Testing Indicators for Use in Monitoring Interventions to Improve Women's Nutritional Status

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Summary

The Reproductive Health Indicators Working Group of the Evaluation Project developed a series of indicators for the evaluation of reproductive health programs. We examined a subset of indicators of women's nutritional status using data from the Cebu Longitudinal Health and Nutrition Survey (CLHNS). The CLHNS is an ongoing community based study of more than 2,200 mothers in Metro Cebu, the second largest and most rapidly growing area of the Philippines.

Our analysis had a focus on intermediate and long term outcomes of undernutrition, including meal patterns and consumption of vitamin A rich foods, low birth weight (LBW) and a range of anthropometric indicators of nutritional status. We present prevalence of each indicator in the Cebu cohort at selected points in time, assess the degree to which each indicator adequately characterizes nutritional risk, determine the degree to which different nutritional indicators lead us to the same conclusions about health or nutritional status, and assess how the prevalence of indicators changes over time as women age. Results are summarized for each of the selected indicators.

Percentage of women who consume vitamin A-rich foods

Virtually all of the women in the CLHNS cohort consumed a food that is a rich source of vitamin A or its precursor at least 3 times per week, yet more than 60% of the women had total intakes of vitamin A that fell below the conservative Philippine RDA. We judged that the absence of a specified amount or portion size of food severely limited the usefulness of this indicator.

Percentage of women who consume less than 2 meals per day

Very few sample women consumed less than 2 meals per day. While this was a specific indicator of dietary inadequacy, it failed to identify the large proportion of women who consumed 2 or more meals per day yet still had diets that provided inadequate energy and nutrients.

Percentage of babies born with low birth weight

The prevalence of LBW is a sensitive but non-specific indicator of women's nutritional status prior to and during pregnancy. Attention should be paid to the source

of birth weight data to insure that it is representative of the community under study. LBW was significantly related to mother's height, BMI and arm circumference during pregnancy, but only a small amount of variability in birth weight could be attributed to maternal anthropometry during pregnancy.

Percentage of women judged to be of inadequate nutritional status based on arm circumference (AC)

AC was found to be independent of maternal pregnancy and lactation status, and was therefore judged a useful indicator of women's nutritional status throughout the reproductive years. AC increased with maternal age, and thus the age structure of the community should be considered when interpreting this indicator.

Percentage of women of low height

About 13% of CLHNS sample women had a height of less than 145 cm. Short stature, which most likely represents early childhood linear growth retardation, is a significant risk factor for LBW. Height is not useful for evaluating interventions during adulthood, since the ability to grow taller ceases several years after menarche.

Percentage of women of low weight

The interpretation of low weight is limited in the absence of height data, since shorter women are more likely to be categorized as underweight based on a simple weight cut-off, but may have adequate nutritional reserves for their height. Weight is highly responsive to the short term effects of pregnancy and lactation, and it increases significantly with age, suggesting the need for further exploration of age-specific cutoffs.

Percentage of malnourished women, based on body mass index (BMI)

Low BMI is a better indicator of undernutrition than is weight, since it accounts for height. BMI increases with parity and age in the CLHNS sample. We suggest that the meaning of low BMI may change with age as well because a low BMI in an older woman poses a greater risk of a poor birth outcome than that same BMI in a younger woman.

Concordance of indicators

AC and low BMI tend to identify the same women as undernourished. Short stature and low weight have relatively little concordance. Poor dietary intake of vitamin A is associated with low energy intakes, and also with low BMI. Vitamin A intake, weight and BMI are likely to be indicators most responsive to nutrition interventions.

Recommendations

Based on our results, we recommend:

(1) a modification of the dietary intake indicators to include a quantitative component;

(2) a further consideration of age-related changes in maternal weight and AC and the need for age-specific cutoffs to define risk; and

(3) inclusion of lactating women when assessing low weight and BMI.

Introduction

Effective monitoring and evaluation of reproductive health requires the collection and interpretation of information about a range of factors that affect women's health from birth to the end of the reproductive life cycle. Women's nutrition, in particular the long term consequences of inadequate intake of energy and protein, and the short and long term consequences of nutrient deficiencies, has been recognized as an important component of reproductive health. The Reproductive Health Indicators Working Group of the EVALUATION Project developed a set of indicators to reflect priorities established by the US Agency for International Development (USAID) related to family planning, safe pregnancy and safe motherhood, breast-feeding, maternal nutrition, and STD/AIDS (Bertrand and Tsui, 1995). This paper has a focus on maternal nutritional indicators of reproductive health.

The working group adopted criteria for a good indicator from a 1994 WHO report, stating that it should: "actually measure the phenomenon it is intended to measure (valid), produce the same results when used more than once to measure precisely the same phenomenon (reliable), measure only the phenomenon it is intended to measure (specific), reflect changes in the state of the phenomenon under study (sensitive), and be measurable or quantifiable with developed and tested definitions and reference standards (operational)" (Bertrand and Tsui 1995:23). We set out to test how well the maternal nutrition indicators recommended by the working group met these criteria using data from the Cebu Longitudinal Health and Nutrition Survey (CLHNS).

The CLHNS follows a cohort of childbearing women from an index pregnancy in 1983 to the present. Participants live in Metro Cebu, the second largest and most rapidly developing metropolitan area in the Philippines. The CLHNS is a community-based study which includes densely populated urban areas of Cebu city and several smaller contiguous cities, peri-urban areas around the cities, and rural areas in the mountains and on small islands. There is a high level of geographic and socioeconomic diversity represented in the sample. Women were intensively followed from the 6^{th} to 7^{th} month of an index pregnancy until 2 years after giving birth, then re-contacted in 1991 and 1994. Detailed community, household, and individual data were collected to inform studies of women's health and nutrition, birth spacing, birth outcomes, and infant feeding, growth and development.

There are a number of important advantages of using a longitudinal data set such as the CLHNS for testing indicators. First, the CLHNS includes much more detailed dietary and reproductive history data than is ordinarily collected in large surveys such the Demographic and Health Surveys. This allows us to compare indicators to more precise measures of behavior or health outcomes. For example, we can test the indicator related to the number of times a vitamin A rich food is consumed to total intake of vitamin A from all food sources. Second, since the study is longitudinal, it allows for comparison of indicators across the reproductive lifespan of individual women. The CLHNS covers a 12 year period of women's lives, and includes women of different ages and parity at the study baseline. Third, the sample is community based and representative of childbearing women in the region where the study was conducted.

There are also limitations to the use of the CLHNS data. The sample includes women who had a pregnancy in a one year time period, and is thus not representative of all women. Since undernutrition contributes to infertility and sub-fecundity, the sample may exclude the most poorly nourished women in the communities sampled. Further, the sample over-represents older, higher parity women in the later follow-up studies in 1991 and 1994. By 1994, a substantial number of sample women had completed childbearing. Finally, the CLHNS has a focus on health and nutrition outcomes, and thus is not useful for testing indicators related to process or health care utilization or services.

Our analysis therefore has a focus on what the Subcommittee on Women's Nutrition has defined as intermediate and long term outcomes of undernutrition. These include meal patterns and consumption of vitamin A rich foods, and a range of anthropometric indicators of nutritional status. We were particularly interested in determining the degree to which different types of nutritional indicators lead us to the same conclusions about health or nutritional status. We were also interested in how life cycle changes alter the occurrence and meaning of an indicator. For example, does a particular indicator (such as the mother's body mass index) have the same meaning at different ages or stages of the reproductive life cycle?

Methods

Sample and data. From the universe of all barangays or administrative units of Metro Cebu, 33 were randomly selected for the study. All pregnant women in the selected barangays were identified and invited to participate in the study. Women who subsequently had a birth or pregnancy termination in a one year period between 1983 and 1984 were included in the study (n=3,327). The mean age of women at entry into the study was 26.5±6.1 years (range 14-47), and mean parity was 2.23±2.20 (range 0-14).

Detailed data were collected by trained interviewers from the Office of Population Studies at the University of San Carlos in Cebu. Interviewers visited each household to obtain sociodemographic, environmental, dietary, anthropometric, and reproductive history data. Data collection took place during the 6th and 7th month of pregnancy, than at bimonthly intervals for 2 years. Initially, because of the CLHNS focus on infant feeding, only those women with a single live birth (n=3,080) were followed. Later, women with multiple births, miscarriages, or stillbirths were brought back into the study to broaden the focus on women's nutrition. Follow-up surveys were conducted in 1991 and 1994 when 2,395 women and 2,279 women, respectively, were located and interviewed. Each woman therefore contributed detailed prospective information about the course and outcome of an index pregnancy and the 2 year period subsequent to that pregnancy, and follow-up data 8 and 11 years after the index birth. Information about other pregnancies was obtained by recall using a reproductive history updated at each follow-up survey.

Height, weight, mid-arm circumference, and triceps skinfold thickness were measured at each survey. All anthropometric measurements were obtained using standard methods.

Women's dietary intake was measured 2, 6, and 14 months after birth of the index child (1983-86), and in 1991 and 1994. Intake was determined from a 24-hour dietary recall for the day prior to the survey in 1983-86 and in 1994 while a quantitative food frequency (QFF) was used in 1991. The QFF included 61 food items selected as the major contributors to energy and nutrient intake from the 24-hour recall data collected during the initial surveys. Food models and measuring aids were used to improve recall of quantity. Nutrient intake was estimated using a computerized version of the Philippines Food Composition Tables (Food and Nutrition Research Institute, 1990).

For many of our analyses of trends over time, we make comparisons of data from the 1983-86 survey at 2, 6 and 14 months after delivery of the index child, since these represent the surveys at which all necessary dietary and anthropometric data were collected.

Analysis methods. We first reviewed all of the indicators established by the Subcommittee on Women's Nutrition (Galloway and Cohn 1995), and selected for analysis, those for which CLHNS data were available. We then selected an appropriate sample for each indicator according to age, reproductive status, or type of data required to test the indicator. We then used standard descriptive statistical methods to characterize each indicator in the population.

In the sections that follow, for each indicator in turn, we present a definition, identify the sample and data used for analysis, presents results, then interpret the findings.

Results

A. Intermediate outcomes.

INDICATOR: PERCENTAGE OF WOMEN WHO CONSUME VITAMIN A-RICH FOODS

Definition: *The percentage of women consuming foods rich in vitamin A at least three times a week. A low risk of dietary vitamin A deficiency exists when vitamin A rich foods are eaten by more than 75 percent of women at least three times a week.*

It is important to note that this indicator is not quantitative, that is, it does not specify a serving size or quantity of vitamin A rich foods. Food frequency data with a good representation of locally available foods are required for this indicator. Dietary data from the 1991 CLHNS were used for this analysis since intake was measured using a QFF. Foods listed on the QFF were chosen based on information collected during earlier 24-hour dietary recalls in CLHNS sample women, and thus include locally available fruits and vegetables as well as animal sources of vitamin A commonly consumed in this population. Women were asked whether they normally consumed a specific food item daily, weekly, or yearly, then how many times a month, day, or week they consumed that item. The sample for this analysis includes 2,395 women present for the 1991 survey. The indicator applies to all women, irrespective of pregnancy or lactation status, although it is recognized that pregnant or lactating women will be at higher risk of deficiency because of increased needs. To fully test this indicator, we would ideally like to have a precise measure of vitamin A status, such as serum retinol. In the absence of biochemical data in the CLHNS, we compared frequency of intake of vitamin A rich foods to total intake of retinol and its precursor, β-carotene. Since vitamin A is a fat soluble vitamin, its absorption may be diminished when the meal in which a vitamin A source is consumed is very low in fat. Thus the dietary content of the vitamin may not be a reliable indicator of vitamin A status.

Vitamin A-rich foods were defined as those containing (1) more than 720 µg of β-carotene/100 g of food or (2) more than 120 µg of retinol/100 g of food. Each of these amounts is equal to 120 µg of retinol equivalents (RE). One RE is equivalent to 1 µg of retinol or 6 µg of β-carotene. Using this definition, vitamin A-rich foods included β-carotene sources such as dark green leafy vegetables, yellow squash, carrots, ripe mango, and papaya; and retinol sources such as dried fish, salted or fermented shrimp, canned sardines, clams, squid, beef, and fortified powdered milk. The rationale for using 120 µg of retinol as a cutpoint to define vitamin A-rich foods is based on the amount of β-carotene and retinol found in "commonly known" sources of vitamin A and on the amount of retinol in vitamin A-rich foods cited in the Final Report of the Subcommittee on Women's Nutrition (Galloway and Cohn, 1995). The vitamin A content for specific food items was obtained from the Food Composition Tables Recommended for Use in the Philippines wherein content was given per 100 grams of food (FNRI 1990). The Philippines Recommended Dietary Allowance (RDA) is 450µg/day for non-pregnant, non lactating women, with an additional 25µg/day for pregnant women, and additional 325µg/day during the first 6 months of lactation. This RDA is substantially below the US RDA of 800 µg/day.

We examined vitamin A intake of women who consumed fewer than 3 vitamin A rich foods per week, as well as overall patterns of consumption. Results are presented in tables 1-3. The mean intake of vitamin A is slightly above the RDA of 450µg/day while the median intake is well below the RDA suggesting that very high intakes of some sample women skewed the data (Table 1). Women with very high intakes were among those few who consumed retinol-rich foods such as organ meats. For most women, β-carotene-rich foods were the major sources of vitamin A. As expected, women with adequate energy intakes (above the RDA of 1900 kcal) were more likely to have an adequate vitamin A intake compared to women with inadequate energy intakes. Seventy one percent of women with inadequate energy intakes also had a vitamin A intake below the RDA. Rural women were more likely to have adequate intakes of vitamin A. Urban-rural comparisons reveal that mean intakes of β- carotene were higher among rural women, but retinol intakes were lower, consistent with higher intakes of leafy greens but low intake of animal products in rural households. Mean intakes of pregnant or lactating women did not differ significantly from those of non-pregnant, non-lactating women. About 61% of sample women consumed less than the RDA for non-pregnant, non-lactating women. If pregnancy and lactation status is considered, 67% of women consumed less than the RDA. Intakes were not significantly related to age.

Table 1. Daily Vitamin A Intake of CLHNS Sample Women in 1991			
Characteristics of Intake	**Mean**	**Standard Deviation**	**Median**
Total Vitamin A Intake (µRE)	471	± 350	393
Retinol (µg)	201	± 116	172
β-carotene (µgRE)	270	± 325	182
Total vit A if kcal ≥ 1900 (n = 814)	591	± 436	499
Total vit A if kcal ≥ 1900 (n = 1581)	409	± 277	349
Vit A intake: urban women (n = 1768)	450	± 296	383
Vit A intake: rural women (n = 627)	530	± 466	419
Percent with intake < RDA	61.1	--	--

Table 2. Frequency of consumption of Vitamin A rich foods and total Vitamin A intake among CLHNS sample women in 1991			
	Mean or %	**S.D.**	**Median**
Frequency of vit A foods per week	26	12.5	25
% consuming vit A foods < 3 times/wk (n=10)	0.4	-	-
Total µgRE if vit A foods < 3 times/wk	179	137.7	188
% of women consuming vit A foods ≥ 3 times/wk (n=2385)	99.6	-	-
Total µgRE if consume vit A foods ≥ 3 times/wk	472	350	394
Frequency of vit A foods/wk if intake≥ 450 µgRE	34	11.8	32
Frequency of vit A foods/wk if intake < 450 µgRE	21	10.2	20

Table 3. Vitamin A Intake by Frequency of Consumption of Vitamin A Rich foods					
Quartile	**Frequency of vit A (times/wk)**	**Mean µgRE**	**Standard Deviation**	**Median µgRE**	**% above RDA**
1	0-16	264	127	239	6.3
2	17-24	400	206	358	28.2
3	25-32	493	258	433	46.4
4	33+	701	498	579	72.6

Nearly all sample women consumed vitamin A rich foods at least 3 times per week (Table 2). Only 10 women reported consumption of these foods less than 3 times a week, and their mean intake of vitamin A was only about 42% of the RDA. The median vitamin A intake of women consuming vitamin A rich foods 3 or more times a week represents about 88% of the RDA. Women whose intake met or exceeded the RDA reported consuming a vitamin A rich food, on average, 34 times per week. This suggests that the indicator is highly likely to miss women with grossly inadequate intakes.

In separate analyses, we restricted our selection of "vitamin A rich foods" to plant sources of β-carotene (dark green leafy vegetables, yellow squash, carrots, ripe mangos, and papayas). Using this approach, nearly 89% of women consumed a vitamin A-rich food at least 3 times per week, thereby meeting the indicator criteria. Women were divided into quartiles based on the frequency of consumption of vitamin A rich foods (Table 3). In the lowest quartile, representing women consuming these foods 0-16 times per week, the mean and median intakes of vitamin A were far below the RDA, and only 6% of intakes were above the RDA for non-pregnant, non-lactating women. Even in the third quartile, which represented consumption of a vitamin A rich food 25-32 times per week, less than half of women had intakes above the RDA.

The QFF used in the 1991 survey was specifically designed to assess nutrients such as vitamin A known to be deficient in the Philippines. The QFF therefore included a wide range of sources of retinol and β-carotene. Since the QFF methodology can overestimate intakes when a large number of items are included, we also assessed intake using 1994 data based on a 24-hour dietary recall. The mean intake in 1994 was 474µg/day (vs. 471 in 1991), but the median of 259µg/day was lower in 1994 and the percent of women with intake below the RDA was higher. This was particularly true in the sample of 500 women, age 15-25 who were added to the 1994 sample. Median intake in this group of younger women was 240µg/day, and 81% had intakes less than the RDA. A 24-hour recall does not represent the usual intake of individuals, and substantial day to day variation may occur. A QFF is a better instrument for measuring usual intake.

The Working Group on Women's Nutrition concluded that "A low risk of dietary Vitamin A deficiency exists when Vitamin A rich foods are eaten by more than 75% of women at least 3 times a week". From this analysis, we conclude that consuming a vitamin A rich food at least 3 times a week is a very poor indicator of the likelihood of adequate intake in this population. The indicator lacks validity in the population, that is, it does not measure adequacy of vitamin A intake. The indicator is operational, but meaningless in this population. Based on 1991 QFF data, almost no women consumed less than 3 vitamin A rich foods per week, yet 15.3% had total intakes that were *less than half* of the Philippines RDA (and only about one-quarter of the US RDA). Overall, the number of times a vitamin A rich food was consumed by sample women appears high. The median weekly consumption pattern suggests that vitamin A rich foods are consumed about 4 times per day. It is important to consider, however, that the quantity consumed might be quite small. In the Philippines, very small quantities of foods rich in vitamin A are typically consumed as part of mixed dishes. For example, a few malunggay leaves may be consumed as a flavoring in soup, or small amounts of vegetables rich in β-carotene may be added to stews.

A better indicator would specify a number of servings or a specific quantity of food to be consumed. For example, in the Philippines, eating 1 cup of locally available kamote leaves (the leafy greens from the sweet potato plant) would provide 535µg RE of Vitamin A, an amount which exceeds the RDA. One half cup of cooked carrots would provide about 750µg RE of Vitamin A, while one small ripe mango would provide about 200µg RE. While locally available sources of β-carotene will vary from country to country, or even regionally within countries, amounts with examples of very common foods would greatly improve the utility of the indicator.

INDICATOR: PERCENTAGE OF WOMEN WHO CONSUME LESS

THAN TWO MEALS PER DAY

Definition: *The percentage of women in a given population that consume less than two meals per day.*

The sample for the analysis of this indicator included 2,278 women in the 1994 survey who had dietary intake data. Intake from meals and "snacks" eaten per day was determined from a 24-hour recall of dietary intake for the day preceding the survey interview. Women were asked what they had to eat before breakfast, what they ate for breakfast, what they ate between breakfast and lunch, and so on. The Cebuano terms used in the questionnaire conveyed the concept of a meal when asking about breakfast, lunch and dinner. Energy intake was estimated separately for each eating episode and corresponding variables were created. Using this method, we were able to estimate the energy intake for meals and “snacks”. Additionally, women were asked how many meals and snacks they usually ate each day allowing us to determine if the 24-hour recall represented the typical frequency of meals and snacks. The analysis related to energy intake is based on the number of meals and snacks included in the 24-hour recall.

As indicated in the Final Report of the Subcommittee on Women's Nutrition (Galloway and Cohn 1995), “snacks” may be difficult to define in certain cultures. In the Philippines, snacking is easily identified (there is a specific work for snack in the language) and is an important component of the culture and contributes substantially to daily energy and nutrient intake.

Only 3 women consumed less than 2 meals per day, and fewer than 4% had only 2 meals on the day covered by the 24 hour recall (Table 4). An even smaller percentage of women reported having 2 meals or less per day on a regular basis. More than 70% of the dietary recalls included snacks in addition to meals, and 79% of women reported that they usually consumed at least one snack per day. Among women who consumed snacks (n=1603), the snacks contributed about 340 kcal to the mean total intake of 1,366 kcal/day. Overall, women who consumed snacks had higher intakes than women who did not consume snacks. For pregnant women, more frequent consumption of smaller meals may contribute to better regulation of blood glucose and insulin levels and possibly to better fetal growth (if total intake is adequate).

Among women who consumed only 2 meals per day, mean energy intake was

57% of the RDA for non-pregnant, non-lactating women. However, even among women who consumed 3 meals per day, mean energy intake was only 72% of the RDA. Among the poorest women, a meal may consist primarily of corn grits or rice with a small amount of dried fish and vegetables. The energy and nutrient content of such meals is low.

The consumption of less than 2 meals is a valid indicator in that it identifies women with deficient dietary intakes, but it is not a useful indicator in this population since only 3 sample women had this meal pattern, and only one woman reported usually consuming only one meal per day. Women consuming only 2 meals per day had much lower mean energy intakes than women consuming 3 meals per day, but a high percentage of women in both groups consumed diets deficient in energy and nutrients. The number of meals per day is relatively easy to measure, but it does not identify the large proportion of women with grossly deficient diets.

We examined the overall adequacy of diets throughout the survey by comparing intakes with the RDA. Diets are generally considered inadequate when they provide less than two thirds of the RDA. Table 5 shows the percentage of women with intakes of specific nutrients less than two thirds of the RDA. In general, intakes were higher in 1991 than in 1994. This is largely a reflection of the differences in methods of assessing intake. A QFF was used in 1991, while a 24-hour recall was used from 1983-86 and 1994. As noted above, a QFF tends to over-estimate intakes when a large number of food items are included. Note that a substantial portion of women consume less than two thirds of the RDA for energy, protein, iron, calcium, B-vitamins, Vitamin A and Vitamin C. Iron intake is of particular concern, since close to 80% of women consume less than 17.3 mg/day. Since iron sources in the diet are largely non-heme and therefore not as well absorbed, these low intakes are likely to contribute substantially to iron deficiency anemia. Women with low iron intake are also highly likely to have low vitamin A intakes.

Table 5 was created without reference to reproductive status of the women. The RDA used for the calculations was that of non-pregnant women up to 39 years of age. Table 6 shows that when pregnancy and lactation are taken into consideration, an even higher percentage of women are judged to have inadequate intakes.

Low dietary energy intake is significantly related to low BMI. In a very conservative analysis, we examined the percentage of women with energy intakes less than two-thirds of the RDA for non-pregnant, non-lactating women based on the mean of the three 24-hour dietary recalls from the 1983-86 survey. The use of 3 recalls reduces bias related to day to day intra-individual variability in intake, and provides a better estimate of usual intake. The sample included 2,153 non-pregnant women with complete dietary intake and BMI data at the 14 months postpartum survey. Mean intake was 1433 ± 578 kcal/day, and 44.5% of this sample had intakes less than two-thirds of the RDA for non-lactating women. Of women with this level of energy inadequacy, 32.6% had a BMI <18.5, which is suggestive of chronic energy deficiency. In contrast, 23.5% of women with intakes that exceeded two thirds of the RDA had a BMI<18.5. The relative risk of CED with low energy intake was 1.57 (95% C.I. 1.31-1.86). It is important to note, however, that energy needs are related to body size, and thus women with low amounts of lean body mass need less dietary energy. A similar analysis using AC showed that among women with inadequate energy intake, 17.3% had low AC, while 12.6% of women with higher energy intakes had low AC. The relative risk of low AC with low energy intake was 1.38 (95% C.I. 1.17-1.1.72).

Table 4. Percentage of Women Consuming A Specified Frequency of Daily Meals and Snacks with Corresponding Energy Intake in 1994

	n	%	Energy Intake
Women consuming <2 meals per day[1]	3	0.1	1140
Women consuming 2 meals per day[2]	83	3.8	1089
Women consuming 3 meals per day	2192	96.2	1377
Women consuming no snacks each day	676	29.7	1042
Women consuming any snacks each day	1603	70.3	1602
Women consuming: 1 snack per day[3]	923	40.5	1395
Women consuming: 2 snacks per day	601	26.4	1624
Women consuming: 3+ snacks per	79	3.4	1839

[1]Of the 3 women consuming less than 2 meals per day, energy intake ranged from 523 kcal to 1598 kcal with a standard deviation of 554 kcal. The woman with the lowest intake consumed no snacks while the others consumed 1 snack per day.

[2]Of women consuming 2 meals per day, energy intake ranged from 292 kcal to 2280 with a standard deviation of 463 kcal. The number of snacks ranged from 0 to 4 with the lowest mean energy intake found among women consuming no snacks (n=30, mean kcal=838) and the highest intake found in women consuming 2 snacks each day (n=16, mean kcal= 1265).

[3]Energy intake for frequency of snacks was estimated without considering the number of meals consumed each day. However, the same trend in energy intake was found when frequency of daily meals was considered.

Table 5. Percentage of Women with a Daily Dietary Intake Providing Less Than two-thirds of the Philippines RDA for Selected Nutrients[1]

Nutrients[2]	2 mo.[3]	6 mo.	14 mo.	1991	1994
Energy <1265 kcal	39.7	50.7	64.6	25.6	49.8
protein < 34.6 g	31.9	38.9	50.7	14.6	38.6
Fat <13.3 g	51.6	59.7	62.4	37.7	42.3
Ca <333 mg	38.2	44.6	58.1	9.3	55.0
Iron <17.3 mg	76.7	82.3	86.4	60.1	82.3
Vitamin C <46.6 mg	--	--	--	39.0	77.3
Vitamin A <300 µgRE	--	--	--	29.9	57.7
Thiamin <0.67 mg	--	--	--	70.4	82.8
Riboflavin <0.67 mg	--	--	--	62.1	81.8
Niacin <12.0 mgNE	--	--	--	43.7	60.9

Note: The nutrients selected for this table are those for which an RDA has been established in the Philippines. Values for 2/3s of the RDA were calculated using the RDA for a nonpregnant, non-lactating reference woman aged 20-39 who is moderately active.

[1]The sample (n=1958) includes all women (non-pregnant, pregnant and lactating) who had dietary data at all of the time points. This method underestimates the percentage with inadequate intakes, since RDAs for pregnant and lactating women are higher.

[2]Values for 2/3s of the RDA are shown for each nutrient. See Appendix A for RDAs for Filipinos.

[3] In this and all subsequent tables, 2, 6 and 14 months refer to the number of months after delivery of the index child in 1983-84.

Table 6. Percent of Pregnant and Lactating Women with Daily Dietary Intake Providing Less Than Two-thirds of the Philippines RDA for Selected Nutrients in 1991[1]

Nutrient	Pregnant (n=199)		Lactating (n=374)	
	2/3 RDA	**%**	**2/3 RDA**	**%**
Energy (kcal)	1465[1]	31.7	1598	49.2
Protein (g)	40.6	21.6	44.0[2]	39.0
Fat (g)	13.3	35.2	13.3	48.4
Calcium (mg)	599	78.9	600	100.0
Iron (mg)	27.3	69.3	15.3	46.0
Vitamin C (mg)	53.3	32.7	68.2[2]	64.4
Vitamin A (µgRE)	316	24.6	500[2]	65.0
Thiamin (mg)	0.9[1]	66.8	0.93	92.2
Riboflavin (mg)	1.1[1]	72.4	0.93	88.2
Niacin (mgNE)	14.0[1]	49.7	15.3	69.5

Note: Among pregnant women, 11 women were pregnant and lactating.

[1]The RDA for the 1st trimester differs from that for the 2nd and 3rd trimester. The mean of 2nd and 3rd trimester values was used to estimate the intake.

[2]The RDA differs for the 1st and 2nd six months of lactation. The mean of the two values was used to estimate 2/3s of the RDA.

B. Long term indicators

INDICATOR: PERCENTAGE OF BABIES BORN WITH LOW BIRTHWEIGHT

Definition: The Percentage of babies born with birth weight <2500 g.

Low birth weight is interpreted as an indirect indicator of maternal nutritional status during pregnancy, but it is likely to underestimate the extent of poor maternal nutritional status (Galloway and Cohn 1995). To assess LBW, one would ideally like to have community based data with weight measured by trained birth attendants. Further, it is desirable to determine whether LBW is the result of prematurity or intrauterine growth retardation (IUGR). Unfortunately, gestational age is often difficult to obtain in developing country settings. While poor maternal nutrition contributes to prematurity *and* IUGR, the evidence supporting a relationship of maternal nutrition to IUGR is the strongest (Kramer 1987).

We use data from the baseline and birth information surveys of the CLHNS (1983-84) to examine the prevalence of LBW, and to assess the relationship of LBW to anthropometric indicators of nutritional status during pregnancy. Data on 3,019 single live births are included.

During the 6^{th} to 7^{th} month of pregnancy, mother's height, weight, and AC were measured by trained project interviewers. Infant birth weight was measured by birth attendants who had been provided with Salter hanging spring balance scales and who had been trained in the use of the scales, or by hospital personnel using hospital scales, depending on the place of delivery.

LBW occurred in 11.5% of single, live born infants (Table 7). However, the prevalence of LBW differed significantly by place of delivery. Mean birth weight was significantly lower among infants born in public facilities compared to those born at home or in private facilities. Birth weight of infants born at home did not differ significantly from that of infants born in private health facilities. The prevalence of LBW was highest among infants born in public facilities, and lowest among infants born in private facilities. There was a clustering of risk factors for LBW among women who chose to deliver in public facilities, including primiparity, low household income and assets, and low maternal education (Adair 1989). These differences by place of delivery point to the importance of examining the source of data when LBW statistics are presented, particularly in countries where a significant portion of births take place at home.

Table 7. Prevalence of Low Birth Weight by Place of Delivery

	N	Mean BW (g)	% LBW	% Preterm
Home	1843	2995±436	10.96	13.3
Public Facility	542	2939±438	15.31	15.8
Private Facility	634	3019±439	9.93	12.2
All	3019	2990±437	11.52	13.5

Does LBW reflect poor nutritional status? We examined the relationship of maternal anthropometric status during pregnancy to LBW. Since AC varies little over the course of pregnancy, AC was analyzed without respect to the week of gestation when the measurement was made. However, the gestational week when weight was measured is important. We assumed a linear weight gain, and predicted weight at 30 weeks gestation (the mean week of gestation at measurement) from each woman's weight and week of measurement using linear regression. BMI was determined from the predicted weight at 30 weeks, and low BMI was defined using a cutoff of 20.5, which represents about 1 standard deviation below the mean BMI at 30 weeks. It is important to note that BMI during pregnancy is not an ideal measure for this analysis, since it reflects the weight of the developing fetus as well as the mother. However, in the absence of pre-pregnancy BMI, it is a reasonably useful indicator (WHO 1995). Furthermore, tables of weight for height by week of pregnancy are often used to assess a woman's prepregnancy nutritional status in the absence of prepregnancy weight or weight gain data.

Table 8 shows that the prevalence of LBW is nearly two times higher among infants born to mothers who are less than 145 cm tall, have AC less than 22.5 cm or low BMI compared to women with adequate nutritional status. The crude risk of LBW is more than doubled among mothers who are short, have low AC, or low BMI during pregnancy compared to better nourished women. Each of the 3 indicators of undernutrition occur in a similar proportion of sample women, and each has about the same effect on the risk of LBW. When all 3 indicators are considered together, all remain significant predictors, but short stature is the most important and most highly significant predictor of LBW. The crude relative risks shown in table 8 are comparable to those from the WHO Collaborative Study on Maternal Anthropometry and Pregnancy Outcome (1995)

In summary, LBW as an indicator of maternal nutrition during pregnancy is operational: a clear, universally agreed upon definition is available. However, LBW does not differentiate low weight because of prematurity from low weight because of intrauterine growth retardation. It is reasonably valid, that is, it reflects poor maternal nutrition. However, it is not specific, since LBW reflects numerous factors other than maternal nutritional status. This study cannot directly assess the degree to which LBW is responsive to improvements in maternal nutrition, but there is an extensive nutrition intervention literature documenting the moderate effects of maternal supplementation during pregnancy on birth weight.

Table 8. LBW is Related to Maternal Nutritional Status During Pregnancy

	% LBW in mothers below the cutoff	% LBW in mothers at or above the cutoff	Crude RR of LBW (95% C.I.) if below the cutoff
Height (<145 cm)	20.36	10.21	2.25 (1.63-2.88)
AC (<22.5cm)	19.18	10.13	2.11 (1.06-2.03)
BMI at 30 weeks (<20.5)	19.65	10.06	2.19 (1.29-2.44)

Anthropometric indicators of nutritional status.

INDICATOR: **PERCENTAGE OF WOMEN WITH INADEQUATE NUTRITIONAL STATUS BASED ON ARM CIRCUMFERENCE**

Definition: *Percentage of women aged 15-49 with a mid-upper arm circumference of <22.0 cm. (James et al., 1994). The ACC/SCN suggests a higher cut-off of 22.5 cm*.

For the study of AC, we used a subsample of 1,860 women with complete data for multiple time points to enable comparisons of the same women at different ages. Women older than 49 in 1994 are excluded to conform with the criteria established for the anthropometric indicators. Pregnant women are included in the sample unless otherwise indicated, since values for AC vary only slightly during pregnancy (Galloway and Cohn, 1995).

Because the cutoff of 22.5 cm has not been well tested and studies have proposed a range of cutoffs, we examined several different cutoffs in our descriptive analysis (Table 9). We examined AC by age and reproductive status over time and compared assessments based on AC and BMI.

Table 9. Trend in Mean Mid-Upper Arm Circumference (AC) from 1983 to 1994[1]

	2 mo.	**6 mo.**	**14 mo.**	**1991**	**1994**
Mean AC (cm ±SD)	24±2.3	24.5±2.5	24.4±2.6	26.9±3.2	27.5±3.4
AC <22.5 cm (%)	15.5	20.2	20.9	6.6	6.2
AC <22.0 cm (%)	10.6	13.7	14.4	4.3	4.0
AC <21.0 cm (%)	3.7	5.1	6.0	1.7	1.6

[1]The sample includes the same 1860 women at each survey point.

There are substantial differences in the percentage of women who would be defined as undernourished based on relatively small differences in the AC cutoff used for assessment. For example, the percentage of women judged inadequate when 23.5 cm is the cutoff is about double that found when 22.5 cm is used, and 6-8 times higher than when 21 cm is used. This suggests the need for a comparison of AC with other indicators of nutritional status, and with important health outcomes. When we assess the relationship of AC in the third trimester of pregnancy to LBW, we find that the relative risk of LBW is 2.11 (1.61-2.74) with a cutoff of 22.5 cm, 2.29 (1.69-3.05) with a cutoff of 22cm, and 3.05 (1.90-4.91) with a cutoff of 21 cm. However, it is important to note that only 3% of sample women had an AC of less than 21 cm during pregnancy.

Most women were lactating in the first 6 months postpartum, and about half were still breast-feeding at 12 months postpartum. In other work, we have shown significant weight loss among lactating women during this time period (Adair 1992, Adair and Popkin 1992). The absence of significant differences in AC at 2, 6, and 14 months postpartum, despite significant weight loss during this period confirms that low AC is a useful indicator irrespective of reproductive status. Furthermore, there are no significant differences in the mean AC of lactating vs. non-lactating women. We also found no differences in mean AC related to subsequent pregnancy status. On the other hand, we see a significant increase in AC with increasing maternal age as evidenced by the higher mean AC values in 1991 and 1994, and a reduction in the percentage of women judged to have inadequate nutritional status.

In summary, AC measures both maternal arm muscle and fat stores. It can be reliably measured with relatively little training of personnel. The selection of a cutoff is crucial, since a 0.5 cm difference in cutoff can make a marked difference in prevalence estimates. AC varies little with reproductive status, so that it is more widely useful than weight-based measures of nutritional status. In the CLHNS sample, AC increased significantly with maternal age, underlining the importance of considering the age structure of the population when comparing the prevalence low AC.

INDICATOR: PERCENTAGE OF WOMEN OF LOW HEIGHT

Definition: *Percent of women aged 15-49 with heights of less than 145 cm (low stature, height deficit, stunting).*

Adult stature is a refection of genetic factors and patterns of early childhood growth. In developing countries, short stature is most often the result of undernutrition and morbidity in the first 2 years of life. In many cases, the same factors that caused stunting in early childhood persist to compromise adult nutritional status as well. Irrespective of cause, short stature is associated with smaller pelvic size, and represents increased risk for cephalopelvic disproportion and maternal mortality (WHO Expert Committee 1995). While the prevalence of short stature in adult women may indicate current community-level risk of poor birth outcomes, height is not an appropriate indicator for the evaluation of short-term nutritional interventions, since height will not increase among adults. However, maternal nutritional interventions during pregnancy may improve height in the next generation.

Height data are available on the full sample of 3,327 women. Mean height of sample women was 150.5 cm, with a range from 132.2 to 169.2 cm and a standard deviation of 5 cm. Height less than 145 cm occurred in 13.2% of women. Among non-pregnant women with short stature, 85% also weighed less than 45 kg at 14 months postpartum, but only 33% of short women had a BMI less than 18.5.

Based on the assumption that adolescent mothers had reached their adult height, we did not anticipate age differences in stature. However, we found that mean height of women under 20 years of age was 1.1 cm less than that of women age 20 and older. This might be explained by (a) a cohort effect, (b) incomplete growth in younger women at the time they were measured, (c) shorter stature among early maturers, or (d) early childbearing limiting post-menarchal growth. To distinguish among these possibilities, we examined height in 1994 when the younger age group was 25-30 years of age. No significant increases in height were observed in the younger age group between 1983 and 1994, and a significant height difference of 0.8 cm between this younger group and older women remained, suggesting that growth was complete at the time they were measured in 1983. We examined age at menarche, and found that early maturers (menarche before age 14) were significantly shorter than late maturers (menarche at or after age 14). This is consistent with a study of US black adolescents (Perry et al 1996) Unfortunately, there is no way of determining whether pregnancy limited post-menarchal growth, since we have no way of knowing how tall the women would have become had they not had a pregnancy during adolescence. However, in a linear regression, controlling for age at menarche, age at first birth was negatively associated with height, giving some credence to the hypothesis that pregnancy at a young gynecologic age may limit linear growth. This is biologically plausible since the hormonal changes related to pregnancy, particularly the rise in estrogen, promote epiphysial fusion and cessation of linear growth (Scholl et al 1997).

Further insights into the height indicator are gained by comparing it to other anthropometric indicators (discussed below).

INDICATOR: PERCENTAGE OF WOMEN OF LOW WEIGHT

Definition: *Percent of non-pregnant, non-lactating women aged 15-49 weighing less than 45 kg (ACC/SCN cutoff, 1993).*

Low weight does not distinguish women who are short, but have adequate current nutritional status from those who are taller but underweight for their height. Thus, this indicator may either represent early child undernutrition which resulted in stunting, or more acute undernutrition in adulthood. Short stature is significantly related to underweight. For example, in the CLHNS sample, women who weigh less than 45 kg are, on average, about 4 cm shorter than women than women who weigh more than 45 kg, and about one quarter of underweight women are also less than 145 cm in height.

We examined the prevalence of low weight in several different samples. One analysis sample included non-pregnant, non-lactating women, aged 15-49. The sample size differs over time as more women ceased lactating. If we included only those women who were non-pregnant *and* non-lactating at all time points, this would severely restrict and bias the analysis sample. This analysis provides cross-sectional data at each time point (Table 10) stratified by age. A second analysis uses all non-pregnant women to make direct comparisons of lactating and non-lactating women.

Weight increases with age as shown by the changes within age categories from the two year postpartum surveys (1984-86) to the follow-up surveys in 1991 and 1994 represented by the rows in Table 10. As weight increases with age, the percentage of women weighing less than 45 kg declines markedly. Mean weight also differs significantly with age early in the survey, as shown by the differences in mean weight in the 3 age categories at 2, 6 and 14 months postpartum (down the columns in Table 10). There are no significant age differences in 1991 and 1994. Women who were adolescents at the time of the baseline survey had larger weight increases over time, thus diminishing the differences in 1991 and 1994. Among women not pregnant at 14 months postpartum or in 1991, mean weight increase during this interval was 7.1 kg in the 15-19 year old age group, 6.4 kg in the 20-29 yr old age group, and 5.1 kg in the oldest age group (ANOVA, p<.01). One interesting finding is that while women who were 15-19 at baseline had the lowest mean weight and highest prevalence of underweight at 6 and 14 months after delivery (1984-85), by 1991 and 1994, women of this age group were the least likely to be underweight. The group of women who were 15-19 years of age at baseline were more likely to have been primigravidas at baseline, and to have had more pregnancies in the interval from birth of the index child to 1994 (a mean of 3.2 among women 15-19 compared to 2.4 among those 20-29, and 1.3 in women 30 and older).

A significantly higher percentage of lactating women were underweight 6 and 14 months after giving birth compared to women not lactating at those points in time. Nearly 40% of non-lactating, but 46% of lactating women weighed less than 45 kg 6 months after delivery, at a time when about 78% of sample women were lactating. By 14 months after delivery when 58% were still breast-feeding, 43% of non-lactating and 53% of lactating women weighed less than 45 kg.

In previous work, we showed a significant and biologically important weight loss related to prolonged lactation during a single reproductive cycle (Adair 1992, Adair and Popkin 1992). Furthermore, women with the longest lactation duration are of lower socioeconomic status than women who wean earlier. With multiple risk factors associated with poverty, these women are at highest risk of poor outcomes in subsequent pregnancies.

Weight is highly responsive to short term changes in energy balance related to seasonal or idiosyncratic differences in maternal work, morbidity and dietary intake, or to factors such as lactation intensity. The low weight indicator pertains to non-lactating women. No rationale is given for the exclusion of lactating women, but their exclusion underestimates the amount of underweight in the sample. The degree to which underweight is underestimated will depend on the percentage of women in the population who are lactating when weight is measured.

One interpretation of the exclusion of lactating women from this indicator is that the cutoff has a different meaning for lactating and non-lactating women and/or that there is an expectation that weight lost during lactation will be repleted prior to a subsequent pregnancy. In fact, many women become pregnant again prior to repletion (Adair 1992, Adair and Popkin 1992), thus putting them at risk of poor pregnancy outcome related to inadequate prepregnancy weight. Furthermore, a significant number of women become pregnant while still lactating (Siega-Riz and Adair, 1993). For these reasons, we conclude that the exclusion of lactating women when defining this indicator is inappropriate because it will result in substantial underestimate of the prevalence of low weight. The same conclusion applies to low BMI (discussed below).

Table 10. Mean Weight of Non-pregnant, Non-lactating Women and the Percent of Women with Low Weight Over Time

	2 mo.		**6 mo.**		**14 mo.**		**1991**		**1994**	
	n=426		**n=540**		**n=901**		**n=1763**		**n=1879**	
Age	**kg**	**%**	**kg**	**%**	**kg**	**%**	**kg**	**%**	**kg**	**%**
15-19	45.5	45.0	44.0	60.4	43.5	55.2	51.1	27.2	53.0	18.7
20-29	48.1	34.4	47.1	42.8	46.7	44.7	52.8	30.2	53.3	20.4
30+	51.7	14.5	50.1	23.2	48.7	35.1	52.2	24.4	52.3	26.4
All	48.8	30.3	47.6	39.2	46.8	43.5	52.4	22.2	53.0	21.9

INDICATOR: PERCENTAGE OF MALNOURISHED WOMEN, BASED ON BODY MASS INDEX

Definition: *Low Body Mass Index (BMI) is the ratio of weight to height: it measures "thinness." The standard cut-point for non-pregnant, non-lactating women aged 15-49 is a BMI <18.5. This cutoff has been determined by the International Dietary Energy Consultative Group as suggestive of chronic energy deficiency (CED) (James et al., 1988).*

The sample for this analysis is the same as that described above for weight. Body mass index is in units of kg/m^2. In addition to the prevalence of CED evidenced by a BMI<18.5, we examined overweight (BMI between 25 and 30), and obesity (BMI greater than or equal to 30), as recommended in the WHO Expert Committee (1995).

The patterns observed for BMI parallel those observed for underweight, since weight changed over the years of the survey, but height did not. The percentage of women with CED increased in the period after delivery of the index infant since most women lose weight after delivery of a child, especially if they are lactating. CED was less frequent in general in 1991 and less frequent as the women get older in 1994 (Table 12). The youngest women were more likely to exhibit CED early in the survey, but by 1994, the highest prevalence of CED is found in the oldest age group. This is most likely to be attributable a slower rate of weight gain in older women, and to the depletive effects of multiple cycles of pregnancy and lactation in the oldest (and highest parity) group (Polhamus and Adair, 1998). The prevalence of obesity in non-pregnant, non-lactating women increased from about 1% in 1983-85 to over 5% in 1991, and over 6% in 1994-5. This points to the importance of monitoring the extremes of nutritional status. As countries progress through what Popkin (1997) has called the nutrition transition - a shift toward increased dietary fat intake and a decline in physical activity levels - we need to be concerned with the health risks of overweight and obesity. Obesity significantly increases the risk of complications of labor and delivery, as well as diabetes and cardiovascular disease (IOM 1990)

Table 11. Percent of Non-pregnant, Non-lactating Women in BMI categories representing CED, normal weight, overweight and obesity

	2 mo. **n=426**	**6 mo.** **n=540**	**14 mo** **n=901**	**1991** **n=1763**	**1994** **n=1878**
<18.5	15.0	20.4	24.0	9.1	10.6
18.5- <25	74.9	69.6	67.5	64.8	58.0
25- <30	8.7	9.1	7,2	20.9	25.2
30 +	1.4	1.0	1.3	5.3	6.2

Table 12. Mean BMI and Percent of Non-Pregnant, Non-Lactating Women with CED, by Age

Age	2 mo. n=426		6 mo. n=540		14 mo. n=901		1991 n=1763		1994 n=1879	
	BMI	**%**	**BMI**	**%**	**BMI**	**%**	**BMI**	**%**	**BMI**	**%**
15-19	20.0	25.0	19.5	27.1	19.5	31.4	22.7	9.9	23.4	10.4
20-29	21.0	18.1	20.6	24.6	20.5	24.8	23.1	7.4	23.4	8.5
30+	22.3	3.6	21.8	7.7	21.2	18.4	22.9	12.4	23.1	15.3
All	21.2	15.0	20.8	20.4	20.5	23.9	23.0	9.1	23.3	10.6

Comparison of results from anthropometric indicators of nutritional status.

Height, weight, BMI and AC each represent a different aspect of maternal body composition. Height is a reflection of skeletal growth during infancy and early childhood. Most of the deficit in adult height observed among women in developing countries is the result of linear growth retardation during the first 2 years of life (Martorell and Habicht 1986). Weight is a measure of height, lean tissue and fat. Weight alone therefore cannot tell us whether a woman is underweight because she is short but has adequate muscle and fat mass, or whether she is taller but has limited fat stores and low muscle mass. BMI is used as an index of relative weight, and it tells us whether a woman is underweight for her height. Arm circumference is a measure of both upper arm muscle and subcutaneous fat. Weight, BMI and arm circumference may reflect nutritional history, but are also responsive to short term nutritional deficits. Height and AC are useful irrespective of pregnancy status. The interpretation of weight and BMI as indicators of maternal nutritional status during pregnancy is complicated by the fact that weight includes both maternal and fetal components, and it changes rapidly over a relatively short period of time.

We explored the extent to which these four measures identify the same women as undernourished. The sample for this analysis included all non-pregnant women in the sample at each point in time, irrespective of lactation status. The prevalence of each indicator did not differ significantly when we used the full sample available at each point in time versus when we used the sample who had complete data for all points in time. We did the analysis without respect to lactation status because while lactation affects the prevalence of the indicator (e.g. lactation results in weight loss), it does not significantly affect *the relationship among indicators*. Concordance was determined by cross tabulating each pair of indicators. Table 13 presents data from 6 months postpartum (1984), 1991 and 1994. The table shows the overall prevalence of each indicator and the percentage of women identified as undernourished by both indicators, and by one but not the other.

First, the prevalence data in the top portion of the table amplify the point that the overall trend is an increase in maternal weight, most likely related to fat accumulation as women age. Thus, there is substantially less evidence of undernutrition among sample women in 1991 and 1994 than in 1984.

Second, comparison of pairs of indicators over time (across rows in the table) shows that as the prevalence of low weight, BMI and AC declines with age, the concordance with other indicators of undernutrition declines, because, for example, height remains the same but weight and AC increase with age. At the same time, the percentage of women who are short but low weight, BMI or AC increases as the women get older.

Third, when comparing pairs of indicators at the same point in time (down columns in the table), we can see that there is best agreement in BMI and AC, that is, low BMI and low AC tend to identify the same women as undernourished. In contrast, short stature and low weight show the least concordance because a substantial number of women more than 145 cm tall are underweight.

Table 13. Anthropometric indicators of women's nutritional status: Percentage of non-pregnant women with each indicator, and pairs of indicators.

	1984 n=2571	1991 n=2196	1994 n=2164
Height <145cm	12.8	12.8	12.9
BMI<18.5	22.9	9.6	10.8
Weight<45 kg	44.7	23.5	23.2
AC<22.5 cm	20.4	6.9	6.7
Height and BMI			
<145cm, <18.5	3.3	1.9	2
<145cm, ≥18.5	9.4	10.9	10.9
≥145cm, <18.5	19.6	7.8	8.7
Height and weight			
<145cm, <45kg	10.2	6.6	6.3
<145cm, ≥45 kg	2.5	6.2	6.7
≥145cm, <45kg	34.4	16.8	17
Height and AC			
<145cm, <22.5cm	3.9	1.8	1.7
<145cm, ≥22.5cm	8.9	11	11.2
≥145cm, <22.5cm	16.6	5.1	4.9
BMI and weight			
<18.5, <45kg	21.9	9.1	10.6
<18.5, ≥45kg	1.1	0.5	0.1
≥18.5, <45kg	22.7	14.4	12.8
<18.5, <22.5 cm	15.5	5.2	6.6
<18.5, ≥22.5cm	7.5	4.4	5.2

Table 13. Anthropometric indicators of women's nutritional status: Percentage of non-pregnant women with each indicator, and pairs of indicators.

	1984 n=2571	1991 n=2196	1994 n=2164
≥18.5, <22.5cm	5	1.7	1.1
Weight and AC			
<45kg, <22.5cm	19.2	6.6	6.5
<45kg, ≥22.5cm	25.5	16.9	16.8
≥45kg, <22.5cm	1.3	0.3	0.2

To further explore the effects of age and other factors that affect nutritional status over time, we used a linear regression model to identify factors significantly associated with an increase in BMI from 1984 to 1991. Age and childbearing in this 6 year interval were significant determinants of change in BMI. Increases in BMI were bigger among younger women, among women with fewer subsequent pregnancies, and among those who were thinner initially. Parity at baseline was not a significant determinant of change in BMI.

A positive relationship of BMI with maternal age is typical of developed countries, and of most developing countries. Only a small number of studies of chronically and severely undernourished women show declines in maternal weight with age, and in these cases, the decline is attributed to the depletive effects of pregnancy and lactation (see review by Merchant and Martorell 1988). Since the trend is toward an increase in BMI with age, one might speculate that a low BMI in older women indicates more chronic and/or severe undernutrition. We tested this assumption in a logistic regression model predicting LBW as a function of maternal anthropometric status during pregnancy. The model included interaction terms to see whether the effects of low BMI were altered by maternal age. The likelihood of having a LBW infant was significantly increased when mothers were short, had a low AC, and low BMI at 30 weeks gestation. The detrimental effect of a low BMI was greater among older women (>35 yrs) than among younger women.

Summary and Conclusions

Indicators related to dietary intake

Virtually all of the women in the CLHNS cohort consumed a food that is a rich source of vitamin A or its precursor at least 3 times per week, yet over 60% of the women had total intakes of vitamin A that fell below the conservative Philippine RDA. We judged that the absence of a specified amount or portion size of food severely limited the usefulness of this indicator. A better indicator would specify a quantity of several readily recognizable foods that would meet the RDA. While the food sources vary substantially from country to country, and within regions of countries, some generic categories of foods could be used as examples. For example, “leafy green vegetables”, or dark yellow or orange vegetables could be specified in the indicator. Assessment could then be tailored by taking into consideration local foods that fell into these broader categories.

Very few sample women consumed less than 2 meals per day. While this is a specific indicator of dietary inadequacy, it fails to identify the large proportion of women who consume 2 or more meals per day but still have diets that provide inadequate energy and nutrients. Under conditions of poverty more extreme or widespread than those found in Cebu, this indicator may be of greater utility in identifying women at the highest risk of poor energy and nutrient intakes. However, it is alarming to note that among Cebu women in the 1991 survey consuming 2 or more meals per day, about 11% had usual dietary intakes (based on the QFF) less than 1000 kcal per day, an amount that would be unquestionably inadequate to maintain energy balance. This very low intake is found disproportionately among poor rural women with little education.

Low birth weight

Low birth weight represents a consequence of poor maternal nutritional status rather than a direct indicator. The prevalence of LBW is a sensitive but non-specific indicator of women’s nutritional status prior to and during pregnancy. Attention should be paid to the source of birth weight data to insure that it is representative of the community under study. LBW was significantly related to mother’s height, BMI and arm circumference during pregnancy.

Anthropometric indicators of nutritional status

Each anthropometric indicator (height, weight, BMI, and AC) provides information about a different dimension of maternal nutritional status, though all of the indicators are correlated with one another.

Height is not useful for evaluating interventions during adulthood, since the ability to grow taller ceases several years after menarche. Interventions to improve maternal height must be intergenerational. The goal should be to provide optimal maternal nutrition during pregnancy and optimal infant feeding and care during infancy to promote linear growth in the first 2 years of life. About 13% of CLHNS sample women had a height of less than 145 cm. Short stature, which most likely represents early childhood linear growth retardation, was found to be the most important risk factor for LBW.

AC and weight change over time. Weight is more responsive to short term changes in energy balance related to pregnancy and lactation, diet and energy expenditure (e.g. seasonal or idiosyncratic differences in work time and intensity). AC was found to be independent of maternal pregnancy and lactation status, and was therefore judged a useful indicator of women's nutritional status throughout the reproductive years. AC increases with maternal age, and thus the age structure of the community should be considered when interpreting this indicator. Relatively small differences in value of AC used as a cutoff to identify undernourished women can result in large differences in estimated prevalence of low AC. Further research is needed to assess the sensitivity and specificity (in epidemiologic terms) of this indicator with respect to outcomes other than LBW.

The interpretation of low weight is limited in the absence of height data, since shorter women are more likely to be underweight based on a simple weight cut-off, but may have more favorable body composition. Low BMI is a better indicator of undernutrition than is weight, since it accounts for maternal height. Weight, and thus BMI increases with parity and age in the CLHNS sample. We suggest that the meaning of low BMI may change with age as well because a low BMI in an older woman poses a greater risk of a poor birth outcome than that same BMI in a younger woman.

To what extent are the results from this study generalizable to other developing countries? The CLHNS sample is low income, and about 75% urban. About 30% of sample women did not complete elementary school, and just over half had no education beyond 6th grade. The prevalence of LBW is substantially lower in Cebu than in some other Asian countries such as Bangladesh or India, but is still of concern. The dietary pattern in the Philippines is comparable to many other developing countries where a relatively low nutrient density staple (rice or corn) is consumed regularly with small amounts of vegetables and animal foods. Overall intakes of energy and nutrients fall below the RDA for a high percentage of women in the population. Results from our analysis of meal patterns and consumption of vitamin A rich foods are likely to be generalizable to other countries like Indonesia, where dietary patterns are similar. Despite lower overall energy intakes, the consumption of foods higher in β-carotene is higher in rural women because of their greater utilization of inexpensive locally grown leafy green vegetables. Greater consumption of these more inexpensive local foods should be encouraged to increase intake of β-carotene. However, the best way to promote adequate vitamin A status is likely to through fortification of commonly consumed foods.

The WHO Expert Committee on Physical Status: The Use and Interpretation of Anthropometry (1995) produced an excellent comprehensive review of all of the anthropometric indicators of nutritional status considered in the CLHNS sample. Our results from the studies described above are generally consistent with results presented in the WHO report, and support the use and interpretation of the anthropometric indicators of women's nutritional status. The CLHNS did not include an intervention component. The ultimate test of the indicators developed by the Subcommittee on Women's Nutrition will be in the context of interventions.

Based on our results, we recommend (1) a modification of the dietary intake indicators to include a quantitative component, (2) a further consideration of age-related changes in maternal weight and AC and the need for age-specific cutoffs to define risk, and (3) inclusion of lactating women when assessing low weight and BMI.

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APPENDIX A:
Recommended Dietary Allowances for Filipinos for Energy and Specific Nutrients[1,2], 1989 Edition.

<table>
<tr><th>NUTRIENTS</th><th>NPNL</th><th colspan="2">PREGNANT</th><th colspan="2">LACTATING</th></tr>
<tr><th></th><th></th><th>1st Tri</th><th>2nd-3rd</th><th>1st 6 mo</th><th>2nd 6 mo</th></tr>
<tr><td>Energy (kcal)</td><td>1900</td><td>1900</td><td>2200</td><td colspan="2">2400</td></tr>
<tr><td>Protein (g)</td><td>52</td><td>61</td><td></td><td>68</td><td>64</td></tr>
<tr><td>Iron (mg)</td><td>26</td><td colspan="2">41</td><td colspan="2">23</td></tr>
<tr><td>Calcium (mg)</td><td>500</td><td colspan="2">900</td><td colspan="2">900</td></tr>
<tr><td>Vitamin C (mg)</td><td>70</td><td colspan="2">80</td><td>105</td><td>100</td></tr>
<tr><td>Vitamin A (µgRE)</td><td>450</td><td colspan="2">475</td><td>775</td><td>725</td></tr>
<tr><td>Thiamin (mg)</td><td>1.0</td><td>1.0</td><td>1.3</td><td colspan="2">1.4</td></tr>
<tr><td>Riboflavin (mg)</td><td>1.0</td><td>1.0</td><td>1.6</td><td colspan="2">1.4</td></tr>
<tr><td>Niacin (mgNE)</td><td>18</td><td>1.0</td><td>21</td><td colspan="2">23</td></tr>
</table>

Note: While there is not an established RDA for fat, a minimum daily intake of 15-25 grams is recommended. The average daily intake of fat in the Philippines is 30 grams.

[1]Recommended Dietary Allowances for Filipinos: 1989 Edition, Food and Nutrition Research Institute, Department of Science and Technology.

[2]The NPNL (non-pregnant, non-lactating) values are given for a reference woman aged 20-39 who is moderately active.