG. 1. Estimates of vitamin A intake using the food-frequency instrument ($N = 33$)

The estimates for each individual resulting from the two food-frequency interviews and the two 24-hour recalls were compared on correlation scattergrams, with the results from the first day on the x axis and those from the second day on the y axis. The same-day pairings of the results from the two instruments were similarly compared with each other, with the food-frequency estimates on the x axis and the 24-hour-recall estimates on the y axis. Pearson's product-moment linear regression analyses were performed on the paired within-individual and inter-method data.

Two-by-two contingency tables for the correspondence of diagnostic classification were constructed relative to three assumptions of adequacy: (1) at 100% of the WHO recommended vitamin A intake [16] for adults (750 RE), (2) at 67% of the recommendation (500 RE), and (3) at 50% of the recommendation (375 RE).

Results

Within-individual test-retest reproducibility (precision)

Food-frequency estimates

Figure 1 shows the intakes of vitamin A as estimated using the food-frequency instrument. The mean for the 33 estimates on the first occasion was 413 ± 446 RE, the median was 274 RE, and the range was 13–1,787 RE. For the second occasion these were respectively 480 ± 420 RE, 351 RE, and 38–1,748 RE. From the first assessment to the second, 17 individuals (52%) reported a greater than 10% increment of vitamin A intake, 12 (36%) reported a decrement of over 10%, and 4 (12%) remained within ±10% of their original estimate. The maximum increase was seen in a subject whose estimated intake rose by 93% from one week to next.

The maximum decrease was a reduction of 78% over seven days. The correlation coefficient for the two frequency estimates was $r = .49$. On the basis of the results obtained in the first interview, it would have been possible to predict only 23% of the variation in the results of the second interview (fig. 2).

The two-by-two tables for the reproducibility of the diagnostic classification at the three assumptions of adequacy in relation to the 1967 WHO/FAO recommended levels [16] are shown in figure 3 for the first and second estimates using food frequency. Twenty-six individuals (79%) were classified twice in the same category at the 750-RE cut-off criterion.

24-hour recall estimates

Figure 4 shows the estimates of vitamin A intakes from the 24-hour recalls. The mean estimate for the 33 recalls on the first of two occasions was 507 ± 1,609

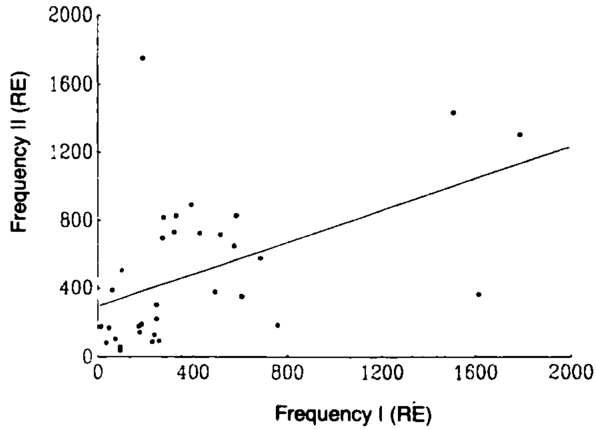

FIG. 2. Correlation coefficient for the two food-frequency estimates ($r = .49$; $y = 294.65 + 0.47\,x$; $N = 33$)

frequency II \ frequency I	≥750	<750
≥750	2	5
<750	2	24

frequency II \ frequency I	≥500	<500
≥500	6	8
<500	3	16

frequency II \ frequency I	≥375	<375
≥375	9	7
<375	3	14

recall II \ recall I	≥750	<750
≥750	0	2
<750	3	28

recall II \ recall I	≥500	<500
≥500	0	5
<500	7	21

recall II \ recall I	≥375	<375
≥375	0	6
<375	10	17

recall \ frequency	≥750	<750
≥750	4	1
<750	8	53

recall \ frequency	≥500	<500
≥500	9	3
<500	13	41

recall \ frequency	≥375	<375
≥375	10	7
<375	17	32

FIG. 3. Reproducibility of the diagnostic classification at three assumptions of adequacy (750 RE, 500 RE, and 375 RE)

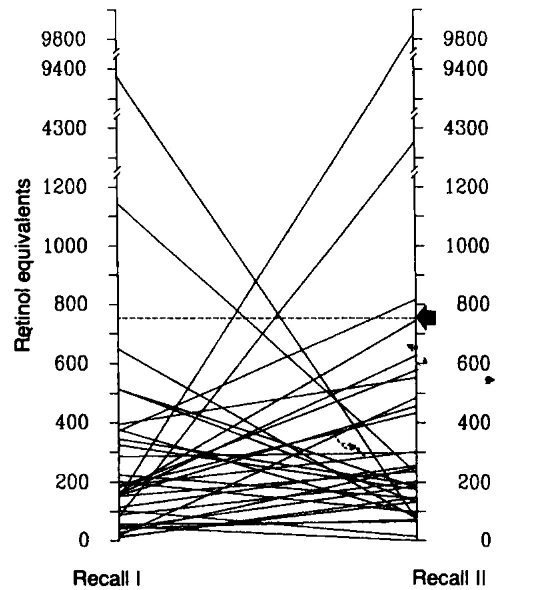

FIG. 4. Estimates of vitamin A intake using the 24-hour-recall instrument ($N = 33$)

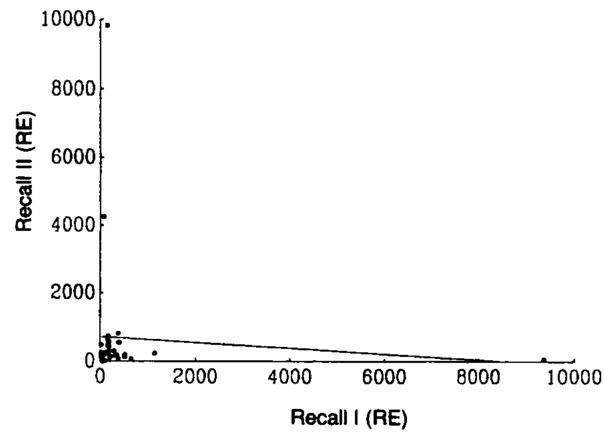

FIG. 5. Correlation coefficient for the two 24-hour-recall estimates ($r = -.07$; $y = 718.83 - 0.08\,x$; $N = 33$)

RE, with a median of 165 RE and a range of 11–9,376 RE. For the second occasion these were respectively 677 ± 1,794 RE, 240 RE, and 0–9,818 RE. Twenty subjects (61%) had an increment of 10% or greater, 12 (36%) had a decrement of 10% or greater, and 1 had a change within ±10%. The maximum increase was 98% and the maximum decrease 100% at the second recall.

Figure 5 shows the correlation of the first and second 24-hour results. The correlation coefficient was −.07. The value for the coefficient of determination, r^2, indicated that data obtained on one day's food consumption by the recall method have limited value in predicting the intake values on another day.

With the two-by-two analysis for diagnostic classification at various levels of intake adequacy with 24-hour recall, 28 (85%) of the individuals were classified twice in the same category at the 750-RE cut-off; this fell progressively at the 500-RE and 375-RE cut-offs.

Inter-method correspondence

The individual relationship between the 24-hour recall and the food-frequency questionnaire for the same participant on the same day was evaluated as shown in figure 6. The mean estimate of vitamin A intake from 66 of the 24-hour recalls was 592 ± 1,693 RE, compared to 450 ± 431 RE for the food-

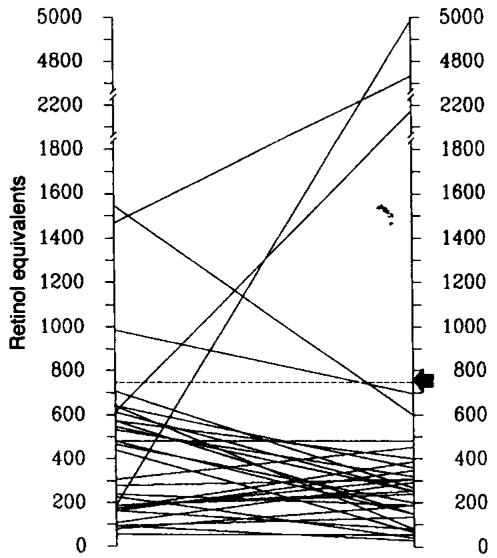

FIG. 6. Estimates of vitamin A intake using the 24-hour-recall and food-frequency instruments ($N = 33$)

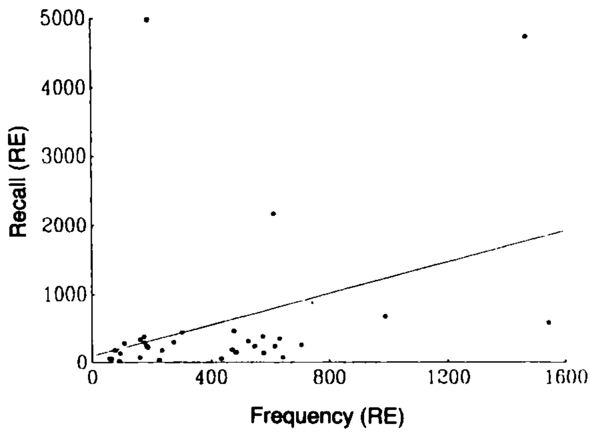

FIG. 7. Correlation coefficient for the food-frequency and 24-hour-recall estimates ($r = .36$; $y = 106.36 + 1.13\ x$; $N = 33$)

frequency questionnaire. The respective medians of intake were 187 RE and 291 RE. In 25 (38%) of the 66 pairs of interviews, the 24-hour-recall value was higher than that derived from the food-frequency method; it was over 10% higher in 24 pairs of interviews (36%). In one subject the 24-hour recall estimated a value 85% higher than that calculated from the corresponding food-frequency questionnaire on the first occasion.

The food-frequency value was the higher of the two; in 39 women (59%) it was 10% or more higher than the corresponding 24-hour estimate. In one subject the estimated intake obtained using the food-frequency method was 100% greater than that obtained using the 24-hour recall. The crude correlation coefficient for the correspondence of the two methods was .36 (fig. 7), but this improved to .58 when the three major outlying data pairs were eliminated from the regression. On the basis of the results obtained by the food-frequency interviews, it would have been possible to predict 34% of the variation in the results of the 24-hour interviews with the optimized data set (eliminating outliers).

Discussion

As both of the methods used in this study involve recall of dietary intake and can be performed in a relatively short period of time, they represent practical options for field survey work. At the level of description of a population both approaches provide about equally accurate estimates. Madden et al. [4], Gersovitz et al. [6], and others have showed clear relationships between reported and weighed group mean values. Hankin et al. [17] found that group mean values do not vary significantly from day to day. Young et al. [5] compared a 24-hour recall with the average value from a seven-day dietary-intake record recorded by the subjects. They found that the group means given by the two methods were "interchangeable" if the number of subjects was greater than 50. Without having a true gold standard for dietary intake, we cannot address this issue with our data. It is comforting, however, that the median estimates derived from both techniques were fairly consistent.

It is at the individual level that the day-to-day variation in dietary intake reduces the representativeness of short-term estimates of consumption. Much has been written about the need for several 24-hour-recall estimates to provide stable averages for individuals [8, 9, 11, 18]. Theoretically, food-frequency data for seven days would smooth out some of the peaks and valleys of each day's variation in intake. If the week during which the interview is conducted is representative of long-term intake, the average from a seven-day food-frequency interview should be more stable. Data sets based on observations covering several days will present less bias in the estimate of centiles, or of prevalences of high or low intake, than data sets based on a single day's observations [8].

A partial test of this notion examined the degree of correspondence between the first and second weeks in our food-frequency test-retest reproducibility format. The correlation coefficient was of a high order ($r = .48$), statistically significant with 33 pairs of data, and suggestive of stability for the seven-day interval. However, the correlation between two 24-hour-recall estimates in the same individual is much lower

($r = -.07$) than for food frequency, which confirms the hierarchical nature of stabilities.

Poor correspondence in the case of the 24-hour-recall method is not unexpected in view of the high day-to-day variation. Food intake data on a single day are of limited value in predicting the intake on another day [9, 11]. Adelson [19] interviewed 39 men, who provided records for two consecutive weeks, and concluded that the most substantial differences of nutritive content of food were in vitamin A and ascorbic acid. Anderson et al. [20] pointed out that three to seven days of observations would provide a reasonable picture of the distribution of usual intakes for many nutrients, but for some nutrients with large day-to-day variations, such as vitamin A, many more days of observation would be required before reliable estimates of the distributions could be obtained.

It is one thing to reproduce with accuracy the same numerical value with the same survey instrument, and another to assign the same diagnostic classification in a system of binary assignment of adequate or inadequate. In terms of their ability to classify the same individuals twice in the same adequacy category, the two methods, frequency and recall, had a reasonable concordance at the 750-RE cut-off criterion. With the food-frequency interview 26 individuals (79%) were classified twice in the same category, and 28 (85%) with the 24-hour recall; but this fell progressively as sequentially lower cut-offs were applied.

It was also our intention to determine how well the 24-hour recall corresponded to the simultaneous food-frequency estimate. The inter-method coefficient between the two instruments, adjusted to remove gross outliers, was .58, and the correspondence of diagnostic classification was 94% of the individuals classified twice in the same category at the 750-RE cut-off criterion.

The design of this study allowed us to evaluate the use of standard dietary survey instruments under real field conditions in the same individuals simultaneously. Even though we were dealing with the estimation of vitamin A intake, reputedly the single most difficult nutrient to estimate in a precise manner [9–12], the expected hierarchical relationships of stability were confirmed. Moreover, we were able to put quantitative numbers on the strength of the correspondence between the two methods for correlations and binary discrimination.

Given the moderate to poor test-retest reproducibility of the instruments in the same individual, the most important conclusions would be to avoid use of the 24-hour recall, and to exercise caution in seeking to explore biological associations using the estimate of vitamin A from a single seven-day food-frequency questionnaire as the individual value [21].

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Nutrition status and the risk of mortality in children 6–36 months old in Tanzania

Olivia Yambi, Michael C. Latham, Jean-Pierre Habicht, and Jere D. Haas

Abstract

Anthropometric measurements were taken on 2,452 children between 6 and 36 months of age at baseline and at two-month intervals thereafter in rural Tanzania. The children were followed for one year. All deaths occurring in this group were recorded using a village registration system introduced as part of a village nutrition status monitoring system. The relationship between the anthropometric indicators (weight for age, height for age, and weight for height, as well as weight increment) and subsequent mortality was assessed. The results indicate that over the one-year period, nutrition status was a significant predictor of mortality, with the probability of survival lower in children of low nutrition status. Low weight for age (<60% of the standard) was associated with a ninefold increase in risk compared to weight for age above 80%; low weight for height (<80%) carried an almost fourfold increase in risk compared to weight for height>90%; and low height for age had a twofold increase in risk compared to the normal categories. An overall linear relationship was found between nutrition status and mortality, suggesting a gradual increase in mortality as nutrition status deteriorates. Incremental weight appears to be a good short-term predicator of mortality.

Introduction

The relationship between anthropometric indicators of nutrition status and subsequent mortality has been documented in hospitalized children [1] and in free-living population groups [2, 3].

Studies in the Indian subcontinent have reported both a linear increase in risk and a threshold phenomenon, indicating an increase in risk only when nutrition status had deteriorated to very low levels [3, 4]. This has raised questions as to the type of risk associated with mild to moderate malnutrition. In Africa, one group found no relationship between anthropometric indicators and mortality [5], raising the question of geographical and cultural specificity in the predictive ability of anthropometric indicators. Subsequent studies in Africa, in Guinea-Bissau and Malawi, reported an increased risk of mortality with poorer nutrition status and demonstrated no threshold effect [6, 7]. The predictive ability of weight gain in terms of risk of death has been inconclusive, mainly because so little work has been done investigating this, but it has been suggested that this is a good short-term indicator [8].

Knowledge of the relationship between nutrition status and functional outcomes has both programmatic and policy implications. Our study was undertaken to contribute to this knowledge by assessing the discriminatory power of anthropometric indicators as predictive of mortality in the specific population studied. The results were intended to guide decisions and operational guidelines for nutrition programmes in Tanzania.

Subjects and methods

A longitudinal study with a one-year follow-up period was undertaken between November 1985 and January 1987. It was conducted in 16 villages in the Iringa region of Tanzania that met specified eligibility criteria and were already participating in a large nutrition programme. All children between the ages of 6 and 36 months at the time of first measurement were enrolled in the study on consent of village leaders and parents, resulting in a total of 2,452 children. The start of the investigation in January coincided with the middle of the rainy season (the long rains in the region started in November), when weeding of the fields was in progress.

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Data collection

Preliminary information on the villages was collected and preparations for the study were finalized during November–December 1985. Baseline measurements and data collection started in January 1986. Height, weight, and arm circumference were measured. Subsequently, weights were recorded every other month and heights were measured every four months, yielding a total of seven weight and four height measurements for each child surviving to the end of the follow-up. Each time the measurements were made, a two-week morbidity recall was undertaken by interviewing one parent, usually the mother. Other information collected included household characteristics, maternal histories, child feeding practices, and the survival status of children at each measurement.

Causes of death were determined by consulting the records of village health workers and reviewing information on the children's growth charts. At each contact the health of the children was discussed with their parents, nutrition and health advice was given, and, where warranted, appropriate actions were taken. The village health workers made household visits to check on the status of children as part of the regular programme implementation.

All anthropometric measurements were taken by the principal investigator and one other trained nutritionist; interviewing for morbidity was done by a trained medical assistant; and other information was collected by two other members of the team throughout the duration of the study.

Data analysis

All statistical analyses were done using the SAS and BMDP packages on the Cornell University IBM mainframe computer. As the actual dates of birth of all children were obtained, the exact ages of the children at the time of each measurement were calculated using the appropriate SAS programme. Distribution characteristics of the main dependent variables were checked for normality. The WHO/NCHS reference standards [8, 9] were used to convert anthropometric measurements into indicators for weight for age, height for age, and weight for height. Both percentage of medians and Z-score values were used in the analysis.

The mean weight and length/height for each age in months were plotted on NCHS charts, separate for males and females, to identify the percentile ranks within which the children tracked compared to the reference standards.

Several statistical tests were chosen to assess the relationship between nutrition status and mortality. The *t* test for group means and the chi-square test with specific cut-off points as appropriate were used to test for differences between dead and surviving children. Relative-risk estimates were calculated for different nutrition-status categories. The Kaplan-Meir method was used to calculate the probability of survival at three-month intervals. The log-rank test was employed to test for differences in survival distribution across nutrition-status categories. Logistic regression was used for multivariate analysis where mortality was the outcome variable. The Cox regression procedure was selected for covariate analysis.

Results

Baseline characteristics

The 2,452 children in the study ranged in age from 6 to 36 months (mean 18.1 ± 6.9 months). Fifty-two percent were female and 48% male. The means of the anthropometric indicators for all the children at baseline expressed as percentage of standard and Z scores are shown in table 1. The greatest deficit in terms of standard deviations below NCHS standards was in height for age. The mean length/height was close to the NCHS fifth percentile up to 12 months of age, after which it fell below this. Moderate and severe stunting (<90% height for age) was found in 26.8% of the children and mild stunting (90%–95% height for age) in 49.1%. The mean weight was between the

TABLE 1. Mean anthropometric indicators at baseline

	Mean	SD	Median
Weight/age (%)	82.6	10.5	82.3
Height/age (%)	92.3	4.2	92.1
Weight/height (%)	95.6	9.2	95.2
Z weight/age	−1.7	1.0	−1.7
Z height/age	−2.1	1.1	−2.1
Z weight/height	−0.5	0.9	−0.5

TABLE 2. Mean weights for age (percentages of standard) at baseline and last assessment before death—by cause of death

		Weight for age	
	N	Baseline	Last assessment
Diarrhoea	46	73.6 ± 10.5	69.7 ± 11.5
Fever	30	79.3 ± 12.4	75.3 ± 19.6
Respiratory infection	7	72.8 ± 12.4	70.9 ± 9.0
Measles	3	85.4 ± 26 7	78.2 ± 29.6
Injury	1	104.0	—
Other	1	84.5	—

TABLE 3. Means of anthropometric indicators of dead and surviving children

	Dead ($N = 88$)	Alive ($N = 2,364$)	t statistic	p value
Weight/age (%)	76.3 ± 12.5	82.8 ± 10.4	−4.8	.0001
Height/age (%)	90.7 ± 4.9	92.3 ± 4.1	−3.0	.0034
Weight/height (%)	91.2 ± 11.3	95.7 ± 9.0	−3.8	.0003

NCHS fifth and twenty-fifth percentiles up to 12 months of age. Above that age it fell below the fifth percentile. About 1.3% of the children were severely underweight (<60% weight for age) and another 35.3% were between 60% and 80% weight for age. Severe wasting (<80% weight for height) was seen in 3.7% of the children; 21.7% were between 80% and 90% weight for height. Thus, overall, stunting was more common than wasting.

Mortality

Of the 2,452 children, 88 had died by the end of the follow-up period. This gives a mortality rate of 35.9 per 1,000 over the one year. Having obtained the dates of death, we were able to calculate the probability of survival at specified time intervals. Almost 80% of the deaths were recorded during the first six months after the baseline examination. Approximately 49% were in females and 51% in males, with gender-specific mortality rates of 33.8 and 38.1 per 1,000 respectively. The mean ages of children who died were 17.9 ± 6.9 months at baseline and 21.5 ± 7.5 months at the time of death. The largest proportion of deaths was recorded in the 12–18 month age group.

As anthropometric measurements were taken at two-month intervals, they were available to within a maximum of two months preceding death. The mean weight for age at baseline for the children who died was 76.3% ± 12.5%, and for the last assessment prior to death for this group it was 72.4% ± 12.6%. Almost all those who died showed a decline in nutrition status assessed by weight for age between measurements.

The majority of deaths were attributed to diarrhoea, followed by fever due to malaria, respiratory infections, measles, injury, and unspecified causes (table 2). Baseline weight for age was lowest in the group reported to have died from respiratory infections, followed by fever and measles.

Nutrition status and mortality

The means of the anthropometric indicators of nutrition status for children who died were significantly lower than those of survivors ($p < .05$) (table 3). Survival analysis showed significant differences by

TABLE 4. Mortality by nutritional-status category

Category[a]	N	Deaths (no.)	Failure rate	SE
Weight for age[b]				
≥75	1,894	48	0.0253	0.0036
60–74	525	33	0.0624	0.0106
<60	33	7	0.2121	0.0712
Height for age[c]				
≥95	592	17	0.0287	0.0069
90–94	1,203	27	0.0224	0.0043
85–89	569	39	0.0685	0.0100
<85	88	5	0.0568	0.0247
Weight for height[d]				
≥90	1,827	46	0.0252	0.0037
80–89	523	33	0.0619	0.0104
70–80	89	7	0.0787	0.0285
<70	3	2	0.6767	0.2722

a. Percentages of standards
b. Log-rank chi-square = 52.1 ($p < .0001$)
c. Log-rank chi-square = 25.96 ($p < .0001$).
d. Log-rank chi-square = 95.75 ($p < .0001$)

nutrition-status categories. Children who had greater weight deficit for age had a higher mortality rate than those with higher weight-for-age measurements (table 4). Comparable results were obtained using height-for-age and weight-for-height measurements.

Estimates of relative risk

Estimates of relative risk showed that children who were severely malnourished using the indicator of weight for age, with the cut-off points used in the analysis of Chen et al. [3], were eight times more likely to die than those categorized as "normal." When 80% weight for age is used (as is usual practice in growth-monitoring programmes), the risk for severely underweight compared to non-underweight children was approximately ninefold. Moderately and severely wasted children (weight for height <80%)) carried a risk about 2.5 times higher than those with 90% or greater weight for height. In the small group of children with severe stunting (<85% height for age;

TABLE 5. Estimates of relative risk of mortality, by nutritional-status category

Category[a]	Relative risk
Weight/age	
≥75	1
60–70	2.48
<60	8.38
Height/age	
≥95	1
90–94	0.78
85–89	2.39
<85	1.98
Weight/height	
≥90	1
80–89	2.46
<80	3.88

a. Percentages of standard.

TABLE 6. Ratio of mortality (per 1,000 over 12 months) between the lowest and highest 10% of children, by nutrition-status indicator

	Mortality rate		Ratio (lowest/ highest)
	Lowest 10%	Highest 10%	
Weight/age	102.4	20.4	5.0
Height/age	79.2	24.2	3.3
Weight/height	77.2	12.1	6.4

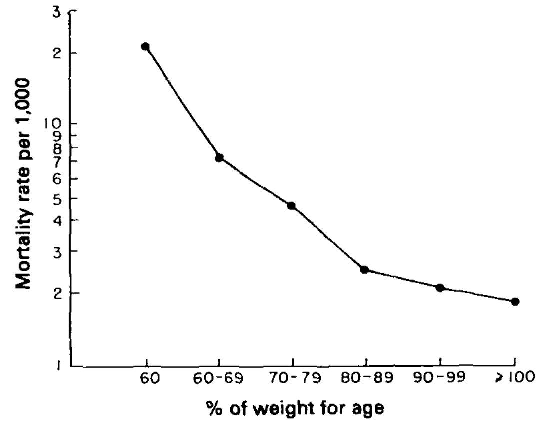

FIG. 1. Mortality rate by percentage of standard weight for age

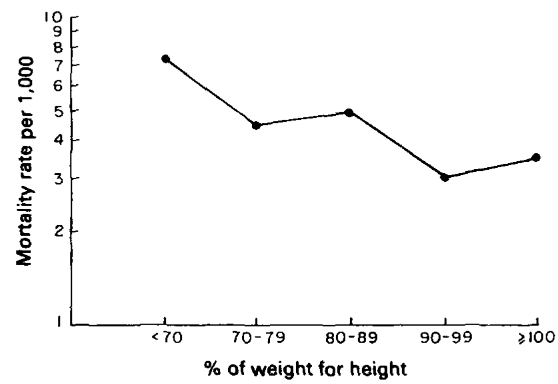

FIG. 2. Mortality rate by percentage of standard weight for height

$N = 88$) the relative risk of mortality is estimated as about 2. In the moderately stunted group (85%–89% height for age) the relative risk of death was 2.4 times that in the group with height for age 95% or greater. The results of relative risk estimates are summarized in table 5.

To take into account the different numbers of children in each of the nutrition-status categories in the estimation of risk, we compared the lowest and highest 10% in terms of mortality. The results, summarized in table 6, show ratios between the two groups ranging from 3.3 to 6.4.

Relationship between nutrition status and mortality

To identify the type of curve relating nutrition status and mortality, and to compare the results with those of earlier studies, we calculated the mortality rates for 10-percentage-point intervals for weight for age and weight for height and 5-percentage-point intervals for height for age.

Figure 1 shows that mortality increased as weight for age decreased, a relationship that was largely linear. Below 90% weight for age, mortality almost doubled for the next 10 percentage points, and it increased about 1.5 times between 70%–79% and 60%–69% weight for age. Below 60% median weight for age, the mortality rate was three times that of the category just above.

Weight for height showed an overall linear relationship to mortality without any threshold effect (fig. 2).

The results for height for age (fig. 3) show a U-shaped curve, with mortality rising above and below the category of 90%–94% height for age. These results may be explained by the very few deaths in the upper values of height for age and a possible effect of age. As more than 50% of the deaths were in children under 18 months of age, we examined the data in two age ranges, with 18 months as a cut-off point. It was in the younger group that the risk of death increased with increase in height for age. In analysis with age at baseline as a covariate when indicators of nutrition

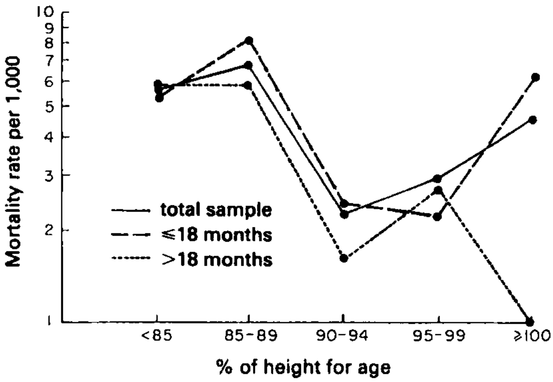

FIG. 3. Mortality rate by percentage of standard height for age

status were in the model, age did not show a significant relationship with mortality.

Incremental weight and mortality

Analysis of the relationship between weight increment and subsequent mortality was undertaken by calculating the weight increment between two successive weighings and comparing the values between dead and living children for each of the periods. For the first and second increment periods, children who died had significantly lower weight gain than those who survived (t statistic = −3.22 for the first period and −3.73 for the second period; $p < .05$). The results for subsequent periods were not significant.

The weight increment between any two adjacent measurements carries error associated with each measurement. Regressing the weight gain on attained weight at the beginning of the interval and controlling for the child's age showed the weight of the child at the beginning of the interval to be a significant predictor of subsequent weight gain. Regression analysis was used to predict mortality from the first period's weight gain with the weight of the child at baseline (weight t_1) and age as covariates. Controlling for the initial weight and age of the child, the weight increment was a significant predictor of mortality (beta = -1.743 ± 0.29; $p < .05$). Weight increment thus was a good short-term predictor of mortality. We could not carry out the regression analysis for subsequent periods due to the small number of deaths beyond the first few months of follow-up.

Discussion

This study confirmed earlier results indicating that malnutrition is associated with mortality. It contradicts findings of one study in Africa [5] that no such relationship exists, but those results may have been due to methodological problems, thus indicating that the relationship is not unique to certain population subgroups. The relationship observed was largely linear, and we could not demonstrate a threshold level above which nutrition status did not become a determinant of mortality in the anthropometric categories used. This finding differs from that of Chen et al. [3].

The fact that mortality was higher in all categories with deterioration of nutrition status has important implications for efforts to address nutrition problems. For example, only 1.3% of the children were severely underweight, whereas about 40% were moderately underweight. If indeed nutrition status is related to mortality among moderately malnourished children, this group also requires serious attention even if immediate efforts focus on those at greatest risk. The resources required to deal with the larger numbers of children will be higher. After controlling for biological characteristics and other factors not discussed here, poor nutrition status remains significantly associated with mortality. Therefore, programmes aimed at reducing mortality must include explicit efforts to reduce malnutrition and not just some by-product of other general activities.

Our finding of a U-shaped relationship between height for age and mortality raised questions about the adequacy of the sample size and possibly age confounding at different ends of the distribution. An analysis with age showed that this variable was not significantly related to mortality. The study in Guinea-Bissau showed similar aberrant results with an inverted U curve [6]. Since other analyses discussed here show significant association between height for age and mortality, the seemingly aberrant results have to be interpreted in conjunction with them.

Evaluation of indicators showed the benefits of weight for age and weight for height in predicting mortality. Even with the limitations of sample size, weight increment appeared as a significant indicator of risk of death. Whereas the choice of an indicator is eventually determined by the specific operational and programmatic conditions, our results suggest that weight for age is a useful indicator for purposes of risk assessment at the community level. This, combined with weight increment, should assist health workers and parents in identifying children requiring focused attention.

We observed that nutrition status can deteriorate rapidly. Given the attendant high risk of mortality, the frequency of contact in growth-monitoring and growth-promotion programmes may be crucial. Our data show that poor growth increments for the last two weighing periods preceding death were associated with a high risk of mortality. Given the ever increasing burden placed on workers in health institutions, trained village workers could provide continuous follow-up in the communities they serve.

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Determinants of community health workers' performance in India

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Abstract

Forty-three anganwadi *workers (community health workers) in Gujarat state, India, were interviewed to record their education level, evaluate their nutrition knowledge, and collect information on the number of visits made by the auxiliary nurse midwife (ANM) in the preceding three months and the activities she performed for the anganwadi. The coverage of five services delivered or assisted by the anganwadi worker—supplementary feeding, growth monitoring, vitamin A prophylaxis, health check-ups, and immunization—was estimated by interviewing the mothers of 3,987 children 0–6 years old. The anganwadi worker's having at least a high school education, a nutrition-knowledge score of more than 4 out of 7, more than one visit by the ANM in three months, and an ANM activity score of more than 2 out of 9 were significant determinants, individually or in combination, for the anganwadi worker's performance. Multiple regression analysis indicated that nutrition knowledge was the most powerful determinant of performance, followed by guidance from the ANM and education level. It is therefore concluded that anganwadi workers should receive nutrition health education and regular guidance from the ANMs, and their education level should be high school or above.*

Editor's note

It is often difficult for the editor and reviewers to judge whether a paper is of interest mainly to the nutrition and health professionals of the country from which it originates or is of potential value to persons in other countries and regions. The Bulletin *regularly returns articles, no matter how worthy, judged to be of mostly local interest. The following article at first reading appeared to be a description of a highly specific programme in India. However, the term "anganwadi worker" is simply the local name for the lowest level of community health worker—with equivalents in other countries, whether classified as volunteers (e.g. the* kaders *of Indonesia) or receiving some small allowance as in India. This paper describes three factors that most influence the performance of community health workers at this level (1) the adequacy of their training, (2) the adequacy of the supervisor, and (3) the level of their formal education. Rapid assessment surveys using anthropological methodologies* have revealed these same three principles in country after country. Too often the first and second are so poor that the third becomes almost irrelevant. This paper has been accepted, therefore, as a reminder of these principles in any nutrition and primary health activity.*

Introduction

The government of India launched the Integrated Child Development Services Scheme (ICDS) [1–3] on an experimental basis in various states of the country in October 1975. Since the impact of the programme was encouraging, it expanded from 33 projects initially to 1,952 by 1989 [4].

The *anganwadi* constitutes the basic institutional infrastructure through which the ICDS operates at the village level. Each anganwadi caters to a population of 1,000 in rural and urban areas and 700 in tribal areas.

The key functionary in the anganwadi is the anganwadi worker, the front-line individual who is expected to implement the programme at the village level. The success of the programme depends mainly on her per-

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* See Scrimshaw SCM, Hurtado E. Rapid assessment procedures for nutrition and primary health care: anthropological approaches to improving programme effectiveness. Los Angeles, Calif, USA: UCLA Latin American Center, 1987.

TABLE 1. Anganwadi workers' performance related to their education level

Services	< high school		≥ high school		Relative coverage
	Children (no.)	Coverage (%)	Children (no.)	Coverage (%)	
Supplementary nutrition	1,636	56.5	1,965	59.6	1.1
Growth monitoring	1,782	22.8	2,161	22.3	1.0
Vitamin A prophylaxis	1,482	11.3	1,787	13.6	1.2
Health check-ups	1,796	13.1	2,166	17.4	1.4*
Immunization	751	13.7	832	19.0	1.5*

*$P < .01$.

formance. As the anganwadi worker is the key person for the development of the community through her performance at the anganwadi, the present study attempts to explore the determinants of her performance.

Performance was evaluated in terms of the proportion of children (0–72 months old) covered for five services: supplementary nutrition, growth monitoring, vitamin A prophylaxis, health check-ups, and immunization. The determinants studied were the worker's education level, her knowledge of nutrition, and the guidance or assistance she received from the auxiliary nurse midwife.

Methods and materials

Three to seven villages were sampled at random from each of 11 blocks (subdistrict administrative units) in the Panchmahals district of Gujarat state. All the houses in a village were covered in census fashion. Data were collected with the help of a pretested questionnaire by teams of investigators working in pairs, consisting of a medical intern and a nutritionist–social scientist.

Data on performance

The coverage for each of the five services was recorded by interviewing the mothers of the children in each anganwadi area.

Data on determinants of performance

The anganwadi worker's education level was categorized as either less than high school, or high school or above.

Her nutrition knowledge was assessed on the basis of her responses to a set of seven questions relating to nutrition and health (covering weaning age, feeding frequency, diet during diarrhoea, causes of malnutrition, treatment of malnutrition, growth-chart knowledge, and preparation of oral-rehydration solution), with one point given for each correct answer, and was categorized as scoring either 4 or less, or more than 4.

The worker was asked the number of visits made by the auxiliary nurse midwife (ANM) to her anganwadi in the past three months, and the response was categorized as either one visit or less, or more than one visit.

She was also asked about the kind of guidance the ANM provided through helping to perform various activities during her visits. This guidance was assessed on the basis of nine possible activities (immunization, weighing children and nutrition gradation, health check-ups, vitamin A distribution, iron–folic acid distribution, home visits, nutrition, family planning and health education, referrals, and treatment of primary ailments), with one point given for each, and was categorized as scoring either 2 or less, or more than 2.

Statistical analysis

Multiple regression analysis, using the Statistical Package for Social Sciences (SPSS/PC) [5], was done to find out which determinants had the greatest influence on the anganwadi workers' performance.

Results

Where the anganwadi worker had at least a high-school-level education, a significantly larger proportion of children received health check-ups and immunizations than in areas where the worker had less than a high school education (table 1).

A positive association was observed between the anganwadi worker's nutrition knowledge and her performance (table 2). Significantly more children