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# MICRONUTRIENT STATUS AND URBAN LIFESTYLE IN BRAZIL

**Proceedings of a Workshop held in Rio de Janeiro, Brazil**
**24-26 April 1997**

## ORGANIZERS AND SCIENTIFIC EDITORS

**Nadia M.F. Trugo, Carmen M. Donangelo and Luiz C. Trugo**
Laboratório de Bioquímica Nutricional e de Alimentos
Departamento de Bioquímica, Instituto de Química
Universidade Federal do Rio de Janeiro

**Klaus Pietrzik**
Institut für Ernährungwissenschaft
Universität Bonn

## UNDER THE AUSPICES OF

- **Seção Regional (Rio de Janeiro) da Sociedade Brasileira de Alimentação e Nutrição (SBAN)**
- **Committee II/3 (Urbanization and Nutrition)- International Union of Nutritional Sciences (IUNS)**

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# WORKSHOP PROGRAM

- **Opening Session**

  Luiz C. Trugo (SBAN, Regional Secretary- Rio de Janeiro)
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  Klaus Pietrzik (Organizing Committee)

- **Micronutrient inadequacies and noncommunicable diseases**

  Dietary and environmental factors affecting micronutrient status
  Benjamin Caballero

  Folate and homocysteine in cardiovascular diseases
  Klaus Pietrzik

  Antioxidants and chronic diseases
  Virginia B.C. Junqueira

  Calcium and osteoporosis
  Carmen M. Donangelo

- **Nutritional trends in Brazil in relation to urban lifestyle**

  Nutrition transition
  Carlos A. Monteiro

  Changes of dietary habits
  Silvana P. de Oliveira

  Prevalence and risk factors of chronic/degenerative diseases
  Paulo A. Lotufo

- **Micronutrient status and urban lifestyle: selected studies in Brazil and comparison with other developing societies.**

  Micronutrient regulation in pregnant and lactating women from Rio de Janeiro
  Nadia M. F. Trugo

  Prevalence and risk factors in iron deficiency and anemia
  Sonia B. de Souza

  Zinc in urban infants and children from Brasília
  José G. Dórea

  Iron-deficiency anemia in children from Ribeirão Preto: characteristics and prevention
  José E. de Oliveira

  Micronutrients and urban lifestyle: lessons from Guatemala
  Noel W. Solomons

  Micronutrients and urban lifestyle in Indonesia
  Rainer Gross

- **Group Discussion**

  Discussion of Objectives by Work Groups.

  Presentation of the Work Groups and Plenary Discussion

  Closing Remarks

Benjamin Caballero
Johns Hopkins University- Center for Human Nutrition
615 North Wolfe Street
Baltimore, MD 21205-2179, USA

Carmen M. Donangelo
Laboratório de Bioquímica Nutricional e de Alimentos
Departamento de Bioquímica
Instituto de Química, CT bloco A
Universidade Federal do Rio de Janeiro
Cidade Universitária
21949-900 Rio de Janeiro RJ, BRASIL

José G. Dorea
Departamento de Nutrição
Universidade de Brasilia
CP 04322
70910-900 Brasilia DF, BRASIL

José E. Dutra de Oliveira
Departamento de Clínica Médica
Faculdade de Medicina de Ribeirão Preto
Universidade de São Paulo
Av. Bandeirantes, 3900
Ribeirão Preto- SP, BRASIL

Rainer Gross
SEAMEO-TROPMED Regional Center for Community Nutrition
University of Indonesia
PO Box 3852
Jakarta 10038, INDONESIA

Virginia B.C. Junqueira
Departamento de Bioquímica, Bloco 12 t.
Instituto de Química- USP
CP 26077
05599-970 São Paulo SP, BRASIL

Paulo A. Lotufo
Faculdade de Medicina-Hospital das Clínicas
Serviço de Clínica Geral/Divisão de Clínica Médica
PAmb- 4° andar- Bloco 6
Universidade de São Paulo
Av Dr Eneas Carvalho Aguiar 155
05403-000 São Paulo SP, BRASIL

Carlos A. Monteiro
Departamento de Nutrição, Faculdade de Saúde Pública
Universidade de São Paulo
Av Dr Arnaldo 715, Cerqueira César
01246-904 São Paulo SP, BRASIL

Silvana P. de Oliveira
Escola de Nutrição
Universidade Federal de Ouro Preto
Campus Universitário- Morro do Cruzeiro
35400-000 Ouro Preto MG, BRASIL

Klaus Pietrzik
Abt. Patophysiologie der Ernährung des Menschen
Institut für Ernährungswissenschaft
Universität Bonn
Endenicher Allee
D-53115 Bonn 1, GERMANY

Noel W. Solomons
CESSIAM -Center for Studies of Sensory Impairment, Aging and Metabolism
Hospital de Ojos y Oídos "Dr. Rodolfo Robles V".
Diagonal 21 y 19 Calle, Zona 11
Guatemala City, 010111, GUATEMALA

Sonia B. de Souza
Departamento de Nutrição, Faculdade de Saúde Pública
Universidade de São Paulo
Av Dr Arnaldo 715, Cerqueira César
01246-904 São Paulo SP, BRASIL

Luiz C. Trugo
Laboratório de Bioquímica Nutricional e de Alimentos
Departamento de Bioquímica
Instituto de Química, CT bloco A
Universidade Federal do Rio de Janeiro
Cidade Universitária
21949-900 Rio de Janeiro RJ, BRASIL

Nadia M. F. Trugo
Laboratório de Bioquímica Nutricional e de Alimentos
Departamento de Bioquímica
Instituto de Química, CT bloco A
Universidade Federal do Rio de Janeiro
Cidade Universitária
21949-900 Rio de Janeiro RJ, BRASIL

# Archivos Latinoamericanos de Nutricion

## Organo Oficial de la Sociedad Latinoamericana de Nutrición

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## Proceedings of the Workshop

## MICRONUTRIENT STATUS AND URBAN LIFESTYLE IN BRAZIL

# EDITORIALS

## "A TIMELY LOOK AT MICRONUTRIENTS AND URBANIZATION IN BRAZIL"

Demographic, epidemiologic and nutrition transitions, related to global socioeconomic changes, have been identified recently in several developing countries in which conditions of wealth and development coexist with those of poverty and underdevelopment. In Brazil, a rapid urbanization process occurred during the last few decades, with about 75% of the population currently living in urban areas. This has resulted in fundamental changes in the processes of provision of and access to food and has lead to problems of concurrent *under-* and *over-*nutrition. In many urban/metropolitan areas of Brazil a remarkable decline in undernutrition has been observed, whereas there is an increase in problems of dietary excess and in morbidity and mortality rates from noncommunicable diseases. This is especially true for cardiovascular diseases, which affect both the poor and the rich. With the transition in dietary patterns and health conditions, possible deficits in micronutrients may become evident, resulting either in marginal deficiencies (limiting the potential to achieve optimal function and health), in classical clinical deficiencies (with pathological manifestations) or both. Specific micronutrient inadequacies may also increase the risk of contracting certain chronic noncommunicable diseases. In general, data on micronutrient status in major Brazilian cities are scarce and fragmented and the impact of micronutrient inadequacies as risk factors for noncommunicable diseases is unknown.

Responding to the present reality of urbanization nd nutrition transition in Brazil, a workshop entitled "Micronutrient Status and Urban Lifestyles in Brazil" was held in Rio de Janeiro in April 1997 under the auspices of the regional branch of *Sociedade Brasileira de Alimentação e Nutrição* (SBAN) and of the Committee II/3 on Urbanization and Nutrition of the International Union of Nutritional Sciences. The general concerns of this Workshop are related to those of a previous International Workshop on "Modern Lifestyles and Micronutrient Deficiency" held in Indonesia in 1995, with the general objectives: 1) "to identify research opportunities" and 2) "to develop new prophylactic and preventive strategies to reduce micronutrient deficiencies in middle and high income groups in South East Asia." (Proceedings published in the Asia Pacific Journal of Clinical Nutrition, vol 5, no. 3, 1996). In many ways, the realities of urbanization and demographic, economic and nutrition transitions in South East Asia present similarities with those of Latin America in general, and Brazil in particular.

The Workshop in Rio aimed at: 1) evaluation of inadequate micronutrient status in major cities; 2) evaluation of its possible relation with noncommunicable diseases; and 3) identification of strategies for prevention of micronutrient inadequacies and of research priorities. Presentations were organized into sections, acquainting the participants with the biological background of the relationship between micronutrient inadequacies and noncommunicable diseases, and with the nutritional and epidemiological trends in Brazil in relation to urbanization. These were followed by a section in which selected studies in Brazil regarding micronutrient status in urban areas were presented along with an overview of the subject in other developing countries, specifically Guatemala (where urban populations are still not predominant), and Indonesia (where a recent and substantial urbanization has occurred).

As an outcome of the group discussions, and considering the available evidences, an urgent need to obtain systematic and comprehensive information on micronutrient status in urban areas of Brazil was recognized. This should be based on a common protocol applied at various urban sites throughout the nation. Descriptive population studies on distribution of biochemical and functional indices and of dietary intakes of micronutrients are required to evaluate the distribution patterns and prevalence of specific micronutrient inadequacies in small, medium and large cities of different Brazilian regions. These studies will be useful for planning case-control studies that relate specific micronutrient inadequacies with morbidity/mortality rates from noncommunicable diseases. Expansion of the data on composition of nutrients and bioactive phytochemicals in Brazilian foods is a requirement for adequate evaluation of dietary effects. Regarding micronutrient deficiencies and their classical consequences, research priorities should be on iron, zinc, and vitamin A in infants and preschool children; and on iron, folate, calcium and vitamin A in pregnant and lactating women. As for the relation between micronutrient status and chronic-degenerative diseases, research should focus on folate/antioxidant micronutrients and cardiovascular diseases, and on calcium and osteoporosis. Strategies for improvement of urban micronutrient status such as food fortification, supplementation and development of novel foods, should be adapted to specific needs. Besides goverment programs, free market strategies and alternative distribution methods could be developed.

This Workshop was a valuable opportunity to bring together investigators actively pursuing research in urban nutrition and micronutrients into a forum for discussion of these issues within the *Brazilian* context. We hope that this first experience will be followed by many others, and will open new research opportunities for a better understanding, and the eventual alleviation, of nutritional problems in Brazil.

**Luiz C. Trugo, PhD**

Regional Secretary (Rio de Janeiro) - SBAN

**Nadia M.F. Trugo, PhD**

**Carmen M. Donangelo, PhD**

**Klaus Pietrzik, VMD**

Co-Organizers of the Workshop

# "THE I.U.N.S. GAINS FROM PARTICIPATION WITH BRAZILIAN COLLEAGUES' DEEPENING INTEREST IN URBAN NUTRITION"

It has been a privilege and an honor for the Committee II/3 of the International Union of Nutritional Sciences on Urbanization and Nutrition to have been a co-sponsor of the Workshop on Micronutrient Status and Urban Life Style in Brazil. It was from professionals who now constitute this Committee that the first strong signals of just how abandoned had been the focus on urban nutrition in developing countries. They also signaled how very complex and dynamic would be the interactions among the various social strata (upper, middle, and lower) and levels of organization (metropolitan area, city, district, neighborhood, household, individual). Subsequently, other seminal thoughts have been mobilized on urban nutrition. Dr. Barry Popkin (also a member of the Committee), in his formulation of the thesis of "nutrition transition," draws our attention to situations in which both diseases of deficiency and of excess are simultaneously important in the public health scenario. Being sedentary may make one gain excess weight, putting the individual at risk for obesity, hypertension, and diabetes.

One must look at the directions in which micronutrient intakes might go as a consequence of low-income people's adopting a more sedentary lifestyle. They will eat less food and thus consume fewer micronutrients. The title of a book edited by Klaus Pietrzik, *Modern Lifestyles, Lower Energy Intakes and Micronutrient Status*, makes an important point in its title, itself. If diets maintain the same nutrient density, lower energy requirements will oblige persons to consume lower total amounts of the micronutrients. The final step is to recognize the potential for synergism between a relatively deficient micronutrient intake and exposure to initiating and promoting factors for chronic diseases; being sedentary may make one eat less food and consume fewer nutrients, and - despite that - gain excess weight. The obese individual's added risks for hypertension, diabetes and osteoarthritis are perhaps exacerbated by relatively lower micronutrient status, thus closing the vicious cycle.

The history of Brazil has been one of notable prevalences of undernutrition. In recent decades, a massive shift in the concentrations of population has occurred, with 73% of its citizens now living in cities. With the possible exception of the slums of Calcutta, the *favelas* of Brazil have become emblematic of urban poverty. Clearly the situations in the North and Northeast cities such as Fortaleza, Belem, Recife, and Salvador might be more precarious, allowing for persistence of both nutritional anemia and other deficiency states of other trace elements and vitamins. The consensus from the data presented at the Workshop was that only iron deficiency, among the various micronutrients, is widely endemic to the point of causing deficiency syndromes within the large cities of the south of Brazil (Sao Paulo; Rio de Janeiro; Brasilia). However, when considerations of other outcomes - such as neural tube defects or elevated circulating homocysteine - are raised, the cut-off for a desirable folate status may be much higher than when traditional nutritional criteria are applied. Brazil's diet may make all urban populations vulnerable for these adversities.

Both of us have collaborated with Brazilian institutions and have published papers based on urban populations in Brazil. We see now that a critical mass of investigators have been doing population research in the metropolises of Brazil, and are now beginning to focus on the paradigm of chronic disease. Confronting diet and health relationships prompted many of those in attendance to call for an immediate effort to train Brazilian professionals in the modern nutritional epidemiological methods. In the end, this meeting in Rio may have done more than bring a group of scientists and students together or to bring a collection of manuscripts together; indeed, it may have brought the stimulus to bring a constituency together to carry public health and community nutrition research to the most relevant next level. If this will have been the outcome of this Workshop, then the IUNS Committee II/3 can really be proud of any role it has played in catalyzing this new departure.

**Noel W. Solomons, MD**

Chair, IUNS Committee II/3

**Rainer Gross, PhD**

Past Chair, IUNS Committee II/3

ARCHIVOS LATINOAMERICANOS DE NUTRICION
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# Environmental factors affecting nutritional status in urban areas of developing countries

*Benjamin Caballero and Sharon Rubinstein*

Center for Human Nutrition, Johns Hopkins School of Public Health Baltimore, MD, USA

**SUMMARY. Environmental factors affecting nutritional status in urban areas of developing countries.** The demographic and economic transition that many developing countries are undergoing is producing important changes in diet and lifestyle that greatly impact on disease risks. Among the risk behaviors associated with socieconomic transition and urbanization are excessive dietary fat intake, sedentary lifestyle, smoking, and environmental contamination. Combined with a reduced infant mortality and increased life expectancy, those risk factors lead to an increasing prevalence of chronic diseases like non-insulin dependent diabetes and coronary heart disease. This disease profile is a relatively new phenomenon in developing countries, where health programs have traditionally focused on "acute" interventions such as immunization or oral rehydration. A new approach will be needed to address chronic diseases, which frequently demand a life-long and technically complex medical management, and may have significant impact on the quality of life and productivity of the population. Efforts to address this situation should focus on a) expanding the information base on diet, nutritional status and lifestyle changes in populations migrating to urban areas; b) developing and evaluating approaches for improving diet quality in urban populations, including fortification and community-based supplementation programs; c) understanding better the social and behavioral determinants of nutritional status in the urban poor; and d) defining the role of the food industry and of agricultural production for improving the quality of the food supply in urban areas.

## INTRODUCTION

The demographic and economic transition that many developing countries are undergoing is also associated with important changes in diet and lifestyle that greatly impact on disease risks. Among the risk behaviors associated with socioeconomic transition and urbanization are excessive dietary fat intake, sedentary lifestyle, smoking, and environmental contamination. Combined with a reduced infant mortality and increased life expectancy, these risk factors lead to an increasing number of adults and elderly affected by chronic diseases like non-insulin dependent diabetes and coronary heart disease (1). This disease profile is a relatively new phenomenon in developing countries, where health programs have traditionally focused on "acute" interventions such as immunization or oral rehydration. A new approach will be needed to address chronic diseases, which frequently demand a life-long and technically complex medical management, and may have a significant impact on the quality of life and productivity of the affected population (2). Although non-communicable chronic diseases are still not the dominant cause of death in the poorest countries, their prevalence is increasing at a much higher rate than in industrialized countries. Worldwide, the two leading causes of death are ischemic heart disease and cerebrovascular disease, and almost 60% of these occur in the developing world (3).

In Latin America, over 80% of the population is considered urban (4). This rapid migration occurred in a relatively short period of time, and did not result from a gradual socio-economic development of rural society, but rather primarily from the pressure of external factors determined by world economic forces (5). A similar process is occurring in several Asian nations, resulting in a shift to the right of the population BMI distribution (Figure 1, ref. (6) ).

## THE NUTRITIONAL ECOSYSTEM IN RURAL AREAS

The nutritional ecosystem in rural areas is characterized by:

- A predominance of vegetable protein sources, usually with low micronutrient content.
- Seasonality of food availability, which causes important cycling in body weight in adults and in growth velocity in children.

Availability of certain items that may be major sources of micronutrients will also be reflected in fluctuations in nutrient status throughout the year.

- A food market system with minimal influence from marketing and commercialization techniques, but strongly affected by agricultural and food aid programs.
- High energy needs relative to intake. Physical activity patterns include farming, transporting water, and raising animals for consumption. Children may have additional energy demands as they may be incorporated into the workforce at an early age.
- High nutrient losses relative to intake, due to gastrointestinal diseases, particularly parasitoses and acute diarrhea of bacterial or viral etiology.

As a result of these unfavorable nutritional and dietary conditions, a process of adaptation takes place, consisting of reduction of growth rate in children, and a reduction in energy expenditure (reduced productivity and leisure activities). This adaptation leads to functional impairment and eventually to irreversible changes.

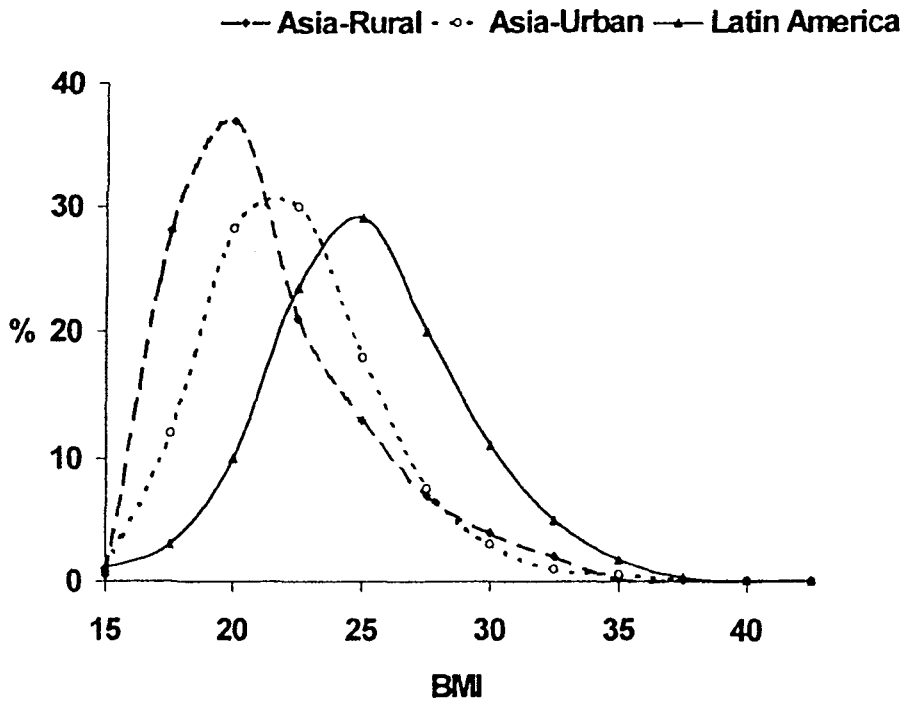
Environmental contaminants are also a factor in determining nutritional status in rural areas. Carbon monoxide is generated by indoor heating through wood fire, and it is also transferred to infants via breast milk. Use of pesticides, particularly those with residual deposition in adipose tissues of animals and humans, may pose an added risk to health and interfere with nutrient utilization or increase requirements for certain essential nutrients (7).

## THE NUTRITIONAL IMPACT OF URBAN MIGRATION

Migration to urban areas is usually associated with major changes in dietary and nutritional conditions. Socioeconomic change include changes in the type of employment, and the loss of the survival system

FIGURE 1

Comparison of population distribution of body mass index (BMI) in three regions of different degree of urbanization. Data from International Clinical Epidemiology Network (INCLEN) (6)




developed over many years in the rural environment. The family nucleus is frequently disassembled in the city, with parents living separately because of work, and children spending long hours with no supervision, either locked at home or in the street. The group (clan) approach to survival in rural areas is replaced by the city's focus on the individual and the competitiveness in the street or the workplace. Some of the nutritional consequences of these changes are summarized in Table 1, and include:

- Eating behavior is less centered in the home and family, and more outside the house. Street food vendors become a major source of daily nutrient intake. This usually means cheap, low-quality foods, perhaps providing equal or more calories than rural foods but with no significant improvement in micronutrient content. As the number of meals consumed outside the house increases, the impact of intrahousehold food distribution is substantially reduced, offering little opportunity to prioritize allocation, which in many cultures tend to favor the child.
- The market forces for food commercialization become a significant factor in food availability and eating behavior. The influence of the media in food preferences is well recognized.
- Environmental contaminants of significance include lead, which enhances the risk of nutritional anemia, and several industrial pollutants. Tobacco use may be more common, aided by intense advertising and ready availability. Smoking increases the requirements for antioxidant micronutrients, and increases the risk of intrauterine growth retardation.
- Illegal drug trafficking and drug addiction are eminently urban phenomena. Victims are primarily in lower socioeconomic class, whether they are users or not, because of the intense use of slums for drug traffic operations and the frequently more aggressive involvement of police in low-income neighborhoods.
- Alcoholism is not uncommon in rural areas, but it may be more prevalent in some urban settings.
- Limited surveys tend to indicate that physical activity is reduced in the city relative to rural areas, but with much more variability. Low-energy output work is much more common in the urban workplace, and the energy expenditure required for basic survival tasks (food and water procurement, transportation) is usually much lower in the city than in the rural environment.

## HEALTH AND NUTRITION IMPLICATIONS

As noted, one consequence of the changes enumerated above is a trend toward increased BMI in the overall population (6). Although carefully controlled comparisons of rural and urban dietary intake are inherently difficult to perform, a rough estimate of urban-rural differences in dietary nutrient composition can be obtained from some of the reported comparisons. We took the food consumption data published by Alarcon et al. (8) and analyzed it using the U.S. food composition database to compare the nutrient content of diets consumed by low-income families in urban and rural Guatemala. The results show that the urban diet is higher in calories, proteins, carbohydrates and fat content (Table 2). The urban diet, nevertheless, provided similar or less amounts of vitamin A, panthotenic acid, folic acid and ascorbic acid. Although the use of a generic food composition database may not reflect the actual nutrient content of food items, it nevertheless permits a restricted comparison between these two diets. The results suggest that the dietary transition towards an urban pattern of food intake may not necessarily improve

micronutrient deficits found in the rural diet.

The fact that the urban diet provides more calories, along with a reduced energy expenditure in the urban lifestyle, may lead to excessive weight gain and an increased prevalence of obesity. Indeed, there is evidence that the rate of obesity is increasing in most urban areas of the developing world (9, 10). Furthermore, some observational studies suggest that chronic malnutrition (stunting) early in life may constitute an additional risk factor for obesity in older children and adolescents (11, 12).

The etiology and mechanisms of the increased prevalence of obesity in less developed countries are still unclear, but lifestyle and diet are likely to be important factors. The association between poverty, malnutrition and risk of obesity has been a focus of interest. For many years, obesity in developing countries was a problem of the higher socioeconomic levels, but this trend is progressively reversing to a developed country model, where the condition is more common in lower socioeconomic strata. Among the socio-economic and cultural factors explaining this prevalence are less opportunities for recreational physical activities, less ability to purchase low-fat, healthier foods, and less exposure to educational messages about healthy eating practices. The possible contribution of genetic factors has also been explored. One hypothesis is that poverty and its associated food scarcity early in life may cause a

TABLE 1
Dietary and lifestyle difference between urban and rural environments

| | Urban | Rural |
|---|---|---|
| Energy Sources | Refined grains (rice, wheat)<br>Sugar<br>Fiber: low | Corn, millet<br>Unrefined sugar<br>Complex carbohydrates<br>Fiber: high |
| Protein Source | Animal | Vegetal |
| Fat | Higher % of calories<br>Animal fat<br>More saturated | Less % of calories<br>Vegetable oils<br>Less saturated |
| Processed foods | Common | Uncommon |
| Eating behavior | Eating out<br>Fast foods | Family/home |
| Breast feeding | Low | High |
| Determinant of diet | Food industry<br>State regulations | Food production<br>Food distribution |
| Role of women | Workforce | Family |
| Type of work | Capital-intensive<br>(low EE) | Labor-intensive<br>(high EE) |
| Stress | High | Variable |

permanent imprinting of the metabolic system toward a higher efficiency of energy utilization, allowing the individual to adapt to low-calorie intake. When dietary energy becomes plentiful, this higher efficiency will result in more excess calories been deposited as body fat. This theory, named the "thrifty gene" hypothesis, was put forward to explain the extraordinarily high rates of obesity among the Pima Indians of Arizona, in the United States, where almost 80% of the adult population is overweight (13). However, genetic factors are unlikely to explain the rapid rise in obesity rates in developing countries, which occurred in a relatively short time span. In addition, there is evidence that environmental factors play a major role in the rise in obesity among American Indians such as the Pimas (14), and it is likely that the same is true in developing countries.

The prevalence of obesity in children is also increasing in urban areas of the developing world (15). It is possible that children who reach school age with a deficit in longitudinal growth and find an improved availability of dietary calories (from a low-quality diet) do increase their rate of body weight gain, but do not catch-up in longitudinal growth. Such situation would tend to result in an increase in body mass index. It is also likely that these urban diets may be only marginally adequate or even inadequate in growth-related micronutrients such as zinc, which will impair longitudinal growth but may not necessarily inhibit body fat

TABLE 2
Comparison of nutrient content of urban and rural diet (Guatemala)

| | URBAN | RURAL |
|---|---|---|
| Calories (kcal) | 2395 | 1538 |
| Protein (g) | 74.6 | 51 |
| Carbohydrates (g) | 406 | 309 |
| Dietary fiber (g) | 52.2 | 52.1 |
| Total fat (g) | 61.7 | 26.7 |
| Saturated fat (g) | 16.3 | 6.9 |
| Monosaturated fat (g) | 19.9 | 8.73 |
| Polysaturated fat (g) | 18.6 | 7.96 |
| Cholesterol (mg) | 314 | 136 |
| Vitamin A total (RE) | 772 | 901 |
| Vitamin A carotene (RE) | 652 | 852 |
| Vitamin A preformed (RE) | 121 | 49.1 |
| Vitamin C (mg) | 74 | 69.8 |
| Vitamin E (mg) | 21.2 | 8.82 |
| Panthotenic (mg) | 5.12 | 7.48 |
| Thiamin (mg) | 1.82 | 1.94 |
| Riboflavin (mg) | 1.52 | 1.05 |
| Niacin (mg) | 21.3 | 18.1 |
| Pyridoxine (mg) | 1.92 | 1.88 |
| Cobalamin (mg) | 3.69 | 1.63 |
| Folacin (mcg) | 335 | 465 |
| Calcium (mg) | 370 | 140 |
| Copper (mg) | 1.45 | 0.995 |
| Iron (mg) | 17.8 | 10.2 |
| Magnesium (mg) | 528 | 397 |
| Phosphorus (mg) | 1543 | 1169 |
| Potasium (mg) | 2472 | 2831 |
| Selenium (mg) | 1047 | 38.7 |
| Sodium (mg) | 863 | 294 |
| Zinc (mg) | 14.8 | 8.91 |

Food intake data from Alarcon et al. (8). Nutrient content calculated from U.S. food composition database.

accumulation.

Ideally, the diagnosis of obesity in children requires an assessment of body fatness, and not only of body weight. Many developing country children with body mass index above the reference cutoff point for obesity may not have a true excess of body fat, but rather an impairment in stature associated with a normal weight. For example, a 9 year-old child with body weight in the 50th 70th percentile and height in the 5th-10th percentile for age, will have a body mass index above the 85th percentile, which is the accepted cutoff point for overweight. It is unclear whether this child has a true excess body fat for his/her age, and if so, whether the risk for chronic diseases associated with that BMI is comparable with those defined for developed country populations.

The growth pattern of urban children shows a slight improvement relative to the rural environment. Comparisons in Venezuelan children by Lopez Blanco et al (16) show that while there is a higher percentage of rural children that are malnourished (below the 10th percentile) there is a higher prevalence of overweight children in the urban area (above the 90th percentile) (Table 3).

The contribution of urban migration to coronary heart diseases can be inferred from the dramatic increase in mortality from heart diseases in still poor countries undergoing rapid urbanization. Statistics from PAHO show that attributed mortality from cardiovascular diseases is increasing at a higher rate in poor countries, compared with developed countries where incidence is stable or decreasing (4).

## PROGRAMMATIC IMPLICATIONS

Health and nutrition in urban areas is a relatively new focus of concern, and still few public health programs adequately address the changing needs called for by urbanization. A major contribution of the scientific community would be to provide a solid foundation to define priorities and modify old programs in order to address the needs of the urban poor (10). Some of the key issues to be addressed should include:

1. Patterns of dietary intake in urban populations
   - Content and bioavailability of micronutrients
   - Nutrient interactions: Calcium, iron and lead
   - Oxidative load (from diet and environment)
2. Nutrient balance and output
   - Changes in nutrient requirements: increased demands of some micronutrient due to increased oxidative load, environmental toxins, etc. Impact of changes in energy balance on requirements of micronutrients.
   - Changes in nutrient losses.

In addition, more general programmatic areas would need to be revised or developed. Among these tasks we should include:

1. Improve the database on dietary intake and nutritional status by obtaining longitudinal information on changes in diet, nutritional status and lifestyle on populations migrating to urban areas.
2. Define strategies for improving diet quality in urban populations, including fortification and community-based supplementation programs.
3. Identify the social and behavioral determinants of nutritional status in the urban poor.
4. Define the role of the food industry and of agricultural production on improving the quality of the food supply in urban areas.
5. Document the role of existing programs, particularly food distribution and supplementation programs created to combat malnutrition, on current dietary trends in low-income urban populations. Identify the changes needed in existing nutrition programs to adapt to the nutrition transition, and develop new components to address emerging diet-related conditions.

TABLE 3
Growth of children in rural and urban areas

| | **WEIGHT/ HEIGHT** | | **HEIGHT/ AGE** | | **WEIGHT/ AGE** | |
|---|---|---|---|---|---|---|
| | URBAN (%) | RURAL (%) | URBAN (%) | RURAL (%) | URBAN (%) | RURAL (%) |
| $> 90^{TH}$ PCT. | 12.01 | 8.42 | 6.75 | 4.83 | 9.06 | 5.09 |
| $10^{th} >< 90^{th}$ PCT. | 78.27 | 78.38 | 76.76 | 68.14 | 72.93 | 67.21 |
| $<10^{th}$ PCT. | 9.72 | 13.19 | 16.46 | 27.02 | 17.99 | 27.69 |

Data from Lopez-Blanco et al. (16).

The potential impact of chronic non-communicable diseases on the health and economic progress of developing countries is enormous. Loss of quality of life and productivity, as well as increasing demand for complex medical care will seriously tax the health care system and society at large. Furthermore, the crisis affecting the technology-driven medical care of industrialized countries is sufficient to discourage any attempts to imitate that model to address this problem. Only a prevention-focused health policy may have a positive impact, by reducing the rate of these diseases. Toward this goal, diet and nutrition efforts should clearly play a major role.

## REFERENCES


1. Popkin, B. The nutrition transition in low-income countries: an emerging crisis. Nutr Rev, 52:285-298 1994.
2. Murray, CJL & Lopez, AD. The Global Burden of Disease. Cambridge, MA: Harvard University Press, 1996.
3. Editorial. From what will we die in 2020? Lancet, 349:1263, 1997.
4. PAHO. Health Conditions in the Americas. Washington, D.C. Pan American Health Organization, 1996.
5. Albala, C & Vio, F. Epidemiological transition in Latin America: the case of Chile. Pub Health, 109: 431-442, 1995.
6. INCLEN. Body mass index and cardiovascular disease risk factors in seven Asian and five Latin American centers: data from the International Clinical Epidemiology Network (INCLEN). Obesity Res, 4: 221-228, 1996.
7. Caballero, B. Nutritional implications of dietary interactions: a review. Food Nutr Bull, 10: 9-20, 1988.
8. Alarcon, JA & Adrino, FJ. Diferencias urbano-rurales en la inges ta de alimentos de familias pobres de Guatemala. Arch Latinoamer Nutr, 51: 327-335, 1991.
9. Pena, M & Freire, WB. Informe de la reunion tecnica sobre obesi dad en la pobreza: situacion de America Latina, 1996. (abst)
10. WHO. Diet, Nutrition, and the Prevention of Chronic Diseases. Geneva: World Health Organization, 1990.
11. Sawaya, AL; Dallal, G; Solymos, G; de Souza, MH; Ventura, ML & Roberts, SB. Obesity and malnutrition in a shantytown popula tion in the city of Sao Paulo, Brazil. Obesity Res, 3:107S-115S, 1995.
12. Popkin, B; Richards, MK & Monteiro CA. Stunting is associated with overweight in children of four nations that are undergoing the nutrition transition. J Nutr, 126: 3009-3016, 1996.
13. Harrison, GG & Ritenbaugh, CK. Obesity among North American Indians. In: Bjorntorp P, Brodoff B ( eds). Philadelphia, Lippincott Co. 1992, p. 610-618.
14. Ravussin, E; Valencia, ME; Esparza, J; Bennett, PH & Schulz, LO. Effects of a traditional lifestyle on obesity in Pima Indians. Diabetes Care, 17:1067-1074. 1994.
15. Arteaga, H; Dos Santos, JE & Dutra de Oliveira, JE. Obesity among schoolchildren of different socioeconomic levels in a devel oping country. Intl J Obesity, 6: 291-297, 1982.
16. Lopez-Blanco, M; Landaeta Jimenez, M & Mendez Castellano, H. Urban-rural differences in the growth status of Venezuelan chil dren. Am J Hum Biol, 4:105-113.1992.

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# The role of homocysteine, folate and other B-vitamins in the development of atherosclerosis

*Klaus Pietrzik and Anja Brönstrup*

Institute of Nutritional Science, Department of Pathophysiology of Nutrition
University of Bonn, Bonn, Germany

**SUMMARY. The role of homocysteine, folate and other B-vitamins in the development of atherosclerosis.** Recently, elevated homocysteine blood concentrations have been identified as an independent risk factor for the development of atherosclerotic lesions. The amino acid homocysteine is metabolized in the human body involving the vitamins folic acid, B12 and B6 as essential cofactors and coenzymes, respectively. There is an inverse relationship between the status of the relevant B-vitamins and the homocysteine blood concentration. Supplementation of these vitamins results in a significant reduction of the homocysteine level. Nutritive amounts seem to be sufficient to obtain this reduction, even in the case of elevated homocysteine levels.

## INTRODUCTION

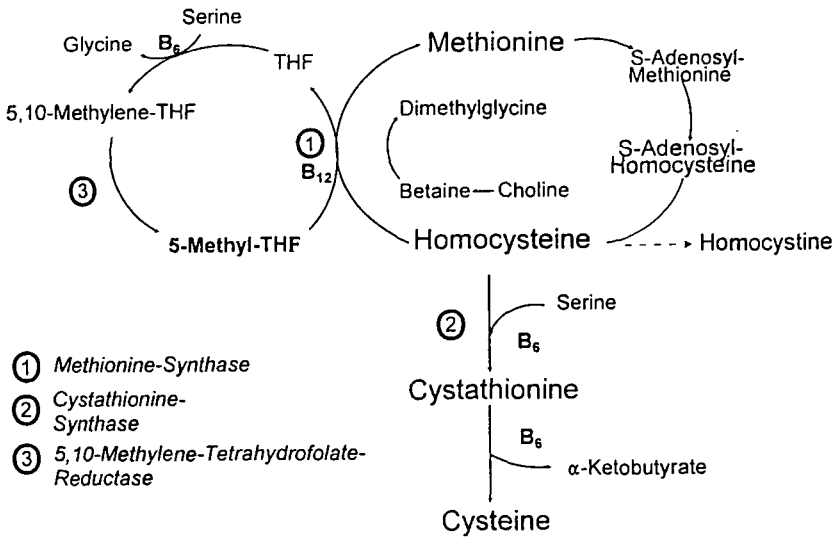
Atherosclerotic diseases like coronary heart disease (CHD) and stroke still are the leading causes of death in the Western World. A variety of risk factors have been associated with the development of atherosclerotic diseases. Among them are hypertension, hypercholesterolemia, smoking and hyperlipidemia, which together account for about 50% of the cases of CHD. However, there must be additional reasons for CHD, since half of the cases cannot be explained by the presence of the established risk factors.

For several years, the amino acid homocysteine has been discussed as a potential risk factor for the development of atherosclerotic diseases. The discovery of homocystinuria in 1962 draw first attention to the association between elevated homocysteine blood levels and the occurence of vascular diseases. In this inborn error of metabolism, homocysteine is accumulated in the blood. This leads to partial oxydation of homocysteine to homocystine, which is then excreted via the urine. If untreated, affected individuals develop large atheroslcerotic lesions as well as thromboembolic events early in life and often die before the age of 30 from stroke or myocardial infarction.

## METABOLISM OF HOMOCYSTEINE

In the organism, homocysteine is exclusively derived from the essential amino acid methionine and is not taken up via the diet. Homocysteine can be remethylated to methionine or catabolized to cys-

FIGURE 1
Metabolism of homocysteine



teine (Fig. 1).Three vitamins of the B-group are involved in the metabolism of homocysteine: Folic acid as 5-methyl-tetrahydrofolic acid (5-methyl-THF) is the donor of the methyl group required for the remethylation reaction. Vitamin B12 functions as coenzyme in this reaction. The formation of cysteine requires 2 enzymes for which vitamin B6 in the form of 5-pyridoxal-phosphate (PLP) serves as coenzyme.

## RELEVANCE OF HOMOCYSTEINE FOR THE DEVELOPMENT OF ATHEROSCLEROSIS

From observations of extendend and early-onset vascular lesions in homocystinuric patients the question arose if homocysteine levels as seen in the general population would be associated with the development of atherosclerosis. Subsequently, several studies examined the association between (moderately) elevated homocysteine levels and the risk for atherosclerosis. In case-control studies, a high percentage of patients with CHD showed elevated homocysteine levels. Clarke et al.(1) found high homocysteine levels in 42% of patients with cerebrovascular diseases, 28% of patients with peripheral vascular diseases and 30% of cases with coronary vascular diseases. However, none of the healthy control persons showed an elevation of homocysteine blood concentration. Others found that the mean homocysteine level of patients with coronary, peripheral and cerebrovascular diseases was significantly higher than that of comparable controls (2-9).

Despite differences in study design, there is a striking agreement between the numerous studies on this topic. So far, there are 38 studies investigating the association of elevated homocysteine levels and risk for atherosclerotic diseases. Of these 38 studies, 34 did find such an association (10). It was also shown that elevated homocysteine levels are an independent risk factor for the development of atherosclerotic diseases (1,7,9,11,12). In other words, even in the absence of other, established risk factors like hypertension, smoking or hypercholesterolemia an increase in homocysteine concentration alone can be responsible for the development of atherosclerosis.

There seems to be a graded increment in the risk of atherosclerosis with increasing homocysteine levels. It is now accepted that a treshold indicating a significantly elevated risk for persons with homocysteine concentrations above that value does not exist. Calculations show that the risk for coronary disease is elevated by 60% for men and 80% for women with every 5 mmol/l increase in homocysteine levels (10).

Upon comparison of data on the relevance of various risk factors it becomes evident that homocysteine plays an important role as risk factor for atherosclerotic diseases (1,10). It is thought to be at least equally important as elevated cholesterol levels (10).

## VITAMIN SUPPLEMENTATION AS A MEANS TO INFLUENCE HOMOCYSTEINE LEVELS

The metabolization and degradation of homocysteine in the body requires the presence of the vitamins folic acid, vitamin B12 and vitamin B6. A low status of these vitamins is rapidly reflected by an increase in the homocysteine blood level. Therefore, homocysteine can be referred to as a functional parameter of the vitamin nutritional status of the respective B-vitamins. Seventy-seven of 78 patients with vitamin B12 -deficiency and 18 of 19 patients with confirmed deficiency of folic acid had elevated homocysteine levels compared to a healthy control group (13). There exists an inverse relationship between homocysteine and the relevant B-vitamins: a low homocysteine level is associated with high blood concentrations of folic acid and vitamin B12 whereas the homocysteine blood concentration increases with decreasing vitamin levels (14)

## EFFECTIVENESS OF THE VITAMINS TO LOWER HOMOCYSTEINE LEVELS

By supplementing the vitamins involved in the metabolism of homocysteine, the blood level of this atherogenic amino acid can be lowered. A combination of folic acid, vitamin B12 and B6 given daily in an amount 2,5-4 times the RDA was able to lower the homocysteine level significantly by 17-50% (15,16). The extent depends on the homocysteine concentration at the onset of supplementation: the higher the level, the greater the observed treatment effect.

In our own studies we were able to show that the homocysteine level could be influenced by low (nutritive) doses of the relevant vitamins even in the case of so-called "normal" homocysteine concentrations and adequate vitamin status prior to supplementation. In one of our studies, 35 female students were supplemented with a multivitamin tablet containing 400 mg folic acid, 2 mg vitamin B6 and 6 mg vitamin B12 daily. Within four weeks, the mean homocysteine level decreased significantly by as much as 21% in this group, whereas no change was observed in the control group (placebo; n= 37). Ongoing supplementation did not lead to a further reduction.

Folic acid, vitamin B12 and vitamin B6 differ in their potential to influence the homocysteine level. Vitamin B6 alone does not seem to have a lowering effect (10,15). Supplementation with vitamin B12 resulted in a decrease by 15% in men with initial elevated homocysteine blood concentrations (16). However, in this study as much as 400 mg vitamin B12 was given, which is about 133 times the daily requirement for healthy adults. Folic acid seems to play a key role in lowering homocysteine. In men, a reduction of 42% in homocysteine levels was obtained by supplementation with folic acid (0.65 mg/d) alone, which was not significantly different from the effect obtained by giving a combination of folic acid (0.65 mg/d), vitamin B12 (0.4 mg/d) and vitamin B6 (10 mg/d) (16). Similarly, supplementation of folic acid to young women was as effective in reducing the homocysteine level as a combination of folic acid and vitamin B6 (15).

In their meta-analysis, Boushey et al. (10) estimated that an increase in folic acid intake could prevent up to 50 000 deaths due to CHD in the USA. Calculations for Germany show that the death rate from CHD could be reduced by up to 15 000 depending on the intervention strategy used for increasing the uptake of folic acid (Table 1).

The key role of folic acid in lowering homocysteine is also supported by other authors (10,12,16) and can be explained biochemically: In the metabolism of homocysteine, the vitamins B6 and B12 serve as coenzymes and thus are not used up during the reaction they are involved in. Folic acid, however, functions as donor of the methyl group in the remethylation reaction and is used up quantitatively so that it has to be regenerated to 5-methyl-THF. During the remethylation reaction, the methyl group of 5-methyl-THF is transferred to vitamin B12 and after that to homocysteine to form methionine. Therefore, folic acid acts as limiting factor for this reaction and the absence of the methyl donor cannot be compensated by vitamin B12. Vitamin B12 does not seem to play a key role because it is usually present in sufficient amounts due to large stores of this B-vitamin in the body.

The minor role of vitamin B6 is thought to result from the possibility of the body to increase the remethylation rate in the case of a lack of the respective coenzyme (PLP) and thus limited degradation of homocysteine to cysteine via the transsulfuration pathway. This increase in the remethylation rate seems to sufficiently prevent an accumulation of homocysteine in the body (17).

So far it is known that nutritive amounts of folic acid are able to lower homocysteine levels in young women. This age group usually has homocysteine levels below 10 mmol/l, even though "normal" levels have not been defined yet. The homocysteine blood concentration

TABLE 1
Potential reduction of deaths from coronary heart disease (CHD) for persons aged 45 years and older based on different intervention strategies

| Intervention strategy | Annual number of potentially preventable deaths | |
|---|---|---|
| | USA | Germany |
| Food fortification (flour and cereal products) | up to 50 000[1] | ~ 15 000[2] |
| Folic acid supplements (assuming high effectiveness) | up to 28 000[1] | ~ 10 000[2] |
| Nutrition education (assuming high effectiveness) | up to 26 500[1] | ~ 8 000[2] |

1 Data for USA from JAMA 1995; 274: 1049 - 1057
2 Data calculated for Germany (Pietrzik 1995)

increases with age and reaches levels of 10-15 mmol/l in healthy adults of middle age. Elderly persons show homocysteine concentrations of about 10-25 mmol/l. We assume that nutritive amounts are still sufficient to effectively lower these levels and are currently investigating this topic. However, it might be possible that elderly people require a combination of all vitamins involved in the metabolism of homocysteine since they often have a suboptimal vitamin status. Data from the Framingham study show that 30% of the patients had an elevated homocysteine level. In 67% of these patients a suboptimal vitamin status of one or more of the three B-vitamins was found and thought to be the cause for the elevation of homocysteine (18). It is also known that about 30% of elderly people have an atrophic gastritis which may lower the absorption of vitamin B12 and lead to a suboptimal status of this vitamin over time.

## REFERENCES


1. Clarke, R; Daly, L; Robinson, K; Naughten, E; Cahalane, S; Fowler, B & Graham, I. Hyperhomocysteinemia: an independent risk factor for vascular disease. N Engl J Med, 324: 1149-1155, 1991.
2. Arnesen, E; Refsum, H; Bønaa, KH; Ueland, PM; Førde, OH & Nordrehaug, JE. Serum total homocysteine and coronary heart disease. Int J Epidemiol, 24: 704-709, 1995.
3. Brattström, LE; Lindgren, A; Israelsson, B; Malinow, M. R.; Norrving, B. & Upson, B. Hyperhomocysteinemia in stroke: prevalence, cause and relationships to type of stroke and stroke risk factors. Eur J Clin Invest, 22: 214-221, 1992.
4. Genest, JJ; McNamara, JR; Salem, DN; Wilson, PWF; Schaefer, EJ & Malinow, MR. Plasma homocyst(e)ine levels in men with premature coronary artery disease. J Am Coll Cardiol, 16: 1114-1119, 1990.
5. Israelsson, B; Brattström, LE & Hultberg, BL. Homocysteine and myocardial infarction. Atherosclerosis, 71: 227-233, 1988.
6. Malinow, MR; Sexton, G; Averbuch, M; Grosman, M; Wilson, D& Upson, B. Homocyst(e)inemia in daily practice. Coron Artery Dis, 1: 215-220, 1990.
7. Mölgaard, J; Malinow, MR; Lassvik, C; Holm, A-C; Upsin, B & Olsson, AG. Hyperhomocyt(e)inemia: an independent risk factor for intermittent claudication. J Intern Med 231: 273-279, 1992.
8. Pancharuniti, N; Lewis, CA; Sauberlich, HE; Perkins, LL; Go, RCP; Alvarez, JO; Macaluso, M; Acton, RT; Copeland, RB; Cousins, AL; Gore, TB; Cornwell, PE & Roseman, JM. Plasma homocyst(e)ine, folate, and vitamin B-12 concentrations and risk for early-onset coronary artery disease. Am J Clin Nutr 59: 940-948, 1994.
9. Stampfer, MJ; Malinow, MR; Willett, WC; Newcomer, LM; Upson, B; Ullmann, D; Tishler, PV & Hennekens, CH. A prospective study of plasma homocyst(e)ine and risk of myocardial infarction in US physicians. JAMA, 268: 877-881, 1992.
10. Boushey, CJ; Beresford, SAA; Omenn, GS & Motulsky, AG. A quantitative assessment of plasma homocysteine as a risk factor for vascular disease. JAMA, 274: 1049-1057, 1995.
11. Coull, BM; Malinow, MR; Beamer, N; Sexton, G; Nordt, F & de Garmo, P. Elevated plasma homocyst(e)ine concentration as a possible independent risk factor for stroke. Stroke, 21: 572-576, 1990.
12. Hopkins, PN; Wu, LL; Wu, J, Hunt, SC; James, BC; Vincent, GM & Williams, RR. Higher plasma homocyst(e)ine and increased susceptibility to adverse effects of low folate in early familial coronary artery disease. Arterioscler Thromb Biol Vasc, 15: 1314-1320, 1995.
13. Stabler, SP; Marcell, PD; Podell, ER; Allen, RH; Savage, DG &

Lindenbaum, J. Elevation of total homocysteine in the serum of patients with cobalamin or folate deficiency detected by capillary gas chromoatography-mass spectrometry. J Clin Invest, 81: 466-474, 1988.

14. Ueland, P M; Refsum, H; Stabler, SP; Malinow, MR; Andersson, A & Allen, RH. Total homocysteine in plasma or serum: methods and clinical applications. Clin Chem, 39: 1764-1779, 1993.
15. Dierkes, J. Vitamin requirements for the reduction of homocysteine blood levels in healthy young women. PhD-Thesis, Faculty of Agriculture, University of Bonn, 1994.
16. Ubbink, JB; Vermaak, WJH; van der Merwe, A; Becker, PJ; Delport, R & Potgieter, HC. Vitamin requirements for the treatment of hyperhomocysteinemia in humans. J Nutr, 124: 1927-1933, 1994.
17. Miller, JW; Nadeau, MR; Smith, D & Selhub, J. Vitamin B-6 deficiency vs folate deficiency: comparison of responses to methionine loading in rats. Am J Clin Nutr, 59: 1033-1039, 1994.
18. Selhub, J; Jacques, PF; Wilson, PWF; Rush, D & Rosenberg, IH. Vitamin status and intake as primary determinants of homocysteinemia in an elderly population. JAMA, 270: 2693-2698, 1993.

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# Calcium and osteoporosis

*Carmen M. Donangelo*

Laboratório de Bioquímica Nutricional e de Alimentos, Departamento de Bioquímica,
Instituto de Química, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

**SUMMARY. Calcium and osteoporosis.** Osteoporosis is a crippling disease that emerges as an important public health problem both in developed and developing countries including Brazil. The clinical condition is characterized mainly by loss of bone mineral mass in later life as the net result of complex physiological and environmental interacting factors during lifetime. Calcium intake appears as an obvious nutritional factor in the prevention of osteoporosis but its contribution is still not well established particularly when populations with different habitual levels of calcium intake are compared. In this section, we examine the role of calcium intake as affecting bone mineral density at different stages of development and with aging, with special attention to the possible stress on bone mass due to pregnancy and lactation. Nutritional studies demonstrate that, in general, adequate calcium intake during lifetime contributes to decrease the risk of osteoporosis. However, the long term effects on bone health of sub-adequate, but not very low, habitual calcium intakes during highly demanding physiological periods such as adolescence, pregnancy and lactation, are still largely unknown. Sub-adequate calcium intakes are probably common in Brazil.

## INTRODUCTION

Osteoporosis is the clinical condition characterized by a reduction in both bone mineral and bone matrix, decreasing bone density with a consequent higher risk of fractures following trauma. This condition is emerging as an important public health problem, both in developed and developing countries, due to the worldwide trend in increased life expectancy leading to a larger number of elderly persons. Osteoporosis affects millions of individuals around the world, but even with reduced bone density incidence of fractures vary for different populations possibly due to the complex etiology of this condition (1,2). Data from Brazil are scarce and it mainly relates to incidence of fractures (3). Considering that on a global basis osteoporosis affects about 10 % of the population older than 60 years (4) it may be estimated that in Brazil at least 1.5 million persons are affected.

Bone density in the adult and aged organism depends both on the peak of bone density achieved through adolescence and early adulthood and on the subsequent bone loss associated with aging. In general, women reach a lower peak bone density and loose bone faster with age than men and therefore have higher life-time risk of fractures than men (5). Complex physiological and environmental interacting factors need to be considered as affecting peak bone density, maintenance of peak bone mass through the reproductive years in the adult, and bone loss with aging. Genetic factors seem to have the higher contribution, accounting for up to 80 % of population variance of peak bone density (5) and about 25 % of bone density in the elderly (1). Most of the genetic differences in bone density seem to be explained by allelic variations of the vitamin D receptor gene (6). Although calcium nutrition seems to contribute with less than 20% to these variances, the importance of adequate calcium intake and calcium status on the prevention of osteoporosis is at present under intense investigation as a readily implementable and relatively inexpensive environmental preventive factor.

We will examine in this section, the role of calcium intake in the prevention of osteoporosis as it affects bone mineral density at different stages of development and aging, with special attention to pregnancy and lactation.

## CALCIUM INTAKE AND PEAK BONE DENSITY

Interest in the role of calcium intake on adolescent bone mineralization as a preventive factor of osteoporosis is based on the hypothesis that a greater peak bone mass reached in young adulthood will be a determinant of a greater bone mass at menopause and a greater sustained bone density during aging.

The acquisition of bone mass and density is a result of age, sex, other genetic factors, pubertal status, physical exercise and calcium intake. Bone density increases dramatically during puberty in response to gonadal steroids. During the adolescent growth spurt, about 45% of the adult's skeletal volume is formed, with the bone mineral content increasing at a rate of about 8.5% per year (5). Increase in bone mass, particularly in cancellous bone, is strongly influenced by hormonal changes in adolescence (7), which is explained by the strong relationship between osteoblast activity and gonadal steroid stimulation (5,8). In situations of puberty delay due to gonadal hormone deficiency, normal peak bone density is not reached (7).

Several recent studies have focused on the role of adequate calcium intake on bone mineral acquisition during adolescence. An investigation examining 487 calcium balance studies in children aged <18 years (9) suggested that together with rates of skeletal modeling and turnover, calcium intake is a main determinant of calcium balance during growth. This investigation also suggested that the threshold for achieving positive adequate balances for skeletal growth may require calcium intakes at levels exceeding present recommended allowances. Moreover, based on estimations from cross-sectional studies relating bone density and calcium intakes, it was concluded that adolescents with average intakes below 1000 mg/d for boys and 850 mg/d for girls, will probably not reach optimal peak bone mass (10). Some recent studies of calcium supplementation during several months of pre-adolescents with average calcium intake of 950 mg/d resulted, in fact, in significant increase of bone mineral density (11,12) consistent with the critical role of calcium intake on bone mineralization during this period.

Low calcium intake in children and adolescents appears to limit acquisition of bone mass and bone maturation. Reduced bone

development and bone density have been observed in African children and adolescents possibly related to low calcium intakes (13). Studies in South African children, 9-12 years of age, with calcium intakes lower than 400 mg/d, showed that many of them had biochemical signs of hyperparathyroidism and delayed bone maturation as indicated by low serum calcium and raised activity of plasma alkaline phosphatase, which normalized after calcium supplementation (14). A study of 900 children in Brazil, 7-17 years of age, comparing bone maturation and biochemical bone indices in privileged and underprivileged (15), showed that plasma alkaline phosphatase and inorganic phosphorous were abnormal in the underprivileged group. Moreover, these children also showed delayed bone maturation as indicated by difference between chronological and bone age. Although differences in calcium intakes between these groups may be expected, calcium intake was not evaluated in this study. In fact, habitual calcium intakes in the Brazilian population, including children and adolescents, are largely unknown (3).

Calcium intake seems to play a critical role for achievement of skeletal maturity since marginal intake in children and adolescents is a limiting factor of peak bone mass and calcium supplementation can increase bone mass, even in individuals with dietary intakes close to present recommendations . What it is still not known is whether an increased bone density in children and adolescents, obtained by a temporary calcium supplementation, will persist during adulthood as an intrinsic part of peak bone mass, thus reducing the risk of osteoporosis, and if this effect will be different in individuals with habitually low or close to adequate dietary calcium intakes.

## CALCIUM INTAKE AND BONE STATUS WITH PREGNANCY AND LACTATION

Pregnancy and lactation may potentially affect the maintenance of peak bone mass during adulthood due to the substantial amounts of calcium that need to be transferred from the mother to the fetus or to the infant. A full-term pregnancy demands about 30 g of calcium for transfer to the fetus while milk production for exclusive breastfeeding during 6 months may demand 47-63 g of calcium (16). If maternal bone mineral was the only source of calcium in these states, the maternal skeleton would lose about 3% and 4-6% of calcium after pregnancy and lactation, respectively. Moreover, both physiological states are characterized by hormonal alterations that may influence bone turnover and bone density (16,17). Levels of circulating maternal estrogen are greatly increased during pregnancy due to the massive placental production; progesterone, prolactin and PTHrP are also increased while PTH levels remain normal or even decreased. Lactation is a hypoestrogenic state with elevated prolactin levels and normal or increased PTH levels. Due to the different hormonal environments, the physiological adjustments to maintain calcium homeostasis are different in these states, with increased efficiency of intestinal calcium absorption occurring in pregnancy, but not in lactation, and renal calcium conservation occurring only in lactation. Although relationship with dietary intake remains largely unknown, the calcium demands of the fetus and infant may outstrip the calcium available from intestinal absorption and renal economy, particularly in women with limited calcium intake, resulting in increased mobilization of maternal bone calcium and increased risk of osteoporosis.

Studies in women with calcium intakes close or higher than present recommendations during pregnancy have obtained biochemical indication of both increased bone resorption and bone formation in this period (18,19), suggesting that increased maternal bone turnover is a physiological mechanism to ensure adequate maternal calcium availability for fetal demands. However, this mechanism will not necessarily result in maternal bone loss. Prospective studies examining changes in bone density during pregnancy in healthy women did not produce consistent results on bone loss with pregnancy since either small detectable decrease in trabecular bone (20,21) or no change in bone mass (22,23) have been observed. There are no reported studies on bone changes during pregnancy in women with low or marginal calcium intakes.

Mobilization of maternal bone calcium may be more variable during lactation than during pregnancy because the degree of calcium demand relates to the amount of breast milk produced and to the duration of breastfeeding. Moreover, the overall demand is generally higher in lactation. Several longitudinal studies have clearly confirmed that there is significant bone loss with established and extended lactation in well nourished women (20, 24-27). These findings are supported by biochemical evidence of increased bone turnover during lactation compared to control women (18,19,28). An interesting fact emerging from some studies (20,26,27) is that bone loss during lactation is followed by recovery of bone mineral mass with re-establishment of menses, particularly after weaning, consistent with increased efficiency of intestinal calcium absorption in those situations (29). The bone mass recovery does not seem to be affected by a subsequent pregnancy following an extended lactation period (30). In fact, multiple pregnancies followed by lactation may have a protective role (31) or no effect (32) on bone density and risk of fractures in later life. Moreover, bone recovery seems to be largely independent of variations in calcium intake in well nourished women (27,28).

Studies in lactating women in The Gambia with very low calcium intakes (< 300 mg/d) (33,34) demonstrated that maternal bone minerals make a substantial contribution to calcium requirements during lactation in these women, by adaptive physiological mechanisms such as high efficiency of intestinal calcium absorption and very low urinary calcium excretion, that do not seem to respond to calcium supplementation. A significant decrease in midshaft radious bone mineral content after 13 weeks of lactation was observed in these women, with recovery after 52 weeks while still breast-feeding, and no effect of calcium supplementation on these changes. It is interesting to note that bone density of Gambian women was not different from that of British women. In fact, osteoporosis is not a clinical problem in The Gambia and it is still unclear if this is due to environmental an/or to genetic factors (33).

There is no information on bone changes after pregnancy and lactation in women with sub-adequate although not very low calcium intakes, a situation that is probably very common worldwide and in many urban areas in Brazil. We have been studying calcium homeostasis during pregnancy and lactation of Brazilian women with habitual calcium intakes of about 600 mg/d, half the RDA for these periods (35-37). We observed renal calcium conservation and increase in markers of both bone mobilization (urinary hydroxyproline and D-pyridinoline) and bone formation (plasma activity of bone-alkaline phosphatase) during pregnancy and lactation in these women compared to never-pregnant women with similar calcium intakes but the consequences on maternal bone mass are unknown. Hydroxyproline excretion in the 3rd trimester of pregnancy was lower in multiparas compared to primiparas (35) but it is unclear if this relates to preservation of maternal bone in multiparas or to differences in composition of gained tissue not related to bone. Responses of biochemical indices to a 7-day calcium supplementation trials with 1000 mg Ca/d given as lactogluconate, measured in 3rd trimester pregnant women, fully lactating women two months postpartum, and never-pregnant women, all with dietary calcium intakes <600 mg/d were, in general, more similar between pregnant and controls than between pregnant and lactating women (36,37). After the supplementation trial, urinary calcium excretion increased in a similar extent in pregnants and controls but did not change in the lactating women. Bone formation, based on bone-alkaline phosphatase activity, was favored in all three groups, but to a smaller extent in the lactating women. Bone degra-

dation, based on hydroxyproline excretion, was reduced mainly in pregnant primiparas and slightly in the lactating women but did not change in the other women. These results may suggest that the increased bone turnover in both pregnancy and lactation in women with sub-adequate calcium intake is sensitive to short term increase in calcium intake although to a lower extent in lactation. It remains to be shown if a sustained increase of calcium intake during pregnancy and lactation with habitual sub-adequate but not very low dietary calcium, will modify the rates of bone loss and recovery associated with these states, and have long-term beneficial effects on maternal bone.

## CALCIUM INTAKE AND BONE LOSS DURING AGING

Bone loss during aging is strongly dependent on physiological factors, initially related to decline in gonadal steroids, affecting mainly trabecular bone, and at later stages related to mild secondary hyperparathyroidism and decrease in osteoblastic bone formation, affecting also cortical bone. Bone loss begins in the pre-menopausal period in women and by the fifth decade in men. During the first decade after menopause, women may lose 25-30% of trabecular bone and 10-15% of cortical bone (5).

The effect of calcium supplementation on bone mass during aging have been examined by several clinical studies, particularly in women. Although some inconsistencies arise from these studies, it appears that both the habitual dietary calcium intake and the stage in life of the woman (pre, early or late menopause) are important factors affecting the rate of bone loss and bone response to calcium supplementation. A longitudinal study of postmenopausal women found that women with dietary intakes < 400 mg/d lost spinal bone density at a greater rate than did those with intakes >770 mg/d (38). Calcium supplementation was beneficial in reducing bone loss in postmenopausal women with calcium intake <400 mg/d, particularly in those at later stages, but not in women with habitually higher calcium intake (39). Studies like these call attention on the critical role of adequate calcium nutrition in reducing the rate of bone loss during aging, particularly in women with habitually low calcium intakes. Although sub-adequate calcium intakes have been observed in adults and older individuals in Brazil (3) the possible association with bone health remains to be established.

## CONCLUSIONS

Although calcium intake is only one of many complex factors affecting bone mineral density during lifetime, nutritional studies have demonstrated that adequate calcium intake makes an important preventive contribution to decrease the risk of osteoporosis, with specific role at different stages of development and during aging. However, evidence is still insufficient to evaluate the long term effects on bone health of sub-adequate but not very low habitual calcium intakes during highly demanding physiological periods such as growth spurt, pregnancy and lactation. These sub-adequate intakes are probably common in Brazil.

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## REFERENCES

1. Heaney, RP. Calcium intake in the osteoporotic fracture context: introduction. Am J Clin Nutr, 54: 242S-244S, 1991.
2. Mehta, S. Bone loss, contraception and lactation. Acta Obstet Gynecol Scand, 72: 148-156, 1993.
3. Dutra de Oliveira, JE; da Cunha, SFC & Marchini, JS. A Desnutrição dos Pobres e dos Ricos: Dados sobre Alimentação no Brasil. São Paulo, Ed. Sarvier, 1996.
4. Young, ME. Health problems and policies for older women: an emerging issue in developing countries. HRO Working Papers, 1994.
5. Finkelstein, JS. Osteoporosis. In: Cecil Textbook of Medicine, Bennet and Plum (Eds.), WB Saunders Co., 1996, p. 1379-1384.
6. Peacock, M. Vitamin D receptor gene alleles and osteoporosis: a contrasting view. J Bone Min Res, 10: 1294-1297, 1995.
7. Mora, S; Goodman, WG; Loro, ML; Roe,TF; Sayre, J & Gilsanz,V. Age-related changes in cortical and cancellous vertebral bone density in girls: assessment with quantitative CT. Am J Roengtgenol, 162: 405-409, 1994.
8. Bronner, F. Calcium and osteoporosis. Am J Clin Nutr, 60: 831-836, 1994.
9. Matkovic, V. Calcium metabolism and calcium requirements during skeletal modeling and consolidation of bone mass. Am J Clin Nutr, 54: 245S-260S, 1991.
10. Peacock, M. Calcium absorption efficiency and calcium requirements in children and adolescents. Am J Clin Nutr, 54: 261S-265S, 1991.
11. Johnston, CCJr; Miller, JZ; Slemenda, CW; Reister,TK; Hui,S; Christian, JC & Peacock, M. Calcium supplementation and increases in bone mineral density in children. N Eng J Med, 327: 82-87, 1992.
12. Lloyd,T; Andon, MB; Rollings, N; Martel, JK; Landia, JR; Demers, LM; Eggli,DF; Kieselhorst, K & Kulin, HE. Calcium supplementation and bone mineral density in adolescent girls. JAMA, 270: 841-844, 1993.
13. Prentice, A & Bates, CJ. An appraisal of the adequacy of dietary mineral intakes in developing countries for bone growth and development in children. Nutr Res Rev, 6: 51-69,1993.
14. Pettifor, JM; Ross, P; Moodley, G & Shuenyane, E. The effect of dietary calcium supplementation on serum calcium, phosphorous and alkaline phosphatase concentrations in a rural black population. Am J Clin Nutr, 34: 2187-2191, 1981.
15. Linhares, EDR; Round, JM & Jones, DA. Growth, bone maturation, and biochemical changes in Brazilian children from two different socioeconomic groups. Am J Clin Nutr, 44: 552-558, 1986.
16. King, JC; Halloran, BP; Huq, N; Diamond, T & Buckendal, PE. Calcium metabolism during pregnancy and lactation. In: Mechanisms Regulating Lactation and Infant Nutrient Utilization. Picciano MF, Lonnerdal B (Eds.), New York, Wiley-Liss, Inc., 1992, p. 129-146.
17. Kolmeier, L & Marcus, R. Calcium disorders of pregnancy. Endocr Metab Clin North America, 24 :15-39, 1995.
18. Huq, N; King, JC; Halloran, BP; Buckendal, P; Cooke, D & Costa, FM. Calcium metabolism in pregnant and lactating women: A longitudinal study. FASEB J, 2 :A654, 1988.
19. Cross, NA; Hillman, LS; Allen, SH; Krause, GF & Vieira, NE. Calcium homeostasis and bone metabolism during pregnancy, lactation and postweaning: a longitudinal study. Am J Clin Nutr, 61 :514-523, 1995.
20. Lamke, B; Brundin, J & Moberg, P. Changes of bone mineral content during pregnancy and lactation. Acta Obstet Gynecol Scand, 56: 217-219, 1977.
21. Cann, CE. Pregnancy and lactation cause reversible trabecular bone loss in humans. J Bone Min Res, 4: 5384, 1989.
22. Sowers, MF; Crutchfield, M; Jannausch, M; Updike, S & Corton, G A prospective evaluation of bone mineral change in pregnancy.

Obstet Gynecol, 77: 841-845, 1991.

23. Kent, GN; Price, RI; Gutteridge, DH; Allen, JR; Rosman, KJ; Smith, M; Bhagat, CI; Wilson, SG & Retallack, RW. Effect of pregnancy and lactation on maternal bone mass and calcium metabolism. Osteoporos Int, 3: S44-S47, 1993.
24. Atkinson, PJ & West, RR. Loss of skeletal calcium in lactating women. J Obstet Gynaecol Brit Commonwlth, 77: 555-560, 1970.
25. Hayslip, CC; Klein, TA; Wray, HL & Duncan, WE. The effects of lactation on bone mineral content in healthy postpartum women. Obstet Gynecol, 73: 588-592, 1989.
26. Kent, GN; Price, RI; Gutteridge, DH; Smith, M; Allen, JR; Bhagat, CI; Barnes, MP; Hickling, CJ; Retallack, RW; Wilson, SG; Devlin, RD; Davies, C & St John, A. Human lactation: forearm trabecular bone loss, increased bone turnover and renal conservation of calcium and inorganic phosphate with recover of bone mass following weaning. J Bone Min Res, 5: 361-369, 1990.
27. Sowers, MF; Corton, G; Shapiro, B; Jannausch, ML; Crutchfield, M; Smith, ML; Randolph, JF & Hollis, B. Changes in bone density with lactation. JAMA, 269: 3130-3135, 1993.
28. Sowers, MF; Eyre, D; Hollis, BW; Randolph, JF; Shapiro, B; Jannausch, ML & Crutchfield, M. Biochemical markers of bone turnover in lactating and non-lactating postpartum women. J Clin Endocrinol Metabol, 80: 2210-2216, 1995.
29. Kalkwarf, HJ; Specker, BL; Heubi, JE; Vieira, NE & Yergey, AL. Intestinal calcium absorption of women during lactation and after weaning. Am J Clin Nutr, 63: 526-531, 1996.
30. Sowers, MF. Bone mass in pregnancy after extended lactation. Obstet Gynecol, 85: 285-290, 1995.
31. Hoffman, S; Grisso, JA; Kelsey, JL; Gammon, MD & O'Brien, LA. Parity, lactation and hip fracture. Osteoporos Int., 3: 171-176, 1993.
32. Cumming, RG & Klineberg, RJ. Breastfeeding and other reproductive factors and the risk of hip fractures in elderly women. Int J Epidemiol, 22: 684-691, 1993.
33. Prentice, A; Jarjaou, LMA; Cole, TJ; Stirling, DM; Dibba, B & Fairweather-Tait, S. Calcium requirements of lactating Gambian mothers: effects of a calcium supplement on breast-milk calcium concentration, maternal bone mineral content and urinary calcium excretion. Am J Clin Nutr, 62: 58-67, 1995.
34. Fairweather-Tait, S; Prentice, A; Heumann, KG; Jarjau, LMA; Stirling, DM; Wharf, SG & Turnlund, JR. Effect of calcium supplements and stage of lactation on the calcium absorption efficiency of lactating women accustomed to low calcium intakes. Am J Clin Nutr, 62: 1188-1192, 1995.
35. Donangelo, CM; Trugo, NMF; Melo, GJO; Gomes, DD & Henriques, C. Calcium homeostasis during pregnancy and lactation in primiparous and multiparous women with subadequate calcium intakes. Nut Res, 16: 1631-1640, 1996.
36. Bezerra, FF; Rodrigues, RB; Laboissiére, F & Donangelo, CM. Homeostase de cálcio em gestantes e nutrizes com ingestão sub-adequada desse nutriente: resposta à suplementação. IV Congresso Nacional da Sociedade Brasilieira de Alimentação e Nutrição, São Paulo, 1996.
37. Laboissiére, F; Rodrigues, RB; Bezerra, FF & Donangelo, CM. Homeostase de cálcio em gestantes com ingestão sub-adequada desse nutriente: efeito da paridade na resposta à suplementação. IV Congresso Nacional da Sociedade Brasileira de Alimentação e Nutrição, São Paulo, 1996
38. Dawson-Hughes, B; Jacques, P & Shipp, C. Dietary calcium intake and bone loss from the spine in healthy postmenopausal women. Am J Clin Nutr, 46: 685-687, 1987.
39. Dawson-Hughes, B; Dallal, GE; Krall, EA; Sadowski, L; Sahyoun, N & Tannenbaum, S. A controlled trial of the effect of calcium supplementation on bone density in postmenopausal women. N Eng J Med, 323: 878-883, 1990.

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# The stage of nutrition transition in different Brazilian regions

*Lenise Mondini and Carlos Augusto Monteiro*

Núcleo de Pesquisas Epidemiológicas em Nutrição e Saúde e
Departamento de Nutrição da Faculdade de Saúde Pública,
Universidade de São Paulo, São Paulo, SP Brazil.

**SUMMARY. The stage of nutrition transition in different Brazilian regions.** The stage of nutrition transition in Brazil at the end of the 1980s was evaluated using the data from a nationwide cross-sectional anthropometry survey in Brazil in 1989 (Pesquisa Nacional sobre Saúde e Nutrição-PNSN). Comparable estimates of undernutrition and obesity were produced for children from 6 to 35 months old (n=3,641), adult males from 20 to 64 years old (n=14,235) and adult females from 18 to 64 years old (n=15,669). Body Mass Index (kg/m2) was employed to assess both undernutrition and obesity in adults and weight-for-age (undernutrition) and weight-for-height (obesity) indices were used for children. The 5th and 95th centiles of the distribution of these indices in a reference population were used as limits for the diagnosis of undernutrition and obesity, respectively. Ordering the frequency of the problems in the population showed obesity in women and undernutrition in children to be the two main nutritional disorders in the country. These two problems are the most frequent in the urban population of the North, Northeast and Center-West regions, and in the Southeast and Center-West rural regions. Obesity leads among both adults and children in the urban areas of the Southeast and South regions, and in the rural South. Only in the rural Northeast, the poorest region in the country, undernutrition leads among children, men and women. This mosaic of situations determines the need for a complete reassessment of traditional nutrition policies and programs employed in the country.

## INTRODUCTION

Both under and overnutrition are important nutritional disturbances that undermine the health of individuals. Undernutrition leads to growth retardation, high vulnerability to infectious diseases, physical and functional impairments, and lower work capacity (1-3). Obesity is associated with an increased incidence of cardiovascular disease, diabetes mellitus and cancer (4).

The relevance of each of these two problems in a specific society and, therefore, the greater or lower priority assigned to controlling them will depend essentially on the prevalence each problem reaches in the population.

Undernutrition has very often been assumed to be a relevant problem for developing countries while obesity is important in developed societies. However, the reality is far more complex. Firstly, neither developed nor developing countries are homogeneous units for under and overnutrition prevalences. For example, the significant difference between the high rate of obesity in the USA and that observed in the Canada or England (5), or the great magnitude of undernutrition in countries of sub-Saharan Africa when compared to countries of South America (6).

Also, in developing countries enormous economic contrasts mean that different regions and social strata may be subject to different degrees of vulnerability to nutritional imbalances. In each stratum, the magnitude of undernutrition and overnutrition may also be very different for children and adults and between men and women. The last and most essential aspect to consider has to do with the simultaneous reduction of undernutrition and increase in obesity observed in developing societies showing a rapid and intense shift in their economic pattern and demographic structure, a phenomenon which makes part of the "nutrition transition" (7).

Trends of reduction in undernutrition and increase of obesity have been demonstrated in Brazil between the 1970's and 1980's (8). These trends have been attributed to aspects related to economics, and to demographic changes which have occurred in the country over recent decades. In this period a moderate improvement in family income and a rapid process of urbanization with expansive public services have been observed, along with changing diet and physical activity patterns of the population .

In a previous work we have demonstrated that distinct income groups in Brazil were in different stages of the nutrition transition (9). The specific aim of the present article is to measure and qualify the stage of nutrition transition in different regions of the country at the end of the 1980's and to discuss its implications for health and nutrition policy planning.

## SOURCE AND ANALYSIS OF DATA

Data were obtained from a nationwide cross-sectional anthropometric survey in Brazil undertaken in 1989 (Pesquisa Nacional sobre Saúde e Nutrição - PNSN) by the Brazilian Agency for national statistics - the Brazilian Institute of Geography and Statistics - IBGE (10).

Multi-stage stratified clustering sampling was used in the survey. The survey consisted of 14,455 households, representative of all urban and rural areas of the Brazilian regions, except the Northern rural area, because of low demographic density and difficulty of access. Adult males from 20 to 64 years of age (n=14,235), adult females from 18 to 64 years of age (n=15,669), excluding pregnant women, and children 6 to 35 month-old (n=3,641) were included in this study (Table 1).

These age groups were selected essentially to facilitate interpretation of anthropometric indicators of undernutrition and obesity. Adults over 64 were excluded because height measurement may be not enough accurate in the elderly population. Males between 18 and 20 years old were excluded because of evidence showing a late weight gain in younger adult males, reflecting the final stages of maturation (11).

Anthropometric indices were employed to assess the nutritional status of adults and children. Body Mass Index -BMI (weight expressed in kg by height expressed in $m^2$) was used to assess both

TABLE 1
Distribution of individuals in the sample by regions. Brazil, 1989.

| REGION | MEN | | WOMEN | | CHILDREN | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| NORTH | | | | | | |
| - Urban | 1,732 | 12.2 | 2,004 | 12.8 | 485 | 13.3 |
| - Rural | - | - | - | - | - | - |
| NORTHEAST | | | | | | |
| - Urban | 1,505 | 10.6 | 2,016 | 12.9 | 400 | 11.0 |
| - Rural | 1,558 | 10.9 | 1,597 | 10.2 | 636 | 17.5 |
| SOUTHEAST | | | | | | |
| - Urban | 1,648 | 11.6 | 1,910 | 12.2 | 292 | 8.0 |
| - Rural | 1,687 | 11.9 | 1,577 | 10.1 | 394 | 10.8 |
| SOUTH | | | | | | |
| - Urban | 1,553 | 10.9 | 1,843 | 11.8 | 319 | 8.8 |
| - Rural | 1,650 | 11.6 | 1,642 | 10.5 | 385 | 10.6 |
| CENTER-WEST | | | | | | |
| - Urban | 1,502 | 10.5 | 1,888 | 12.0 | 373 | 10.2 |
| - Rural | 1,400 | 9.8 | 1,192 | 7.6 | 357 | 9.8 |
| BRAZIL | 14,235 | 100.0 | 15,669 | 100.0 | 3,641 | 100.0 |
| - Urban | 7,940 | 55.8 | 9,661 | 61.7 | 1,869 | 51.3 |
| - Rural | 6,295 | 44.2 | 6,008 | 38.3 | 1,772 | 48.7 |

undernutrition and obesity in adults and weight-for-age (undernutrition) and weight-for-height (obesity) were used in the case of children. Age was always based on birth certificates or equivalent documents. Trained teams measured weight using calibrated, portable micro-electronic scales with individuals wearing light clothes and no shoes. Portable stadiometers were used to measure height of adults and older children and length of infants and toddlers.

The normative model was used to diagnose both undernutrition and obesity. With a view to ascribing identical specificity to the diagnosis of both events, the 5th and 95th centiles of the distribution of anthropometric indices in a reference population were used as cut-offs. In the case of weight-for-age (5th centile) and weight-for-height (95th centile) in children, the international NCHS/WHO reference was adopted (12).

In the absence of an internationally recommended reference for adult BMI, the adult Brazilian high-income population (individuals studied by the PNSN survey with a monthly per capita family income equivalent to US$ 78 or plus) was adopted as reference. Gender and age-specific 5th centiles of the BMI distribution in the high-income Brazilian population were used as cut-offs to assess the prevalence of adult undernutrition. A single gender-specific (but not age-specific). BMI cut-off were used to assess the prevalence of adult obesity: the one corresponding to the 95th centile of high-income Brazilians with ages from 18 to 24 years (females) or from 20 to 24 years (males). The age restriction was essential to secure that the reference population was free from obesity. Table 2 displays the BMI values employed as cut-offs for the diagnosis of both adult undernutrition and obesity.

Estimates of undernutrition and obesity in children, men and women are presented for the whole country and for its main regions. Brazil is divided in five macro-regions: North, Northeast, Center-West, Southeast and South. North and Northeast are the poorest regions in the country. They have a Gross Domestic Product equivalent to US$ 2,000 per capita and near 45% of its population with income below the poverty line. South and Southeast are the richest regions having a GDP per capita around to US$ 4,000 and near 20% of its population below poverty line. The Center-West is both geographically and economically situ-

TABLE 2
Body Mass Index ($kg/m^2$) cut-offs employed in the diagnosis of adult undernutrition and obesity.

| AGE GROUP | UNDERNUTRITION [1] | | OBESITY[2] | |
|---|---|---|---|---|
| (years) | MALES | FEMALES | MALES | FEMALES |
| 18 - 19 | - | 17.2 | 28.4 | 27.7 |
| 20 - 24 | 18.4 | 17.6 | 28.4 | 27.7 |
| 25 - 29 | 19.2 | 18.3 | 28.4 | 27.7 |
| 30 - 39 | 19.6 | 19.3 | 28.4 | 27.7 |
| 40 - 49 | 19.3 | 19.4 | 28.4 | 27.7 |
| 50 - 59 | 20.0 | 20.0 | 28.4 | 27.7 |
| 60 - 64 | 19.9 | 20.1 | 28.4 | 27.7 |

(1) Gender and age-specific 5$^{th}$ centile of the BMI distribution of high-income Brazilians.
(2) Gender specific 95$^{th}$ centile of the BMI distribution of young high-income Brazilians.

ated between the poor North/Northeast and the rich South/Southeast (13).

## THE SITUATION OF THE GENERAL POPULATION

Table 3 displays comparable prevalences of undernutrition and obesity in the Brazilian population. Among children, undernutrition is more common than obesity (about 1.5 times) being similar the prevalence in both sexes. Among adults an opposite situation is observed being the excess of obesity slight in men (1.1 times) and stronger in women (2.6 times). In absolute terms, female obesity (20.0%) and child undernutrition (13.1%) are the two most frequent events. Undernourished adults, obese children and obese men are less frequent in the country (around 8%-9%).

## THE SITUATION OF THE URBAN POPULATION IN DIFFERENT REGIONS

Table 4 presents comparable prevalences of undernutrition and obesity in urban populations of different Brazilian regions.

Among urban children, undernutrition far exceeds obesity in the poor North and Northeast regions (near 4 times). In the rich South and Southeast regions child obesity is twice as frequent as child undernutrition. In the Center-West there is a relative equilibrium between obesity and undernutrition.

Among urban males, obesity exceeds undernutrition in all regions except in the poor Northeast where there is a slight predominance of undernutrition. Obesity in females far exceeds undernutrition in all five Brazilian regions.The ratio obesity:undernutrition among urban women reaches 4 to 1 in the rich South and Southeast regions.

TABLE 3
Prevalence (%) of undernutrition and obesity by sex in children and adults. Brazil,1989.

| SEX | CHILDREN | | ADULTS | |
|---|---|---|---|---|
| | UNDERNOURISHED | OBESE | UNDERNOURISHED | OBESE |
| MALE | 13.4 | 8.5 | 8.3 | 9.5 |
| | (11.1 - 15.7) | (6.4 - 10.6) | (7.5 - 9.1) | (8.6 - 10.4) |
| FEMALE | 12.9 | 9.6 | 7.6 | 20.0 |
| | (10.6 - 15.2) | (7.3 - 11.8) | (6.9 - 8.2) | (18.8 - 21.1) |
| TOTAL | 13.1 | 9.0 | 7.9 | 15.0 |
| | (11.3 - 14.9) | (7.4 - 10.6) | (7.1 - 8.6) | (13.6 - 16.4) |

Note: See text for the criteria employed in the diagnosis of undernutrition and obesity. Confidence intervals (95%) in parenthesis, taking into account sampling design effect.

## THE SITUATION OF THE RURAL POPULATION IN DIFFERENT REGIONS

Table 5 shows comparable prevalences of undernutrition and obesity in rural populations of different Brazilian regions.

Among rural children, undernutrition exceeds obesity near 5 times in the Northeast region and near 2 times in the Center-West and Southeast. Only in rural South child obesity exceeds child

TABLE 4
Prevalence (%) of undernutrition and obesity by urban regional strata in children and adults. Brazil, 1989.

| URBAN REGIONS | CHILDREN | | WOMEN | | MEN | |
|---|---|---|---|---|---|---|
| | Undernourished | Obese | Undernourished | Obese | Undernourished | Obese |
| NORTH | 22.5 | 5.9 | 7.7 | 18.6 | 6.2 | 10.8 |
| | (17.3-27.7) | (3.4-8.3) | (6.2-9.2) | (16.9-20.3) | (5.1-7.3) | (8.9-12.8) |
| NORTHEAST | 18.6 | 4.3 | 9.0 | 16.7 | 8.8 | 7.2 |
| | (13.8-23.5) | (2.1-6.5) | (7.4-10.6) | (14.7-18.7) | (6.9-10.6) | (5.6-8.8) |
| SOUTHEAST | 6.9 | 13.2 | 5.8 | 22.5 | 8.0 | 11.5 |
| | (3.1-10.6) | (10.0-17.4) | (4.7-6.9) | (20.1-24.9) | (6.5-9.5) | (9.5-13.6) |
| SOUTH | 5.1 | 14.5 | 4.5 | 24.2 | 4.1 | 15.4 |
| | (2.1-8.1) | (10.3-18.7) | (3.4-5.6) | (21.9-26.6) | (3.0-5.3) | (13.6-17.3) |
| CENTER-WEST | 7.7 | 6.3 | 7.4 | 17.6 | 5.9 | 11.0 |
| | (4.9-10.4) | (3.5-9.2) | (6.1-8.7) | (15.6-19.5) | (4.8-6.9) | (9.1-12.9) |
| URBAN BRAZIL | 10.4 | 10.2 | 6.5 | 21.1 | 7.4 | 11.2 |
| | (8.0-12.8) | (8.0-12.5) | (5.7-7.2) | (19.7-22.4) | (6.4-8.3) | (10.0-12.5) |

undernutrition.

Among rural males, undernutrition exceeds obesity in near 7 times in Northeast and near 3 times in Center-West and Southeast. Only in rural South male obesity is more frequent than male undernutrition. However, obese females far exceed undernourished females in all regions but the Northeast.

## DISCUSSION

The distribution of energy imbalances in children and adults of different Brazilian regions indicates a mosaic of situations, which suggest three stages of the process of nutrition transition.

The first stage occurs in the poorest country's region, the rural Northeast, where the process of nutrition transition has practically not

TABLE 5
Prevalence (%) of undernutrition and obesity by rural regional strata in children and adults. Brazil, 1989.

| RURAL REGIONS | CHILDREN | | WOMEN | | MEN | |
|---|---|---|---|---|---|---|
| | Undernourished | Obese | Undernourished | Obese | Undernourished | Obese |
| NORTHEAST | 25.3 (22.0-28.6) | 5.5 (3.6-7.4) | 15.9 (13.9-17.8) | 9.4 (7.6-11.2) | 12.2 (9.9-14.5) | 1.7 (1.0-2.5) |
| SOUTHEAST | 13.8 (9.5-18.2) | 5.0 (2.7-7.3) | 8.6 (6.8-10.4) | 20.0 (17.3-22.9) | 13.0 (10.9-15.1) | 4.7 (3.3-6.0) |
| SOUTH | 5.6 (3.1-8.0) | 11.0 (8.0-14.1) | 6.7 (5.1-8.4) | 23.9 (21.3-26.4) | 6.6 (5.0-8.3) | 8.2 (6.6-9.7) |
| CENTER-WEST | 13.2 (8.6-17.8) | 6.8 (4.4-9.3) | 10.0 (8.2-11.8) | 173 (14.8-19.7) | 10.8 (8.3-13.3) | 4.6 (3.1-6.0) |
| RURAL BRAZIL | 18.9 (16.7-21.1) | 6.4 (5.1-7.7) | 11.6 (10.4-12.7) | 15.9 (14.6-17.3) | 11.1 (9.9-12.3) | 4.2 (3.5-4.8) |

yet begun. Undernutrition is the major nutritional problem in children and adults, and obesity is restricted, albeit rarely, to adult women.

The next stage can be recognized as the nutrition transition itself . Problems of different nature - in this case, child undernutrition and women's obesity - lead the ranking of nutritional imbalances. This stage is seen in most Brazilian regions including the urban population living in the poor North and Northeast and the rural population of the rich Southeast.

The last stage can be identified as that in which the process of nutrition transition has already been completed, such as when obesity appears as the only epidemiologically relevant problem, both in children and adults. The South (both urban and rural) and the urban Southeast are at this stage.

In Brazil, nutrition interventions, when employed, have been directed exclusively towards controlling and preventing undernutrition in children. Data shown in this study indicate that the control of obesity, particularly among adult women, is fully justified all over the country.

For at least five decades developed countries have promoted programs to control and prevent obesity and other related problems. These actions include public education through health campaigns promoting better food habits and physical activity, as well as manufacturing and food processing related actions, involving the food industry (14). In Brazil the same path might be followed as regards urban areas in the South and Southeast. Of course, in poor regions, as the North and Northeast, and in poor segments of the population in general, educational actions should be combined with other interventions aiming the increased availability of and access to appropriate food.

In contrast to obesity, adult undernutrition is restricted to the population living in rural areas, particularly that one living in the Northeast. In this case, programs to ensure food security should be employed as well as actions focused on land reform, job's creation and extension of education, health and sanitation services. Child undernutrition remains an important public health problem in North and Northeast and also in rural areas of the Southeast and Center-West regions. In this case, apart from socioeconomic interventions, it is mandatory the universalization of effective preventive actions as breast-feeding promotion, growth monitoring, appropriate management of diarrhea and respiratory infections, and health and nutrition education in general.

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## REFERENCES

1. Pelletier, DL. The relationship between child anthropometry and mortality in developing countries: implications for policy and future research. Ithaca NY, Cornell University, 1991. (Monograph 13).
2. Administrative Committee on Coordination/Subcommittee on Nutrition. Some options for improving nutrition in the 1990s. SCN News, 7 (suppl.), 1991.
3. Ferro-Luzzi, A; Branca, F & Pastore, G. Body mass index defines the risk of seasonal energy stress in the Third World. Eur J Clin Nutr,

48 (suppl. 3): S165-S178, 1994.

4. Pi-Sunyer, FX.. Health implications of obesity. Am J Clin Nutr, 53: 1595S-603, 1991.
5. Millar, WJ & Stephens, T. The prevalence of overweight and obesity in Britain, Canada and United States. Am J Publ Health, 77: 38-41,1987.
6. De Onís, M; Monteiro, CA & Clugston, G The worldwide magnitude of protein-energy malnutrition: an overview from the WHO Global Database on Child Growth. Bull World Health Org, 71: 703-12, 1993.
7. Popkin, BM. Nutrition patterns and transition. Popul Dev Rev, 19: 138-57, 1993.
8. Monteiro, CA; Mondini, L; Souza, ALM & Popkin, BM. The nutrition transition in Brazil. Eur J Clin Nutr, 49: 105-13, 1995.
9. Mondini, L & Monteiro, CA. Relevância epidemiológica da desnutrição e da obesidade em distintas classes sociais: métodos de estudo e aplicação à população brasileira. Rev Bras Epidemiol, 1977. (in press).
10. Fundação IBGE/IPEA/INAN.Pesquisa nacional sobre saúde e nutrição. Brasília, IBGE, 1988.
11. World Health Organization. Physical status: the use and interpretation of anthropometry. Geneva, 1995. (WHO - Technical Report Series, 854).
12. Hamill, PVV; Drizd, TA; Johnson, CL; Reed, RB; Roche, AF; Moore, WMM . Physical growth: National Center of Health Statistics percentiles. Am J Clin Nutr, 32: 607-629, 1979.
13. IPEA. Atlas regional das desigualdades. Rio de Janeiro, Instituto de Pesquisa Econômica Aplicada, 1997.
14. World Health Organization. Diet, nutrition and the prevention of chronic diseases. Geneva, 1990. (WHO - Technical Report Series, 797).

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# Changes in food consumption in Brazil

*Silvana P. de Oliveira*

Escola de Nutrição, Universidade Federal de Ouro Preto, Ouro Preto, Brazil

**SUMMARY. Changes in food consumption in Brazil.** Changes in eating habits have occurred in the last decades in several countries associated to demographic, economic, social and epidemiologic factors. In Brazil, the available data about food consumption are the result of Family Budget Surveys undertaken by Getúlio Vargas Foundation and IBGE (Brazilian Institute of Geography and Statistics) in 1961/1963 and 1987/88, respectively, and the National Study of Family Expenditure (ENDEF), carried ouy by IBGE during 1974/75. They reveal as principal tendencies the decreasing consumption of staple foodstuffs (beans, rice, manioc flour), pork meat, lard and butter, the replacement of bovine meat for chicken, and the increase in the comsumption of eggs, milk products and vegetable oils. Based on these surveys, the intake of macronutrients in urban areas showed a decrease of carbohydrate and an increase of fat contribution as sources of calories, an increase in the consumption of animal protein in detriment of vegetable protein, and substitution of animal fats for vegetable fats. It was also observed an increase in the use of industrialized foodstuffs, directly related to income, leading to a greater diversity of foodstuffs and lower consumption of staple foods. Recent studies with adult and elderly population from the city of São Paulo show a reduction in the consumption of fatty and fried foods and sugar, and an increase in the consumption of fruits and vegetables because of health concern. Studies that take into account the verified changes in eating habits and the new consumption tendencies, as well as their impact on nutritional and health conditions of the Brazilian urban population, are presently needed.

## INTRODUCTION

Changes in eating habits have been observed in recent decades in several countries. These changes are associated, among other factors, with the development of systems of production and distribution of foodstuffs and with the phenomenon of urbanization, influencing the life-style and health of the population.

The evolution of eating habits in western countries, such as the United States and European countries, over this century shows initially an improvement in quantitative terms and then an intensification of replacement of some products by others. In general, there has been a decrease in the consumption of cereals and starchy foods and an increase in the consumption of fruits and vegetables, products of animal origin, sugar and fats.

From the seventies, new trends have been emerging, arising mainly from the concerns with nutrition and health. Among these trends, the reduction in the direct consumption of sugar stands out, as also does a decrease in the consumption of products of animal origin, especially meats, and fats, and an increase in consumption of carbohydrates, fruits and vegetables (1,2). This phase has also been characterized by a gradual replacement of manufactured foodstuffs by the traditional agricultural foodstuffs and of some manufactured foodstuffs by others.

In Brazil, the change in eating patterns is seen by some authors as being mainly a consequence of the policies which have favored the option for the economic development model of the oligopolistic capitalist type, leading to the imitation of the patterns of production and consumption characteristic of the western countries (3,4).

## SURVEYS ON FOOD CONSUMPTION

There are few data on the eating habits of the Brazilian population which would allow an assessment of their evolution over time. On a National level, the data available are those from the National Study of Family Expenditure (ENDEF), an inquiry on food intake carried out by the IBGE (the Brazilian Institute of Geography and Statistics) in 1974/75 (5), and from the Family Budget Surveys undertaken in 1961/63 by Getúlio Vargas Foundation (6) and, in 1987/88, by IBGE (7,8).

These data surveys, despite their limitations arising from the differences in the methodologies used for data collection, provide us with information on some important changes over this period as, for example, the reduction in the consumption of staple foodstuffs (rice, beans, manioc flour), of pork and fats of animal origin (lard, butter) and the increase in the consumption of chickens, eggs, milk products (cheese, yogurt), margarine and vegetable oils (especially soya oil).

Based on the same surveys, the consumption of nutrients from foodstuffs of the Brazilian urban population was analyzed (9). There is a general tendency towards a lower contribution of carbohydrates in the total consumption of calories and their replacement by fats, especially over the period from 1974/75 to 1987/88. The increasing trend towards the consumption of animal protein and the increase in the consumption of vegetable fats replacing fats of animal origin, resulting in an increase in the consumption of polyunsaturated fatty acids and a decrease in consumption of dietary cholesterol. It is interesting to note that some of these trends are similar to those observed in the western countries in past decades, such as the reduction in the consumption of cereals and tubers and the increase in the consumption of fats and animal protein, while others, such as the replacement of animal fats by vegetable fats, have behaved differently.

Tasco in 1991 (10) analyzed the various family budget surveys undertaken in the city of São Paulo in 1971/72 and 1981/82 by FIPE (Institute of Economic Research Foundation), in 1982/83 and 1987 by DIEESE (Inter-Union Department of Statistics and Socio-economic Studies), including the ENDEF data of 1974/75. In the period from 1971/72 to 1987 a reduction in the contribution of beans, rice and bread as sources of calories was registered, parallel to an increase in that of pasta and oils. The contribution of meats and beans to the protein intake decreased in this period, while that of milk products and eggs increased. Furthermore, in accordance with these data, the consumption

of animal proteins increased in detriment of proteins of vegetable origin, which may be related to the increase in the consumption of milk and eggs.

As for the consumption of vegetables, data of the DIEESE surveys of 1982/83 and 1987, presented by Tasco (10), showed an increase of 130% in the per capita consumption of green vegetables and 65% in that of other vegetables. There was also an increase of 31% in the consumption of fruits. Another study on the consumption of fruits in the metropolitan region of São Paulo (11) concluded that there was a reduction in consumption of oranges and bananas from 1961/63 to 1974/75 and an increase in the consumption of other kinds of fruits (pawpaw, mangoes, pineapples and apples) in the period from 1974/75 to 1987/88.

With regard to the differences between the various income groups in the population, the data of the Family Budget Survey of the IBGE (7) for the metropolitan region of São Paulo showed that the five main items of expenditure regarding food consumption at home, for the families with a monthly income of less than 2 minimum salaries, reference value of October 1987, were: a- milk and dairy products, b- meats, entrails and fish, c- cereals and leguminous and oleaginous produce, d- chicken and eggs and e- bakery products (breads, biscuits). For the families with a monthly income above 30 minimun salaries, the five main items of expenses were: a- meats, entrails and fish, b- milk and dairy products, c-other products (frozen foods, potato chips, pre-prepared meals, savories, etc.), d- fruits and e-drinks (coffee, soft drinks). Noteworthy are expenses on food consumed outside the home for the higher income group: 33% of total expenditure on foodstuffs, as against 4.8% for the lowest income families.

On the basis of these data, one may observe the existence of some common and some divergent characteristics between different population groups based on their income. For example, on one hand, the share of products of animal origin (meats, dairy products) in the main items of expenditure on foodstuffs is similar, regardless of income; and on the other hand, the importance of fruits and of diversified food choices among the higher income groups, and that of the staple products (cereals, legumes and oleaginous products) among people of lower income.

As for the development of industrialized foodstuffs in Brazil, data from ABIA (the Brazilian Association of Producers of Industrialized Foodstuffs) (12) show, for 1985 to 1993, an increase in the production of chocolates (155.0%), condensed milk (147.8%), chocolate in bars (120.4%), chickens (109.5%), long-life milk (88.8%), yogurts (85.5%), milk powder (74.1%) and cream cheese (73.5%), some of them considered to be superfluous foodstuffs. There was also a reduction in the production of tomato concentrates (-29.2%), refined sugar (-19.9%), banana and guava pastes (-12.0%) and butter (-11.2%).

In a survey undertaken by Nielsen and published in the newspaper "O Estado de São Paulo" on January 8, 1996, in 1995 as compared to the previous year, there was an increase in the volume of sales for pre-prepared frozen foods (92.8%), for yogurts (89.4%), for industrialized meats (42.1%), for canned vegetables (40.1%), for fruit juices (33.5%) and for biscuits (29.6%).

The industrialized foodstuffs of greatest consumption in Brazil are still the traditional, relatively unmodified ones (vegetable oils, sugar, pasteurized milk). For products with a higher degree of transformation (dairy and meat products, canned vegetables), consumption is directly related to income but may, occasionally, be a part of the diet of the less favored groups in the population.

A pilot project was undertaken in São Paulo in 1993 by Oliveira (13) in which thirty-two women were interviewed, comprising three groups of distinct socio-economic characteristics (low, medium and high income). The results of the frequency of consumption questionnaire showed that the same staple foodstuffs appear in all three groups, namely, rice, beans, coffee, sugar, milk, eggs, bread, beef, chicken, macaroni, tomato and potato. However, the number of foodstuffs most frequently consumed (at least once a week) increases in accordance with the rise in income as also the consumption of industrialized foodstuffs of a greater degree of transformation (dairy products, biscuits, canned vegetables). Thus it is concluded that there are similarities between the different socio-economic groups as regards to staple foodstuffs, though this was not assessed in quantitative terms in this study. At the same time, a greater diversity of foodstuffs and greater consumption of fruits and salad vegetables was observed according to the rise in income level. There also appears, in the three groups, a concern regarding eating habits and health, a trend which has been observed since the seventies in the western countries.

Recent studies by Monteiro et al. (14,15) have observed the phenomenon of "nutrition transition" in Brazil and have shown the association between the pattern of food consumption and the increase of obesity in this country.

A study was carried out in São Paulo in 1996, involving 122 women and 8 men, aged between 39 and 80, students of the Open University for the Third Age, with the purpose of assessing the changes in eating habits associated with the prevention and/or control of the chronic-degenerative diseases. The preliminary results, obtained on the basis of the analysis of the questionnaires applied, show that, in the last ten years, there has been an increase in the consumption of fruits and salad vegetables, chicken and fish and a reduction in the consumption of fatty and fried foods and sugar. Among the causes of these changes, the most noteworthy are the easier access to information, the prevention of disease, age, health problems and the need to lose weight. The eating frequency data points to a trend towards a reduction in the consumption of fats and sugar, because of the use of products such as skimmed milk, "light" margarine, "light" cheese and dietetic sweeteners, with a possible increase also in the intake of fibers, vitamins and minerals due to the more frequent consumption of fruits and salad vegetables.

## CONCLUSIONS

The changes observed on the basis of the surveys and studies quoted, reflect, on one hand, the variations in relative prices of the foodstuffs leading to the replacement of some by others, as with meat, beans and even some industrialized foodstuffs and, on the other hand, the concerns relating to nutrition and health arising from the phenomenon of the epidemiological transition which has been taking place in Brazil.

Other characteristics observed in the behavior of the Brazilian consumer, especially in the large urban centers, are the increase in food eaten away from home and the preference for the supermarket as the place for the purchase of foodstuffs, a fact which favors the diversification of foodstuffs consumed and the consumption of industrialized products. These trends must be related to changes in the life-style of the population, in the quest for amenities and saving of time spent in shopping and in preparation and/or consumption of the foodstuffs and also related to the role of supply in the distribution of certain products in detriment of staple foodstuffs (13).

The differences that exist between the various classes of the population as regards to access to foodstuffs, both in quantitative and qualitative terms, are worth emphasizing as also is the appearance of new nutritional imbalances besides the continued prevalence of the traditional forms of subnutrition.

The changes in the consumption of foodstuffs by the Brazilian population lead us further to reflect on the speed at which these changes are taking place within the different population groups and the consequences of the imitation of international patterns of consumption on the local level. To what extent do the new trends observed correspond in fact

to the practice of a healthier and more balanced diet?

The data presented in this paper demonstrate, moreover, the importance of periodical surveys which will enable researchers to gain knowledge on the consumption trends of the population in general and/or of particular groups (income, age, etc.), and to analyze this information in terms of macro and micro-nutrients for the definition of policies which seek to meet the specific nutritional needs of Brazilians.

## REFERENCES


1. Padilla, M. Satiété alimentaire et internationalisation de l'agro-industrie, Economie e gestion agro-alimentaire, 19:18-23, 1991.
2. Popkin, B.M. Nutrition patterns and transitions. Popul Develop Rev, 19:138-157, 1993.
3. Müller, RG. Nutrição e desenvolvimento econômico. In: Nutrição e Desenvolvimento Econômico. São Paulo, IPE/USP, Campino, A.C.C., 1983.
4. Müller, G. Fome: o não-direito do não-cidadão. In: A cidadania que não temos. São Paulo, Covre, M.L.M., 1986.
5. IBGE. Estudo Nacional da Despesa Familiar. Consumo alimentar, despesas das famílias. Dados preliminares. Tabelas selecionadas. Rio de Janeiro, IBGE, 1978.
6. Getulio Vargas Foundation. Food consumption in Brazil: family budget survey in the early 1960's. Jerusalem, Keter Pres, 1970.
7. IBGE. Pesquisa de Orçamentos Familiares 1987/88 nº1. Domicílios, famílias, instrução, despesas, recebimentos. Regiões Metropolitanas, Brasília, DF, Goiânia. Rio de Janeiro, 1991.
8. IBGE. Pesquisa de Orçamentos Familiares 1987/88 nº2. Consumo alimentar domiciliar per capita. Regiões Metropolitanas, Brasília, DF, Goiânia. Rio de Janeiro, IBGE, 1991.
9. Mondini, L & Monteiro, CA. Mudanças no padrão de alimentação da população urbana brasileira (1962-1988). Rev. Saúde Pública, 28:433-439, 1994.
10. Tasco, AMP. Cesta básica. Conjuntura Alimentos, volume especial: 8-21, 1991.
11. Tasco, AMP & Menegario, RS. Consumo de frutas. Conjuntura Alimentos,
12. ABIA. O mercado brasileiro de alimentos industrializados. Produção e demanda: situação atual e perspectivas. São Paulo, ABIA, 1994.
13. Oliveira, SP. Mode de consommation agro-industriel: homogénéisation ou diversification des habitudes alimentaires? Approche comparative franco-brésilienne. Etude de cas dans la ville de São Paulo. Doctoral thesis - Ecole des Hautes Etudes en Sciences Sociales, Paris, 1995.
14. Monteiro, CA; Mondini, L; Souza, ALM & Popkin, BM. The nutrition transition in Brazil. Eur J Clin Nut, 49:105-113, 1995.
15. Monteiro, CA; Mondini, L; Souza, ALM & Popkin, BM. Da desnutrição para a obesidade: a transição nutricional no Brasil. In: Velhos e novos males da saúde no Brasil. São Paulo, HUCITEC, NUPENS/USP, 1995.

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# Non-communicable diseases in Brazil: mortality patterns, morbidity studies and risk factors

*Paulo Andrade Lotufo*

Departamento de Medicina Interna, Faculdade de Medicina,
Universidade de São Paulo, São Paulo, Brazil

**SUMMARY. Non-communicable diseases in Brazil: mortality patterns, morbidity studies and risk factors.** The aim of this presentation is to give an overview on non-communicable diseases in Brazil and to speculate about singular data that have been described in our country. The high rates of esophageal cancer, the elevated high blood pressure prevalence and some determinants of the decline of cardiovascular mortality are discussed more deeply.

## INTRODUCTION

Since the decade of 1940, Brazil has changed from an agricultural-dependent economy to an urban and industrialized country, with an increasing recent substitution of factories by commercial and service activities occurring mainly in the Southeast. A rise in the magnitude of non-communicable diseases and a sharply decrease in waterborne diseases and in infectious and parasitic diseases, made the former the more important disease group in Brazil, particularly after the decade of 1960 (1).

Cardiovascular diseases (CVD), cancer, respiratory diseases and cirrhosis are a set of diseases with common risk factors. In Brazil, these diseases are responsible for more than two-thirds of the deaths. In general, the non-communicable diseases have had a rising significance during the last four decades. Since the end of the seventies, mortality from stroke, coronary disease and gastric cancer has declined in some cities and states. However, total mortality, stroke and coronary heart disease among women are responsible at present for extremely high mortality rates in comparison with other countries, mainly when deaths below age 65 are analyzed (2,3).

## MORTALITY PATTERNS

The proportional mortality in the adulthood by non-communicable diseases shows that cardiovascular diseases including stroke, coronary heart disease (CHD) and chronic heart failure, are the more frequent causes of death for both sexes (Table 1). Cirrhosis among men and diabetes and hypertension among women are important causes with more deaths than specific cancers.

In the United States and Europe, CHD is the leading cardiovascular disease, but in Brazil and in Japan, the most prevalent one is stroke, although CHD rates in Brazil are also very high. São Paulo is the only Brazilian state where CHD is more frequent than stroke as the cause of death. In Rio Grande do Sul, Rio de Janeiro and Mato Grosso do Sul there is an equilibrium between these two causes of death (4). Among the nine biggest metropolitan areas of the country, CHD mor-

TABLE 1
The five top death causes classified by ICD-9 Chapters for Brazil (1990-92) for all ages (mortality proportion in percentage)

| | |
|---|---|
| MALE | |
| CARDIOVASCULAR | 25,4 |
| EXTERNAL | 17,2 |
| CANCER | 9,7 |
| RESPIRATORY | 8,2 |
| INFECCIOUS | 4,9 |
| FEMALE | |
| CARDIOVASCULAR | 31,8 |
| CANCER | 11,9 |
| RESPIRATORY | 8,6 |
| EXTERNAL | 5,2 |
| METABOLIC & IMMUNE DISEASES | 5,2 |

tality surpasses stroke mortality only in the cities of Rio de Janeiro, São Paulo, Curitiba and Porto Alegre (5). Morbidity studies in cardiovascular diseases such as the incidence of coronary and stroke are rare (6,7) and the prevalence studies for risk factors are punctual (8). In the city of São Paulo, the prevalence of angina pectoris using the Rose questionnaire was 6,6% (9). The incidence of stroke in Salvador (Bahia) when compared with other places in the Western hemisphere was the highest among women and classified in second place among men (6).

Opposite to what occurs in the United States or Europe, gastric cancer has still high rates in Brazil, but it is surpassed by lung cancer in men and by breast cancer in women. Among women, liver and biliary tract and uterine cervix cancers are also important causes of death (4).There are no studies exploring specific determinants of hepatic-biliary tract cancer among Brazilian women. Uterine cervix cancer has high rates due to its high prevalence in north-northeast regions where the coverage of preventive measures for all diseases, including immune-preventable is low .

For the "top 5 cancers", gastric cancer and cervix cancer have had downward trends since the seventies. Others (prostate and lung) have increased or have had no temporal changes. The most important studies about cancer etiology were performed using migrants in comparative studies. Brazil has received since the third quarter of the 19th century a large amount of migrants from Europe (Portuguese, Hispanic and Italian) from Middle East (Lebanese) and Asia (Japanese, Chinese and Korean). One study has compared cancer mortality and morbidity among Japanese in Brazil (10); another among Europeans (11).

Cancer incidence rates among first-generation Japanese immigrants in the city of São Paulo were compared with those among Japanese in Japan; cancer of the stomach and rectum revealed significantly lower rates, while non-melanoma skin cancer, and prostate and breast cancer showed higher rates. No significant increase of colorectal cancer was recognized among Japanese migrants in São Paulo, contrary to the remarkably high rates of colorectal cancer observed among Japanese migrants in the US (10).

Italian and Spanish migrants in Brazil show changes in cancer risks, with an increase in rates of oropharyngeal, esophageal, cervical and breast cancers and a decrease in rates of lung cancers. However, for cancer of the esophagus, the changes are greater in São Paulo, where migrants acquire rates similar to those of Brazilians. For colon cancer, rates in Italian migrants decrease in Sao Paulo. Changes in Portuguese migrants are less evident: their rates of colorectal cancer remain high, and they also retain their higher risks of gastric cancer (11).

## RISK FACTORS

All published studies about primordial risk factors and non-communicable diseases in Brazil have cross-sectional designs. There are no cohort-studies published and no ongoing observational studies about the relationship between risk factors and major outcomes as cardiovascular diseases and cancer. A summary of risk factors, except high blood pressure, is given in Table 2.

A seminal study was performed in Porto Alegre to assess the degree to which the prevalence of five risk factors for non-communicable diseases (hypertension, smoking, obesity, sedentary lifestyle, and excessive alcohol consumption) varied individually and in combination for urban Brazilians with differing socioeconomic status in terms of educational achievement, income, and social class. It was found that less privileged socioeconomic situations tended to be associated with higher

TABLE 2
Frequencies of obesity, smoking, alcoholism and hypercholesterolemia obtained from different and non-comparable cross-sectional studies.

| PLACE | SEX | OBESITY | SMOKING | ALCOHOL ADDICTION | HIGH CHOLESTEROL |
|---|---|---|---|---|---|
| P.ALEGRE | M | 15 | 52 | 13 | |
| | F | 24 | 33 | 3 | |
| P.ALEGRE | M/F | | | | 34 |
| S.PAULO | M/F | 18 | 38 | 8 | |
| R.JANEIRO | M/F | 46 | 30 | | |
| FORTALEZA | M/F | 40 | | | 6 |
| R.JANEIRO | M/F | 55 | | | 26 |

Source: Lessa, 1993 (34)

risk factor prevalence. However, this was not the case for obesity and sedentary lifestyle among men, and may not have been the case concerning hypertension among women. When the effects of education, income, and social class were considered simultaneously, higher risk factor prevalence was most strongly associated with low educational attainment. Important exceptions to this rule were found for smoking among women and excessive alcohol consumption among men, where higher risk factor prevalence was mostly associated with social class. Once the effects of education and social class were accounted for, low income generally tended to be associated with lower prevalence of the

risk factors studied (12). The age- and sex-adjusted prevalence of smoking was 40%, hypertension 14%, obesity 18%, overall sedentary lifestyle 47%, and excessive alcohol consumption 7%. Thirty-nine percent of the sample presented two or more of these five risk factors, and only 22% of men and 21% of women had none of them. The high frequencies and simultaneous presence of these risk factors indicate their importance for programs aimed at the prevention of non-communicable diseases and the promotion of adult health (13). In the city of São Paulo, one cross-sectional study showed the prevalence of hypertension (22.3%), smoking habit (37.9%), obesity (18.0%), alcoholism (7.7%) and physical inactivity (69.3%) (14).

An important modification in dietary patterns was detected in the southeast of the country between 1960 and 1988: an important decrease both for the relation of ingestion of polyunsaturated-saturated fat (P/S ratio) (-60,7%), as well as for the ingestion of cholesterol (-19,8%) (30). Today, Brazil has a favorable P/S ratio when compared with countries in the northern hemisphere, but the high intake of polyunsaturated fat could be one of the many reasons for the increase of obesity in all regions of the country. Considering that coronary heart disease presents an "incubation period" of about 10 years (31), we could credit the alteration of the dietary pattern of the Brazilian population since the seventies as responsible for the decrease in mortality rates of this disease at the end of the decade in the state of São Paulo. According to Rose (32) "the mass diseases can only be controlled by mass actions", which are usually the result of governmental actions for promotion of health and medical activities, determined by economic, social and cultural factors. For instance, the decrease of consumption of saturated fats would be an economic phenomenon resulting from the replacement of pork fat (reduction of 79.7%) by vegetable oils (rise of 91%), mainly soy bean oil.

There is a cluster of high-incidence areas of esophageal cancer in South America, including Southern Brazil, Uruguay and parts of Argentina. Drinking hot mate (a traditional beverage drunk at a very high temperature) and eating barbecue, are daily living habits in those places. One case-control study failed to show the use of hot mate as a risk factor when it was adjusted for smoking habit, alcoholism, and dietary habits. Although the study failed to provide evidence of a strong association between drinking mate and esophageal cancer, the cluster of high rates could be explained by relative risks of the magnitude observed. This is because approximately 70% of adult males and 50% of females are daily drinkers. In addition, this study revealed that alcohol, tobacco smoking and rural residence are the main risk factors for esophageal cancer in this population and the fruit consumption gives some degree of protection (15). However, a cross-sectional design had detected that esofagitis (as cancer precursor) is more prevalent in hot-mate drinkers than in controls (16). In São Paulo, where the hot mate is not a habit and the rates are high, but lower than in Southern states, one case-control study revealed that alcoholism, smoking habit and the frequent eating of hot pepper, are important risk factors for the disease. The estimate of odd ratios for smoking ordinary cigarettes was 3.4 and for smoking corn-straw hand-rolled cigarettes was of 4.2 (17).

In Southern Brazil, in spite of heavy consumption of meat and milk, there is a high mortality from esophagus cancer associated with a very low mortality from colon cancer, posing a most interesting epidemiological problem.

In general, there are conflicting data of risk factors of esophageal/colon cancer in Brazil. However, for breast cancer, it seems that risks (monthly family income; being a housewife; parity of less than six deliveries and nulliparous women; history of breast cancer among first degree female relatives and use of oral contraceptives) or protective factors (irregular menstrual cycle) are similar to those previously demonstrated elsewhere in the world (18).

## HYPERTENSION AS A MAJOR RISK FACTOR

The assumption that cardiovascular diseases are the products of affluence, based on the British and North American examples, is contradicted by two other experiences: in Japan, the country with the greatest post-war economic development, cardiovascular death rates diminished vertiginously, whereas in countries of eastern Europe, which suffered great deprivations during the seventies and eighties, death rates increased (33). An observation supporting the view that the "American-Northern European" pattern cannot be generalized emerges from the comparison between the Brazilian experience in São Paulo and in Great Britain. The period of rise of CHD mortality in Great Britain is concomitant with the decrease of infant mortality rate, whereas in São Paulo the mortality from cardiovascular disease and the infant mortality rate showed similar behaviors during the seventies and eighties.

In São Paulo, a peculiar pattern of cardiovascular death rate is observed, with the decrease in CHD mortality being similar to that of cerebrovascular diseases. The decrease of stroke mortality is also described both in the western (with higher rates for CHD than stroke) and Japanese (rates for stroke superior to CHD) countries. The explanation for this particular behavior could be related to the distribution of arterial hypertension: the decline of mortality from cerebrovascular diseases was related to the rise on detection, treatment and control of high blood pressure. Arterial hypertension is highly prevalent in the Brazilian population (34) and is unequally distributed in the population, being more frequent among the poorer (2,21,23). Therefore, the risk of developing cerebrovascular disease would be greater in the low income group.Comparison of the curve of systolic pressure according to age, as standardized by Epstein-Eckoff, obtained in a prevalence study in Araraquara, which showed a very high blood pressure-age relationship, with the INTERSALT study, revealed that it was only surpassed by a community in Portugal (32). On the other side, other two risk factors for CHD, cholesterol levels and smoking, which also show a differentiated social distribution, have lower contributions than arterial hypertension. The few studies that correlate cholesterol levels with social strata showed no differences among poor, middle or rich people (23). Smoking is nowadays a habit with a higher prevalence in the poorer (2). Thus, in theory, the social differences for the risk of developing coronary disease are less apparent than for stroke.

Using the Omran theory for the epidemiological transition under the Latin-American viewpoint, it could be said that, among the cardiovascular diseases, there is a "polarized and prolonged transition" (36) between coronary and cerebrovascular diseases that could explain the slow decline of cerebrovascular when compared to coronary disease. The main determinant for this peculiar characteristic would be the difference among the several social strata of the population with a differentiated pattern of risk factors, mainly arterial hypertension.

## SOCIAL DETERMINANTS OF HYPERTENSION

Many population-based studies of hypertension in Brazil were performed using cross-sectional designs. The majority of these studies were conducted in the south-southeast regions or among natives living in the rain forest. The most recent population study was carried out in Rio de Janeiro, where the prevalence of hypertension increased 2.4 fold from the lowest (25kg/m$^2$-) to the highest ($^3$30kg/m$^2$) range of body mass index.. This increase persisted after adjusting for sex, age, skin color, smoking, physical activity and level of education. Interaction of obesity with sex, age and skin color was found. The association between hypertension and obesity was stronger for men (19).

The first population-based study cross-sectionally designed was performed in Rio Grande do Sul (20). In this study, a geographical

analysis was done in four regions with specific characteristics patterns: the highest rate was detected in the surrounding cities of the state capital Porto Alegre (13.8%), Porto Alegre had the second rate (12.3%), people living in inner towns had 11.4% of hypertensives and the lowest rate was detected among rural people (9.2%). The migrants from the rural areas to the city acquired the urban level of blood pressure (21). This study was analyzed also by social stratification revealing higher hypertension rates among factory workers and clerks than among other professionals (22). A relationship between hypertension and social stratification was detected also in the Northeast (Fortaleza,CE) (23), where a specific neighborhood was studied, divided based in housing quality. The highest rate was detected among people living in slums (18%), the median rate was among poor people living in projects (14.9%) and the lowest was detected among people living in houses (9%). In another study carried out in Araraquara (SP) (24), there was a greater percentage of hypertensives in the mulatto and black groups, in the obese, and among those of lower family income, with a lower level of school education and with less well paid jobs. Another view about social differences in hypertension prevalence was shown in São Paulo, where steel workers, media professionals and bus drivers had higher blood pressure levels than teachers, physicians and lawyers (25).

The most impressive study was one of anthropological-epidemiological design, done in the most affluent region of the country, Ribeirão Preto (SP). Its aim was to study ethnicity and psychological resources and hypertension. The results were very important because social support (mainly kin support and coping style) were positive and strongly related to people with low blood pressure. These factors deny the importance of black skin color or African ancestry as determinants of hypertension (26). Although hypertension was detected more in black and mulatto population in all studies, social support and coping style could be confounding factors, since all black people in Brazil are descendants from African slaves and have a lower economic and social level than white people, although there is a lesser prejudice load than in the United States. An observational study confirms the hypothesis that hypertension is more related to psychological resources than ethnicity. An isolated community of black people whose ancestors escaped from the farms where they were slaves and settled in a town surrounded by mountains near the rain forest, was studied. The prevalence of hypertension was lower than in the cities (6,2%), body mass index had also lower levels, sodium intake was low, physical activity was high, but alcohol intake was higher than in the cities (27).

Many studies were performed among natives living in the rain forest. The more important was the INTERSALT-Brazilian branch, that detected no high blood pressure among Yanomamo, with no salt and alcohol intake and body mass index not higher than 25 kg/m2 (28). Another study among Xavantes evaluated the influence of new habits (changing from hunting to a rural style with rice and bean cultures) on blood pressure and during fifteen years (1975-90) no changes were detected. Obesity, tobacco, alcoholic beverage consumption and social organization also did not change and sodium intake did not increase during that period (29).

## RESEARCH AGENDA

Many studies with several designs need to be planned for future widening of the comprehension about Brazilian mortality and morbidity patterns as well as to contribute to the universal knowledge. The non-communicable disease epidemiology has been based solely in the "American- Western European" experiences, with some comparative studies in Japan and China. Thus, collaborative research with other South-American countries, mainly observational studies, could be a useful proposal for American and European epidemiologists.

The data from Brazil suggest that future studies should be pursued on why stroke mortality is higher than CHD and to evaluate if alcoholism has an important gender gap prevalence, explaining the high mortality by cirrhosis and upper-respiratory and digestive cancers among men. Moreover, it would be necessary to improve the comprehension about the influence of social inequalities in our epidemiological pattern. Social, economical and educational differences among Brazilians are wider and deeper than abroad, mainly when compared with countries with the same gross national product per capita.

## PUBLIC HEALTH AGENDA

In conclusion, the orientations that could be derived from the analysis of cardiovascular mortality in Brazil are useful for future measures since with few policies from the Ministry of Health it seems possible to reduce mortality.

The public health service is responsible for the coordination of efforts of the society, aiming at a greater reduction of mortality and morbidity from non-communicable diseases, with a priority for stroke, using what has been learned from almost 40 years of systematization of cardiovascular disease epidemiology. A mass program for detection, treatment and control of high blood pressure by means of dietary, sanitary and pharmacological measures, will be useful for the reduction of mean values of high blood pressure in the whole population.

The efforts for control and eradication of alcoholism and smoking could be a useful tool for decrease cancer and cirrhosis.

Promotion of proper dietary habits with a specific target on obesity prevention, and premature diabetes diagnosis would be the more important programs for the first quarter of the 21th century in our country.

## REFERENCES


1. Bayer, GF & Goes de Paula, S. Mortalidade nas capitais brasileiras 1930-1980. RADIS-dados, 2, 1984.
2. Duncan, B & Schimidt, MI. Altos coeficientes de mortalidade em populações adultas brasileiras. Rev Assoc Med Bras, 38:138-144, 1992.
3. Lotufo, PA. A mortalidade precoce por doenças crônicas nas capitais de áreas metropolitanas do Brasil. São Paulo. Faculdade de Saúde Pública da Universidade de São Paulo. (Doctoral Thesis), 1996.
4. Ministério da Saúde. Estatísticas de mortalidade 1994. Brasília, D.F., 1997.
5. Lolio, CA; Lotufo, PA; Lira, AC.Tendência da mortalidade por doença isquêmica do coração nas capitais de regiões metropolitanas do Brasil, 1979-89. Arq Bras Cardiol, 64: 195-199, 1995.
6. Lessa, I & Bastos, CA. Epidemiology of cerebrovascular accidents in the city of Salvador, Bahia, Brazil. PAHO Bulletin, 17: 292-303, 1983.
7. Lessa, I; Cortes, E; Souza-Filho, J; Netto, JP & Almeida, FA. Epidemiology of acute myocardial infarction in Salvador, Brazil: Incidence, lethality and mortality. PAHO Bulletin, 22: 28-37, 1987.
8. Lotufo, PA. As doenças cardiovasculares no Brasil: estudo de caso da tendência da mortalidade no estado de São Paulo, 1970-1989. Faculdade de Saúde Pública da Universidade de São Paulo (Dissertation of Master), 1993.
9. Lotufo, PA & Lolio, CA. Prevalência da doença isquêmica do coração- angina pectoris e infarto antigo - em São Paulo: resultados preliminares de aplicação do questionário de Rose. Arq Bras Cardiol, 65 (Supl. 1): 85, 1995.
10. Tsugane, S; De Souza, JM; Costa, M.LJR.; Gotlieb, SL; Laurenti, R & Watanabe, S. Cancer incidence rates among Japanese immigrants

in the city of São Paulo, Brazil, 1969-78. Cancer Causes Control, 1:189-193, 1990.

11. Bouchardy, C; Khlat, M; Mirra, AP & Parkin, DM. Cancer risks among European migrants in São Paulo, Brazil. Eur J Cancer, 29A: 1418-1423, 1993.
12. Duncan BB; Schmidt, MI; Achutti, AC; Polanczyk, CA; Benia, LR & Maia, AA. Socioeconomic distribuition of non-communicable disease risk factors in urban Brazil: the casee of Porto Alegre. Bull Pan Am Health Organ, 27: 337-349, 1993.
13. Duncan , BB; Schmidt, MI; Polanczyk, CA; Homrich, CS; Rosa, RSE; Achutti, AC. Risk factors for non-communicable diseases in a metropolitan area in the south of Brazil. Prevalence and simultaneity. Rev Saude Publica. 27: 43-48, 1993.
14. Rego, RA; Berardo, F & Rodrigues, S. Fatores de risco para as doenças crônicas não transmissíveis no Município de São Paulo. Rev Saude Publica, 24: 277-285, 1990.
15. Victora, CG; Munoz, N; Day, NE; Barcelos, LB; Peccin, DA & Braga, NM. Hot beverages and esophageal cancer in southern Brazil: a case-control study. Int J Cancer, 39: 710-716, 1987.
16. Munoz, N; Victora, CG; Crespi, M; Saul, C; Braga, NM & Correa, P. Hot mate drinking and precancerous lesions of the esophagus: an endoscopic survey in southern Brazil. Int J Cancer, 39: 708-709, 1987.
17. Gimeno, SG; De Souza, JM; Mirra, AP; Correa, P & Haenszel, W. Risk factors for cancer of the esophagus: a case control study in a metropolitan area of south eastern Brazil. Rev Saude Publica 29: 159-165, 1995.
18. Gomes, AL; Guimaraes, MD; Gomes, CC; Chaves, IG; Gobbi, H & Camargos, AF. A case control study of risk factors for breast cancer in Brazil, 1978-1987. Int J Epidemiol, 24: 292, 1995.
19. Bloch, KV; Klein, CH; De Souza e Silva, NA; Nogueira, ADAR & Campos, LH. Arterial hypertension and obesity in Ilha do Governador, Rio de Janeiro. Arq Bras Cardiol, 62: 17-22, 1994.
20. Costa, E. A cross sectional survey of blood pressure in Rio Grande do Sul, Brazil. (PhD Thesis), Faculty of Medicine, University of London , 1981.
21. Leal, MC. Migrações internas e pressão arterial. Rio de Janeiro. Escola Nacional de Súde Pública. (Dissertation of Master), 1981.
22. Klein, CH. Hipertensão arterial nos estratos geo-econômicos do Rio Grande do Sul. Escola Nacional de Saúde Pública. Rio de Janeiro. (Dissertation of Master), 1984.
23. Rouquayrol, MZ; Veras, F; Vasconcelos, J; Bezerra, R; Gomes, I & Bezerra, F. Fatores de risco na doença coronariana. Inquérito epidemiológico em estratos habitacionais de um bairro de Fortaleza. Arq Bras Cardiol, 49: 339-347, 1987.
24. Lolio, CA; Pereira, JC; Lotufo, PA & De Souza, JM. Arterial hypertension and possible risks factors. Rev Saude Publica, 27: 357-362, 1993.
25. Debert Ribeiro, M; Ribeiro, AB & Stabile Neto, C. Hypertension and economic activities in São Paulo, Brazil. Hypertension, 3: 233-237, 1981.

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# Micronutrient regulation in pregnant and lactating women from Rio de Janeiro

*Nadia M. F. Trugo*

Laboratório de Bioquímica Nutricional e de Alimentos, Departamento de Bioquímica, Instituto de Química, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

**SUMMARY. Micronutrient regulation in pregnant and lactating women from Rio de Janeiro.** Studies with low-income pregnant and lactating women from the city of Rio de Janeiro, concerned mainly with the changes in micronutrient homeostasis during pregnancy and lactation in the absence of overt clinical deficiencies, are reported. These studies focused on folate, cobalamin, iron, zinc and vitamin A. Factors that may affect the maternal micronutrient state, such as dietary intakes, use of supplements and interrelationships of micronutrients have been considered, as well as the implications of these changes for maternal-fetal transfer and milk composition. Although these studies were not designed to evaluate the prevalence of sub-clinical micronutrient deficiencies in pregnant and lactating women, they indicate that high frequencies of sub-clinical deficiencies of folate, iron, zinc and vitamin A, especially in pregnant women, are expected to be found in Rio de Janeiro.

## INTRODUCTION

Pregnancy and lactation impose a high demand of nutrients for growth of maternal, placental and fetal tissues, and for milk production. This demand should be met by maternal body stores and increased intake of essential nutrients. Physiological and hormonal changes in these periods affect nutrient metabolism and regulation of homeostasis in order to attain an efficient nutrient utilization by the maternal organism and transfer to fetus and to milk.Iron and folate are good examples of nutrients which highly increased requirements during pregnancy are difficult to achieve through the habitual diet, especially for low income women in developing countries who may be at risk for the development of both nutrient deficiencies. As a consequence, iron and folate deficiencies are the most prevalent nutritional disorders during pregnancy (1).

It is estimated that 90% of all anemias in the world are due to iron deficiency. Worldwide, 60% of pregnant women are anemic and in developed countries the prevalence of anemia oscillates between 9 and 14% (2). In Brazil, data on prevalence of nutritional anemias in pregnant women are limited to some regions and the few studies available are concerned with iron-deficiency anemia, showing high intra and inter-regional differences (3). Prevalences of iron-deficiency anemia in pregnant women vary from 14% in São Paulo to 35% in Pernambuco (4). Data on sub-clinical iron deficiency during pregnancy and lactation are scarcely available, but limited studies in Rio de Janeiro (5,6) have shown that 40% of pregnant and 21% of lactating women have depleted iron reserves.

Nutritional folate deficiency has a worldwide distribution, differing greatly in severity, with the sub-clinical, non-anemic forms being predominant in pregnant women. Megaloblastic anemia due to dietary folate deficiency affects up to 25% of non-supplemented pregnancies in certain parts of Asia, Africa and Latin America, and 2.5-5.0 % in developed countries. It is estimated that sub-clinical folate deficiency has even higher prevalences, affecting up to one-third of the pregnant women on a global scale (1). In Brazil, folate has received much less attention than iron and only very few studies have been carried out concerning folate status, in general, and in pregnancy and lactation in particular. In this country, megaloblastic anemia is not considered common during pregnancy, but limited studies in the urban regions of Rio de Janeiro (6) and Manaus (7) have shown that 20% and 22% of non-supplemented pregnant women, respectively, have sub-clinical folate deficiency.

The undesirable effects of overt, clinical maternal deficiency of these micronutrients on pregnancy development and outcome, and on infant status and milk composition are generally well-known. However, as mentioned previously, sub-clinical deficiencies are more prevalent, this being probably especially true in urban regions and metropolises. Moreover, their effects are poorly evaluated and understood.

The objective of this paper, in the context of the present workshop, is to review the main results obtained in studies carried out by our research group with low-income pregnant and lactating women, from the city of Rio de Janeiro. These studies have been concerned mainly with the changes in micronutrient homeostasis during pregnancy and lactation, in women without clinical micronutrient deficiencies. The implications of these changes for fetal nutritional status, maternal-fetal transfer and milk composition have been considered, as well as factors that may affect these changes, such as maternal sub-optimal states, dietary intakes and use of supplements. We have focused our interest in the following micronutrients: folate, cobalamin, iron, zinc, and more recently vitamin A.

## CHANGES IN MICRONUTRIENT STATUS OF LOW-INCOME WOMEN DURING PREGNANCY AND LACTATION

Pregnancy is usually associated with iron and folate depletion, especially in women of low socio-economic level, multiparas, and with low dietary intakes (1), but information regarding Brazilian women is scarce. Because of the risks of the negative effects on the mother, conceptus and infants caused by iron and folate deficiencies, routine supplementation with both nutrients throughout pregnancy has been recommended (1,2). In the case of folate, supplementation of all women in the periconceptional period is recommended in some developed countries to decrease the risk of first occurrence and recurrence of neural tube

defects of the fetus (8). Despite the known beneficial effects of iron and folate supplementation of deficient women during pregnancy, its indiscriminate use as a routine procedure for all pregnant women is controversial regarding its potential benefits and possible risks, such as those resulting from excessive nutrient intake and/or adverse nutrient-nutrient interactions (9).

Changes in folate and iron status during pregnancy and lactation (2-3 months post partum) were evaluated in a study with a cohort of non-anemic pregnant women attending a public prenatal clinic in Rio de Janeiro (6). We also assessed whether the indiscriminate supplementation with iron (80-160 mg/d) and with combined folate (2-4 mg/d) and iron supplementation (80-160 mg/d), as routinely prescribed during pregnancy, brings a substantial benefit in terms of pregnancy outcome and of nutrient status to women who begin pregnancy with adequate iron and folate reserves, and do not become anemic during pregnancy. Maternal weight gain, absence of serious complications in pregnancy, delivery and post partum, and the infants' birth weight and length showed that pregnancy proceeded normally and adequately, independently of the use of supplements. Hemoglobin and hematocrit remained adequate throughout these periods and did not further improve with the use of supplements.

Mean dietary intakes of iron and folate during pregnancy were, respectively, 50% and 83% of the recommended intakes for pregnant women (10). Despite this, mean plasma and erythrocyte folate levels were adequate and did not change during pregnancy and lactation in unsupplemented women (6). It would be interesting to ascertain whether their folate catabolism and urinary excretion are lower than the reported high values for well-nourished pregnant women (11). Folate indices were further improved in both periods with the use of folate supplements, but were not affected by exclusive iron supplementation. Plasma cobalamin levels were adequate throughout these periods and correlated with plasma folate (6).

Iron stores of most of the women were adequate at the beginning of pregnancy and were able to prevent iron-deficiency anemia during gestation. Although mean plasma ferritin levels were adequate throughout the study, they decreased during pregnancy, regardless the use of iron supplements (6), as has also been shown by studies with Scandinavian women (12), with the frequency of depleted iron reserves (plasma ferritin < 12 mg/l) increasing to 40% in the third trimester. However, iron supplementation was effective in maintaining adequate circulating plasma iron during pregnancy and was beneficial for the recovery of iron stores in the lactation period (6).

Since plasma iron represents the iron in transit from liver stores and intestine to the highly demanding hematopoietic, placental and fetal tissues during pregnancy, the extra iron provided by the supplements during pregnancy seems to be preferentially directed to these sites rather than to the stores. The fact that oral iron supplementation of non-anemic women during pregnancy was not effective in avoiding a decrease in plasma ferritin (6), whereas supplementation during 3 months of lactation, a period of lower iron demands, was effective in increasing iron stores (13), suggests that iron mobilization from stores during pregnancy may be regulated by a specific mechanism that favors intense mobilization independently of intestinal iron absorption.

## INTER-RELATIONSHIP OF MICRONUTRIENTS DURING PREGNANCY AND LACTATION

Evidences provided by several studies in humans and animals suggest that iron deficiency can affect folate utilization and that a complex relationship between both nutrients occurs during reproduction (14).

A relation between iron stores and folate status in non-anemic women from Rio de Janeiro was found in several studies (6,15,16). There was a correlation between plasma ferritin and erythrocyte folate in the second and third trimesters of pregnancy, but not in the first trimester or during lactation. The women with iron depleted reserves (serum ferritin < 12µg/l) in the third trimester, either supplemented or not with folate, presented lower erythrocyte folate levels than the non-depleted women in this period, in spite of a similar dietary folate intake. Also, erythrocyte folate levels in the women with depleted iron reserves tended to be less responsive to folate supplementation and, in the case of no folate supplementation, showed a decrease in comparison with the beginning of pregnancy (6).

In other groups of volunteers without depleted iron reserves, the women with ferritin levels in the lower quartile at parturition (15) and 1-2 days post partum (16) had erythrocyte folate levels lower than those with ferritin in the higher quartile, possibly reflecting the situation during pregnancy. Again, this was not evident at 3 months post partum (16).

These results suggest that a relation between erythrocyte folate and iron stores occurs in periods of high simultaneous demand for both nutrients and increased erythropoiesis, such as pregnancy.

## MATERNAL-FETAL TRANSFER OF MICRONUTRIENTS

Maternal-fetal transfer of folate, cobalamin, iron and zinc is very efficient and competes favorably with maternal tissues, assuring an adequate fetal status even in maternal deficiency. Umbilical cord and newborn serum levels of these nutrients are usually higher than in maternal serum. The high rates of placental transfer from mother to fetus and preferential uptake of the first three nutrients by the placenta are mainly explained by the higher expression of folate, transcobalamin and transferrin receptors in the microvilli (maternal surface) of the placental syncitiothrophoblast (17-19). For zinc, the mechanism for placental transfer is not well known, and involves more than one carrier system in the microvilli and intracellular zinc ligands, such as metallothionein (20).

In the case of vitamin A, the placenta ensures an adequate supply to the fetus despite a wide variation in the maternal vitamin A circulating levels, except when there is a maternal clinical deficiency of vitamin A, and probably also when an excess intake occurs (21). However, the umbilical cord serum concentrations of retinol and carotenoids are usually lower than in the maternal serum (22,23). The mechanism and regulation of transplacental flux of vitamin A are still poorly understood. Retinol uptake in placental microvillous membrane is possibly regulated by a specific receptor for the serum retinol-binding protein, which would control the accumulation of retinol in the placenta and its transfer to the fetus (24).

A main concern regarding the maternal-fetal transfer of micronutrients to the fetus is the extent to which the process is regulated by the nutritional status of the mother. The relation of iron, folate and cobalamin states of the newborn with maternal circulating levels and reserves, which varied within an adequate range, was investigated in a study with 24 pregnant women at parturition (15). Cord levels of serum and erythrocyte folate, serum cobalamin, iron, transferrin saturation and ferritin, as well as hemoglobin and hematocrit, were higher than in maternal blood, as expected. Cord serum folate and cobalamin were correlated with maternal levels, whereas iron status of the newborn did not depend on the maternal circulating iron or iron reserves. Folate and cobalamin states of the newborn were not related to maternal iron status. In a study with pregnant women at parturition (25), grouped according to their serum zinc levels (low < 7.6 ; intermediate 7.6-10.7, high zinc > 10.7 µmol/l), cord serum zinc levels were higher than the maternal ones, adequate in all groups, and slightly higher in the high zinc group.

There was a correlation between maternal and cord serum zinc. Erythrocyte zinc and metallothionein in blood cord were similar for all groups, and the low zinc levels in maternal serum did not affect zinc and metallothionein levels in placenta.

In vitro models using microvillous membrane vesicles from human placental syncitiothrophoblast have been used in our laboratory to further explore the transport of folate, cobalamin and zinc at the membrane level in various conditions (26-30). These experiments showed that neither folate or iron deficiency affected biochemical parameters of folate transport (27). Folate receptor affinities for folic acid (Kd= 0.5-1.8 nmol/l) in placentas from deficient mothers were similar to that of the controls and would be appropriate for an efficient folate uptake, even in the presence of a maternal folate deficiency, when concentration of serum folate is lower than 6.8 nmol/l. In the case of placentas from women with low serum zinc levels, also no difference was observed in zinc transport from those with normal levels (28). Conditions, such as gestational period, severe maternal hypertension and fetal neural tube defects, in which structural and morphological characteristics of the placenta are different from the normal placenta, do not impair folate transport (29). However, in premature placentas, the transport of cobalamin and zinc was more efficient. Cobalamin transport was twice higher (30) and there was an increase in concentration of zinc-binding sites, with no effect on affinity (28).

A sub-clinical vitamin A deficiency of the mothers may have no effect on fetal circulating retinol, but may affect the placental handling of retinol and carotenoids to ensure an adequate retinol supply to the fetus. The placental transfer of retinol and β-carotene was investigated in pregnant women with adequate (serum retinol > 20 μg/dl) and sub-adequate (serum retinol ≤ 20 μg/dl) vitamin A status (22). Although there was no difference in retinol and β-carotene levels in placenta and cord serum between these groups, and no correlation between maternal serum retinol and placental or cord retinol, a significant correlation was found between maternal serum β-carotene and placental retinol in mothers with sub-adequate vitamin A status, particularly in those with retinol levels lower than 15μg/dl, whom also presented a significant correlation between maternal β-carotene and cord serum retinol. These results suggest that β-carotene may be a precursor of retinol in placenta, which would then be available to the fetus, and that it could be dependent on the retinol status of the mother. Also, the decrease of β-carotene in relation to α-carotene and licopene in the placenta, when compared to maternal serum (31), is suggestive of β-carotene catabolism in placenta.

## MATERNAL MICRONUTRIENT STATUS AND MILK COMPOSITION

Mean levels and range of folate, cobalamin, iron and zinc in milk from low-income women at different periods of lactation (5) were similar to those found for well-nourished mothers in developed countries (32,33).

There was no relationship between maternal indices of iron, zinc, folate and cobalamin status and the milk concentrations of these nutrients, in spite of the risk of poor status observed in some of the mothers. Milk components related to a better availability of these nutrients to the infants, such as cobalamin-binding protein, folate-binding protein and lactoferrin, or whey bound zinc and iron, were not affected by maternal status. Partial weaning (pasteurized cow's milk, cooked vegetables and bananas substituting at least two daily feedings from the breast) did not affect milk composition, except for total iron which was lower in milk from mothers who were exclusively breast feeding. Folate and iron supplementation during pregnancy did not affect milk composition (5).

Although the means of folate, cobalamin and iron indices in the infants with ages varying from 31-280 d were within the normal limits, regardless the type of feeding, a substantial proportion of exclusively breast-fed and partially weaned infants presented low levels of serum folate (33 and 67%, respectively) and hemoglobin (33 and 43%, respectively) (34).

In another study (13), iron supplementation (40 mg/d) of lactating women for three months after delivery did not affect iron and zinc levels, but increased total iron ligands and lactoferrin/protein ratio in milk, which could be a response of the mammary gland to the higher plasma transferrin saturation found in these mothers in comparison to the non-supplemented ones.

## SUB-ADEQUATE MICRONUTRIENT STATUS IN PREGNANT AND LACTATING WOMEN

Although the afore-mentioned studies were not designed to evaluate the prevalence of sub-clinical micronutrient deficiencies and are not representative of low-income pregnant and lactating women from Rio de Janeiro, they have drawn attention to micronutrient inadequacies in these groups. They provide some evidence regarding high frequencies of sub-clinical deficiencies of folate, iron, zinc and vitamin A and the striking beneficial effect of folate supplementation during pregnancy.

In one study with non-anemic women (6), 22% started pregnancy with low erythrocyte folate levels (<360 nmol/l; 35) and this proportion was also found in the third trimester of pregnancy and during lactation (2-3 months) only in those who did not use folate supplements. Regarding iron status, eight percent of the women started pregnancy with depleted iron stores (plasma ferritin levels <12 μg/l; 36), whereas in the third trimester this frequency had increased to about 40%, irrespective of iron supplementation. However, in the post partum, 40% of the women who did not take iron supplements during pregnancy had low iron reserves as compared to 18% in the group using iron supplements. None of the women presented low levels of plasma cobalamin ( <110 pmol/l; 37).

Other studies showed that 25% of the pregnant women at parturition (25), and 11% after 3 months of lactation (5) had low serum zinc levels (< 7.6 and 9.9 μmol/l, respectively; 38). Low serum retinol levels (<0.7 μmol/l, 36) were found in 35% of pregnant women at parturition (22).

Dietary intakes of folate, iron, zinc and calcium were assessed in pregnant and lactating women (6,39) by food frequency questionnaires. Mean dietary intakes of these nutrients were 83, 50, 73 and 53%, respectively, of the recommended intakes for pregnant women (10). In this period, 80, 100, 82 and 95% of the women had lower dietary intakes, respectively, than the recommendations.

During lactation, mean dietary intakes of these nutrients were similar to intakes during pregnancy, but adequacy of dietary intakes of folate and iron improved, since recommendations for this period are lower, with mean intakes of 120 and 100%, respectively, of the recommended intakes. As for zinc and calcium, mean dietary intakes were 64 and 57% of recommendations in this period, since recommended intakes for zinc are higher and for calcium are the same in comparison of recommendations for pregnant women. In the lactation period, 35, 52, 93 and 90% of the women, respectively, had folate, iron, zinc and calcium intakes lower than the recommendations.

In both periods, mean cobalamin dietary intakes were higher and none of the women had cobalamin intakes lower than the recommendations.

## CONCLUSIONS

Representative data on prevalence of sub-clinical and clinical deficiencies of micronutrients are generally lacking in different popula-

tion groups from Rio de Janeiro, particularly in pregnant and lactating women. Although the studies reported in this paper were not designed to assess prevalences of micronutrient deficiencies in pregnant and lactating women from Rio de Janeiro, they indicate that high frequencies of sub-clinical deficiencies of folate, iron, zinc and vitamin A, especially in pregnant women, are to be expected.

Sub-adequate micronutrient status may not have an important impact on pregnancy development and outcome, or on milk composition, but may be involved in problems that have not been specifically addressed, such as chronic and degenerative diseases.

For instance, in the case of folate deficiency, besides its manifestation as the classical clinical deficiency, megaloblastic anemia, subclinical deficiency has been associated with increased risk for cardiovascular diseases, due to hyperhomocysteinemia, and various types of cancer. The possible impact of transient and chronic sub-clinical folate deficiencies during pregnancy and lactation on folate homeostasis and on women's health, may be related to a future onset of these diseases. Serum homocysteine is a sensitive indicator of intracellular folate and it is increased when depletion of this vitamin occur. Evaluation of homocysteine levels in pregnant and lactating women is lacking, as well as studies concerned with the extent to which a marginal folate deficiency in these periods contributes to hyperhomocysteinemia. Validated biochemical and functional tests to evaluate micronutrient status specifically in pregnancy and lactation are needed, since at present this evaluation relies on poor indicators of status for some nutrients such as zinc, and disputable cut off values for most nutrients.

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## REFERENCES

1. Bailey, LB & Cerda, JJ. Iron and folate nutriture during life cycle. Wld Rev Nutr Diet, 56: 56-92, 1988.
2. Viteri, FE. The consequences of iron deficiency and anemia in pregnancy. Adv Exp Med Biol, 352: 127-140, 1994.
3. Dutra de Oliveira, JE; Cunha, SFC & Marchini, JS. A desnutrição dos pobres e dos ricos: dados sobre a alimentação no Brasil. São Paulo, Ed. Sarvier, 1996.
4. Vannucchi, H; Freitas, ML & Szarfac, SC. Prevalência de anemias nutricionais no Brasil. Cadernos de Nutrição, 4: 7-26, 1992.
5. Donangelo, CM; Trugo, NMF; Koury, JC; Barreto Silva, MI; Freitas, LA; Feldheim, W & Barth, C. Iron, zinc, folate and vitamin B12 nutritional status and milk composition of low income Brazilian mothers. Eur J Clin Nutr, 43: 253-266, 1989.
6. Trugo, NMF; Donangelo, CM; Seyfarth, BSP; Henriques, C & Andrade, LP. Folate and iron status of non-anemic women during pregnancy: effect of routine folate and iron supplementation and relation of erythrocyte folate with iron stores. Nutr Res, 16: 1267-1276, 1996.
7. Lehti, KK. Stillbirth rates and folic acid and zinc status in low-socioeconomic pregnant women of Brazilian Amazon. Nutrition, 9: 156-158, 1993.
8. Bower, C. Folate and neural tube defects. Nutr Rev, 53: 533-538, 1995.
9. Keen, CL & Zindenberg-Cherr, S. Should vitamin-mineral supplements be recommended for all women with chilbearing potential? Am J Clin Nutr, 59: 532S-539S, 1994.
10. National Research Council, Food and Nutrition Board. Recommended Dietary Allowances, Washington, D.C., National Academy Press, 1989.
11. Mc Partlin, J; Halligan, A; Scott, JM; Darling, M & Weir, DG Accelerated folate breakdown in pregnancy. Lancet, 341: 148-149, 1993.
12. Qvist, I; Abdulla, M; Jagerstad, M & Svensson, S. Iron, zinc and folate status during pregnancy and two months after delivery. Acta. Obst Gynecol Scand, 65: 15-22, 1986.
13. Zapata, CV; Donangelo, CM & Trugo, NMF. Effect of iron supplementation during lactation on human milk composition. J Nutr Biochem, 5: 331-337, 1994.
14. O'Connor, D. Interaction of iron and folate during reproduction. Progr Food Nutr Sci, 15: 231-254, 1991.
15. Soares, CR; Mora Santos, IB; Donangelo, CM & Trugo, NMF. Transferência materno-fetal de folato e ferro: estudo da relação entre indicadores desses nutrientes no sangue materno e de cordão umbilical. IV Congresso Nacional da Sociedade Brasileira de Alimentação e Nutrição, São Paulo, 1996.
16. Vargas Zapata, CL; Donangelo, CM & Trugo, NMF. Indicadores maternos de folato na lactação e sua relação com o uso de suplementos de folato na gestação e com as reservas maternas de ferro. IV Congresso Nacional da Sociedade Brasileira de Alimentação e Nutrição. São Paulo, 1996.
17. Cook, JD; Baynes, RD & Skikne, B. The physiological significance of circulating transferrin receptors. Adv Exp Med Biol, 352: 119-126. 1994.
18. Selhub, J. Folate binding proteins: mechanisms for placental and intestinal uptake. Adv Exp Med Biol, 352: 141-150, 1994.
19. Miller, R; Faber, W; Asai, M; D'Gregorio, R; NG, W; Shah, Y & Neth-Jesse, L. The role of the human placenta in embryonic nutrition: impact of environmental and social factors. Ann N Y Acad Sci, 678: 92-107, 1993.
20. Aslan, N & Mc Ardle, HJ. Mechanism of zinc uptake by microvilli isolated from human term placenta. J Cell Physiol, 151:533-538, 1992.
21. Ross, AC & Gardner, EM. The function of vitamin A in cellular growth and differentiation, and its roles during pregnancy and lactation. Adv Exp Med Biol, 352:187-200, 1994.
22. Dimenstein, R; Trugo, NMF; Donangelo, CM; Trugo, LC & Anastácio, AS. Effect of sub-adequate maternal vitamin A status on placental transfer of retinol and b-carotene to the human fetus. Biol Neonate, 69: 230-234, 1996.
23. Shirali, GS; Oelberg, DG & Mehta, KP. Maternal-Neonatal serum vitamin A concentration. J Pediatr Gastroenterol Nutr, 9: 62-66, 1989.
24. Dancis, J; Levitz, M; Katz, J; Wilson, D; Blaner, WS; Piantedosi, R & Goodman, DS. Transfer and metabolism of retinol by perfused human placenta. Pediatr Res 32:195-199, 1992.
25. Vargas Zapata, CL; Melo, MRM & Donangelo, CM. Maternal placental and cord zinc components in healthy women with different levels of serum zinc. Biol Neonate, 72: 84-93, 1997.
26. Henriques, C & Trugo, NMF. Partial characterization of folate uptake in microvillous membrane vesicles isolated from human placenta. Braz J Med Biol Res, 29: 1583-1591, 1996.
27. Soares, CR & Trugo, NMF. Folate transport in placental microvillous membrane vesicles from iron- and folate- deficient women. XXVI Reunião da Sociedade Brasileira de Bioquimica e Biologia Molecular, Caxambu, 1997.
28. Vargas Zapata, C. Homeostase e transferência materno-fetal de zinco na gestação humana. Tese de Doutorado. Instituto de Química, Universidade Federal do Rio de Janeiro, 1997.
29. Melo, GJO; Almeida, R & Trugo, NMF. Folate transport in human placenta: study of the effects of prematurity and pregnancies affect-

ed by severe hypertension and neural tube defect. XXVI Reunião da Sociedade Brasileira de Bioquimica e Biologia Molecular, Caxambu, 1997.

30. Melo, GJO; Almeida, R. & Trugo, NMF. Transporte de cobalamina em microvilos de placenta humana:estudo do efeito da toxemia materna e da prematuridade. IV Congresso Nacional da Sociedade Brasileira de Alimentação e Nutrição, São Paulo. 1996.
31. Dimenstein, R; Anastacio, AS; Trugo, LC; Donangelo, CM & Trugo, NMF. Relative distribution of carotenoids in term placenta and maternal serum of healthy women. XXVI Reunião da Sociedade Brasileira de Bioquimica e Biologia Molecular, Caxambu, 1997.
32. Ford, JE; Zechalko, A; Murphy, J & Brooke, OG Comparison of the B vitamin composition of milk from mothers of preterm and term babies. Arch Dis Child, 58: 367-372, 1983.
33. Iyengar, GV & Parr, RM. Trace element concentrations in human milk from several global regions. In: Composition and physiological properties of human milk..Schaub, J (Ed.), Amsterdam, Elsevier, 1985, pp 17-31.
34. Trugo, NMF; Donangelo, CM; Koury, JC; Freitas, LA & Feldheim, W. Folate, vitamin B12 and iron status of exclusively breast-fed and partially weaned infants from low-income families. Ecol Food Nutr, 25: 333-341, 1991.
35. Herbert, V. Recommended dietary intakes (RDI) of folate in humans. Am J Clin Nutr, 45:661-670, 1987.
36. Cook, JD; Baynes, RD & Skikne, BS. Iron deficiency and the measurement of iron status. Nutr Res Rev, 5: 189-202, 1992.
37. Sauberlich, HE; Skala, JH; Dowdy, RP. Laboratory tests for the assessment of nutritional status, Boca Raton, Florida, CRC Press, Inc, 1984, pp 114-124.
38. Pilch, SM & Senti, FR. Analysis of the zinc data from the Second National Health and Nutrition Examination Survey (NHANES II). J Nutr, 115: 1393-1397, 1985.
39. Donangelo, CM; Trugo, NMF; Melo, GJO; Gomes, DD & Henriques,C. Calcium homeostasis during pregnancy and lactation in primiparous and multiparous women with sub-adequate calcium intakes. Nutr Res, 16: 1631-1640, 1996.

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# Prevalence and risk factors in iron deficiency and anemia

*Sophia C. Szarfarc and Sonia B. de Souza*

Departamento de Nutrição, Faculdade de Saúde Pública,
Universidade de São Paulo, São Paulo, Brasil

**SUMMARY. Prevalence and risk factors in iron deficiency and anemia**. Iron deficiency anemia is nowadays the world most prevalent nutritional problem. Several studies concerning anemia prevalence were carried out in Brazil with pregnant women and children aged less than 5 years, restricted mainly to northeast and southeast regions of the country. More recently, groups other than those of pregnant women and children aged less than 5 years, such as school children and adolescents, have become the target of those concerned with the issue. The differences found out among the groups and the diversity of methodologies employed, prevent us from reaching an evolutionary profile concerning nutritional anemia in Brazil. However, the high rates of prevalence verified by the various studies carried out are enough for justifying the general interest in controlling and/or eradicating the disease. This paper presents a model of causal determination of anemia, that points out the diet as the principal immediate factor. The typical Brazilian diet is poor in bioavailable iron. The two foods - meat and beans - responsible for the totality of this mineral in the habitual Brazilian diet have been registering a decreasing intake in the last decades. Iron deficiency is also observed in the food practice of infants and children aged less than 5 years. This situation justifying the urgency in finding an effective intervention to control this relevant nutritional problem.

## INTRODUCTION

Iron deficiency anemia is nowadays the world most prevalent nutritional problem. Anemia brings about innumerable consequences to the organism, symptoms of which vary from a diminishment in the productive ability and less resistance to fatigue, common to all anemic individuals, to an increase on the morbid-mortality in the infant-maternal group as well as behavioral disorders among children (1,2).

In 1980, the World Health Organization (1) estimated that approximately 700 millions of persons in the whole world were anemic, including more than half the children aged less than five years and pregnant women from underdeveloped countries

## PREVALENCE AND RISK FACTORS

An exhaustive survey on studies concerning anemia prevalence in Brazil was carried out by Vannucchi, Freitas & Szarfarc (3), covering the period from 1965 to 1990. Among them, Table 1 empha-

TABLE.1
Prevalence of anemia in Brazil, considering geografic regions and studied groups: 1980-1997

| Region/State | Group (Sample Size) | Prevalence Anemia | Source/Year |
|---|---|---|---|
| **Northeast** | | | |
| Paraíba | pregnants (217) | 36,9 | Salzano et al., 1980 |
| Pernambuco | pregnants (194) | 35,5 | Romani et al., 1982 |
| Pernambuco | pregnants | 35,5 | Torres et al., 1984 |
| Pernambuco | 0-2 years (1306) | 51e77 | Salzano et al., 1985 |
| Pernambuco | 1-4 years (573) | 41,9 | Mariath et al., 1985 |
| Bahia | < 5 years | 22,4 | Assis et al., 1990 |
| **Southeast** | | | |
| São Paulo | < 2 years | 35,0 | Sigulem et al., 1983 |
| São Paulo | < 3 years | 38,9 | Guerra et al., 1983 |
| São Paulo | 4-5 years (370) | 24,5 | Tone, 1984 |
| Rio de Janeiro | pregnants | 13,7 | Batista Filho et al.,1984 |
| São Paulo | pregnants | 35,1 | Szarfarc, 1985 |
| São Paulo | 2-5 years (912) | 35,6 | Monteiro et al., 1987 |
| São Paulo | < 2 years | 40e 45 | Torres et al., 1987 |
| São Paulo | 6-24 months(307) | 26,0 | Sichieri, 1988 |
| São Paulo | pregnants | 29,0 | Sinisterra-Rodriguez, 1991 |
| São Paulo | pregnants | 14,2 | Fujimori, 1994 (5) |
| São Paulo | 12 months (371) | 42,6 | Szarfarc et al., 1996 (6) |
| São Paulo | 0-1 year (317) | 14,5 | Souza et al., 1997 (7) |
| **South** | | | |
| Paraná | 4-6 months (284) | 9,3 | Uchimura et al., 1989 |

SOURCE: Adapted from Vannucchi.H.: Freitas.M.L.S. & Szarfarc.S.C. (3)

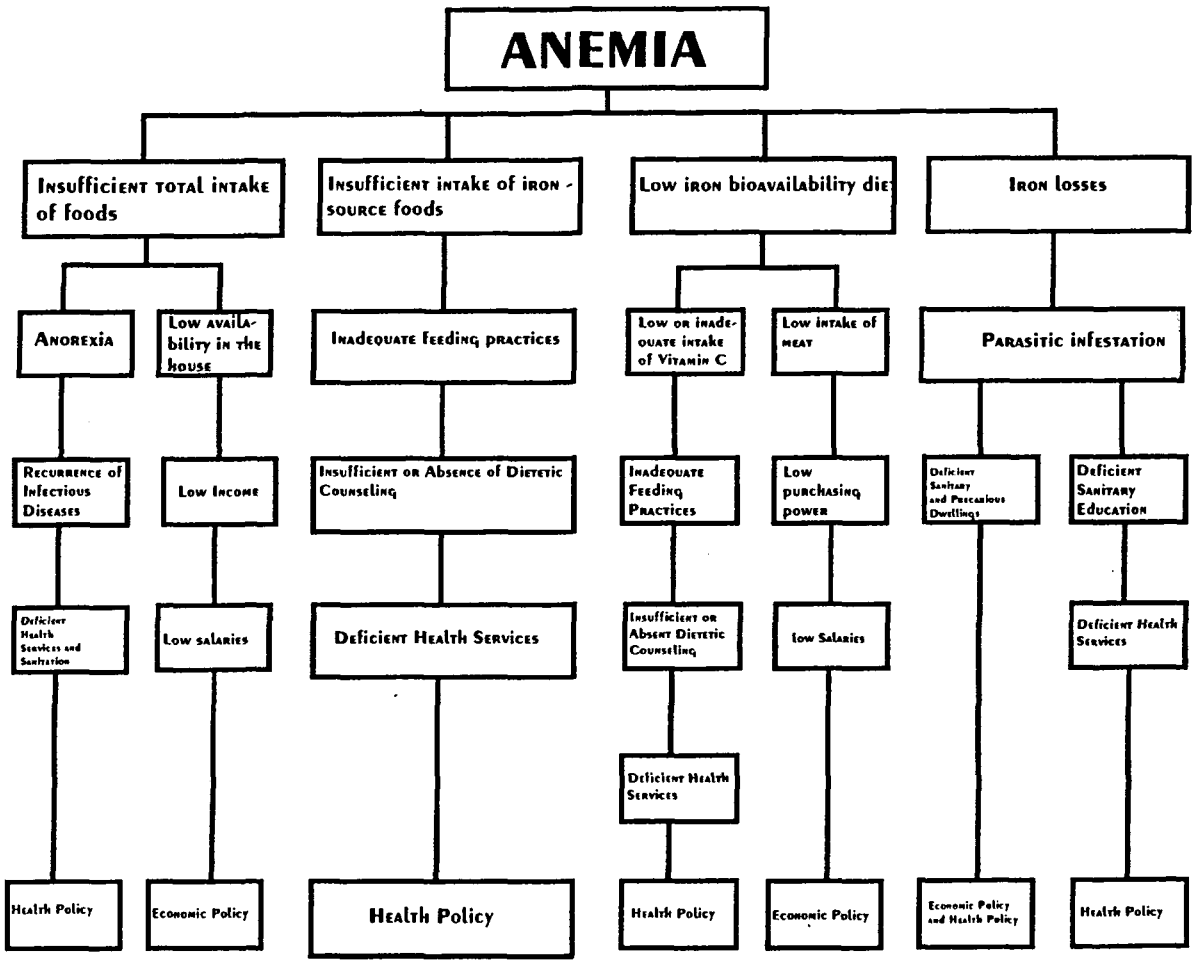
sizes those carried out from 1980 on, with pregnant women and children aged less than 5 years and showing that they are restricted to solely two Brazilian regions: Northeast and Southeast.

More recently, groups other than those of pregnant women and children aged less than 5 years have becoming the target of those concerned with the issue. Some studies carried out with school children and adolescents in Brazil are worth being mentioned. A survey carried out with 554 school children attending the 5th. and 8th. grades of public schools in the city of Osasco, SP, Brazil, observed 5.3% of anemia prevalence among the entire target population (4). On the other hand, another survey (8) found out 51% of anemics in children of both sexes entering the 1st. school grade, in the same city. In Maringa, PR (9) another survey pointed out 31.7% of anemia prevalence in children entering the 1st. grade of state elementary schools. A survey carried out with 262 female adolescents in the city of Taboão da Serra, SP (10), reported the finding that 17.6% of them were anemic.

The differences found out among the groups studied covering localities presenting diverse realities and employing different methodologies prevented us from reaching an evolutionary profile concerning nutritional anemia in Brazil. However, the high rates of prevalence disclosed by the various studies carried out are enough for justifying the interest of all in identifying the determinants of this process as well as in controlling and/or eradicating the disease, moreover when it is a well-known fact that iron deficiency is a process of gradual onset in human organisms and that anemia, even in its initial phases when it has not yet manifest itself, can seriously affect health.

Chart 1 shows a model of causal determination contemplating from the immediate factors - inadequate diet and iron losses - to the basic

CHART 1
Model of anemia causal determination




ones, establishing that anemia, as all other nutritional deficiencies, is ultimately the consequence of poor socio-economic conditions.

Epidemiological studies (11,12) carried out in the municipality of São Paulo, State of São Paulo, Brazil, vouch for the gradual decrease in the parasitic infestation rates as well as the absence, in those infested with, of Ancylostoma and Necator, parasites responsible for blood losses which might lead to anemia. Therefore, diet assumes a prevalent role as a causal factor of iron deficiency.

A study aiming at the evaluation of the density of iron bioavailability on the daily Brazilian dietary pattern was carried out (13).

This dietary pattern included three meals: sweetened black coffee with white bread with margarine, for breakfast; rice, bean, meat, tomato and sweetened black coffee for lunch; and rice, bean, eggs and sweetened black coffee for dinner. Meals without meat, as in the case of the dinner on the focused diet, even with a reasonable content of iron provided for by the bean, are potentially very far from being effective in granting the organism the needed amount of this mineral. The presence of eggs (ordinarily used as a substitute for meat) and the absence of citrus fruits or other sources of vitamin C, conferred a very low iron bioavailability upon the meal, similar to that of the breakfast. The presence of a small amount of meat at lunch increased in 3 to 4 times the iron utilization when compared with that of the other meals. The study pointed out that this kind of diet meets the adult male's iron needs; however, regarding the adult female, it does not supply the recommended iron amount, even when meeting the energetic needs.

Brazilian feeding practices are very poor in absorbable iron. It is worth emphasizing that the two foods (meat and beans) responsible for practically all of iron intake in the customary diet have been registering a decreasing intake in the last decades in the Brazilian metropolitan regions (14), as it is shown on Table 2.

It is worth mentioning that the reduction of intake, common to all the studied localities, is strongly linked to the supply and cost of

TABLE 2
Per capita daily average consumption of meat and beans, according to place and period

| Metropolitan Regions | Period | | | | | |
|---|---|---|---|---|---|---|
| | Meat | | | Beans | | |
| | 61-62 | 74-75 | 87-88 | 61-62 | 74-75 | 87-88 |
| São Paulo | 45 | 50 | 28 | 88 | 76 | 57 |
| Rio De Janeiro | 63 | 53 | 36 | 167 | 96 | 70 |
| Belo Horizonte | 37 | 44 | 33 | 94 | 56 | 46 |
| Curitiba | 55 | 46 | 21 | 122 | 74 | 44 |
| Salvador | 51 | 46 | 28 | 156 | 108 | 74 |
| Fortaleza | 90 | 66 | 44 | 148 | 69 | 47 |
| Recife | 54 | 45 | 26 | 124 | 75 | 56 |

SOURCE: Adapted from Szarfarc,S.C.; Lerner,B.R.; & Stefanini,M.L.R.(14).

food-stuff and not necessarily to a change in the population's dietary habits. Vouching for this statement, an important increase on the chicken intake (which price suffered a marked decrease in the period) was registered, although being not enough to replace for the decreased intake observed in products of bovine origin.

The monotony of this diet, leading to a deficient absorbable iron, is also observed on the food practice of infants and children aged less than 5 years. Szarfarc and colleagues (unpublished), in a research carried out with children aged 0-1 year attending health centers in the municipality of Santo André, SP, Brazil, reported that milk was practically the single food the infants were fed with in their first six months of life. Exclusive breast-feeding takes, in general, no longer than the first three months of life when infants pass to be fed whole cow's milk. The nursing bottle is, in general, prepared with sugar and a thickening stuff (any kind of flour), a habit that turns milk into the most important energetic food source during the children's whole first year of life. The first salt meal is introduced between the 4th and 6th months of age, including an insignificant amount of meat and roots, tubers, vegetables and cereals, all of them poor in iron. The second salt meal, with the same composition as that of the first one, is given between the 7th and 8th months of age. Orange juice, the diet single source of vitamin C, is offered isolated from the salt meals, a practice beginning, in most of the cases, at the 4th month of age.

In the situation mentioned above, the infant feeding practice does not meet the recommendation of iron. Similar feeding practice was observed in the Municipality of São Paulo, SP, Brazil (15,16). Even among children aged 24-60 months feeding practices which meet iron recommendation are infrequent (15). In relation to the first year of life (16), it is emphasized that the feeding practice is eminently lacteous. Since this is a period for introducing new foods, the amounts ingested are small, not only due to the infant's limited gastric capacity, but also to the impact of accepting them. It must also be taken into consideration the restrict variety of foods the children are offered to.

## CONCLUSIONS

The observed Brazilian feeding practices, recognized as the main cause of the high prevalence of anemia, as well as the adverse consequences of iron deficiency to the health of the population are enough for justifying the urgency in finding mechanisms of intervention which lead to successful fight against these relevant nutritional problems.

## REFERENCES

1. DeMaeyer, EM; Dallman, P; Gurney, JM; Hallberg, L; Sood, SK & Srikantia, SG. Preventing and controlling iron deficiency anaemia

through primary health care: a guide for health administration and programme managers. Geneva, World Health Organization, 1989.
2. International Nutritional Anemia Consultative Group. Guidelines for the eradication of iron deficiency anemia, Report. Washington, D.C., The Nutrition Foundation, 1977.
3. Vannucchi, H; Freitas, MLS & Szarfarc, SC. Prevalência de anemias nutricionais no Brasil. Cad Nut, 4: 7-26, 1992.
4. Lerner, BR. A alimentação e a anemia carencial em adolescentes. Tese de Doutorado, Faculdade de Saúde Pública da USP, São Paulo, 1994.
5. Fujimori, E. Gravidez na adolescência: estado nutricional referente ao ferro. Tese de Doutorado, Faculdade de Saúde Pública da USP, São Paulo, 1994.
6. Szarfarc, SC; Berg, G; Santos, ALS; Souza, SB & Monteiro, CA. Prevenção de anemia no primeiro ano de vida em Centros de Saúde do Município de Santo André, São Paulo. J Pediatr, 72: 329-334, 1996.
7. Souza, SB; Szarfarc, SC & Souza, JMP. Anemia no primeiro ano de vida em relação ao aleitamento materno. Rev Saúde Públ, 31:15-20, 1997.
8. Stefanini, MLR; Colli, C; Lerner, BR; Lei, DLM; Chaves, SP; DiPiro, MS; Oliveira, AAM & Szarfarc, SC. Anemia e desnutrição em escolares da rede pública do Município de Osasco, São Paulo, Brasil. Cad Saúde Públ, 11: 439-447, 1995.
9. Uchimura, TT. Anemia e desnutrição em escolares ingressantes nas escolas estaduais de Maringá-PR. Dissertação de Mestrado, Faculdade de Saúde Pública da USP, São Paulo, 1994.
10. Fujimori, E; Szarfarc, SC & Oliveira, IMV. Prevalência de anemia e deficiência de ferro em adolescentes do sexo feminino Taboão da Serra, SP. Brasil. Rev. Latinoam. Enfermagem, 4: 49-63, 1996.
11. Monteiro, CA & Szarfarc, SC. Estudo das condições de saúde das crianças do Município de São Paulo, SP (Brasil), 1984-1985.V-Anemia. Rev Saúde Púb, 21: 255-260, 1987.
12. Sigulem, DM; Tudisco, ES; Paiva, ER & Guerra, CCC. Anemia nutricional e parasitose intestinal em menores de 5 anos. Rev Paul Med, 103: 308-312, 1985.
13. Szarfarc, SC. Densidade de ferro biodisponível em uma dieta habitual no Estado de São Paulo. Rev Saúde Públ, 17: 290-296, 1983.
14. Szarfarc, SC; Lerner, BR & Stefanini, MLR. Anemia nutricional no Brasil. Cad Nutr, 9:5-24, 1995.
15. Szarfarc, SC; Monteiro, CA; Meyer, M; Tudisco, ES & Reis, IM. Estudo das condições de saúde das crianças do Município de São Paulo, SP. (Brasil), 1984-1985. X- Consumo alimentar. Rev Saúde Públ, 22: 266-272, 1988.
16. Souza, SB. Anemia e alimentação no primeiro ano de vida. Tese de Doutorado, Faculdade de Saúde Pública da USP, São Paulo, 1994.

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# Zinc in urban infants and children from Brasilia

*José G. Dórea*

Departamento de Nutrição, Universidade de Brasilia, Brasilia DF, Brazil

**SUMMARY. Zinc in urban infants and children from Brasilia.** The substandard living conditions of the poor families in the fast growing urban population of Brazilian cities puts children in the more vulnerable group of micronutrient deficiency. The chemical analysis of milk diets consumed by infants showed that zinc is insufficiently provided in bottle-fed infants, and possibly a first-limiting nutrient in breast-fed babies, at least during the first 6 months of life.

## INTRODUCTION

The rapid growth of Brazilian cities is a new phenomenon in the urbanization process particularly over the last three decades. Such phenomenon has brought about dramatic changes in our human ecology. The traditional way of life of a rural and agricultural society has made way for the urban and proletarian manner of living of the migrating masses. The consumption of a variety of locally grown foods has been displaced by mass production and income dependent types of food, typical of large urban centers. Such subtle but nonetheless fundamental changes in the process of food provision has raised questions such as: "What are the nutritional consequences of this process in the urban population" ? We hope that this initiative will open the debate, and some light will be shed on this contemporary issue of human ecology, in order to guide future research in human nutrition.

## ZINC IN URBAN INFANTS AND CHILDREN

The case which I bring to this meeting is similar for all large Brazilian cities. The last twenty years of our research activity in the Nutrition Laboratory at University of Brasilia has focused on micronutrient nutritional status (zinc in particular) of children of the migrant population, mostly, but not exclusively, shanty town dwellers. Choices had to be made as to the best methods of assessing the zinc nutritional status. In the seventies hair zinc content was our choice, but then, as today reliable indicators are hard to find.

Since zinc is a component of a few hundred enzymes its deficiency may sometime be confounded by, or with, general malnutrition to the untrained clinician. In spite of finding differences in hair zinc distribution between studies we never could find a direct relationship between hair zinc concentrations and anthropometric data (1,2).

In our early studies (2) we found that among children of poor families 72% were found normal, 16% stunted, 8% wasted and 3% stunted and wasted. Almost all children were infected with intestinal parasites, and 20% were positive for two or more parasites. The families were characteristically low income, large number of members (including children) and substandard living conditions. In such children we could not find a significant association between anthropometric assessment of nutritional status and hair zinc levels. Under conditions of a heavily parasitic load and inadequate nutrition it would be difficult to find, through hair, that zinc was the only or primary micronutrient associated with anthropometric deficits.

Our suspicion that zinc is an important contributor of poor nutritional performance appeared during our studies of diets of infants and pregnant and lactating mothers. In surveys of poor families (3), we found that in children and lactating mothers the requirements for zinc, vitamin A and riboflavin were less likely to be met than for macronutrients.

The feeding practices of poor families (4), unveiled certain characteristics of important nutritional consequences. The milk based diets of infants less than one year of age were also low in zinc, vitamin A, and thiamin and recommended daily allowance (RDA) were only marginally met for vitamin C. Thus revealing that in this case also micronutrient deficits were more likely to cause poor nutritional performance than those of macronutrients.

The situation of urban infants becomes more complicated when we consider the working mother and the weaning process. It is not just a question of quality of bottle milk *vis a vis* breast-milk, but also the regularity of feedings, contamination of bottles and the preparatory process. Studying infant feeding practices among the poor urban families in shanty towns we (4) found that breast- and mixed-fed infants were likely to receive more milk feedings that non-breast fed infants. The disadvantages of less feeding *per se*, in the case of bottle-fed infants, is exacerbated by the nutritionally unbalanced diets or preparations. This may lead to nutritional inadequacies especially micronutrients imbalances/deficiencies, as a consequence of practices involved in the process used to prepare bottle-milks.

During the first year of life, milk feeding, with either breast- or bottle-milk, is the principal determinant of nutritional support. As a consequence, the development of malnutrition in infancy, in some circumstances, can be a direct result of faulty nutritional practices in milk feedings. The breast-fed infant receives more feedings (and perhaps attention from mothers), while bottle-fed babies receive less feedings, maybe from caretakers, if mothers are at work (4).

First, let's look at the types of food consumed by these infants in the first year of life. It is clear that economic limitations will place constrains on acquisition of certain food items, and, in consequence, on the provision of key nutrients. This situation is aggravated by the introduction of bottle-milks. Sugar and liquids such as teas, fruit juices and soft drinks were introduced at an early age. With such food consump-

tion, Fe and vitamin A were estimated to be below the RDA in the group that was not receiving breast-milk (4).

In spite of the importance of milk feedings among poor families, information on milk composition has been based mainly on breast milk, and, in fewest instances, on industrially produced powdered milks or formula as marketed. The information on zinc concentration in these foods was obtained after laboratory reconstitution of known commercially powdered cow's milk or formulae according the manufacturer's instructions. Reconstitution of powdered milk products by mothers under home conditions may result in improper dilution or in nutritionally unbalanced milks.

Among "favelados" (shanty town dwellers), 84% of children were fed either breast-milk plus cow's milk (44%) or only cow's milk (40%). In these children 44% of the mixed feed group and 47% of the cow-milk fed were malnourished (5). The milk prepared at home, either from formulas or dilution of cow's milk as powdered or fluid and the addition of sugar always end up with a hyperosmolar solution. This is an aspect grossly neglected in food surveys of very young children (5). Such a concentrated diet in itself could favor osmotic diarrhea, however the nutritional imbalance is an additional matter of concern.

The essential role that zinc plays in growth results in an infant's requirements being higher than those of older children and adults. At the beginning of lactation, when growth is at its peak, the zinc:calorie ratio is at its highest. When breast-fed, infants have access to a higher zinc:calorie ratio diet in the first three months of lactation (6). The peculiar rate of secretion of zinc in human milk during the first month of lactation makes this milk unique in the provision of zinc during a fast-growing period. Regardless of the different ways of expressing zinc concentration, i.e. Zn mass/volume, or as either mass of zinc/total mineral mass or total calorie, there is always a higher proportion of zinc than any other micronutrient during the first three months of lactation (6).

In the case of home preparations based on cow's milk, no such adjustments exist and bottle milks may provide less than the minimum requirement for the majority of poor children (7). Our studies consistently point to the specific nutrient deficits in cow's milk-based diet of young children. The analytical data obtained from chemical analysis of milk preparations done by mothers and caretakers from shanty towns (7) showed that based on minimum recommendations for formulae, 55% of bottle milks had zinc below 3.2 mg/L. Owing to added sugar and high calorie preparations, metal:calorie ratios were below the minimum recommendations in 72.5% of cases (7).

Growth failure is a common and essential feature of protein, energy, and zinc deficiency in the growing organism. Adequacy of weight gain in exclusively breast-fed infant has varied from 3 to 6 months in developing and developed countries respectively. Assuming that changes in milk composition can modulate total nutrient utilization, multiple regression was used to interpret the dependence of growth on nutrients in milk. The length and weight gain of infants during the first 6 months of lactation and concentrations of zinc, nitrogen, and fat in human milk were analyzed by multiple regression. Using this method we assessed the effects of macronutrients (protein and energy) and zinc (micronutrient) concentrations in human milk and we found that concentration of milk zinc and nitrogen but not fat, were significant predictors of weight gain in breast-fed infants. Zinc concentration, however, was the strongest predictor of weight gain of breast-fed infants, thus indicating zinc as a first limiting nutrient in human milk (8).

## CONCLUSIONS

The substandard living conditions of the fast growing urban population puts children in the more vulnerable group of micronutrient deficiency. In the case of Brasilia, the micronutrient deficits may come from many different causes. The chemical analysis of milk diets consumed by infants showed, indeed, that zinc is insufficiently provided in bottle-fed infants and possibly a first-limiting nutrient in breast-fed babies, at least during the first 6 months of life.

## REFERENCES


1. Dorea, JG; Horner, MR; Bezerra, VLVA; Pereira, M & Salomon, JBR. Hair zinc levels and nutritional status in urban children from Ilhéus, Bahia, Brazil. Hum Nutr: App Nutr, 36A: 63-67, 1982
2. Dorea, JG; Almeida, IS; Queiroz, E & Horner, MR. Nutritional status and Zn nutriture in infants and children in a poor community of Brazil. Ecol Food Nutr, 12: 1-6, 1982.
3. Horner, MR; Dorea, JG; Pereira, MG; Bezerra, VL & Salomon, JB. Inquerito dietetico com base no consumo familiar. Arch Latinoam Nutr, 31: 726-729, 1981.
4. Dorea, JG & Furumoto, RAV. Infant feeding practices among poor families of an urban squatter community. Ann Nutr Metab, 36: 257-264, 1992.
5. Dorea, J; Cabral, M; Wright, MGM & Rodrigues, KH. Osmolalities of bottle- and breast-milk fed to poor urban Brazilian infants. Ann Trop Paediat, 8: 181-183, 1988.
6. Dorea, JG; Horner, MR & Campanate, M. Lacteal Zinc and Copper in relation to volume total ash and energy during the first three months of lactation. Acta Paediat Scand, 74: 891-6, 1985.
7. Dorea, JG Concentration of zinc and copper and metallocalorie ratio in bottle-milks as prepared by poor urban families. Ann Trop Paediat, 12: 7-11, 1992.
8. Dorea, JG Is zinc a first limiting nutrient in human milk ? Nutr Res, 13: 659-666, 1993.

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# Iron deficiency anemia in children: prevalence and prevention studies in Ribeirão Preto, Brazil

*Jose E. Dutra de Oliveira, S. Ventura, A.M. Souza and J. Sergio Marchini*

Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, Brazil

SUMMARY. **Iron deficiency anemia in children: prevalence and prevention studies in Ribeirão Preto**, Brazil. Iron deficiency and ferropenic anemia are, certainly, the most prevalent and specific nutritional problems in Brazil. The Ribeirão Preto region is no exception to it. A large prevalence of iron deficiency/anemia is found, mainly in the age group 6-24 months. In spite of the fact that several aspects of its physiopathology are known it is a very difficult problem to be solved. Many approaches and alternatives for their prevention have been tried but we are far from controlling the situation. Several studies carried out at the Medical School of Ribeirão Preto, University of São Paulo, Brazil have shown this high incidence of iron deficiency and iron anemia among infants and preschool children. The importance of iron supplementation to preterm, premature and normal infants was pointed out. The possibility of use of iron complexes to prevent iron deficiency, besides the usual ferrous sulfate, was shown. Several community studies proved the feasibility of distribution and intake of iron as supplements or fortification of carriers as alternatives to prevent iron deficiency.

## INTRODUCTION

As in many other parts of the world iron deficiency anemia is still quite common in Brazil. Surveys carried out in different regions of the country show its presence all over, both in urban and rural areas, affecting mainly pregnant/lactating mothers, 6 months infants and preschool children of poor socioeconomic groups. It is undoubtedly linked to low food iron intake, although parasitic infestation may play an important role in specific areas of Brazil. The prevalence of iron deficiency among infants from 6 to 24 months of age is so high in rich areas of the South, where it reaches more than 50% of their unprivileged population, as in the poorer Northeastern regions of the country, where energy-protein children undernutrition is also quite widespread. That age group along with prematures, low birth weight infants and pre-school children are, certainly, the highest target group to be protected against iron deficiency. On the other hand anemia among low socio-economic pregnant/lactating women seems to be less prevalent than in young children, reaching 20-30% of them and being apparently less common than in other developing countries.

The problem of iron deficiency and anemia although prevalent in the country has not brought the needed attention of the public health community, less to say of government personnel. Physicians know little about iron deficiency and iron anemia is only taken care of when values of hemoglobin reach very low values. Few nutritional investigators exist in the country and not many of them are regularly studying and dealing with the problem .

Theoretically, iron supplementation of pregnant/lactating mothers is accepted as a need in the country, but implementation and adherence of this practice is poorly controlled and low along the needed population.

Food fortification with iron and other nutrients is present in several industrial products but is only used by privileged medium and high classes groups. Low classes families have little knowledge and access to it.

Nutrition and dietary orientation/education is practically absent in the country. Ignorance, at all levels concerning food and nutrition problems and solutions, is the rule. A lot is said in the country about hunger, mainly as political tool, but very little of practical and well planned projects and programs are implemented. Nutritional personnel, with poor knowledge and lack of interest in public health nutrition problems is doing too little to solve the iron deficiency/anemia situation.

## WHAT HAS BEEN DONE AND WHAT TO DO?

It is not an easy task to deal with iron deficiency and anemia. If it would be, the solution being available, an answer could be found. The problem is still present everywhere in the planet, even in some population groups of the rich world. There is not only one solution to this serious iron nutrition problem. Its consequences are dreadful to the individual and specially detrimental to the mental and physical development of our children, to the working capacity of adults and to the quality of life of communities and nations.

This report will concentrate on data from Ribeirão Preto, Brazil. It is noteworthy to say that Ribeirão Preto is one of the richest regions of Brazil. The area has a good health infrastructure, a high economic development and very good educational system. On this situation it is a surprise to find there a high prevalence of iron deficiency and iron anemia among children. This deficiency picture certainly has a different physiopathology in our area than that of iron anemia from the Northeast Brazil. which is linked also to a high protein energy malnutrition plus poor iron intake and a greater parasitic infestation. Our situation is most dependent on low iron intake, high cow's milk intake and adequate energy-protein diet.

Several studies carried out all over different areas of the State of São Paulo, on normal infants as well as preschoolers, have showed several times the presence of anemia above 50%, affecting mainly children of low socio-economic level.

At the Medical School of Ribeirão Preto, University of São Paulo, Brazil, a group of the Department of Pediatrics and the Division

of Nutrition of the Department of Medicine, carried out several studies on the subject. These were carried out in rats, infants and children.

Data on the prevalence of iron deficiency and anemia in Ribeirão Preto of preterm and term infants followed during 6, 9 and 12 months are available (1,2) and show that the highest frequencies of anemia occurred at 6 months after birth in the preterm infants (80%) and at 9 months for term infants (31%). The type of feeding, mother's milk or cow's milk combined or not with beef and egg yolk, given to infants from 6 to 12 months of age presented a poor relationship with prevalence of anemia, which increased after 6 months (1). The effect of preventive iron supplements starting either at 15 or 60 days after birth has also been evaluated (3) and showed that prevalence of anemia at 12 months was 27.3% and 35.7 %, respectively. Bioavailability of iron from infant food cooked on iron pots was demonstrated (4). The effect of different iron supplements on the hematological picture of 6 to 60 months children attending a day care center (5) and experiments with rats (6) showed that FeEDTA and Fe aminochelate gave similar results as ferrous sulfate for hematological iron indices and other parameters.

At our Clinical Nutrition Division the iron work includes a series of experimental and community studies. Our aim is to implement a national program to guarantee the intake of iron by the pregnant women through the once a week iron tablet, to fortify with iron salts the Brazilian Government cow's milk distribution already available and offered free to a very large number of infants, and to fortify with iron the drinking water available to pre-school children attending day-care community institutions.

During the last 5-6 years our iron work has, mostly, concentrated on this possibility of using drinking water as an alternative carrier for iron. This would guarantee an adequate daily intake of this mineral by preschool children (7). Certainly drinking water suits the known requisites for an effective fortification vehicle such as: it has a daily intake by everyone; delivery systems can be directed to the global population or to target groups; high bioavailable iron salts exist and may be easily added to water with small or no change of taste/appearance, and iron salts are quite cheap. A similar approach has been used for years, with the addition of fluoride to global drinking water systems, but these modus operandi are not always available. It was then decided to prove its feasibility to a target group, such as the preschoolers who attend urban day-care institutions all over the country. This was hypothesized as an easy and practical approach to supply iron.

From this theoretical reasoning we started to do physical-chemical studies of fortified water with different iron salts followed by experiments with rats and humans. The latter included studies with small groups of children under very close observation in a community day-care institution and later on large scale implementation programs, including nutritional and logistic aspects.

Physical-chemical studies of ferrous sulfate and NaFeEDTA fortified water were the subject of a MSc Thesis (8) and showed that greater solubility and less physical changes occurred when EDTA salts were used. The addition of ascorbic acid or citric acid to the ferrous sulfate solution increased the iron solubility and kept it more stable. This can also be important for maintaining iron as ferrous and not ferric ion. The EDTAFe solution is kept clear for a period of at least 7 days and has a better taste than the ferrous salt, which keeps a residual iron flavor. When the drinking water is chloride treated it is necessary to control the iron content to maintain the chloride activity. The FeEDTA, on the other hand does not react with the water chloride.

Studies with preschool children were carried out in a day-care Ribeirão Preto institution including 31 children, 2-6 years old. They attended the institution, Monday to Friday, from 7.00 a.m. to 5.00 p.m., while their mothers were at work. There, they received food and were submitted to a complete clinical-nutritional examination. Blood samples were collected 4 times during the experimental period of 12 months, for hematological and chemical analysis. No clinical malnutrition was found in these children, their food intake was adequate and low parasitic infestation was found, on routine examination. Fifty eight percent of the children were anemic with hemoglobin below 11 g/dL and 45% had ferritin below 12 mg/L, at the beginning of the experiment. Ferrous sulfate was added daily to their water pot to reach a concentration of 20 mg Fe/L. After an eight months follow up the percent of hemoglobin below 11 was 3 % and of ferritin below 12 was 7 %. It was demonstrated that ferrous sulfate added to the drinking water was accepted by the children and reduced drastically the anemia of these low-socio-economic children. Fe-enriched water was shown to be a practical alternative to supply Fe to children attending day-care institutions (9).

The same experimental approach, now adding ferrous sulfate solution to home drinking water pot was tested in 21 families living at their community homes. The Fe was added to their drinking pot to give a final solution of 10 mg Fe/L. This water was drunk by all family members. Its effect was measured by changes in the hemoglobin level and compared to another group of families who received a placebo, instead of the iron. The mean hemoglobin levels of the children and adults who received iron fortified drinking water for 4 months increased significantly ($P<0.01$) as compared to levels before fortification. The placebo did not change their hemoglobin levels (10).

Several other larger community studies, including city day-care institutions, with preschool children were carried out in the last 3-4 years. Their objective was to call the attention to iron deficiency, to test the intake and the delivery system of the concentrated iron solutions. These were diluted locally by a trained person in charge, at the day care institutions. At these places, all the local working personnel, the children and their mothers received classes about the importance and the need of iron for the better development of the children. Earth pots were furnished to the day-care institutions and the dilution was controlled by measuring the amount of concentrated iron solution to be added to the drinking water. The water was well accepted by the children and persons in charge expressed the fact that children improved their appetite and physical activities.

In one of these day-care institution trials, located in a small city nearby Ribeirão Preto, the program included blood sampling for hematological examination. After one year of ferrous solution added to the drinking water pot hemoglobin levels were higher and anemia prevalence decreased from 41% to 22% (11).

## CONCLUSIONS

Drinking water was shown to be a suitable vehicle to carry Fe to supply iron needs of preschool children kept at community day-care institutions. These institutions exist everywhere in Brazil and local pharmacies can prepare the iron solution to be added to the drinking water pot. The children staying at these centers all day could have an adequate supply/intake of Fe, sufficient to prevent iron deficiency/anemia. A strong educational input on the importance of iron to the nutritional well-being has to be offered to all participants of the program. These include children and their mothers as well as professionals, local workers, community representatives and local government. This educational input is very important for the success of the program.

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This paper is published as a tribute to the young professional Valéria Vasconcellos who started to work with us on iron research and prematurely died, a few years after finishing her BS degree at UNESP, Araraquara, Brazil, 1994

## REFERENCES


1. Cipolotti, R. Prevalence of iron deficiency anemia among infants 6 to 12 years old followed at the Puericulture Ambulatory of the University Hospital in Ribeirão Preto, Brazil. MSc Thesis, 1990
2. Garcia, PM. Longitudinal study of blood picture of 0-12 months of age born at the Univeristy Hospital of the Medical School of Ribeirão Preto, Brazil. MSc Thesis, 1995
3. Ferlin, MLS. Hemoglobin, serum iron, ferritin, vitamin E and folic acid levels during the first year of preterm newborn who received profilatic iron starting on the 15th day or 2 months of age. Ribeirão Preto, Brazil. MSc Thesis, 1988.
4. Borigato, EVM. Iron status of preterm infants at 12 months, fed diets cooked on iron or alumnium utensils. Ribeirão Preto, MSc Thesis, 1993.
5. Freitas, MLS. Infant iron deficiency: prevention and control. Ribeirão Preto. PhD Thesis 1996.
6. Dutra-de-Oliveira, JE; Freitas, MLS; Ferreira, JF; Gonçalves, AL & Marchini, JS. Ironfrom complex salts and its bioavailability to rats. *Internat J Vit Nutr Res*, 65: 272-275, 1995.
7. Dutra-de-Oliveira, JE. & Marchini, JS. Fortification of drinking water with iron: a new strategy for combating iron deficiency in Brazil. Am J Clin Nutr (Letter to the Editor) 63: 612-614, 1996.
8. Vasconcellos, V. Utilization of drinking water as a vehicle to nutrients. Iron studies: physical, chemical and sensorial aspects. Departement of Food and Nutrition, School of Pharmaceutical Sciences, State Univeristy of São Paulo, Araraquara, Brazil, MSc Thesis, 1994.
9. Dutra-de-Oliveira, JE; Ferreira, JB; Vasconcellos, VF; Marchini, JS. Drinking water as an iron carrier to control anemia in preschool children in a day-care center. J Am Coll Nut, 13: 198-202, 1994.
10. Dutra-de-Oliveira, JE; Amaral Scheid, MM; Desai, ID; Marchini, JS. Iron fortification of domestic drinking water to prevent anemia among low socioeconomic families in Brazil. Intern J Food Sci Nutr 47: 213-219, 1996.
11. Souza, AM. Iron deficiency on 297 preschool children attending a day care center with iron fortified drinking water in Ribeirão Preto, Brazil, Iron Study Group. Personal communication. Ribeirão Preto, 1997.

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# Micronutrients and urban life-style: lessons from Guatemala

*Noel W. Solomons*

CeSSIAM, Hospital de Ojos y Oídos "Dr Rodolfo Robles V", Guatemala, Guatemala

**SUMMARY. Micronutrients and urban life-style: lessons from Guatemala.** Guatemala is a nation of 10 million persons, at the northern point of the chain of five Republics derived from Spanish colonies on the Isthmus of Central America. The country is diverse in its ethnicities, its climate and terrain, and its agricultural pursuits. The majority of its population is poor, illiterate, and under-employed. It has had a unique and turbulent political history, and only recently has emerged. The traditional basis of the diet, dating to Mayan times, is maize and beans. Guatemala City, with its population in excess of 2 million inhabitants, having doubled since the Earthquake of 1976, is the only major metropolis. The pattern of dietary selection and the format of eating meals is changing in relationship to the size, congestion, economic evolution, and modernization of the capital city. A wider selection of foods is consumed in the city, but preparation follows the traditions of the rural cuisine. Street vendors play an ever larger role in the feeding of the urban poor. Quantitative data are only available for vitamin A and zinc, and only in certain subsegments of the population. The vitamin A in fortified foods, notably table sugar which is fortified with retinyl palmitate by legal mandate, makes up over one-third of the intake. The maize tortilla is an important sources of calcium, iron, zinc and copper. Average zinc intakes are appropriate, but the biological availability of the metal is low. The intake of iodine is totally dependent upon table salt which is inconsistently fortified. Data on micronutrient status exists for vitamin A, iron, iodine, riboflavin and zinc. With respect to rural areas, no major advantages or disadvantages in the adequacy of micronutrient nutriture can be claimed for the urban population. It is probable that, in the metropolitan area, vitamin A nutriture is slightly better and riboflavin status somewhat poorer than in the countryside. The prospects for future directions in urban lifestyle, in micronutrient status and in their interaction are uncertain. The pressures of growth are straining the ability of the municipal infrastructure and the industrial base to respond with provision of services and employment.

## INTRODUCTION

The major focus of this meeting is the issue of micronutrients and urban life-style in Brazil, which has a population of 146.000.000 (1992) inhabitants distributed over a country with an area of 8.511.965 km$^2$. Guatemala is a nation of 10,000,000 distributed over 108,900 km$^2$. Despite the dissimilarities in size and population, one can find a number of superficial similarities between these two nations. For instance, both have extensive rain forest: the Amazon basin in the former and the Peten's Mayan biosphere in the latter. This has placed on them the burden of supporting oxygen-generation for the planet as a whole. Reports of criminal abuse of street children has reached the worldwide syndicated news services from both nations.

In the nutritional area, both countries are nations of beans. Legumes (*feijao, frijol*) are the traditional basis of the diets of both countries. Both are multi-ethnic societies. With respect to nutrition research, the countries have a similar important legacy of contributions to the scientific literature and to important investigations in nutritional science. The persistent and aggressive pursuit of knowledge, specifically in the areas of ***urban*** nutrition and of diet and health, characterize the nutrition communities of both nations.

Dissimilarities and contrasts between the two nations also exist. The partition of urban-to-rural of the present Brazilian population is 73:27. In Guatemala, it is 40:60. As such, within Latin America, Guatemala, along with its Central America neighbors, represents the more rural predominant populations In fact, the mayors of Sao Paulo and Rio de Janeiro govern more citizens (20 million and 11.8 million, respectively) than the President of Guatemala governs in the Republic as a whole. Guatemala City, the capital with 2 million residents, is the only major metropolis in that Republic.

## A PROFILE OF GUATEMALA

Nutritional status of societies is strongly influenced by dietary intake as well as by the physical and biological environment. Social, economic and cultural features give the shape and texture to the interaction of man with his surroundings. The foods available from local production will be determined by factors such as climate, terrain, soil conditions, and native and imported flora and fauna. The geographic and geological position of Guatemala, along with its anthropological and political history are an important backdrop to the analysis of nutrition for any subpopulation within its borders.

The terrain of the Republic is a blend of rain forest, volcanic highlands, arid desert and coastal plain. Guatemala has a tropical climate with rainy and dry seasons equally dividing the calendar. The *Sierra Madre* mountains constitute a continental divide and the northeastern part of the country is under the influence of the Caribbean (Atlantic) tropical weather patterns while the southwestern sector is response to the Pacific pattern.

The Isthmus of Central America has been inhabited for millennia by Amerindian groups common to the MesoAmerican region. The Mayan civilization was established parts of Mexico and Guatemala. Guatemala is a mixture of European (mostly Spanish), African and native Caribbean ethnic groups, but the majority of the population is of post-Mayan indigenous heritage, speaking one of 21 Mayan languages as their first tongue. The first contact with the Spanish came in 1524 with the arrival of the Conquistadors under Pedro Alvarado. Guatemala was the seat of the Spanish colony of Central America until 1821 when they obtained their independence from the Spanish Crown. A Republic emerged thereafter which has had a turbulent political history, with alternating periods of enlightenment and reform and of military dictatorship. On January 29, 1997, a formal peace agreement was signed between the constitutional government and the insurgent groups that had engaged in

a civil was for 36 years. The median household income is $600 (US) annual. In terms of the ability to satisfy basic household needs, 85% are below the poverty line, and 63% are below the extreme poverty line. On the other hand, half of the arable land is concentrated in the hands of 3% of the population. Guatemala is second only to Haiti in terms of the percentage of the population that cannot read or write the official language, in this case Castellan Spanish. Guatemala, the republic, has a relatively high fertility rate and a doubling time of <25 years. The majority of the population is below 15 years of age.

Most of the population lives in the highlands. Conflict over land and its ownership has existed since the time of the Conquest. There is also conflict over the ***use*** of land. When placed to commercial export-crop use, coffee is the leading crop, growing well in the highland, volcanic solid. Also grown in the highlands are snow-peas, a non-traditional export crop. Banana's are grown near the Atlantic coast and sugar cane on the Pacific coast. When subsistence and food-crop farming wins out, maize and bean cultivation is the most important. Pumpkins, squashes, orchard fruits, and vegetable are also grown for personal consumption and sale in the local produce market. The livestock include cattle, raised on the coast for meat, and sheep, raised in the highlands for wool.

## URBANIZATION IN GUATEMALA

In fact, improvements in transportation and communications during the latter half of the 20th Century be the single·most important factor, favoring migration to the capital city. Through the first four and one-half centuries after the Conquest, most of the settlements and plantations (***fincas***) were isolated and accessible over very difficult roads by food or with beasts of burden. The advent of paved highways affected both the rural gentry, who could administer their lands while based in more comfortable capital, and the rural peasantry, who could visit cities with regularity.

Guatemala City had a population of less than 1 million at the beginning of the 1970s. On February 4, 1976 a devastating earthquake with a magnitude of 7.6 on the Richter Scale, shook the country with a cumulative mortality of over 30,000. The majority of these deaths occurred in rural provinces close to the capital. This seismic event set of a chain reaction of demographic events. The population of the city has more than doubled over the next two decades. Part of this came from natural growth, i.e. children born in the capital. Most of it was due to rural-to-urban migration. The great majority of the increases was among the poor.

The central city itself has undergone rapid change. Like most Latin American cities the capital began around a main plaza with the religious center, the Cathedral, and the seat of government. It was earthquakes in 1773 the colonial era that, in fact, had produced the translocation of the capital of the Spanish colony on the Isthmus from it setting at Antigua Guatemala after almost 250 y. From its founding in 1776 through the early part of this Century, this city center (Zona 1) and its contiguous zones were both the residential and commercial heart. The foreign diplomatic embassies were in this downtown sector until the 1970s. After the revolution of 1944 and the counter-revolution of 1954, the wealthier families began to build larger houses and estates to the south of the central zones. As tourism grew as an industry, the tourist hotel zone grew up in the new elite residential areas. Since the Earthquake another demographic shift for the rich and powerful has occurred. Guatemala has begun to achieve a skyline of high-rise office buildings and hotels. These have arisen in this southern sector, and the elite have moved once more to the hills surrounding the city or into condominium developments. All of this has left the original downtown to a lower middle class. Meanwhile, vast sectors of the city — including the precarious slopes of the ravines — have been given over to sprawling, unsightly slums and provisional settlements.

Very little about the low-income neighborhoods of Guatemala is not generic to the region, having been described in the *favelas* of Brazil or the *pueblos jovenes* of Peru. They are best described as agglomerations of household. The construction is precarious, of corrugated metal sheets and whatever other materials (wood, plastic, brick, block, cornstalks) is available. Floors are of dirt. Streets are of dirt. Drainage for water and sewage is non existent. Intrahousehold water taps are the exception, communal faucets are the rule, and purchase of water from tank-trucks is common. In the city, electrification is generally complete although telephone lines are scares. With electricity comes the ironic paradox of electrical appliances (radios, cassette and CD players, televisions and VCRs) under the roofs of provisional domiciles. Shade trees and grassy areas are rare. In the dry season this makes for dust bowls; in the rainy season, for mud bowls. Such neighborhoods are subject damage to the natural elements such as earth tremors, flash floods, and (recently) wind storms.

Personal and property security has become precarious. Many migrants to the city came to find refuge from the crossfire of insurgents and military forces in their countryside hamlets. Now the menace is petty theft and organized youth gangs. Extortion, larceny and rape are the crimes of note. Access to patrol cars is difficult and police presence is minimal. A major recent concern by a frustrated citizenry is vigilante justice and lynchings. The elite are not immune to the rising criminality which involves house burglaries and kidnappings for ransom. Private security police for home and business is a flourishing growth industry. Ironically, the second leading industry in terms of income in foreign exchange is tourism. Security concerns in both the capital and the countryside may be a poison attacking the goose that lays the golden eggs of tourism dollars.

Analogous to the experience throughout the region, structural adjustment — and the culture of structural adjustment - has supplanted a bloated state and municipal bureaucracy with its powerful unions. Once the tools and trophies of those who governed, the public servants have become the objects of a rush to downsizing and privatization of public services. Never efficient, municipal services and national functions such as public hospitals and schools, are in transition to decentralization and local responsibility (at best) and non-existence (at worst).

## URBAN LIFESTYLE AND DIETARY PATTERN

It is safe to say that urban life-style in Guatemala has always been distinct from rural life-style. It is also rather evident that predominant rural life-style, that of agricultural work — either in subsistence or cash-crop cultivation, for men, and maintenance of a peasant household for women — has not changed substantially during several centuries. Work in construction in the cities can be as physically intense as work on the farm, but most of the occupations of men in the cities are more sedentary than those of the agrarian. For those who are born in the countryside and who migrate to the capital, there is a *transition* of activity pattern within the lifespan.

"Nutrition transition" is a concept which has been introduced by Prof. Barry Popkin (1) in which the "problems of under- and overnutrition often coexist, reflecting the trend in which an increasing proportion of people consume the types of diets associated with a number of chronic diseases." The book by Prof. Klaus Pietzrik (2) and published by the International Life Science Institute, entitled "*Modern Lifestyles, Lower Energy Intake and Micronutrient Status*" sets the stage for the quantitative and qualitative consideration of this topic, as it relates the lower energy intakes of more sedentary life-styles to a lesser total intake of foods, and possibly of key sources of micronutrients. Hence, a con-

sideration of diseases related to dietary excess, but more specifically of chronic and degenerative diseases in which micronutrients in generous amounts may be protective.

Household diets for the low-income populations in Guatemala have changed in two dimensions. The basic menu at home is different from what is still eaten in the countryside, and more meals are eaten away from home. In a monetary economy (purchase) compared to a non-monetarized provisioning (self-production, gathering, barter) sets the pattern for a very different selection of foods. The issue can be framed in terms of availability and accessibility. To the shopper in the urban milieu, there is vastly greater selection of food than for the mother in the rural hamlet. In the province bordering the metropolitan area to the southwest, a rural-to-urban gradient in the number of items reported in a 7-day period in the gradient from a township to a village to a plantation was reported (3). The diversity of the diet was three-fold greater in the township as compared to the plantations. However, its accessibility, i.e. does it come within the household budget, is the greater determinant of how many different items are in the diet. The distillation of these forces is seen in a survey (4) with 52 pregnant mothers from the periurban neighborhood of Guajitos, interviewed from 9 to 14 times (mode: 14) during their third trimester of pregnancy in 1987. Over 706 person-days among these 52 women, 254 food and beverage items were reported as consumed. However, only seven items were common to all 52 women, and only 5% of the total of items accounted for 75% of total energy and protein intake for the population, with maize tortillas accounting for 25% of total energy.

The options for eating outside of the home have expanded rapidly for all of the visitors to and residents of the capital city. For the upper class and foreign tourists, restaurants and hotel dining rooms have proliferated. For the middle-class there are cafeterias and fast-food eateries, the latter specializing in fried chicken, hamburgers, pizza and specialty sandwiches. Street food are the primary option for the urban majority, the poor. Street foods have always existed, but with the proliferation of the urban population and the inability to return home from work for meals, the services of street-food vendors has proliferated (5, 6). With the exception of the Guatemalan—style hot-dog, the *mixta*, most of the meals and snacks are based on traditional Guatemalan foods.

Globalization of import-export of commercial foodstuffs has overtaken Guatemala, but it is expressed more on a franchise basis with actual manufacture of the products in Guatemalan factories, This is true for the highly visible beverages: Coca Cola and Pepsi Cola. Rolled oats and cornflakes are manufactured in Guatemala under the Quaker and Kellogg labels, respectively. Imports of wine from Chile, of chocolates from Switzerland and the USA. Beer and rum were true monopolies; two *cervecerias*, both owned by the same family, controlling the manufacture and importation of most beer. One *liquorera* has the same hegemony over sale and import of spirits.

Globalization interacts with currents that are intrinsic to local conditions. Maize is the cereal staple of MesoAmerica. The tortilla (corn pancake) and the tamal (baked corn) were the dominant cereal-based food at Guatemalan meals. White (bleached wheat flour) bread has been baked in bakeries in Guatemala since the colonial period, but it had been a minor constituent of the diet in deference to the maize products. At CeSSIAM the hypothesis of the existence of a gradient of increasing wheat bread consumption, displacing maize from the diet was confirmed (7). Another finding in that study was a progressive reduction in the weight and diameter of tortillas among the Kekchi from the most rural to the most urban settings. With respect to globalization, bread has become part of a franchise. *Pan Bimbo* is a mass produced standardized line of sandwich bread and packages pastries.

*Vitamin intakes*: A comparison of preschool children in five localities, two rural and three peri-urban neighborhoods of the capital, was made in 1987 (8, 9). The average intake was estimated a 200 to 250 RE in the three urban sites. This was higher than the 125 RE in the remote location on the Rio Dulce, but less than the 299 RE in the nearby hamlet of Las Trojes. However, in terms of the percentage of subjects consuming an adequate intake of 400 RE, the three urban areas were numerically better off than the two rural settings.

Vitamin A intakes must be considered both in terms of the basic, "natural" foods in the diet, both of animal and vegetable origin, as well as intake from fortification. Guatemala is one of several Central American countries to have government-mandated fortification of sugar. This is a process developed at INCAP (10). The target level of retinyl palmitate per gram of sugar is 14 RE (50 IU), but the tolerances are set at from 11 to 17 RE. The recent National Micronutrient Survey (11) found an average, per person consumption of 60 g in the metropolitan area, The median fortification level fell well below the target, at 7 g, but this combination would provide 420 RE from sugar daily. Sources of vitamin A are from fortified foods has often been ignored in the past, but since fortification was re-instituted in 1989 the concern has become prominent. About half of the median intake of 427 3 RE of vitamin A in the diet of peri-urban toddlers in a community of Guatemala City is from fortified foods (12). The rest is from natural foods. Sugar, which, as analyzed, contained 3 RE/g contributed 2/3 of the fortificant vitamin A and 1/3 of all the vitamin.

For pregnant women in a peri-urban neighborhoods, perfbrmed in 1987-88 before the re-institution of sugar fortification and, using 24-h recall as the instrument, found median intakes of vitamin A to be in the 170 to 240 RE range (13).

The mean and median daily intakes of riboflavin were obtained from data on 217 rural and 86 urban school children aged 5 to 11 y (9). The intake of the former was 0.71 mg (median: 0.74 mg/day) whereas that for the latter was 1.07 mg (median: 0.82 mg/day).

*Mineral Intakes*: Iodine deficiency disorders have been common in Guatemala since the first systematic surveys in the early 1950s revealed a goiter rate of 38% (14). The same fortification law that mandates fortification of table salt at a level between 30 and 100 parts per million (ppm). Potassium iodate is the fortificant. The National Survey (11) found a median level of around 22 ppm. The estimate of individual salt intake, based on disappearance data for the metropolitan areas is 9 g per person. CeSSIAM has conducted studies with lithium labeled salt in a village near the capital, that suggests that adults consume more iodine than children, and that the 9 g figure is much too high for both populations (15). Aside from salt, there is virtually no source of iodine in the diet. In the capital, the supermarket as the source of salt tends to guarantee the highest adequacy (16).

The variation in the content of four mineral nutrients - calcium, iron, zinc and copper - in the traditional staple food, the maize tortilla was studied (17). They found that, per 100 mg of edible portion, the tortillas provided: 108 mg of calcium; 1,5 mg of iron; 1.8 mg of zinc; and 0.2 mg of copper. The impact of these differences, however, is modulated by the strict gradient in the volume of tortilla consumption from rural to urban. Urban mothers of a specific linguistic group, the Kekchi, were found to consume daily,, on average: 444 mg calcium; 5.7 mg, iron; 6.9 mg, zinc, and 0.6 mg, copper, from the most rural hamlet to a neighborhood in Guatemala City (7). As noted, this same study showed that white bread (pan francés) was the item that replace tortilla with urbanization. This white bread has lesser amount of all of these elements.

Consumption of zinc by pregnant women in Guajitos was 11.3 mg (range 5.8 to 20.7) based on the 706 person-days of 24-h recalls (18). School children aged 6-7 y in a low-income neighborhood (19). The mean daily zinc intake for boys was 10.1 mg/day and for girls 8.4 mg/day. The urban diet in Guatemala has also been assayed for the potential for the absorption of zinc to be reduced. The Zn/phytate ratio

for the women's diet averaged 18.8 and that for the children's diet averaged 12.1 and 9.9 for boys and girls, respectively. A critical level for significant inhibition is >20. Thirty-eight percent of the women's diets exceeded this inhibitory threshold.

Additional mineral daily mineral intake data obtained in the 52 peri-urban, third-trimester women were as follows: calcium, 727 mg; copper, 1.3 mg; and manganese 2.8 mg (18).

*Conclusions*: Possible **compensating** factors for reduced energy intake would be a diversification of the diet and a net increase in **micronutrient density**. Also, in urban setting, the general sanitation of foods may be superior to that of rural homes, reducing micronutrient losses related to episodes of food-borne gastroenteritis.

## SURVEY OF MICRONUTRIENT NUTRITURE

Data on the status of the metropolitan population exists with respect to vitamin A, iron, iodine, zinc and riboflavin. Vitamin A status in both the urban and rural areas has been dominated and determined by the fortification of sugar. Preschool children in the two rural locations (Rio Dulce, Las Trojes) had a tendency toward higher prevalences of low retinol levels and abnormal relative dose responses than those at the three urban sites in the 1987 (pre-fortification of sugar)CeSSIAM studies discussed above (8, 9). In the recent National Survey (Ministerio de Salud Pública), the national rate of retinol concentrations below 20 ug/dL was 15.8% for children from 1 to 5 years of age, but for the metropolitan area preschoolers it was only 10.4%.

The groups most vulnerable for iron deficiency and anemia are women of childbearing age and preschoolers. Of 44 non-pregnant women in Guajitos, 20% had "anemia," as defined by a packed cell volume of <37%. For the pregnant women, using a cut-off criterion of 34% hematocrit, which is adjusted for the hemodilution of late pregnancy, the rate of "anemia" was only 4%. The National Micronutrient Survey (11) classified 23% of metropolitan Guatemala City women between 15 and 44 years as "anemic," as compared to 36% in the childbearing women across the republic. At CeSSIAM, a group of preschool children from a peri-urban neighborhood (Peronia) was compared with peers in the northerly province of Alta Verapaz (20). The number with low hematocrit values (<38%) was in the mid-30% range for both populations, but the only 37% of former and 54% of the latter had deficient iron stores as defined by a plasma ferritin of <12 mg/L. The National Survey (11) again found a lower rate of anemia in the metropolitan area (15%), than as in the nation as a whole (26%) in children 1 to 5 years of age.

Iodization of salt has been variable over the recent history of Guatemala. In 1987, a nationally representative sample of school children were examined for goiter by palpation (21). She found, curiously, that the rate of thyroid enlargement was slightly higher in the urban areas (including the capital) than in the rural areas. More recently, the National Micronutrient Survey (11) measured urinary iodine concentration by regions. The mean of low iodine concentrations for the capital of 22.1% is identical to that of the nation as a whole, 22.2%. However, consistent with the goiter survey (21), the 22.1% rate of low iodine was lower than the 16.1% rate across the highlands (***altiplano***), which is largely rural.

Riboflavin deficiency is prevalent in Guatemala. Although this vitamin is found in avocados and in most green herbs, epidemiologically speaking, the limiting factor in riboflavin adequacy is a low milk and dairy product intake. Studies in elderly adults in six localities in Guatemala is enlightening (22). The rate of deficiency of elders samples in Guatemala City (50%) was only slightly lower than the 60% found in three rural populations. However, persons over 60 y of age in a dairy cattle region, had a riboflavin deficiency prevalence of only 33%. Access to dairy items and the frequency of their consumption, rather than geography, per se, continues to be the determinant. The riboflavin nutriture of young school children, aged 5 to 11 y, were examined by erythrocyte glutathione reductase activity coefficients (EGRAC) (9). Blood was obtained on 102 rural and 180 urban children. The median activity coefficient was 1.24 in the former and 1.19 in the latter; 29% of the former, and 46% of the latter had an activity coefficient of<1.20 considered to signify deficiency. The freshness of the milk and cheese, as consumed, may be another factor in riboflavin status. We compared riboflavin status in schoolchildren from a rural, coffee-growing area and from a peri-urban neighborhood (9).

There is no ideal manner to measure zinc status. Data has been collected in 162 school children, aged 6 and 7 y. There were 89 boys and 73 girls. A total of 12.3% of the males, but only 1.5% of females had a low plasma zinc concentration of <70 ug/dL. With respect to hair zinc concentration, 63% of boys and 44% of girls had levels of <110 ppm. The principal findings of the cross-sectional, pre-intervention relationship were a tendency to greater weight (for height and for age) in those with low hair zinc (<110 ppm), as well higher mid-arm fat areas (19). In taste acuity, a functional index of zinc status, the recognition threshold for salt was higher in the low-hair-zinc subgroup. The same children underwent an intervention trial over 5 months with a cumulative dose of about 900 mg of oral zinc. The differential changes in the zinc and non-zinc groups were not found with respect to either total linear or ponderal growth. The effect of zinc was more on the composition of growth in terms of greater responses in increase in triceps skinfolds and better preservation of midarm circumference (23). These various measures, associations and responses have been interpreted as evidence of a prevalence of zinc deficiency.

## PERSPECTIVES FOR THE NEAR FUTURE

Guatemala City lies in a valley in the midst of mountains, 5000 ft above sea-level. As it is perched on a plateau and surrounded by deep ravines, the margin for further territorial expansion is limited. In theory, that should eventually stem the tide of immigration to the capital. However, before that happens, saturation of the density of inhabitants will be probed. Limitations of potable water availability have already become manifest, and the prospects for resolving the situation are dismal. Neither the streets and boulevards nor the off-street parking are sufficient to contain the increase number of internal combustion vehicles. Gasoline is still leaded and the influence of automobile emissions on air quality has it heading toward the situation that is legendary in Mexico City. The middle and upper classes are remaining in the metropolitan area, but fleeing the city proper. This reduces the median income of those residents that remain. All in all, the general "liveability" of Guatemala City, especially for its poor, seems to be on a decline.

With this panorama of evolving chaos, crowding and collapse of infrastructure, we can develop both a bleak and a rosy scenario for micronutrient nutriture. The bleak scenario is one of a return to greater prevalences of micronutrient malnutrition. On the other hand, to the extent that measures such as fortification of sugar with vitamin A and salt with iodine are maintained, and quality control improved, hypovitaminosis A and iodine deficiency disorders might be kept at bay. Also, simply the greater diversification of the diet in the city is likely to reduce micronutrient deficiencies even if the population remains equally impoverished.

Moreover, the globalization of the diet as outlines above, will continue to advance. The traditional, high-fiber and low-fat fare which has been synonymous with Guatemalan cuisine will, with time, comprise less and less of the total diet. The diet will be more refined and more energy-dense, while daily pursuits will be more sedentary and less energy-demanding. The environment will become more contaminated with particles and chemicals. Persons will live longer. All of this is a

recipe for greater incidences of chronic diseases. How one would preserve Food-Pyramid guideline profile in the nutritional transition is hard to imagine. And, to the extent that a certain balance of micronutrients reduce free-radical formation and bolster the immune system, increasing intake of "antioxidant" micro-nutrients in the diet could be seen as an appropriate public health move. Some feel that a single, universal dietary prescription can minimize chronic diseases for all populations. My opinion differs from that point of view. The combinations and interactions of genetic and environmental factors — both protective and predisposing to chronic illness — varies from site to site. If we had the knowledge and wisdom, we could develop specific formulas for dietary and life-style change to counteract the specific circumstances of a given locality. However, as documented here and in other contributions, when it comes to the metropolises of Latin America, nothing is static, everything is dynamic, and change is ongoing, unpredictable and unstable. A prescription for today will logically be obsolete tomorrow. Hence, the more modest and universal guidelines may represent the prudent course. What they lose in targeted efficiency, they might gain in long-term sustainability, especially if the worldwide marketing of food becomes "health conscious" in the formulation of its food for export and franchise.

## CONCLUSIONS

In his book on the longitudinal study of the village of Santa María Cauqué (located 38 km from Guatemala City), derived from a longitudinal study that lasted from 1962 to 1976, Leonardo Mata (24) suggests that the habits and life-style were virtually unchanged from the arrival of the Spanish, some 450 years earlier. Such was the apparent stability of rural Guatemala. In the years since the Earthquake of 1976, however, growth and change in the capital of the Republic has been both chaotic and exponential.

The greatest benefits for the present process is to compare and contrast the situation in Guatemala with that of Brazil. Guatemala combines three features that make it a suitable and apt subject for a comparative discussion of micronutrients and urban life-style. There is relatively abundant information about diets and nutritional status. The Institute of Nutrition of Central America and Panama (INCAP) has been operating for 48 years and has contributed a legacy of both understanding of how to study diet and nutrition and of tangible information. The Center for Studies of Sensory Impairment, Aging and Metabolism (CeSSIAM), founded in 1985, has joined that tradition. Secondly, there is interest and focus on urban nutrition. CeSSIAM has been at the forefront on the subject from its founding, working closely with the urban nutrition activities of the International Union of Nutritional Sciences. Thirdly, in the Latin American context, Guatemala is among the least advanced in the process of the global shift from a rural, agrarian society to an industrialized, urbanized one. If nutrition transition (1) addresses the situation in which under- and overnutrition co-exist in the context of poverty and lack of power, then contemporary Guatemala City and the emerging urb has the characteristics. Only with respect to vitamin A nutriture is there a clear tendency to better nutritional status in urban — as compared to rural — areas. The situation for iodine and riboflavin may have been, as recently as the late 1980s, slightly worse among the urban population. Dietary change is accelerating and a less protective and more "pathogenic" diet is combining with a more sedentary life-style even for the urban poor, and the sharing the focus between alleviation of undernutrition and prevention of chronic diseases is warranted. Only through ongoing local scientific investigation, and transfer of its derivative fruits to the public health and agricultural sectors, combined with a linkage to the global effort to understand the mechanisms of urbanization and its nutritional consequences, can the best individual and collective decisions for health and wellbeing be taken. Hopefully, the resources to allow for both expert inquiry and concerted action will continue to be made available.

## REFERENCES


1. Popkin, B. Nutrition transition: An emerging crisis in developing countries. Nutr Rev, 52: 285-298, 1994.
2. Pietzrik, K. Modern Lifestyles, Lower Energy Intake and Micronutrient Status. ILSI Human Nutrition Reviews. New York, Springer-Verlag, 1991.
3. Mendoza, I; Saenz de Tejada, E; Sanchez, ME & Solomons, NW. Dietary pattern of preschool children during diarrhea in a coffee-growing area in rural Guatemala. Ecol Food Nutr, 35: 25-41, 1996.
4. Fitzgerald, SL; Gibson, RS; Thompson, LU; Quan de Serrano, J; Portocarrero, L; Vasquez, A; Zepeda, E; Lopez, CY & Solomons NW. Trace element intakes and dietary phytate/Zn and Ca X phytate/Zn millimolar ratios of periurban Guatemalan women during the third trimester of pregnancy. Am J Clin Nutr, 57: 195-201, 1993.
5. Bressani, R. Alimentos de venta callejera en Guatemala. In: Taller Latino americano FAO/OPS sobre Alimentos Comercializados en la Vía Pública. Lima, Perú, Rome, Food and Agricultural Organization, 1985.
6. Freese, E; Romero-Abal, ME & Solomons, NW. The street food culture of Guatemala, City: A case study of an urban park. Arch Latinoamer Nutr (in press), 1997.
7. Krause, V; Solomons, NW; Tucker, KL; Lopez, CY; Ruz, M & Kuhnlein, KV. Rural-urban variation in the calcium, iron, zinc and copper content of tortilla and intake of these minerals from tortilla by women in Guatemala. Ecol Food Nutr, 28: 289-297, 1992.
8. Solomons, NW; Bulux, J; Guerrero, AM; Portocarrero, L; Quan de Serrano, J; Quiñonez, J; Rosas, AM; Vasquez, A; Zepeda, E; Brown, KH; Forman, M; Gadomski, A; Kjolhede, C; Morrow, F & Russell, RM. Vitamin A en áreas urbanas marginales de la capital de Guatemala. Rev Chil Nutr, 17: 41-45, 1989.
9. Solomons, NW; Haskell, M; Bulux, J & Molina, S. Nutrition and health conditions of the periurban preschool and child populations of Guatemala City. In: Urban Nutrition: Pre-school Children. Aalbersberg, W, Hautvast, J (eds). Ede, Holland. Foundation for the Advancement of the Knowledge of the Nutrition of Mother and Child in Developing Countries, 1990, p. 119-150.
10. Arroyave, G. Evaluación del Programa Naciional de Fortificacion de Azúcar con Vitamina A. Washington, D.C., Pan American Health Organization. PAHO Scientific Publication No. 384,1979.
11. Ministerio de Salud Pública y Assistencia Social. Encuesta Nacional de Micronutrientes. Guatemala City, 1996.
12. Krause, VM; Delisle, H; & Solomons, NW. Fortified foods contribute one half of vitamin A intake from non-breast milk sources in peri-urban in peri-urban Guatemalan toddlers. (Submitted for publication), 1997.
13. Portocarrero, L; Quan de Serrano, J; Lopez, CY; Zepeda, E; Vasquez, A; Bulux, J & Solomons NW. Comparison of food-frequency and twenty-four hour recall instruments for estimation of vitamin A intake. Food Nutr Bull, 13: 265-270, 1991.
14. Behár, M. Progress and delays in combating goiter in Latin America. Fed Proc 27: 939-944, 1968.
15. Boonstra-Melse, A. Studies on Salt related to Iodine Deficiency Disorders in a Rural Guatemalan village. MSc. Thesis, Wageningen Agricultural University, 1996.
16. Quataert, MCJ; van der Poll, C; Bulux, J; Solomons, NW; May, S & Maberly, G. The intermethod and interobserver correspondence for assays for salt iodine content, with specific reference to the moni-

toring of the consistency of salt fortification in Guatemala. Bulletin of the Pan American Health Organization (in press), 1996.

17. Krause, V; Tucker, KL; Kuhnlein, KV; Lopez, CY; Ruz, M & Solomons, NW. Rural-urban variation in limed maize use and tortilla consumption by women in Guatemala. Ecol Food Nutr, 28: 279-287, 1992.
18. Fitzgerald, SL; Gibson, RS; Portocarrero, L; Quan de Serrano, J; Vasquez, A; Zepeda, E; Lopez, CY & Solomons, NW. Food consumption patterns and dietary diversity of pregnant women living in a periurban area of Guatemala City. Ecol Food Nutr, 27: 115-121, 1992.
19. Cavan, KR; Gibson, RS; Grazioso, CF; Isalgue, AM; Ruz, M & Solomons, NW. Growth and body composition of periurban Guatemalan children in relation to zinc status: A cross-sectional study. Am J Clin Nutr, 57: 334-343, 1993.
20. Romero-Abal, ME; Bulux, J; Mendoza, I; Grazioso, C & Solomons, NW. Hematological status of preschool and school children in urban and rural areas of Guatemala. Food Nutr Bull, 16: 60-66, 1995.
21. Martínez, MM. Deficiencia de yodo, bocio endémico y su relación con el estado nutricional *en* escolares de la República de Guatemala. Masters Thesis. Guatemala. Instituto de Nutrición de Cento America y Panamá, 1988
22. Boisvert, WA; Castañeda, C; Mendoza, I; Mazariegos, M; Langeloh, G; Solomons, NW; Gershoff, SN & Russell, RM. Prevalence of riboflavin deficiency among Guatemalan people and its relationship to milk intake. Am J Clin Nutr, 58: 85-90, 1993.
23. Cavan, KR; Gibson, RS; Grazioso, CF; Isalgue, AM; Ruz, M & Solomons, NW. Growth and body composition of periurban Guatemalan children in relation to zinc status: A longitudinal zinc intervention trial. Am J Clin Nutr, 57: 344-352, 1993.
24. Mata L The children of Santa María Cauqué. Cambridge, M.I.T. Press, 1978.

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# Micronutrient deficiency in urban Indonesia

*Rainer Gross and Werner Schultink*

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) / SEAMEO-TROPMED Jakarta, Indonesia

**SUMMARY. Micronutrient deficiency in urban Indonesia.** The economic situation of Indonesia is characterized by a large increase in the gross national product which has been on average 7% annually during the last ten years. This was accompanied by rapid urbanization. With the economic improvement, "First World" and "Third World" health and nutrition problems are coexisting in Indonesia. In 1992, the most common of death cause was cardiovascular disease whereas tuberculosis was the second ranking. About 40% of the preschool children are stunted. The main stable food and energy source is rice, although the urban population has a more diverse food pattern than the rural population. In Jakarta, many children receive too late colostrum feeding and mothers are not aware about the importance of correct breastfeeding practices after delivery. Three studies had shown that about one fifth of preschool children and one fourth of elderly take micronutrient supplements. Nevertheless, micronutrient deficiencies are prevalent in Jakarta. About one third of women suffer from moderate vitamin A deficiency (plasma retinol <0.70 mmol/L) and 50% of pregnant women are anemic. More information is necessary on other micronutrient deficiencies. For example, a small study revealed that nearly two thirds of non-institutionalized elderly living in Jakarta experience thiamine deficiency. Appropriate interventions to reduce micronutrient deficiencies should sensitize the urban population to the fact that the government should restrict itself to use its resources to assist only the poorest individuals and groups, whereas it must be expected from the middle class to spend more time and money to solve their own problems.

## INTRODUCTION

During the last decades, Southeast Asia has become a region with an impressive economic growth. Nevertheless, within the region there is still a wide difference in the economic situation among the people. Countries such as Myanmar or Cambodia battle to successfully begin economic growth, whereas Singapore is among the richest nations in the world.

## POPULATION AND SOCIOECONOMIC DEVELOPMENT IN INDONESIA

During the last ten years Indonesia has undergone remarkable economic growth. The gross national product (GNP) per capita increased from US$ 440 to an estimated US$ 1100 in 1996. As a result, hunger and severe symptoms of undernutrition had been successfully eradicated. For several years, Indonesia has produced enough rice to meet its own demand. The economic growth has been accompanied by increased urbanization. About 40% of its 200 million inhabitants live in urban areas. It is estimated that in about 10 years more than half of Indonesians will live in towns or cities. Life expectancy has increased to 62 years for men and to 66 years for women. Furthermore, within countries such as Indonesia, the Philippines, or Thailand, the economic situation differs between the urban and rural populations.

## NUTRITIONAL STATUS AND DISEASES

Table 1 shows the changes in the ranking of causes of death during the last 20 years in Indonesia according to the Ministry of Health. In 1972 the first three causes of death - diarrheal diseases, tuberculosis and respiratory diseases - reflected the health situation of a developing country, whereas in 1992 the most common cause of death was cardiovascular diseases, which are characteristic of high income countries, and tuberculosis a symptom of poverty, was the second ranking cause of death.

This diversity is also expressed by the wide range of the prevalence of stunting in children less than six years of age in different population groups in Indonesia, according to data collected during several nutrition baseline surveys, conducted during the last ten years in Indonesia by the SEAMEO-TROPMED Regional Center for Community Nutrition at the University of Indonesia, Jakarta. The prevalence of stunting does not reflect the situation of entire provinces, they are rather representative for smaller sub-populations at district or sub-district levels. According to these data, prevalence of stunting ranges from 23 to 69%. The lowest prevalence was found in the capital city of Jakarta, on Java, whereas the highest was observed in villages on outer islands of East Kalimantan. The nutrition status of different age groups within urban Jakarta also reflects a remarkable diversity of under- and overnutrition as can be observed on Table 2 (1-9). As a result, despite the significant increase in the GNP, the disease pattern and nutrition situation of Indonesia still shows a wide divergence within its population.

## FOOD INTAKE

Assessment of the energy intake of the Indonesian population during the last two decades by the Household Surveys (10) and by the Food Balance Sheets (11), showed a consistent increase of energy consumption in Indonesia. This increase relies mainly on an increased grain consumption, with 90% contribution from rice. As a result, for the broad Indonesian population, the increased income has not yet diversified the energy supply and the main staple food continues to be rice.

Comparison of the food frequency surveyed in West Kalimantan with that in Jakarta, presenting, respectively, the highest and the lowest prevalence of stunting, showed that selected food stuffs (egg, chicken, fish, tofu, peanuts, vegetables, jackfruit and tubers) were more frequently consumed in the urban households of Jakarta than in the rural households of West Kalimatan. Remarkably, the families in Jakarta did not consume less frequently traditional food stuffs such as cassava or other tubers, compared to the rural population of West Kalimantan.

TABLE 1
Changes in causes of death in Indonesia over 20 years

| Ranking | 1972 | 1980 | 1988 | 1992 |
|---|---|---|---|---|
| 1 | Diarrheal diseases | Respiratory diseases | Diarrheal diseases | Cardiovascular diseases |
| 2 | Respiratory infections | Diarrheal diseases | Tuberculosis | Tuberculosis |
| 3 | Tuberculosis | Circulatory diseases | Diphtheria | Respiratory diseases |
| 4 | Circulatory diseases | Tuberculosis | Tetanus | Diarrheal diseases |
| 5 | Tetanus | Tetanus | Malaria | Other infectious diseases |

(Ministry of Health 1993)

Traditional prelactal feeding practices of infants have been widespread in the rural population of Indonesia (12) and also in urban teaching hospitals (13). In urban areas, the delayed initiation of breast-feeding occurs and other types of inadequate colostrum feeding practices are still widespread (14). Independent of the type of maternity ward (public hospitals, private hospitals, health centers or midwife's birth wards), a considerable proportion of mothers does not think that prelactal (colostrum) feeding is needed. Furthermore, particularly in public hospitals and midwife's wards, many infants receive the colostrum more than 12 hours after birth.

Changed food practices and behavior in the urban area are also reflected in the observation that a considerable proportion of the urban population provides their micronutrient intake by supplements. Twenty percent of the preschool children (15), 23% of adolescents (4 ) and 25% of elderly (5) were taking a multi micronutrient supplement at the time of the interview.

TABLE 2
Under and overweight in different population groups of Jakarta

| Population groups | n | Age range (years) | Under† nutrition (%) | Over‡ nutrition (%) |
|---|---|---|---|---|
| Underfives | | | | |
| High-income, both sexes[3] | 168 | 4-5 | 1 | 16 |
| Middle-low income | 628 | 0-5 | 23 | 2 |
| Schoolchildren | | | | |
| Low/middle-income, both sexes[7] | 91 | 6-10 | 5 | 9 |
| Adolescents | | | | |
| Middle-income, males[4] | 118 | 14-16 | 43 | 9 |
| Middle-income, females[4] | 805 | 14-17 | 10 | 33 |
| Middle-aged | | | | |
| Female industrial workers[1] | 92 | 16-36 | 23 | 2 |
| Middle income breastfeeding females[8] | 92 | 18-40 | 9 | 17 |
| Elderly | | | | |
| Free living, low-income, males[2] | 69 | 60-69 | 32 | 21 |
| Free living, low-income, females[2] | 69 | 60-69 | 31 | 31 |
| Free living, middle-income, males[5] | 93 | 60-75 | 17 | 10 |
| Free living, middle-income, females[5] | 111 | 60-75 | 25 | 15 |
| Free living, low-income, males[6] | 48 | 60-75 | 29 | 9 |
| Free living, low-income, females[6] | 51 | 60-75 | 35 | 19 |
| Institutionalized males and females[9] | 42 | 53-88 | 33 | 26 |

† Below 11 years: Weight-for-age < -2 Z-score NCHS reference population
From 11 years: BMI < 18.5 kg/m²
‡ Below 11 years: Weight-for-age < +2 Z-score NCHS reference population
From 11 years: BMI < 25.0 kg/m²

From references 1-9.

## MICRONUTRIENT STATUS

Based on several small studies conducted by the SEAMEO-TROPMED, anemia is still widespread in Indonesia but occurs at different rates in different age groups. A high prevalence occurs in preschool children, and of particular risk are children between 6 and 18 months of age. Due to the slowing down of the growth spurt, the rate of anemia decreases steadily after the age of 2 years and shows lower rates in primary schoolchildren. After the beginning of menarche, the prevalence in adolescent girls increases again, reaches its peak in pregnant women, and declines after the menopause. Besides of biological factors such as growth spurt, menarche and pregnancy, specific contributing factors to anemia in Indonesia are low iron intake, with reduced bioavailability particularly due to high rice consumption, and iron losses caused by parasitic infections.

Indonesia has remarkably minimized the prevalence of xerophthalmia with an effective vitamin A capsule distribution program (16). However, subclinical vitamin A deficiencies still seem to persist even in Jakarta, where food consumption is more balanced than in rural areas. Prevalence of serum retinol levels lower than 0.7 mmol/l was 81% in anemic underfives (15), 30% in adolescents (4) and 33% in lactating women (8).

During the last three to four years in collaboration with UNICEF, the government of Indonesia has put much emphasis in the iodization of salt. Results from a spot survey of the performance of the program, conducted in 1996, showed that most of the salt, sampled either in households or in markets, was iodized, although about half of the salt samples in urban sites had an insufficient amount of iodine (17). The quality of the rural samples was even worse, with about 80 % of samples considered inadequate. Furthermore, it seemed that due to inadequate storage, the salt obtained from the households showed less iodine than the samples bought in the market.

With decreased fertility and mortality, the proportion of elderly is increasing over-proportionally, particularly in the urban area of Indonesia. Table 3 shows the biochemical indicators of selected micronutrients in a male and female subgroup of elderly in Jakarta. In addition to the commonly known micronutrient deficiencies discussed above, thiamin deficiency expressed as stimulation of erythrocyte transketolase appears to be an additional nutrient-related obstacle in later life. This example shows that there is a further need for identification of micronutrient deficiencies in different urban population groups beyond that of vitamin A, iron and iodine.

## MICRONUTRIENT STRATEGIES FOR THE URBAN POPULATION

One of the major differences between the rural and urban populations is that most of the latter does not produce their own food and rely therefore fully on their purchasing power, access to food sources and decision making abilities. Although the availability of food is far greater and purchasing power is higher in the urban than in the rural area, the access to and intake of adequate food of the urban population is limited by lack of time and appropriate information. As a result, strategies need to be developed that take into consideration these two main constraints. In particular, lessons can be learned from private enterprises which often have successfully adapted their marketing strategies to the specific needs of their clients, reaching even low-income groups, where as public programs, despite subsidization, often fail to reach effectively the risk groups.

Dietary intervention, fortification, and supplementation are the three strategies to overcome micronutrient deficiencies in the urban area. In fast growing economies it must be expected from the emerging urban middle class to commit themselves to securing their own food and nutrition needs and choose for themselves the right option, which requires money and time for information, food and nutrient purchase, food preparation and feeding practices. As a result, governments should restrict themselves to define and supervise appropriate legislation securing the highest possible quality of food production and distribution and assist directly only the poorest segment of their society.

TABLE 3
Biochemical indicators of selected micronutrients in male and female subgroups of elderly in Jakarta

| Biochemical indicators | All (n=204) | Male (n=93) | | Female (n=111) | |
|---|---|---|---|---|---|
| | Mean±SD | Mean±SD | (%)[/] | Mean ±SD | (%)[/] |
| Hemoglobin (g/L) | 136±24 | 145±23*** | 25 | 129 ± 22 | 33 |
| Plasma retinol (µmol/L) | 1.30±0.35 | 1.37±0.37* | 4.3 | 1.26±0.33 | 6.3 |
| RBC Folic acid (nmol/L) | 653±232 (621) | 600±196 (573)***‡ | 5.4 | 697±251 (664) | 0.9 |
| Plasma vitamin $B_{12}$ (pmol/L) | 371±207 (435) | 371±200 (441) | 3.2 | 372±213 (431) | 12 |
| Stimulation of the ETK (%)[†] | 21.3±17.7 (17.5) | 24.0±19.8 (19. 7) | 58 | 19.0±15.3 (15.7) | 70 |

n=92 in men for retinol and ETK; n=110 in women for ETK
Untransformed values; geometric means in brackets
† ETK - Erythrocyte Transketolase
*** Significance difference between gender at P<0.001 (t-test)
* Significance difference between gender at P<0.05 (t-test)
‡ Data $\log_{10}$ transformed before t-test
/ Low status: Hb men <130 g/L, Hb women <120 g/L; retinol < 0.70 µmol/L; folate< 368 nmol/L; B12<148 pmol/L; ETK > 14%
Calculation factor for RBC folate 160 ng/L = 368 nmol/L

## REFERENCES


1. Scholz, B; Gross, R; Schultink, W & Sastroamidjojo, S. Anaemia is associated with reduced productivity of women workers even in less physically strenuous tasks. Brit J Nutr, 77: 47-57, 1997.
2. Rabe, B; Thamrin, MH; Gross, R; Solomons, NW & Schultink, W. Body mass index of the elderly derived from height and from armspan. Asia Pacific J Clin Nutr, 5: 79-83, 1996.
3. Droomers, M; Gross, R; Schultink, W. & Sastroamidjojo, S. High socioeconomic class preschool children from Jakarta, Indonesia are taller and heavier than NCHS reference population. Europ J Clin Nutr, 49: 740-744, 1995.
4. Angeles-Agdeppa, I. Daily versus weekly supplementation with iron, vitamin A, folic acid and vitamin C to improve iron and vitamin C status of female adolescents. PhD Thesis. SEAMEO-TROPMED Regional Center for Community Nutrition. University of Indonesia. Jakarta, Indonesia, 1997.
5. Juguan, JA. Micronutrient status of a selected group of elderly in an urban sub-district: Jakarta Pusat. MSc Thesis. SEAMEO-TROPMED Regional Center for Community Nutrition. University of Indonesia. Jakarta, Indonesia, 1996.
6. Kvalbein, A. Nutritional status and diet of Indonesian elderly, West Java. MSc Thesis. Nordic School of Nutrition, University of Oslo, Norway, 1996.
7. Heinze, I. Lead poisoning in school children in Jakarta. Thesis. Faculty of Agriculture. University of Bonn. Bonn, Germany, 1997.
8. Hänsel, H. Zinc and vitamin A in breast milk and blood of lactating women in a low-income area in East-Jakarta, Indonesia. Thesis. Faculty of Agriculture. University of Giessen, Germany, 1995.
9. Van Hal, L & Kleinjan, E. Comparison of three dietary intake assessment methods among institutionalized elderly. SEAMEO-TROPMED Regional Center. Jakarta, Indonesia, 1996.
10. Central Bureau of Statistics National socio-economic survey 1995. Biro Pusat Statistik. Jakarta, Indonesia, 1995.
11. FAO Food balance sheets 1992-1994. Food and Agriculture Organization of the United Nations. Rome, Italy, 1996.
12. Laudner LJ & Habicht JP. Concept about infants' health, growth and weaning: a comparison between nutritional scientists and Madurese mothers. Soc Sci Med., 29: 13-22, 1989.
13. Hull, V et al. Breast-feeding in the modern health sector in Indonesia: the mother's perspective. Soc Sci Med, 30:625-633, 1990.
14. Martini, E. Magnitude of colostrum feeding practices among mothers at selected maternity wards in east and south Jakarta. MSc Thesis. SEAMEO-TROPMED Regional Center for Community Nutrition. University of Indonesia. Jakarta, Indonesia, 1996.
15. Merzenich, M. Effect of iron supplementation alone and in combination with zinc on hematopoietic parameters and on plasma levels of zinc: vitamin A and vitamin E in anemic Indonesian children. Thesis. Faculty of Agriculture. University of Kiel. Germany, 1997.
16. Muhilal; Tarwotjo, I; Kodyat, B; Herman, S; Permaesih, D; Karyadi, D; Wilbur, S & Tielsch, J.M. Changing prevalence of xerophthalmia in Indonesia, 1977-1992. Europ J Clin Nutr, 48: 708-714, 1994.
17. Krupp, S. Assessment of salt iodization activities in Indonesia: Background and current situation at the household and retail levels, with spot-checks in selected cases. Thesis. Faculty of Agriculture. University of Bonn. Bonn, Germany, 1996.

ONE A DAY
Multivitaminas
ONE A DAY
Men's

**ONE-A-DAY MEN'S**
Desenvolvida especialmente para as necessidades do homem contendo 11 vitaminas em diferentes níveis de dosagem.

Specially developed for men's necessity, including 11 vitamins in different dose levels.

| Componentes<br>Components | Quantidade por Comprimidos<br>Quality per tablets | Dose Profilática Brasileira<br>Brasilian* profiletic dose |
|---|---|---|
| Ácido Fólico/Folic Acid | 0,4 mg | 0,4 mg |
| Vitamina B 12/Vitamin B 12 | 9 mcg | 6 mcg |
| Vitamina B 6/Vitamin B 6 | 3 mg | 2 mg |
| Vitamina B 1/Vitamin B 1 | 2,25 mg | 1,5 mg |
| Vitamina D/Vitamin D | 400 UI/IU | 400 UI/IU |
| Vitamina B 2/Vitamin B 2 | 2,25 mg | 1,7 mg |
| Vitamina A/Vitamin A | 5.000 UI/IU | 5.000 UI/IU |
| Vitamina E/Vitamin E | 45 UI/IU | 30 UI/IU |
| Niacina/Niacin | 20 mg | 20 mg |
| Vitamina C/Vitamin C | 200 mg | 65 mg |
| Ácido Pantotênico/Pantothenic Acid | 10 mg | 10 mg |

ONE A DAY
Multivitaminas
ONE A DAY
Women's

**ONE-A-DAY WOMEN'S**
Desenvolvida especialmente para as necessidades da mulher proporcionando 100% do RDA com 11 vitaminas essenciais com quantidade extra de Ferro, Cálcio e Zinco.

Specially developed for women's necessity, offering 100% the RDA with 11 essential vitamins, the right portions of Calcium, Iron and Zinc.

| Componentes<br>Components | Quantidade por Comprimidos<br>Quality per tablets | Dose Profilática Brasileira<br>Brasilian* profiletic dose |
|---|---|---|
| Ácido Fólico/Folic Acid | 0,4 mg | 0,4 mg |
| Vitamina B 12/Vitamin B 12 | 6 mcg | 6 mcg |
| Vitamina B 6/Vitamin B 6 | 2 mg | 2 mg |
| Vitamina B 1/Vitamin B 1 | 1,5 mg | 1,5 mg |
| Vitamina D/Vitamin D | 400 UI/IU | 400 UI/IU |
| Vitamina B 2/Vitamin B 2 | 1,7 mg | 1,7 mg |
| Vitamina A/Vitamin A | 5.000 UI/IU | 5.000 UI/IU |
| Vitamina E/Vitamin E | 30 UI/IU | 30 UI/IU |
| Niacina/Niacin | 20 mg | 20 mg |
| Vitamina C/Vitamin C | 60 mg | 65 mg |
| Ácido Pantotênico/Pantothenic Acid | 10 mg | 10 mg |
| Ferro/Iron | 27 mg | - |
| Cálcio/Calcium | 450 mg | - |
| Zinco/Zinc | 15 mg | - |

ONE A DAY
Multivitaminas
ONE A DAY
50 +

**ONE-A-DAY 50+**
Desenvolvida especialmente para pessoas acima de 50 anos possuindo 13 vitaminas e 11 sais minerais essenciais.

Specially developed for people over 50, including 13 vitamins and 11 essential

| Componentes<br>Components | Quantidade por Comprimidos<br>Quality per tablets | Dose Profilática Brasileira<br>Brasilian* profiletic dose |
|---|---|---|
| Ácido Fólico/Folic Acid | 0,4 mg | 0,4 mg |
| Vitamina B 12/Vitamin B 12 | 25,0 mcg | 6 mcg |
| Vitamina B 6/Vitamin B 6 | 6,0 mg | 2 mg |
| Vitamina B 1/Vitamin B 1 | 4,5 mg | 1,5 mg |
| Vitamina D/Vitamin D | 400 UI/IU | 400 UI/IU |
| Vitamina B 2/Vitamin B 2 | 3,4 mg | 1,7 mg |
| Vitamina A/Vitamin A | 6.000 UI/IU | 5.000 UI/IU |
| Vitamina E/Vitamin E | 60 UI/IU | 30 UI/IU |
| Vitamina K/Vitamin K | 25 mcg | - |
| Niacina/Niacin | 20 mg | 20 mg |
| Vitamina C/Vitamin C | 120 mg | 65 mg |
| Biotina/Biotin | 30 mcg | - |
| Ácido Pantotênico/Pantothenic Acid | 20 mg | 10 mg |
| Iodo/Iodine | 150 mg | - |
| Cálcio/Calcium | 220 mg | - |
| Zinco/Zinc | 15 mg | - |
| Selênio/Selenium | 10 mcg | - |
| Magnésio/magnesium | 100 mg | - |
| Cromo/Chromium | 10 mcg | - |
| Molibdênio/Molybdenum | 10 mcg | - |
| Manganês/Manganese | 2,5 mg | - |
| Cobre/ | 2,0 mg | - |
| Potássio/Potassium | 37,5 mg | - |

Bayer
Se é Bayer, é bom.

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