Brief communication

Maternal energy and macronutrient insecurity in an ensete-corn staple village of Southern Ethiopia

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Abstract: Thirty three rural women from Shafina, a Sidama village, aged 25-48 years, were followed longitudinally for their dietary intake for eight rounds from april 1986 to march 1987. Food consumption was measured by the weighed food record technique. The mean habitual daily energy intake was 1833±563 kcal/day, 94% adequate compared to WHO recommendations. Carbohydrate provided 88% of the total daily energy which was 15% higher than the reference upper limit. Total fat intake was critically low contributing only 6.9% of the total daily energy, 54% lower than the lower reference limit reccomended for optimal nutritional health. Protein provided 5.7% of the total daily energy with unmet animal-origin protein requirement amounting to about 78%. Foods of ensete origin provided the largest proportion of the daily energy (46%) followed by cereals, mainly corn, (39.7%). Legumes and tubers provide 3.7% and 2.0% of the total daily energy, respectively. Intakes of all macronutrients and energy were relatively higher during the post-harvest months of December through February compared to the pre-harvest months of June through November. The results from this study indicate that maternal macronutrient and energy nutriture of the study population is both chronically and seasonally insecure. Moreover, the diet is characterised by very high carbohydrate, very low fat and low animal origin protein, which is not consistent with the recommended balance for optimal long term good health, productivity, and reproductive performance. Alleviation of the adverse consequences requires emphasis on the nutrition dimension by the education, health, agricultural, industrial, and other policy sectors within the country. [*Ethiop. J. Health Dev.* 1999;13(3):285-290]

Background

Mothers living in developing countries are often exhausted by the combination of pregnancy and child birth which can end in the loss of their lives. Low birthweight and/or immature and malnourished infants born to such women are vulnerable to life-threatening diseases and nutritional problems(1). Moreover, the productivity potential of women is critically hampered by undernutrition(2). The causes of maternal malnutrition are many ranging from inadequate food supply to food taboos and the physiological drain of child bearing and inequitable intra-household food distribution with the women generally eating last and least.

In many developing countries, especially in Africa, where climatic seasonality govern agricultural production, food availability is not constant throughout the year. These subsistence farming communities experience various food-insecure periods during each production year. Such seasonal variations in food production and fluctuations in prices of foods could be considered as contributing to transitory food insecurity of poor households, which over time, escalate into chronic food insecurity and nutritional deterioration(3).

In Ethiopia poor maternal nutritional status and high incidence of infection among mothers cause high perinatal and neonatal mortality. These problems are also responsible for low birth-weights which account for 10% of all live births(4). Chronic as well as transient forms of energy deficiency have also been reported to prevail among the Sidama in Southern Ethiopia (5,6). Although this varies with seasons, food stock, in the Sidama area is highest in December and lowest in July(8).

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However, there is lack of information as to the actual patterns of maternal macronutrient intakes. Macronutrients are broadly defined as those food components which are present in quantities of one gram or more in the daily diet, and which generally provide energy. They, therefore include protein, fat, carbohydrates,and most dietary fibers and alcohol. Such an information is useful to health, nutrition, and agricultural policies of Ethiopia.

The aim of this study was to investigate the extent of maternal macronutrient and energy insecurity in an ensete-corn staple zone of Ethiopia.

Methods

Thirty-three women who were non-pregnant but lactating, with a parity of 2-8, were randomly selected from a larger list of logistically potential subjects. These were followed from April 1986 to March 1987 (European Calendar) for a total of eight rounds. Dietary intake was monitored at about 45 day intervals by the weighed food record technique using an electronic balance (Terrailon digital scales, 5kg max., ± 5kg accuracy). Scales were regularly calibrated using standard weights. All food consumed was weighed by trained local girl-enumerators who followed the subjects for five consecutive days during each period. Food intake was converted to nutrient intakes using nutrient values from the Food Composition Table for use in Ethiopian (9). Habitual intakes are represented by the overall means. Body weight was measured using digital adult scales. Height was measured by Holtain stadiometer. Percent body fat was calculated from four skinfolds using the equations of Durnin & Womersley (10).

Data entry and analysis was performed using the SPSS/PC software (11). One way ANOVA with the tukey HSD test was employed to examine the significance of differences between means of different groups.

Results

Energy and macronutrient intakes: Table 2 summarizes energy, protein, fat, and carbo-hydrate intakes of the group during different periods. The mean total daily energy intake was 1833±563. ANOVA revealed an overall statistically significant difference p<0.05, between energy intakes during the various months. The difference between the maximum energy intake, 2015±585 kcal/day recorded during the post-harvest season of January/February and the minimum mean daily energy intake, 1694±543 kcal/day, recorded during the pre-harvest months of June/July was statistically significant (P<0.05).

Table 1: **Anthropometric characeteristics of subjects**

	Mean±SD
Age (yrs)	36±7
Weight (kg)	45.0±4.0
Height (m)	1.57±5.7
Body mass index (kg/m^2)	18.4±1.6
Mid upper arm circumference(cm)	23.8±1.1
Biceps skinfold (mm)	3.4±0.8
Triceps skinfold (mm)	8.9±2.3
Subscapular skinfold (mm)	10.4±4.2
Suprailliac skinfold (mm)	8.6±3.4
Percent fat	21.6±3.8

The habitual mean daily protein intake was 34.5±14.4 g/day. There was a statistically significant seasonal difference with a maximum of 43.0±15.8 g/day, during the month of December. This value was signifcntly higher than the minimum protien intake, 29.5±10.7 g/day, observed during the preharvest months of June/July.

The overall mean daily total fat intake was 16.8±9.5 g/day. Total fat intake also showed seasonal variability with the mean highest fat intake, 19.8±8.1 g/day, during the month of December, which was significantly higher than the lowest mean fat intake recorded during the pre-harvest months of June/July, 15.0±9.5 g/day ($p<0.05$).

Table 2: **Mean quantitative macronutrient and energy intakes, by months of observation**

Months	Energy (Kcal/day)	Protein (g/day)	Total fat (g/day)	Total carbohydrate (g/day)
Apr/May	1871±566	37.0±15.3	18.7±11.4	361±109
Jun/Jul	1694±543*	29.5±10.7*	15.0±09.5	335±106*
Jul/Aug	1847±573	32.7±10.2	18.0±10.4	375±113
Sep/Oct	1704±541	31.9±10.1	14.0±06.7	360±119
Oct/Nov	1808±442	32.4±10.9	18.0±09.5	365±091
December	1895±507	43.0±15.8*	19.8±08.1**	350±095
Jan/Feb	2015±585**	38.8±18.0	17.4±09.1	382±114**
March	1833±589	30.9±14.3	13.5±08.4*	355±113
Mean±SD	1833±563	34.5±14.4	16.8±9.5	360±133
P	0.000	0.000	0.000	0.018

* lowest intake ** highest intake

The overall mean total daily carbohydrate intake was 360±113 g/day which varied between a maximum of 382±114 g/day during the months of January/February and a minimum of 335±106 g/day during the months of June/July ($p<0.05$).

Contribution of macronutrients to total calorie intake: Table 3 sumarizes the contributions of various macronutrients to total daily energy intake during various months of observation. On average, total fat contributed about 6.5% of the total daily energy. The average contribution of protein to total energy was 5.4% ranging from 2.8% during July/August to a maximum of 7.8% in December. Total carbohydrate contributed 83% (December) to 94% (July/August) of the total daily energy intake, with the average being about 88.1±7.1%. Total fat provided 2.6% (September/October) to 9.5% (December) of the total daily energy intake.

Table 3: **Mean percentage energy contribution of macronutrients, by months of observation**

Months	Protein	Fat	Carbohydrate
Apr/May	6.6±2.7	8.6±7.1	84.8±6.5
Jun/Jul	5.6±2.4	7.1±4.7	87.3±6.4
Jul/Aug	2.8±2.6	3.0±03.4	94.2±5.3
Sep/Oct	3.0±2.2	2.6±2.7	94.4±4.4
Oct/Nov	4.8±2.1	7.8±4.6	87.3±6.2
December	7.8±3.6	9.5±4.7	82.8±6.7
Jan/Feb	6.6±3.2	6.5±4.0	86.9±5.8
March	6.0±3.0	6.7±4.4	87.3±6.2
Mean±SD	5.4±3.2	6.5±4.9	88.1±7.1
P	0.000	0.001	0.047

Calorie contribution of various food sources: Table 4 presents the contribution of various food groups to total daily energy intake in various periods. The overall average indicates that the two major sources of energy were ensete and corn contributing 46% and 39.7% of the total daily energy intake, respectively. Legumes and nuts provide about 3.7% while animal food sources, including milk, butter, eggs, and meats contribute only about 2% of the total calorie.

Ensete provided the highest proportion of energy (62.6%) during the months of June/July while cereals served as a major source, providing 49.9% of the total daily energy during September/October. The lowest proportion of energy from ensete, 36.6%, was contributed during September/October while the lowest cereal energy contribution, 22.2%, was recorded during June/July. Energy from tubers was practically absent during April/May and highest during July/August and September/October (6.6%). Milk and butter provided their highest energy contribution during June/July and December, (1.9%) and lowest during January/February.

Table 4: **Mean energy contribution (%) of various food groups, by months of observation**

Month	Cereal	Ensete	Tubers	Legumes/nuts	Milk/butter	Meat/poultry
Apr/May ‘86	36.8	48.6	0.0	2.9	1.5	0.7
Jun/Jul ‘86	22.2	62.6	0.2	3.7	1.9	0.0
July/Agu ‘86	48.1	39.4	6.6	0.3	1.5	0.4
Sep/Oct ‘86	49.9	36.6	6.6	0.6	0.7	0.5
Oct/Nov ‘96	44.1	43.5	4.5	0.9	0.8	0.3
December ‘86	40.1	42.8	1.1	6.7	1.9	1.1
Jan/Feb ‘87	33.0	48.7	1.1	7.6	1.0	0.1
March ‘87	30.1	55.3	0.2	6.9	1.5	0.2
Mean	39.7	46.0	2.0	3.7	1.5	0.4

Discussion

The average maternal BMI categorizes the group to chronic energy deficiency Grade I. The mean upper arm circumference is 5% higher than the minimum recommended (12). However, the mean bodyweight lies 1% below the minimum prepregnancy weight (13) associated with increased risk of delivering a small-for-gestational-age (SGA) infant. Hence, generally maternal nutritional status appear to be poor compared to international standards.

The major food items included in the diet are corn and ensete with their relative proportion varying with seasons. Overall, ensete is served as a major component of the diet and as a source of energy followed by cereals. This is consistent with a previous report on sidama population (14). Minor components of the diet include legumes and tubers which were not reported in the later study.

The habitual energy intake apeared to be relatively sufficient, about 94%, compared to the recommended energy requirement (15). This was 3% lower compared to the Southern Beninese study (16). However, there was a considerable seasonal fluctuation in the adequacy of maternal energy intake ranging from 85% adequacy during June/July to 101% during the months of January/Februray. Similar studies among the Arsi Oromos (17) indicate that energy adequacy varied seasonally in a range of 55-100% from the hungry to the harvest seasons.

For predominantly mixed vegetable diets in developing countries it is suggested that protein should contribute 10-12% since protein needs should be corrected for lower digestibility and an increased incidence of diarrhoeal diseases (18). Maternal protein intake among the present study population contributed much below the recommendations. The contrbution of animal protein was 78% lower than the lower recommended range. A previous report for an adjacent population (14) indicated that protein contributed 39% lower to total daily energy. Compared to figures reported for Southern Beninese women (16), the contribution of protein to total daily energy was 46% higher than the present study. These findings suggest that both quality and quantity of protein were below the standard recommended for optimal protein nutriture. There was also a significant seasonal trend in absolute protein intake.

Recommendations for fat vary depending, *inter alia*, on the prevalence of protein energy malnutrition and diet related non- communicable diseases (NCD). For the former, promoting increased consumption of fat is usually desirable while, for the latter decreasing it may be in order (18). Compared to the WHO recommendations, maternal fat intake among our subjects was critically low especially for pregnant and lactating mothers who have had marginal levels of nutritional status. The overall mean shows that the contribution of fat to the daily energy intake was 57% lower than what is recommended for women of child bearing age (17). The contribution of fat to total calories (6% vs. 6.5%) was consistent with those reported for an adjacent population (14). This finding might have implications for intervention work, such as vitamin A supplementation which requires relatively proper fat nutriture for the physiological effectiveness of the supplement.

Studies among Beninese women (16) reported 70% higher contribution of the daily energy compared to this study.

A significant seasonal trend has also been revealed for maternal fat intakes. Fat intakes were not lowest during the pre-harvest months of June/July unlike energy and the other macronutrients. This was due to the increased proportion of cereal-ensete ratio augumented by improved food variety and a relatively higher availability of milk and butter.

Carbohydrate intake was relatively high. The dietary energy contributed from carbohydrates was 17% higher than the upper limit of WHO recommendations (18) and 10% lower than those reported for Sidma adults (14). This indicates that carbohydrates remain to be the dominant source of energy. However, it probably tend to exhibit secular trends as cropping changes from ensete monocrop to ensete-cereal corpping. The Beninese study (16) reported 47% lower contribution of carbohydrate compard to the present study.

This study has demonstratd that there exist considerable chronic and seasonal macro-nutrient and energy insecurity. The seasonal deficiency probably has pulled down the mean annual intake which represented the habitual intakes of mothers in the study area. Such a low intake of fat and protein is not consistent with what is recommended for optimal long term good health. The study indicates that the quality of protein is substandard with very low animal protein intake which probably fails to fulfil the essential aminoacid requirements. In our study macronutrient and energy requirements for reproductively inactive women were used as references. This indicates that maternal intakes of protein and fat were too low to allow for normal reproductive demads. Complementing the dominant ensete diet with increased animal products, leguminous crops, and vegetables in a more consitent rather than seasonal fashion would be worthwhile to eliminate the likely harmful nutritional consequences.

Multisectoral efforts are required to alleviate overall nutritional problems in the country. Nutritional security could only be attained with the involvement of the educational, health, and agricultural sectors as well as others. Production should be increased to cover for the annual requirements of households so that seasonal fluctuation of dietary intake is controlled. Not only quantitative production but also food diversity should be the objective of intervention activities such as agricultural extension efforts. Efforts to impove the energy density of the overall dietary habit should be given due emphasis as the impacts of nutritional insecurity have both current and intergenerational dimensions. Crop diversity with small-scale animal husbandury, rather than monoculture, should be encouraged to fulfil protein and fat requirements. Women should also be empowered and educated to look after their diet and the diet of their off-springs. Moreovr, generation of scientific information and research outputs which create awareness to policy makers should be encouraged by all concerened bodies.

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References

1. UN ACC/SCN. Women and ntrition. ACC/SCN symposium report nutrition policy discussion paper no.6. October 1990.

2. Phillip P & Lipton M. How third world rural households adapt to dietary energy stress: The evidence and issues. Food policy review. International Food Policy resarch Institute. 1994.
3. Samson T. The effect of seasonal variatio of nutritional status on the physical work capacity of Ethiopian rural adults and the implication for productivity. Proceedings of the african regional conference on genetic Resources and rural Centered Development for African survival. Institute for Sustainable Development. Addis Ababa. August 1996. 4. Chambers R, Longhurst R, Pachey A editors. Seasonal dimensions to rural poverty. U.S.A. Frances printer Ltd.
1981.
5. UNICEF. Children and women in Ethiopia: a situation report. UNICEF. 1993.
6. Ferro-Luzzi A, Scaccini C, Taffesse S, Bekele A, Demeke T. Seasonal energy deficiency in Ethiopian rural women. Eur J Clin Nutr 1990;44 (suppl.1) 7-18.
7. Branca F, Pastore G, Demissie T, Ferro-Luzzi A. The nutritional impact of seasonality in children and adults of rural Ethiopia. Eur J Clin Nutr 1993;47:851-862.
8. Pastore G, Branca F, Demissie T, Ferro-Luzzi A. Seasonal energy stress in an Ethiopian rural community: an analysis of the impact at the household level. Eur J clin Nutr 1993;47:840-850 9. Food composition table for use in Ethiopia I. Ethiopian Nutrition Institute. 1968.
10. Durnin JVGA, Womersley J. Body fat assessed from body density and its estimation from skinfold thickness. Brit J nutr 1974;32: 77-97.
11. Statistical Package for Social Sciences (SPSS). MS-DOS version. 1990.

12. James WPT, Mascie-Taylor GCN, Norgan NG, Bistrian BR, Shetty PS, Ferro-Luzzi A. The value of arm circumference measurements in assessing chronic energy deficiency in third world adults. Eur J clin Nutr 1994;48:883-894.
13. Berklow R. editor. The Merck manual of diagnosis and therapy. U.S.A. Merk & Co. INC. 1992.
14. Selinus R, Gobezie A, Vahlquist B, dietary studies in Ethiopia III. Dietary patterns among the Sidama ethnic group. Acta Soc med upsal 1971;76:158-178.
15. Diet, nutrition and the prevention of chronic diseases. Tehnical Report Series 797. WHO, Geneva. 1990.
16. Chultnik WJ, Klaver W, Van Wijk H, Van Raaij JMA, and Hautvast JGAG. Body weight changes and basal metabolic rates of rural Beninese women during seasons with different energy intakes. Eur J Clin Nutr 1990;44 (suppl.1)31-40.
17. Selinus R, Gobezie A, Knutsson RE, vahlquist B. Dietary studies in Ethiopia: dietary studies among the rift valley Arsi Oromo. Am J Clin Nutr 1971;24:365-377.
18. WHO/FAO. Preparation of and use of food-based dietary guidelines. Report of a joint FAO/WHO consultation Nicosia, Cyprus. WHO Geneva. 1996.