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Review Article

Regional food culture and development

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Food culture is most influenced by the locality of its origin, which will have been one of food acquisition and processing by various means. It is generally agreed, and is the basis of much United Nations, especially Food and Agriculture Organisation strategic development policy, that *successful agriculture*, horticulture and aquaculture along with fishing, underpin economically viable and healthy communities with their various food cultures. We also know that this must be in tandem with maternal literacy and operational health care systems. These elements are best represented on a regional basis. There is a growing consumer interest in knowing where one's food comes from as a measure of "food integrity". However, food production alone can be a precarious business and relate to a lesser or greater extent to *local food culture* and to trade, which may be complementary or at-odds with each other. Likewise, the local food culture may have its strengths and weaknesses as far as its *ability to meet nutritional and health needs* is concerned. Local food production may be restricted because of geographical or socio-economic conditions which preclude *food diversity*, although this may be compensated for by trade. Where food adequacy and diversity is compromised, and soils poor, various macronutrient, micronutrient (from animals and plants) and phytonutrient (nutritionally-advantageous food component from plants) deficiencies may be in evidence. These food system problems may be intertwined with *food culture* – for example, "rice-based and water-soluble vitamin poor"; "few animal-derived foods like meat, fish, eggs and milk with associated low calcium, vitamin D, Vitamin B_{12} and long chain n-3 fatty acid intakes"; "low fruit and vegetable intake with limited carotenoids and other phytonutrients". Geo-satellite surveillance and *mapping* as identifying such "hot spots": for *regional food problems*, as well as hot spots where most of the world's biodiversity is found (1.4 % of land on earth). On the other hand, regional food culture can confer considerable advantage for health and economic development, but does not necessarily do so. The challenge is to respect and retain *traditional food knowledge* and *sustainable food systems*, with *good governance* for food security. There has been a recent awakening of interest and concern about the *lack of documentation of traditional and indigenous food cultures* which are important not only for their own sake, but for the legacy of food knowledge which they can confer on future generations, provided they are not lost. Hence, the value of a special focus on African food cultures (www.healthyeatingclub.org/Africa), including Rift and Nile Valleys and North West African foods, which are the cradles of human food systems and habits. This is the case too with indigenous foods and food cultures (whether hunter-gatherer or subsistence agriculture); with relatively long-living food cultures in North East Asia, with food cultural distinction and fusion (FHILL and SENECA studies) and with migratory Food Habits. By and large, there is a remarkable resilience and ingenuity of people and their food systems, but monoculture and lack of diversity encourage food system failure.

Key Words: food regions, food systems, food words, African foods, north-east Asian foods, eco-nutrition, nutritional adversity, ethnicity

Introduction

1. Regional food culture and development

At all stages of human development, from the poor to the affluent, there is a sense of local if not regional food culture. *Food culture* arises out of the place of a people's origin, whether they still live there or not, but is shaped by resources (climate, land, soil, water, and fuel), by belief and information (religion, education and literacy, communication), by ethnicity (indigenous or immigrant), technology (hunting, gathering, agricultural, horticultural, aquacultural, fishing; food processing and storage, transport, cooking); colonisation; and by health status and health care.

In the past, *the rate of change of food culture* has been relatively slow, in response to these factors, but most of the relevant factors are themselves now undergoing rapid change, notably, population growth, displacement and migration with land degradation, changing affordability with the parallel phenomenon of increasing impoverishment and greater affluence, with resource wastage on both counts. In the interests of available and affordable food, for the short to medium term, an identifiable and sustain-

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able regional food system and culture may be lost.

Successful food acquisition, by whatever means, must be sustainable in the long term. This understanding and its application underpins economically viable and healthy communities, as is reflected in most development policy. Such policy must be inter-sectoral, however, and link food and health strategies together, and, whilst there may be international frameworks for this, operationally the region in where it is likely and needs to work best. This is at least one reason to understand and support regional food culture in development.

2. Consumers, trade and food regions

Not only do consumers have their own food cultural reference point, but as they become more dependent on others to grow, process, deliver and prepare their food, they want to know more about its origins. In some cultures, like Chinese, this has even been represented in the language which makes these distinctions (Table 1) This has to do with *a sense of food integrity*, namely its expected palatability, safety and healthfulness (nutritional value). Food exporters and traders have often relied on place of origin as a selling point and added a profit margin if the region or district were highly regarded – this has applied particularly to rice, meat, seafood, fruit, vegetables, cheese and beverages like wine, beer, tea and coffee.

In recent times *safety concerns* like pest control methods, and animal feeding (BSE is the most prominent example) have accentuated the consumer interest in place of origin.

Greater travel to food growing regions is also sharpening consumer focus on locality and food.

3. Food systems, their strengths and weaknesses

Throughout human history, people have been making adjustments to their food intake, by trial and error, and through necessity or opportunity. There have emerged some major food systems which are known by their original location, the people that mainly consume them or the dominant food items or acquisition methods (Table 2). Their recognition has merit when considering the major risks and benefits of regional food cultures. However, these categorizations generally overlap or merge. They are also gross generalisations of what are often striking differences in the detail of food intake and habits, especially where there are ancient and long-separated micro-ecosystems where people have lived (much of Africa; Meso America and the Andes; the Indonesian archipelago, for example).

It is apparent that some of these food systems are highly dependent on their original locality (eg. Kalahari bushmen and Aboriginal Australians as hunter-gatherers) and other are very transportable (eg. Chinese restaurants as family businesses in almost every part of the world). This also points to the likely survival or otherwise of certain food cultures and the need for strenuous efforts to understand and document those in same localities before it is too late!

The *strengths and weaknesses* of various food systems relate to their prospects for survival in a changing world, their ecological sustainability, their amenability to commercialization and their health advantage.

Those that are *ecologically sustainable* will be characterized by biodiversity with a plant food orientation and where there are no threats to water (eg. dams upstream) and energy (eg. limited firewood) and loss of habitat (excessive human development).

Those food systems that are *amenable to commercialisation* will generally be best-served by local economies (subsistence agriculture; family and community gardens), circumscribed cash-cropping for trade and supported as necessary through the ability to buy and import foods from elsewhere (hopefully not at an environmental cost in another place).

Food systems that confer health advantage will themselves be characterized by adequacy (enough food and good management of what is produced) and variety to allow for the full range of essential nutrients to be obtained for an omnivorous human species. A staple is a way of providing enough energy (to balance expenditure), but not necessarily optimal health.

4. Regional food culture and health

It is extraordinary how disparate the locations are where people live and eat – hot equatorial and cold arctic, coastal and mountainous, wet forests and dry deserts and much in between. There is a vast array of human food stuffs and dietary patterns.

However, people may have comparable status in health (as judged by measures of disability) and life expectancies (using the combined health expression of DALE (Disability Adjusted Life Expectancy) [4] (if one examines say the top and bottom 10 on the international league) despite vastly different regionality and food culture.

What then is it that people must have in common about the way they eat for favourable health outcomes, and in what respects can they differ? From cross-cultural studies like FHILL (Food Habits in Later Life) [5,6] and SENECA (Survey Europe on Nutrition in the Elderly: a

Table 1. Representation of origin of foods by Chinese vocabulary

English	Chinese	Meaning	Other example
Onion	/yang cong/	: foreign, especially Western	
Pepper	/hu jiao/	: introduced or imported into China proper in ancient times	(cucumber) (carrot)
Sweet potato	/fan shu/	: uncivilized; foreign	or (tomato) or (corn)
Water melon	/xi gua/	: west, Western	(tomato)

Concerted Action) [7,8], we can gain some idea of this (Table 3).

By generations of cultural sifting, reflection, connection, and innovation, in possibly advantageous localities, some communities have gained health advantage in relation to their food supply. An example of this is Okinawa in the Ryuku islands, where the inhabitants have traded and exchanged ideas widely and over centuries. The Okinawans have had one of the longest life expectancies with a rather distinctive diet for, *inter alia*, its culinary herbs and fungi. Against the conventional food-health wisdom, they have successfully incorporated fatty pork into their cuisine. Pigs arrived in Okinawa via China and initially their production and dietary success failed. But, after the sweet potato arrived in China, trans-migrated to Okinawa and was fed to the pigs, their culinary success grew. In a somewhat similar way, longevity amongst Greeks is not just "Mediterranean", although Crete in the 1950s has served as a valuable food system reference point, but, in Thessalonika, the pigs eaten are grass fed to apparent health advantage. It is worth noting that the fat composition of a monogastric animal, the pig, depends very much on the food eaten (and varies greatly from location to location). This exemplifies the potential value of *an integrated food system*, whether pre-agricultural, subsistence agricultural or modern technologically-supported agribusiness.

The value of *food systems as regionally relevant* is that the "feed-back loops" for sustainability, local economic development and health are more likely to be functional and amenable to good governance. Communities can increasingly take advantage of production, processing, transport and communication, information and health technologies to make these outcomes more likely.[11,12] *Explicit inter-community collaboration* in these regional food and health pursuits is likely to add further value, with the added potential advantage of *averting conflict* (a

Table 2. Food systems by original location, ethnicity or characterizing foods; some examples

Locality of origin	Ethnicity	Characterizing foods or food production
• China (eg. Cantonese, Yangtze delta, Hainan, Northern, Szechuan) • Japan • France (eg. Provincial, Parisian, Coastal) • Africa (eg. North-West, Nile Valley, Rift Valley, Kalahari desert) • India (eg. Chennai (Madras), Punjab, Bengal) • Indonesia • Andes • Scandinavian • Mediterranean	• Various indigenous people (eg. Australian, Pacific Islands, Native Americans, Andean, Okinawans) • Chinese (in various locations – SE Asia, North America, Australia) • European (eg. Italian, Greek, French, Swedish, German, Polish) • Russian • Minangkabau in West Sumatra; Batknese in North Sumatra [1,2]	• Hunter-gatherer 3 • Subsistence agriculture • Rice-based (eg. Asia) • Potato-based (eg. Andes, Meso-American, Europe) • Wheat-based (eg. Middle East, Europe, America) • Plentiful horticultural products (eg. Tropical, Mediterranean) • Pulses (eg. soy, beans) and leafy greens as a principal source of protein (South Asia, NE Asia, Meso and South America) • Fish (eg. Islands, Coastal) • Meat (eg. Pork in China, beef in Argentina, and USA, lamb in New Zealand, chicken in SE Asia)

Table 3. Food commonalities which allow for optimal health, based on longevity food cultural observations.

Commonalities between regions	Tolerable Differences
1. Secure maternal nutrition 2. An adequate food supply 3. Enough physical activity so that enough food to meet nutritional needs can be consumed without excessive body fat 4. Food diversity (probably more than 20 biologically distinct types/week) [9] 5. Patterns of eating which are plant-food in orientation, and where the food is relatively intact (not unduly refined), and including legumes [5] 6. Regular intake of fish, at least once or twice a week 7. Meat or poultry in small quantities which is preferably fresh or refrigerated rather than cured or salted 8. Celebratory occasions (2-3/year) 9. Alcohol not used excessively 10. A safe water supply	1. Kinds of seed-based foods (cereals, nuts, legumes) 2. Kinds of leafy (eg. Chinese greens or floral vegetables (eg. cauliflower, broccoli)) or vegetable stems 3. Kinds of fruits 4. Distribution of food across day 5. Seasonal variation 6. Less diversity required where some items highly nutritious (especially lean animal-derived foods; legumes, nuts and berries) 7. Celebratory occasions with food (several in a year as in Okinawa) [10]

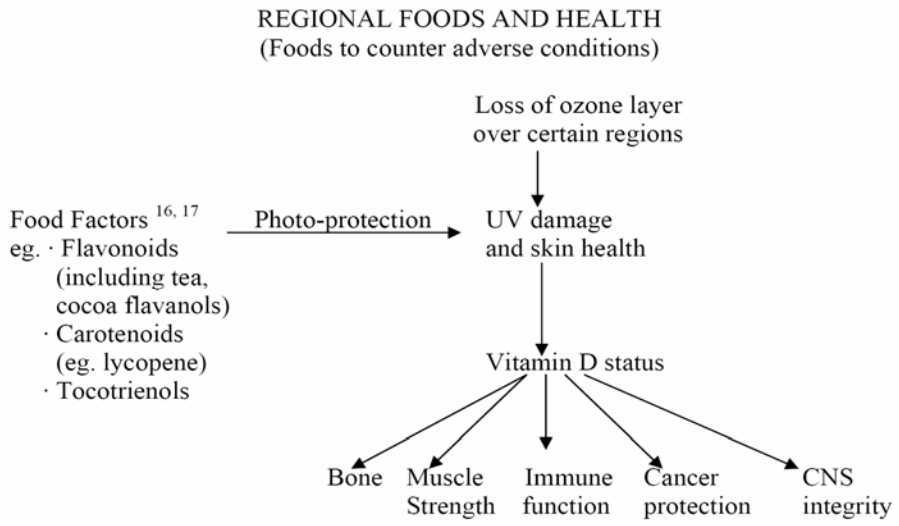

Figure 1. Counteraction of regional health adversity by local foods

major cause of impoverishment and famine as well as a whole spectrum of nutritional disorders).

One of the greatest threats to regional health comes from high *dependence on fuel* in *the food system*, including the purchase of food where consumers are automobile dependent (eg. at supermarkets).[13] Not only does this involve less personal energy expenditure, it is part of a culture which orientates food choice towards energy dense, nutrient-poor items, and the misuse of precious natural resources that are required for energy and packaging and waste management. Body compositional (along with mental health and social health) disorders develop. Sustainable food systems are threatened. At the community level, much can be done to avert these problems. [14]

Food and Nutrition Policy can support Regional Food Culture through the Food Based Dietary Guidelines (FBDG) approach developed by WHO & FAO, which encourage local food and food system approaches to health policy.[15]

FBDGs require an emphasis on sustainability for health-giving food system. An example of how important this is comes from loss of the ozone layer and its contribution to skin health (adverse) and vitamin D deficiency. Even here foods can help counter these new environmental conditions (Fig 1).

5. Indigenous and traditional food cultures

Indigenous and traditional food cultures inevitably have strong locality connections. They are of particular interest in regard to regional food culture and health because they represent the longest period of history of the 150000 years or so of our species. Homo Sapiens sapiens. They do represent many generations of observation and adjustment to eating patterns from foraging, to hunting and gathering (especially as technologies developed to assist), pastoralism, subsistence agriculture, and fishing.

The exposé of the Paleolithic diet by Eaton and Konner [18] has encouraged the view that animal foods (fish, meat from land animals, birds and eggs) could, at least episodically, provide for a substantial part of energy intake, but with the macronutrients protein and fat coming from diverse sources, but, with, of course, carbohydrate and dietary fibre being of plant, albeit diverse, origin. Although an important template for the human diet, it does not follow that it was necessarily optimal. What is optimal allows for survival to old age with disability, for successful reproduction and for security and happiness. Food culture plays a role in each of these optimal health goals.

With time, eco-systems developed around human settlements or camp-sites. For example, preferred fruit-seeds travelled with people and the trees from which they came grew in the new places. There were limits as to how many types of starchy (relatively energy-rich, although not as energy-dense as fatty non-aqueous foods) food species could be grown and translocated so that there are only about a dozen or so (rice, wheat, maize, potatoes, sweet potatoes, cassava, barley, rye, oats) that have formed the basis of energy intake with more settled populations. [19] However, some people, like the Incas in the Andes were remarkable for their plant-breeding facility and developed scores of cultivars of beans and of sweet potatoes, for example.

Thus, regional food diversity is a product of the natural environment and human settlement, with associated-changes in wild life, insects and micro-organisms too.

Indigenous and traditional foods and food systems are disappearing, however, and this may be a significant loss and threat to future personal health and security at the regional and international level. [20]

6. The future of regional food cultures

Although globalization is on the move, it is possible to envisage and identify “the internationalization of locality”. In any case this has happened with the great cuisines of the world – Chinese, Japanese, Thai, French, Italian, Scandinavian, Mexican and Andean, Middle Eastern, Moroccan and more, which have spread well-beyond their original locality. Others, possibly as important, interesting and healthful, have been neglected on the international food stage and are under threat even at home. Should we be concerned? Yes, because these is still a great deal of food-health knowledge embedded in regional food cultures which may be important for all of us. Yes, too, because of the local eco-systems which support these food cultures and whose intrinsic biodiversity is important for planetary health. Yes, again, because, with

a loss of food culture, goes a loss of a sense of identity and dignity. These are reasons why the IUNS (International Union of Nutritional Sciences) and other organisations (www.healthyeatingclub.org/Africa) have promoted regional approaches to their work in food and health.

A recent example of what can be done relates to Hangzhou, Zhejiang province, China. [21] Hangzhou was a major trading centre during the Southern Song dynasty, about a 1000 years ago (960 – 1279 AD), when the Grand Canal was built between Beijing and Hangzhou, the latter situated in the Yangtze river delta region. It developed a cuisine based on aquatic foods, plentiful fruits and vegetables, soy beans, fungi, culinary herbs and rice. It, arguably, had the world's first restaurant. [22] Food also developed into an art form, linked to music, poetry and interior decoration, with cooking skills regarded most highly. Perhaps Hangzhou even over-developed in culinary terms, although its peasant versions with freshness and taste were, of course, very current and contemporary. Food technology, notably in tea (camellia sinensis) production and processing, paralleled the exceptional development in textile technology (notably with the development of silk production and trade), and was accompanied by the flourishment of the arts (notably calligraphy). Economic development was integral to this development in regional food culture. Much later there was a major set-back with the Sino-Japanese wars, the rise of Communism, and especially the Great Cultural Revolution in the 20th century. But by the end of the 20th century it was recognized that Hangzhou's food habits were robust and persistent and that they may have been giving Hangzhou citizens relative longevity in China. People, especially from Shanghai, began travelling more and more to Hangzhou for its food.

In 2003, ZAST (the Zhejiang Academy of Science and Technology), with WHO (World Health Organization) and FAO (Food and Agriculture Organization) convened a working group on Regional Cuisine and Health [21] to document its history, characteristics, and health correlates. We can now see the re-emergence of a regional cuisine, evident in Hangzhou homes and in its many tea-houses, like those around the beautiful West Lake. It is a good example of how regional food, health and economic development can move together.

In Australia, Erlich, Riddell and Wahlqvist [23] have studied the extent to which indicative food regions do or do not have associated health and economic advantage. The short answer is, not necessarily, as the nature of rural food production varies widely both to enfranchise and disenfranchise families and communities of the food patterns which enhance health. Broad-acre farmers with one or two crops, or sheep or cattle farmers, may themselves grow or purchase few fruits or vegetables. Horticulturalists, too, may be compromised through water shortage, and economic and health adversity. Fishermen may be remote from health care. Wine growing and cheese producing regions tend to attract "food tourists" and thrive on this supplementary income; facilities improve as local government and business prospers.

So, whilst, as in Hangzhou, food, health and economic development may go together (although there are now concerns about sustainability and environmental degradation in that part of China), in Australia and elsewhere they may not. Yet, regional food culture seems worthy of survival and support if we are not to be overwhelmed by a narrowing of the food supply and the associated ill-health and economic cost. It may, of course, be that well managed infrastructural development; town planning, communication technology and crop improvement (as with biofortification [24, 25] and food processing technology) may yet support regional food culture and counter the difficulties it faces. [26]

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Original Article

Diet quality and nutritional status of rural adolescent girl beneficiaries of ICDS in north India

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This study assessed the diet quality and nutritional status of beneficiaries of Adolescent Girl scheme, a national programme targeted towards their nutrition/health needs. 209 girls (aged 11-21 years) from six rural blocks - Delhi (Alipur, Kanjhawala and Mehrauli), Haryana (Madhosinghana), Rajasthan (Deeg) and Uttar Pradesh (Fatehpur Sikri) comprised the sample. Weight and height were measured and dietary intake data were gathered by one day 24 Hour Recall coupled with Food Frequency approach. Incidence of thinness ('BMI for age' <5th percentile) and stunting ('height for age' <3rd percentile) was 30.6% and 29.7%. The subjects followed a two-meal pattern and their diets were monotonous and cereal-based. 49.3% of them were found to have energy intake less than 75% of RDA while a substantial proportion of them had inadequate nutrient intake (NAR <0.66) with respect to most of the micronutrients especially iron (84.7%), folic acid (79.4%) and vitamin A (73.2%). The mean daily intake of milk and milk products, pulses, green leafy vegetables, other vegetables and fruits was grossly inadequate meeting only 47%, 36%, 26%, 34% and 3% of the suggested allowances; that of fats/oils and roots/tubers was somewhat adequate meeting 65% and 72% of the allowances while the intake of cereals and sugar was almost adequate revealing a deficit of only 7% and 3%. The study reveals not only a high incidence of under-nutrition but also an inadequate energy/micronutrient intake among the beneficiaries of Adolescent Girl scheme. Therefore, sustained efforts are needed to strengthen the scheme for improving its field-level implementation.

Key Words: dietary intake, diet quality, nutritional status, adolescent girl, rural communities, India

Introduction

World Health Organization (WHO) has defined 'adolescence' as the period between 10 and 19 years.[1] Adolescent girls, constituting nearly one tenth of Indian population, form a crucial segment of the society.[2] Their current nutritional status will decide the well being of the present as well as the future generations. Under-nutrition among these girls is associated with reduced lean body mass, lack of muscular strength and decreased work capacity.[3] Moreover, under-fed girls are at risk of being stunted mothers who are likely to suffer obstetric complications and to deliver low birth weight babies.[4] In the absence of effective nutritional interventions, the low birth weight girls become the next generation of stunted mothers, thus, perpetuating the vicious cycle of malnutrition. Nevertheless, second decade of life is the only time following infancy when the growth rate is very rapid and an individual acquires 35% of adult weight and 11-18% of adult height.[5] In other words, adolescence provides a second opportunity for girls to attain 'catch up growth' and break the intergenerational cycle of malnutrition provided there is a significant increase in their nutrient intake.[6]

However, the state of rural adolescent girls in India is quite dismal. Despite the increased nutritional requirements during adolescence,[7, 8] their average nutrient intake is much below the recommended allowances.[9, 10] It has been estimated that 35% of rural girls, at 17 years of age, are underweight (<38 kg) and 23% are under height (<145 cm) which is recognized as obstetric risk factor.[11]

Till late, the nutritional needs of these girls had been sadly ignored in our developmental programmes; the focus had rather been only on the preschool children and the mothers.[12] It was in the year 1991 that the Government of India took the initiative of including adolescent girls as the beneficiaries of Adolescent Girl (AG) scheme under the Integrated Child Development Services (ICDS) programme. One of the largest in the world in terms of its reach, ICDS scheme is a comprehensive programme for delivery of an integrated package of services to achieve the overall development of children.[13] In spite of its shortcomings; it has been quite successful in achieving its objectives.[14]

The AG scheme, on the other hand, focuses on out-of-school adolescent girls (ICDS defines 11 to 18 years olds as adolescents) and aims to improve their nutritional status. Under the AG scheme, there are two sub schemes- AG I for 11 to 15 years old girls and AG II for all girls aged 11 to 18 years.[15]

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This scheme has now been revised as *'Kishori Shakti Yojna'* and expanded to two thousand blocks covering 1.3 million girls. The revised scheme provides the states, union territories and districts an option to either continue with the earlier AG scheme or develop their own plan of action to meet their area-specific needs.[16] The present study was undertaken in blocks where AG scheme was in implementation.

While ICDS scheme and its impact on child beneficiaries have been studied extensively, [17-19] the studies on AG scheme [20-21] are limited and there is paucity of data on the nutritional status of its beneficiaries. Therefore, this investigation was undertaken to assess the diet quality and nutritional status of adolescent girl beneficiaries of AG scheme.

Materials and methods

This cross-sectional study was carried out in the capital of India (Delhi) and its neighbouring states (Rajasthan, Uttar Pradesh and Haryana) where the scheme had been in operation before 1995-96. From Delhi, all the three blocks namely, *Alipur*, *Kanjhawala* and *Mehrauli* where the scheme had been in implementation were included in the study. In case of other states, one block per state i.e. *Deeg* (Rajasthan); *Fatehpur Sikri* (Uttar Pradesh) and *Madhosinghana* (Haryana) were selected. The study area, thus, covered six blocks in four states.

Sampling

Purposive sampling was used to identify the blocks; the criteria of selection being the existence of AG scheme for at least five years at the time of data collection and the convenience of visiting the area. On the other hand, random sampling techniques were employed to select the beneficiaries from the identified blocks. Using random sampling, two circle areas per block were selected from which nine *Anganwadi Centre*s (the focal point for delivery of ICDS services) were identified. From each of the identified *Anganwadi Centre*s, 2 or 3 beneficiaries of AG I were selected and in case of AG II, 16 to 20 girls per block were included in the study giving preference to the target beneficiaries (out-of-school adolescent girls belonging to low socio-economic group). The sample comprised of 209 adolescent girl beneficiaries of whom 147 were from AG I and 62 from AG II (while AG I was operational all the six blocks under study, AG II was operating only in *Alipur, Kanjhawala, Fatehpur Sikri* and *Madhosinghana*.

Prior to data collection, necessary permission was sought from the Department of Social Welfare in the respective states and the informed oral consent of adolescent girl respondents as well as that of their parents was obtained and their anonymity has been preserved.

Assessment of dietary intake and diet quality

The data on dietary intake of the subjects were gathered by one day 24 Hour Recall; Food Frequency Questionnaire was employed for validating the dietary data. Mean daily intake of the subjects was computed and compared with the suggested amounts of various food groups in a balanced diet for Indian girls aged 13 to 15 years.[22] The nutrient intake was calculated using the computerized programme based on food composition tables. Thereafter, mean nutrient intake was assessed and compared with the recommended dietary allowances (RDA) for the respective age groups (10-12 years, 13-15 years, 16-18 years and above 18 years).[23]

In order to assess the diet quality, the adequacy of nutrient intake by each subject was computed in terms of Nutrient Adequacy Ratio (NAR) using

$$\text{NAR} = \frac{\text{Subject's nutrient intake of a day}}{\text{RDA of the respective nutrient}}$$

Thereafter, the subjects were categorized as those having an adequate (≥1.00), fairly adequate (0.66−<1.00) or inadequate (<0.66) NAR for various nutrients. Since NAR is not a good indicator for assessing the adequacy or inadequacy of energy intake therefore, energy intake data were expressed as percent of RDA for the particular age group. In the present study, 25% below the RDA has been employed as the cut-off for estimating energy inadequacy while 25% above the RDA has been used to identify subjects with excess energy intake.[24]

Weight/height measurement and BMI

Height (to the nearest 0.1 cm) and weight (to the nearest 0.5 kg) were measured using Libra scale and the anthropometric rod. Body Mass Index (BMI) was subsequently computed by dividing the weight in kilograms by the square of height in metres (kg/m^2). Mean weight, height and BMI were calculated for different age categories. The anthropometric nutritional status was assessed by 'BMI for age' and 'height for age' as per National Centre for Health Statistics (NCHS)/WHO standards. The subjects with 'BMI for age' less than 5^{th} percentile were categorized as thin and those with 'BMI for age' ≥ 85^{th} percentile were considered to be at risk of being overweight while subjects having 'BMI for age' between 5^{th} and 85^{th} percentile were categorized as normal. The subjects with 'height for age' less than 3^{rd} percentiles were considered to be stunted.[3]

Statistical analysis

The data were analysed using Statistical Package of Social Sciences (SPSS, version 9). Statistical measures such as frequency, percentage, mean, range, standard deviation and t test were employed to describe and analyse the data.

Results

Profile of the subjects

Mean age of the subjects was 13.6 years (ranging from 11 to 21 years); the proportion of adolescent beneficiaries (11-18 years) being 95.2%. Younger beneficiaries (11-15 years) constituted 78.5% while 16-18 year old formed 16.7 % of the sample; only 4.8% were aged above 18 years. Of them, 19% were illiterate and 29% school dropout; only four were married but none had attained motherhood. They were predominantly Hindu (97%) and nearly 60% of them belonged to the scheduled castes, scheduled tribes or other backward classes. 55% reportedly had their family income less than 2000 Rupees per month (45 Rupees = 1 US Dollar) and thus belonged to low socio-economic group as per income categorization.[25]

Table 1. Socio-economic and demographic profile of the subjects (N=209)

Characteristics	No.	%	Characteristics	No.	%
Age (in years)			Religion		
11-12	88	42.1	Hindu	203	97.1
13-15	76	36.4	Muslim	6	2.9
16-18	35	16.7	Caste		
>18	10	4.8	SC/ST	71	34.0
Schooling status			OBC	54	25.8
Never gone to school	39	18.7	Others	84	40.2
School drop-out	60	28.7	Family income (Rupees†)		
School going	110	52.6	≤1000	59	28.2
Last class passed			1001 - ≤ 2000	55	26.3
None	39	18.7	2001 - ≤ 4000	54	25.8
I – V	62	29.7	> 4000	41	19.7
VI – VIII	66	31.5	Family occupation		
X –XII	39	18.7	Agriculture	34	16.3
> XII	3	1.4	Labour	79	37.8
Marital status			Service	59	28.2
Unmarried	205	98.1	Business	17	8.1
Married	4	1.9	Others	20	9.6

† 45 Rupees = 1US Dollars

Nearly half (54%) of the subjects were from the families engaged in agriculture, agricultural labour or non-agricultural labour (Table 1).

Food intake

Data indicate that most of the subjects followed a two-meal pattern; their diets were vegetarian, cereal based and monotonous. The mean daily intake of cereals, pulses, milk and milk products, sugar and fats/oils was 250 g, 22 g, 234 g, 20 g and 16 g while that of roots/tubers, green leafy vegetables, other vegetables and fruits was 72g, 26g, 34g and 3g respectively (Fig 1). Data reveal that the mean daily intake of milk and milk products, pulses, green leafy vegetables, other vegetables and fruits was grossly inadequate meeting only 47%, 36%, 26%, 34% and 3% of the suggested amounts; that of fats/oils and roots/tubers was somewhat adequate meeting 65% and 72% of the allowances while the intake of cereals and sugar was almost adequate revealing a deficit of only 7% and 3%.

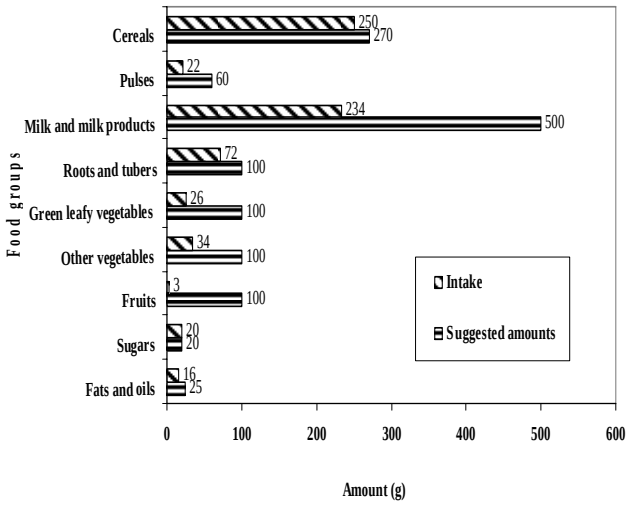

Figure 1. Mean daily intake versus suggested amounts of various food groups (N=209)

Energy/nutrient intake and diet quality

Table 2 shows the mean nutrient intake of the subjects by age. In case of 11-18 year old subjects, the mean daily intake of energy was 68.0% to 75.3% of the RDA and that of protein was between 68.3% and 79.8%. Mineral and vitamin intake data indicate that with the exception of calcium and thiamin, the intake of all other nutrients was below the recommended allowances especially, vitamin A, folic acid and iron where the intake was only half to two-third of the RDA. The energy and nutrient gap (particularly for protein, riboflavin and niacin) was found to be more pronounced in case of the younger subjects (10-12 and 13-15 years old) than those aged 16 years and above. However, in case of iron and folic acid, the diets of older subjects were rather deficient.

Energy intake data, expressed as percent of RDA for the particular age group, are presented in Table 3. Data indicate that nearly half of the subjects (52.2%) had inadequate energy intake (<75% of RDA) while only one subjsct (0.5%) had excessive energy intake (>125% of RDA). Block-wise data reveal that three-fourth of the subjects from *Deeg* (72.8%) and *Mehrauli* (73.4%); about half from Alipur (55.5%) and *Fatehpur Sikri* (52.8%) and less than two-fifth from *Kanjhawala* (42.2%) and *Madhosinghana* (30.6%) had inadequate energy intake

Table 4 reveals nutrient intake data expressed as nutrient adequacy ratio (NAR). Findings indicate that though a large majority of the subjects had adequate or fairly adequate NAR (≥ 0.66) with respect to protein (83.7%), calcium (94.7%), thiamin (98.1%), riboflavin (60.8%), niacin (87.1%) and vitamin C (56.9%); only a small number had adequate/fairly adequate intake with respect to vitamin A (26.8%), folic acid (15.8%) and iron (15.3%).

Nutritional status

The mean weight, height and BMI by age of the subjects are presented in Table 5. Data indicate that the mean weight in all the age groups was below the NCHS stan-

Table 2. Mean nutrient intake of the subjects by age (N=209)

Nutrient	10-12 years (n=88)			13-15 years (n=76)			16-18 years (n=35)			> 18 years (n=10)		
	RDA†	Mean ± SD‡	% adequacy	RDA	Mean ± SD	% adequacy	RDA	Mean ± SD	% adequacy	RDA	Mean ± SD	% adequacy
Energy (kcal)	1970	1340 ± 350 (587 – 3129)	68.0	2060	1417 ± 309 (525 – 2139)	68.8	2060	1552 ± 391 (543 – 2261)	75.3	2225	1603 ± 297 (1250 – 2149)	72.1
Protein (g)	57	41.3 ± 12.3 (10.1 – 104.0)	72.5	65	44.4 ± 11.0 (9.8 – 67.2)	68.3	63	50.3 ± 14.4 (15.2 – 72.3)	79.8	50	51.9 ± 12.0 (34.5 – 75.4)	103.8
Calcium (mg)	600	563 ± 278 (101 – 1656)	93.8	600	623 ± 282 (227 – 1426)	103.8	500	750 ± 358 (166 – 1343)	150.0	400	651 ± 301 (161 – 1205)	162.8
Iron (mg)	19	13.5 ± 5.4 (1.6 – 40.0)	71.0	28	15.2 ± 6.1 (1.6 – 34.4)	54.3	30	18.4 ± 9.3 (3.7 – 51.1)	61.3	30	17.9 ± 7.0 (13.0 – 36.5)	59.7
Vitamin A (µg RE)	600	399 ± 549 (32 – 2626)	66.5	600	423 ± 513 (59 – 2017)	70.5	600	413 ± 505 (57 – 2212)	68.8	600	299 ± 273 (96 – 845)	49.8
Thiamin (mg)	1.0	1.33 ± 0.39 (0.32 – 3.2)	133.0	1.0	1.39 ± 0.39 (0.18 – 2.28)	139.0	1.0	1.59 ± 0.44 (0.42 – 2.18)	159.0	1.1	1.72 ± 0.30 (1.34 – 2.14)	156.4
Riboflavin (mg)	1.2	0.74 ± 0.25 (0.20 – 1.7)	61.7	1.2	0.78 ± 0.20 (0.29 – 1.29)	65.0	1.2	0.87 ± 0.30 (0.31 – 1.57)	72.5	1.3	0.87 ± 0.30 (0.31 – 1.57)	66.9
Niacin (mg)	13	10.7 ± 3.3 (1.2 – 26.0)	82.3	14	11.2 ± 3.5 (1.3 – 20.2)	80.0	14	12.9 ± 3.7 (3.4 – 18.1)	92.1	14	13.8 ± 2.5 (11.1 – 17.2)	98.6
Folic acid (µg)	70	49.5 ± 23.0 (18.0 – 140.4)	70.7	100	49.4 ± 20.9 (6.5 – 115.2)	49.4	100	52.6 ± 19.6 (16.2 – 125.3)	52.6	100	52.8 ± 9.4 (36.3 – 65.3)	52.8
Vitamin C (mg)	40	37.0 ± 26.5 (1.5 – 133.3)	92.5	40	39.9 ± 56.3 (1.5 – 460.3)	99.8	40	39.4 ± 30.8 (3.4 – 108.4)	98.5	40	31.7 ±10.2 (19.7 – 51.1)	79.3

† RDA – Recommended Dietary Allowances; ‡ SD – Standard Deviation. Figures in parenthesis indicate range

Table 3. Block-wise data on the adequacy of energy intake (N=209)

Block	N	Distribution of the subjects by energy intake (% RDA†)						
		<50	50-<60	60-<75	75-<90	90-<110	110-<125	125-<140
Alipur	40 (100)	5 (12.5)	3 (7.5)	14 (35.0)	14 (35.0)	3 (7.5)	0 (0.0)	1 (2.5)
Kanjhawala	45 (100)	3 (6.7)	2 (4.4)	14 (31.1)	11 (24.5)	14 (31.1)	1 (2.2)	0 (0.0)
Mehrauli	30 (100)	2 (6.7)	4 (13.3)	16 (53.4)	7 (23.3)	1 (3.3)	0 (0.0)	0 (0.0)
Deeg	22 (100)	4 (18.3)	5 (22.7)	7 (31.8)	6 (27.2)	0 (0.0)	0 (0.0)	0 (0.0)
Madhosinghana	36 (100)	0 (0.0)	0 (0.0)	11 (30.6)	11 (30.6)	12 (33.2)	2 (5.6)	0 (0.0)
Fatehpur Sikri	36 (100)	3 (8.3)	5 (13.9)	11 (30.6)	8 (22.2)	7 (19.4)	2 (5.6)	0 (0.0)
Grand total	209 (100)	17 (8.1)	19 (9.1)	73 (35.0)	57 (27.3)	37 (17.7)	5 (2.4)	1 (0.5)

† RDA – Recommended Dietary Allowances. Figures in parenthesis indicate percentages

Table 4. Subjects by adequacy of protein, mineral and vitamin intake (N=209)

Nutrient	Nutrient Adequacy Ratio (NAR†)		
	Inadequate (<0.66)	Fairly adequate (0.66 − <1.00)	Adequate (≥1.00)
Protein	34 (16.3)	119 (56.9)	56 (26.8)
Calcium	11 (5.3)	48 (23.0)	150 (71.7)
Iron	177 (84.7)	21 (10.0)	11 (5.3)
Vitamin A	153 (73.2)	16 (7.7)	40 (19.1)
Thiamin	4 (1.9)	14 (6.7)	191 (91.4)
Riboflavin	82 (39.2)	109 (52.2)	18 (8.6)
Niacin	27 (12.9)	102 (48.8)	80 (38.3)
Folic acid	176 (84.2)	24 (11.5)	9 (4.3)
Vitamin C	90 (43.1)	50 (23.9)	69 (33.0)

†NAR- Nutrient Adequacy Ratio. Figures in parenthesis indicate percentages

dard but the subjects aged 13-14 years were significantly (p<0.01) heavier than the preceding age group. The deficit at eleven years of age was 1.8 kilogram which widened to 3.3 kilogram after eighteen years of age. In all, 67.5% of the subjects were found to have 'weight for age' less than the 5th percentile. The mean height in the age groups of 11-14 years was below the NCHS standard but the subjects aged 13-14 years as well as 14-15 years were significantly (p<0.01) taller than the preceding age groups. Overall, 29.7% of the subjects were found to be stunted ('height for age' < 3rd percentile). Though the mean BMI of the subjects in the all the age groups was higher than the 5th percentile of NCHS standard, 44 % of 13-14 year olds and 53% of 14-15 year olds were found to be thin. On the whole, 30.6% of subjects were thin ('BMI for age' < 5th percentile), 0.5% were overweight ('BMI for age' ≥ 85th percentile) and 68.9% had normal weight (BMI for age' 5th– < 85th percentile).

Table 6 presents block-wise data on prevalence of stunting and thinness and it reveals substantial differences in the nutritional status of the subjects from various blocks under study. In contrast to *Deeg, Fatehpur Sikri* and *Mehrauli* where the incidence of thinness (63.6%, 38.9% and 33.3%) as well as stunting (40.9%, 55.6% and 30.0%) was quite high, a lower proportion of subjects from *Alipur, Kanjhawala* and *Madhosinghana* were found to be thin (27.5%, 15.6% and 22.2%) and stunted (20.0%, 28.9% and 13.9%).

Nearly half (42.6%) of the subjects had attained puberty; the reported mean age at menarche was 13.8 years; though block-wise differences existed. The beneficiaries from Delhi blocks were found have a lower mean age at menarche (13.3 to 13.9 years) as compared to those from the rural blocks of *Madhosinghana,* or *Fatehpur Sikri* (14.0 to 14.6 years). Among the subjects from *Deeg*, only one had entered puberty. Data further reveal that of the post-menarche girls only 21% had prior knowledge regarding menarche and majority felt scared at its onset (Table 7).

Discussion

The aim of this study was to assess the diet quality and nutritional status of the beneficiaries of Adolescent Girl scheme. The findings indicate that dietary intake met only two-third to three-fourth of the energy and protein requirements. These findings are consistent with the results of a study conducted among poor adolescent girls in rural Rajasthan [26] where the energy and protein intake was 64-74% and 65-77% of the recommended allowances respectively. However, a lower caloric intake (55-64% of the RDA) has been reported by another study carried out on young girls belonging to a low socio-economic group in Delhi.[27]

The food intake, in the present study, was low particularly with respect to pulses, milk and milk products. This could be the possible reason for the energy and protein deficit in the diets. Moreover, the diets were cereal based and vegetarian so, the quality of protein can be expected to be rather low. The intake of fruits and vegetables particularly, that of green leafy vegetables was also found to be grossly inadequate which could possibly have led to the deficient micronutrient intake. Overall, the diets were lacking in most of the micronutrients - iron, vitamin A and folic acid in particular. These findings are comparable to other micro and macro studies indicating a substantial nutrient gap in the daily diets of Indian adolescent girls. [4, 5, 28]

The energy and nutrient gap, in our study, was found to be somewhat wider in case of younger subjects (10-15 years old) than those aged above 16 years; these findings are consistent with those of a national study.[10] However, in case of iron and folic acid, the intake had either decreased or registered only a minor increment with age. To make the situation worse, the diets were cereal based as well as vegetarian and lacked in promoters of iron; thus, the bio-availability of iron was probably quite low. It is a well known fact that during adolescence, the iron requirements increase due to the changes in body mass,

Table 5. Age-wise data on mean weight, height, BMI along with prevalence of stunting and thinness (N=209)

Age(yrs)	N	Weight for age (kg)		'Weight for age' < 5th percentile n (%) ¶	Height for age (cm)		Stunted ('height for age' < 3rd percentile) n (%) ¶	BMI † for age (kg/m^2)		Thin ('BMI† for age' < 5th percentile) n (%)¶
		NCHS‡ standard (5th percentile)	Present study Mean ± SD (Range)§		NCHS‡ standard (3rd percentile)	Present study Mean ± SD (Range) §		NCHS‡ standard (5th percentile)	Present study Mean ± SD (Range) §	
11-<12	34	30.5	28.7 ± 5.2 (19.0 – 42.5)	20 (58.8)	138.1	136.9 ± 7.6 (113.5 – 147.5)	10 (29.4)	14.60	15.19 ± 1.58 (11.99 – 19.53)	7 (20.6)
12-<13	54	34.1	30.2 ± 6.6 (21.0 – 45.0)	33 (61.1)	144.2	139.8 ± 9.5 (123.0 – 161.0)	14 (30.0)	14.98	15.28 ± 1.98 (12.07 – 21.28)	12 (22.2)
13-<14	34	37.8	34.8** ± 6.3 (24.5 – 49.5)	25 (73.5)	147.6	146.0** ± 7.1 (131.2 –159.3)	12 (35.3)	15.36	16.19* ± 1.81 (13.48 – 21.21)	15 (44.1)
14-<15	17	41.0	37.0 ± 5.4 (25.5 – 47.0)	12 (70.6)	149.0	151.8** ± 5.5 (140.9 – 158.9)	11 (64..7)	15.67	15.98 ± 1.70 (12.84 – 18.65)	9 (53.0)
15-<16	25	43.4	42.4* ± 6.7 (34.0 – 63.0)	17 (68.0)	149.8	154.2 ± 4.7 (144.2 – 161.2)	9 (36.0)	16.01	17.82* ± 2.63 (13.92 – 21.39)	9 (36.0)
16-<17	19	44.7	42.5 ± 4.0 (37.0 – 55.0)	14 (73.7)	151.0	153.2 ± 6.1 (140.2 –164.0)	3 (15.8)	16.37	18.16 ± 1.76 (15.24 – 23.34)	7 (38.8)
17-<18	16	45.3	43.1 ± 5.2 (36.5 – 54.0)	11 (68.8)	152.4	152.6 ± 4.6 (144.2 – 164.3)	2 (12.5)	16.59	18.51 ± 2.04 (15.25 – 21.71)	2 (12.5)
≥ 18	10	45.3	42.0 ± 5.7 (32.0 – 55.0)	9 (90.0)	152.5	152.0 ± 4.4 (143.5 – 160.5)	1 (10.0)	16.71	18.11 ± 2.15 (15.23 – 22.46)	3 (30.0)
Total	209	–	35.7 ± 8.3 (19.0 – 63.0)	141 (67.5)	–	146.2 ± 9.79 (113.5 – 164.3)	62 (29.7)	–	16.50 ± 2.34 (11.99 – 26.39)	64 (30.6)

† BMI – Body Mass Index; ‡ NCHS – National Center for Health Statistics; § figures in parenthesis indicate range; ¶ figures in parenthesis indicate percentages. * p<0.05; ** p<0.01 (comparison with the preceding age group)

Table 6. Block-wise data on the incidence of thinness and stunting (N=209)

Blocks	N	Thin ('BMI† for age' < 5th percentile)	Stunted ('height for age' < 3rd percentile)
Alipur	40	11 (27.5)	8 (20.0)
Kanjhawala	45	7 (15.6)	13 (28.9)
Mehrauli	30	10 (33.3)	9 (30.0)
Deeg	22	14 (63.6)	9 (40.9)
Madhosinghana	36	8 (22.2)	3 (13.9)
Fatehpur Sikri	36	14 (38.9)	20 (55.6)
Total	209	64 (30.6)	62 (29.7)

† BMI – Body Mass Index. Figures in parenthesis indicate percentages

Table 7. Mean age at menarche and related information (N=209)

Blocks	N	Pre-pubertal	Post-pubertal	Among the post-pubertal				
				Mean age at menarche (yrs)	Prior knowledge of menarche		Scared at menarche	
					Yes no. (%)	No no. (%)	Yes no. (%)	No no. (%)
Alipur	40	25 (62.5)	15 (37.5)	13.27	0 (0)	15 (100)	9 (60.0)	6 (40.0)
Kanjhawala	45	21 (46.7)	24 (53.3)	13.54	5 (20.8)	19 (79.2)	18 (75.0)	6 (25.0)
Mehrauli	30	19 (63.3)	11 (36.7)	13.91	4 (36.4)	7 (63.6)	5 (45.5)	6 (54.5)
Deeg	22	21 (95.5)	1[#] (4.5)	14.00	1 (100)	0 (0)	1 (100)	0 (0)
Madhosinghana	36	9 (25.0)	27 (75.0)	14.00	5 (18.5)	22 (81.5)	13 (48.2)	14 (51.8)
Fatehpur Sikri	36	25 (69.4)	11 (30.6)	14.61	4 (36.4)	7 (63.6)	6 (54.5)	5 (45.5)
Total	209	120 (57.4)	89 (42.6)	13.82	19 (21.3)	70 (78.7)	52 (58.4)	37 (41.6)

Figures in parenthesis indicate the percentages. [#] Only one subject from Deeg had entered puberty

expanded blood volume and increased respiratory enzymes; the onset of menstruation one year after the peak growth further increases these requirements. [29] But in the absence of adequate dietary intake of iron, the girls become highly prone to anaemia. In India, the prevalence of anaemia among adolescent girls has been reported to be 75-90 %.[30, 31]

To combat this public health problem of iron deficiency anaemia, Govenrnment of India has launched National Nutritional Anaemia Control Programme which provides iron and folic acid tablets to girls and women only after they conceive and very often when they reach the third trimester of pregnancy. This strategy has been found ineffective in a micro-level study [32] and a possible reason for this inefficacy could be the prior prevalence of anaemia in women at the time of conception. In the light of these findings, it has been proposed to start iron supplementation for the girls from the adolescent period itself to build their stores for present as well as the future demands.[33-35] There is also evidence to show that iron and folic acid supplementation enhances growth of 10-14 year old girls in India.[36]

Nearly 31% of the subjects, in the present study, were found to be thin and an almost similar proportion stunted. These findings are comparable to other micro-level studies carried on adolescent girls in different parts of India.[37,38] Stunting has important implications for adolescent reproductive health of girls as it can lead to obstructed labour during child birth due to a small birth canal. [39] On the other hand, thinness can result in poor pregnancy outcome especially in terms of low birth weight and increased risk of infant mortality.[40] The poor nutritional status, in the present study, could be attributed to the inadequate food intake as majority of the subjects belonged to poor families. Lack of access to sufficient food and inequities in food allocation have been reported as the key causes of malnutrition in poor households of India.[41] Moreover, there is evidence to prove that subjects living in poorer households are more likely to be underweight than those living in households with higher socioeconomic status.[42]

Though the study presents a grim picture of the nutritional status of rural poor adolescent girls yet, adolescence provides a unique opportunity to help these girls to attain their full growth potential. National Nutrition Monitoring Bureau (NNMB) surveys have indicated that girls from poor communities gain over 5 centimetre in height and 6.8 kilogram in weight between the ages of 14 and 18 years.[43] Further, a follow up study of rural girls in Andhra Pradesh aged, 5 to 18 years, has shown that despite continuing poverty, girls who arrive their fifth year with considerable height deficit register impressive increments in height by the time they are 18 year old.[44] This higher rate alone may not be enough to complete the 'catch-up growth'; nevertheless, additional growth may be achieved by nutritional interventions during this period. Therefore, nutritional supplements must be provided to undernourished girls prior to the onset of menarche so that they are able to achieve their full growth potential. In view of the dual burden of malnutrition facing the country Government of India, in its Tenth Plan, has emphasized on screening the adolescent girls for malnutrition (under nutrition or over nutrition) and tackling their nutritional problems through targeted interventions. [45]

Age at menarche is also an indicator of nutrition and health status of the girls as poor nutritional status delays menarche.[46] In the present study, the significantly higher mean weight and height of the subjects aged 13-14 years (as compared to those aged 12-13 years) may be indicating a delayed menarche. It is a known fact that menarche follows nearly 1.3 years after an increase in height and weight velocity.[47] However, as compared to other blocks the lower age at menarche, reported by the subjects from Delhi blocks in our study, may be attributed to socioeconomic factors, dietary intake as well as the exposure to urban life and television. Similar findings have been

reported by other studies where the mean age at menarche was 14 years for rural and 13 years for urban girls/women.[48, 49] In the present study, the awareness regarding menstruation was reported to be poor; these findings are consistent with those of a study covering 400 rural girls (aged 10-16 years) in north India.[50]

In conclusion, the present study reveals not only a high incidence of under nutrition but also the dietary inadequacy of the subjects particularly in respect of energy, protein and micronutrient intake. If this is the scenario among the ICDS adolescent girl beneficiaries who had been receiving nutritional supplement for almost a period of six months, the status of non-beneficiaries can be expected to be worse. During the course of study, a process evaluation of the scheme was also carried out which revealed that its implementation was rather weak. The functionaries had neither received proper training and nor were they fully aware of the services to be provided. The delivery of services was partial and through inadequate activities.

Therefore, need of the hour is to plan and implement innovative developmental programmes to address the nutrition and health needs of rural adolescent girls in a comprehensive manner. These programmes should include provision of food supplements (particularly for 11 to 14 year olds for 'catch up growth'), iron-folate as well as nutrition and health education. Some of these interventions, though proposed in the existing Adolescent Girl scheme (now revised as '*Kishori Shakti Yojna'*) are not being implemented adequately. Hence, continuous efforts are needed at the national level to strengthen the scheme by greater involvement of the beneficiaries; capacity building of its functionaries and flexibility in the services, activities and utilization of funds so as to improve its field level implementation. Active participation of the adolescent girl beneficiaries must be sought by engaging them in food production through the establishment of nutrition gardens which may help in increasing the availability of food, green leafy vegetables in particular. They should also be involved in the preparation of low-cost nutritious food using the locally available ingredients and also be encouraged to respect and retain the traditional food knowledge and sustainable food systems. Such a holistic approach shall not only address the nutritional needs of these girls (the would-be-mothers) but shall go a long way in breaking the intergenerational cycle of malnutrition.

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Original Article

Investigation of health and nutrition status of middle-aged and old residents in the urban district of Chongqing

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Objective To investigate the health and nutrition status in middle-aged and old people in the urban district of Chongqing City, China in order to provide a rational diet construction for the population.
Method: This investigation was performed in 2004 and 1801 public officials both at post and retired in the urban district of Chongqinging City were enrolled in this investigation. Among them 96.7% were at age of over 40. The investigation was based on questionnaire, physical examination, laboratory biochemical test and bone density measurement.
Result: In the incidences of nutrition-related non-communicable diseases, overweight/obesity accounted for 50.5 , hyperlipidemia 36.1 , hypertension 30.3 , fatty liver 22.3 , osteoporosis 16.1 , hyperuricemia 12.2 , and diabetes 11.2 , while the incidence of dystrophy is low. Correlation analysis of these diseases demonstrated that the rates of hypertension, hyperlipidemia, fatty liver, diabetes, coronary heart disease and gallstone were significantly higher in overweight or obesity than in normal-weight people. The rates of hypertriglyceride, hypercholesteremia, diabetes, hyperuricemia, coronary heart disease, and fatty liver were higher in people with hypertension than in people with normal blood pressure. The rates of hypertension, hypertriglyceride and hypercholesteremia, coronary heart disease and fatty liver were higher in diabetes than in non-diabetes people.
Conclusion: Our study shows that health and nutrition status of the public officials of Chongqing city is not favourable Overnutrition is the main problem.

Key Words: middle-aged and old people, health and nutrition status, investigation, urban district, Chongqing.

Introduction

With the development of economy and continuous improvement of citizens' life, the types of diseases have been varying. Though Department of Health carried out the fourth investigation of public nutrition and health status in 2002, there was no report about it in middle-aged and old people in cities. The incidence of non-communicable diseases, such as coronary heart disease, hypertension, stroke, diabetes, tumor, etc, which closely associate with nutrition in food and diet, has increased obviously in middle-aged and old people. Therefore, the prevention of nutrition-related diseases for the middle-aged and old people has become the highlight in the whole society. This text shows our investigation of nutrition status and nutrition-related diseases in the middle-aged and old people living in the urban area of Chongqing City of China in order to provide a rational diet construction for this population.

Materials and Method

This investigation was performed in 2004 and the subjects were from a survey of measurement of health status in 1801 public officials both at post and retired in the urban area of ChongQing city, China in 2004. After ethics committee approval and informed consent, we randomly choosed the samples. All the 1801 public officials were enrolled in our investigation. Among the 1801 people, 62 were under 40 years, 942 were at the ages of 40 - 60, and 797 were over 60. This investigation items included questionnaire, food intake, nutritional status, physical measurement, clinical/physical examination, laboratory biochemistry test, bone density measurement and other related examinations. SPSS statistical software was used for statistical analysis of the results.

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Results

1. Testing results of body mass index (BMI) is shown in Table 1.

Table 1. The result of BMI measurement

	BMI*	Male (%	Female (%	Total number (%)
Underweight	<18.5	48 (4.1)	19 (6.6)	67 (3.9)
Nor-mal-weight	18.5~23.9	489 (41.5)	286 (54.8%)	775 (45.6)
Overweigh	24~27.9	506 (43.0)	172 (33.0%)	678 (39.9)
Obesity	≥28	135 (11.5)	45 (8.6)	180 (10.6)
Total		1178 (100)	522 (100)	1700 (100)

According to the standard proposed in the article written by Chinese Working Group for Obesity Problems published in Nutritional Journal, 2004, 26 (1):1-4.

2. Table 2 shows nutrition dependent diseases in people of different ages.
3. The relationship between weight and nutrition dependent diseases is shown in Table 3.
4. The relationship between diabetes and nutrition dependent diseases is seen in Table 4.
5. The relationship between hypertension and nutrition dependent diseases is shown in Table 5.
6. The result of bone density measured is shown in Table 6.

Discussion

1. The incidence of nutrition dependent diseases

Tables 1 and 2 reveal that among the non-communicable nutrition-related diseases mentioned above, overweight (39.9%) and obesity (10.6%) account for 50.5%, occupying 1/2 of the population, being the highest rate, followed by hyperlipemia(36.1%), hypertension (30.3%), fatty liver (22.3%), osteoporosis, (16.1%), hyperuricemia (12.2%), and diabetesmellitus (11.2%). Our investigation has found that the incidences of overweight/obesity, diabetes, hypertension, fatty liver, hyperuricemia are obviously higher in males than in females, but there is no significant difference in the incidence of hyperlipemia between men and women. Fatty liver is not an independent disease, its pathological phenomenon is caused by multiple factors, such as alcohol, obesity, diabetes, and hyperlipoidemia, ect, all of them are risk factors for fatty liver. [1] Our investigation indicates that the total incidence of fatty liver is 22.3%, with a high rate in men in all different age groups; but the incidence is high in women aged over 50 years; this significant difference may be the cause that men drink more alcohol.

"The study on nutrition and health status of Chinese citizens" by Information Office of the State Council on Oct 12, 2004 [2] announces that in citizens aged over 18 years the incidence of hypertension is 18.8%, the rate of diabetes is 2.6%; for people living in large cities, 30.0% adults suffer overweight, 12.3% have obesity, and 18.6% have hyperlipidaemia. Li Rong's study on the health of people aged over 60 in Chongqing shows that the rates of overweight / obesity, hyperlipidemia, hypertension, diabetes are 36.55%, 52.42%, 50.92% and 15.86%, respectively. Our investigation demonstrates that the rates of overweight/obesity, diabetes, hypertension, and hyperlipidemia are higher than the results reported by the Information Office of the State Council; and the incidence of hyperlipidemia is lower than that reported by Li Rong, while the rate of diabetes is similar to that by reported Li Rong. The difference may contribute to the different ages investigated. As the sources of food are various and abundant now, the rate of dystrophy is very low, for instance, underweight occupies only 3.9% in our series. This suggests that with the development of economy and improvement of life quality, dystrophy rarely occurs, on the contrary, overnutrition has become the main nutrition problem among the middle-aged and old people in cities.

Currently, osteoporosis is the most important public health issue in developed countries, and it has become a predominant issue in China. It is reported that in Europe and America, 30% of women and 12% of men have experienced osteoporotic fracture during their lifetime. In America, an investigation shows that in 1995 the annual incidence of osteoporotic fracture was far higher than that of heart attack, stroke, and breast cancer. In 2000, Hanmin Zhu reported that for people at the age of over 60, the incidence of osteoporotic fracture was 14.6% in males and 61.8% in females. [4] Bingyan Chang reported that the incidence rate of osteoporosis after 40 years old was 28.3% (male) and 45.2% (female) in urumqi in 2005. [5] Our investigation shows that the total rate of osteoporotic fracture is 14%, with 10.6% in males and 21.4% in fe

Table 2. The incidence of nutrition-related diseases in people of different ages (%)

Sex	Age	Number of persons	Hypertension	Hyperlipide-mia	Diabetes	Fatty liver	Hyperurice-mia
Male	30~	45	8.9	26.7	2.3	31.1	17.8
	40~	306	13.6	39.2	8.6	27.5	15.4
	50~	315	24.1	38.4	11.1	31.1	12.4
	60~	581	47.7	32.4	15.8	17.0	15.7
	total	1265	31.7	35.9	12.3	23.7	14.1
Female	30~	17	5.9	5.9	0	5.9	0
	40~	146	6.8	22.6	3.4	4.8	2.0
	50~	157	15.9	41.4	4.4	25.4	6.4
	60~	216	50.5	48.1	15.7	25.0	13.9
	total	536	27.0	37.9	8.6	19.0	8.0
	sum	1801	30.3	36.1	11.2	22.3	12.2

how the diagnoses were made: Hypertension: the diagnostic standard by WHO in 1999; Hyperlipidemia: total cholesterol 572mmol/L triglyceride 1.70mmol/L; Diabetes: the diagnostic standard by WHO in 1999; Fatty liver: by the ultrasonic diagnosis; Hyperuricemia: blood uric acid 390umol/L

Table 3. The relationship between weight and nutrition dependent diseases (n=1176)

	Incidence in weight normal	Incidence in overweight	Incidence in obesity
Hypertension	22.9% (20.5%, 25.3%)	42.8%**(39.97%, 45.63%	55.3%**(52.46, 58.14)
Hyperlipidemia	35.2% (32.47%, 37.93%	49.2%**(46.34%, 52.06%)	47.4%**(44.55, 50.25
Coronary heart disease	2% (1.2%, 2.8%)	3.1%(2.11%, 4.09%	7.9%**(6.36, 9.44)
Diabetes	8.8% (7.18%, 10.42%)	12.5%* (10.61% 14.39%)	23.7%**(21.27, 26.13)
Fatty liver	11% (9.21% 12.79%	40.4%** (37.60%, 43.20%	63.2%**(60.44, 65.96
Gallstone	7.5% (5.99%, 9.01%)	10.4% (8.66%, 12.14%)	21.2%**(18.86, 23.54)

*compared with the normal weight group , $p<0.05$; ** compared with the normal weight group , $p<0.01$

Table 4. The relationship between diabetes and nutrition dependent diseases

	Hypertension	Hypercholesteremia	Hypertriglyceridema	Hypertriglyceridema hypercholesteremia	Hyperuricemia	Coronary heart disease	Fatty liver
202 Diabetes	105 (52%)** (45.11%, 58.89%)	12 (5.9%) (2.65%, 9.15%)	34 (16.8%) (11.64%, 21.96%)	15 (7.4%)** (3.79%, 11.01%)	18 (8.9%)** (4.97%, 12.83%)	11 (5.4) ** (2.28,8.52)	80 (39.6%)** (32.86%, 46.34%)
1601 nondiabetes	444 (27.6%) (25.41%, 29.79%)	105 6.5%) (5.29%, 7.71%)	252 (15.7%) (13.92%, 17.48%)	73 (4.5%) (3.48%, 5.52%)	204 (12.7%) (11.07%, 14.33%)	27 (1.7%) (1.07%, 2.33%)	324 (20.1%) (18.14%, 22.06%)

There is a significant difference compared with the non-diabetes group ($p<0.01$).

Table 5. The relationship between hypertension and nutrition dependent diseases

	Hypercholesteremia	Hypertriglyceridema	Hypertriglyceridema & hypercholesteremia	Diabetes	Hyperuricemia	Coronary heart disease	Fatty liver
549 persons with hypertension	37 (6.7%)	97 (17.7%)	40 (7.3%)**	105 (19.1%)**	93 (16.9%)**	29 (5.3%)**	167 (30.4%)**
1263 persons without hyperten-sion	80 (6.3%)	189 (15%)	48 (3.8%)	97 (7.7%)	129 (10.2%)	9 (0.7%)	237 (18.8%)

There is a significant difference compared with the no-hypertension group ($p<0.01$).

Table 6. The result of bone density measured

Age	Male			Female			Total		
	Normal (%)	Osteoporosis (%)	Reduced (%)	Normal (%)	Osteoporosis (%)	Reduced (%)	Normal (%)	Osteoporosis (%)	Reduce (%)
0 44	54	6 (6.7)	30 (33.3)	16	4 (9.3)	23 (53.5) **	70 (52.6)	10 (7.5)	53 (39.8)
45~59	378	49 (9.9)	70 (14.1)	149	33 (13.4) **	65 (26.3) **	527 (70.8)	82 (11.0)	135 (18.1)
60	435	65 (12)	43 (7.9)	94	72 (32.9) **	53 (24.2) **	529 (69.4)	137 (18)	96 (12.6)
total	867 (26.7)	120 (10.6)	143 (12.7)	259 (50.9)	109 (21.4) **	141 (27.7) **	1126 (68.7)	229 (14)	284 (17.3)

There is a significant difference compared the male group (p<0.01).

males, and it increases with age. As bone fracture happens easily in osteoporosis people, and the symptom of osteoporosis is latent, only when fracture happens, is the osteoporosis found and diagnosed in many middle-aged and old people. Therefore, much attention should be paid to osteoporosis for the middle-aged and the old, and prevention measures and treatment of osteoporosis should be carried out as early as possible.

2. Correlated analysis of nutrition dependent diseases

Overweight/obesity

Overweight/obesity is a chronic metabolic disease that is caused by multiple factors. [6] Table 3 displays that there are significant differences in the rates of hypertension , hyperlipidemia and fatty liver (p<0.01) and in the rate of diabetes (p <0.05) between the overweight and the normal weight groups; there are significant differences in the rates of hypertension , hyperlipidemia,, coronary heart disease, diabetes, fatty liver, and gallstone between the obesity and the normal weight groups (p<0.01), with the rate of fatty liver being the highest (63.2%) among all the diseases, followed by hypertension and hyperlipidemia. This result is coincident with that reported in resent years in China.

Hypertension

Hypertension, the most common cardiovascular disease, is a common issue all over the world, with a high incident. It causes high rates of disablement and death, also result in complications of heart, brain, kidney and is the main risk factor for coronary heart disease, stroke, and early death. The incidence of hypertension increases with age, generally after 35 years, and is higher in men than in women at the age of under 60 years, but higher in women than in men at the age of over 60. [7] It is shown in table 4 that the rate of hypertension increases with age and reaches the peak after 60 years in both sexes, but higher in females than in males aged over 60 years, and there is a significant difference in ages of 70 -80 between male and female (p<0.01), which is coincident with that reported in most literatures. Table 5 shows that have obviously higher the incidences of hypertriglyceridema, hypercholesteremia, diabetes, hyperuricemia, coronary heart disease, and fatty liver are higher in the people with hypertension than in the people without hypertension, while single hypertriglyceridema or hypercholesteremia has no significant difference between them. We consider that this difference may result from multiple factors that interact with each other.

Diabetes

Recently, more and more scholars notice that insulin resistance is the main factor to cause not only diabetes but also obesity, hypertension, coronary heart disease and hyperlipoidemia. Table 4 shows that the prevalence rates of hypertension, hypertriglyceridema, hypercholesteremia, coronary heart disease, and fatty liver are all higher in the people with diabetes than in the people without diabetes. Therefore, effective prevention and treatment of diabetes can decrease the incidences of the diseases mentioned above. A prospective study on diabetes from England reported in Britain, the rate of hypertension is 1.5~2.5 times higher in people with diabetes than in the patients without diabetes, and the disease occurs 10 years ahead in age and the death rate of the disease has obviously increased. It is considered that the high rate of hypertension in people with diabetes may be related with family heredity. In our investigation the results show that among all the diseases the rate of hypertension is highest in diabetes patients (52%), which is in accordance with the report mentioned above. So it is very important for diabetes patients to diagnose and treat hypertension as early as possible.

Conclusion

The results of our investigation indicate that the health and nutrition status of public officials of Chongqing City is not that optimistical. Overnutrition is the main problem. We consider that propaganda and public education on the knowledge of nutritional sciences should be launched to instruct citizens to have scientific and rational diet and healthy lifestyle in order to prevent and decrease nutrition dependent diseases. Our research only studied the the public nutrition and health status in middle-aged and old people in chongqing city. So if the results can be extrapolated to other populations still needs other studies.

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Original Article

Sucrose consumption in Thai undergraduate students

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Highly added sugar diets have been associated with various health problems such as dental caries, dyslipidemia, obesity and poor quality of life. Unfortunately, sugar consumption, especially sucrose, has increased continuously worldwide. The purpose of the study was to examine sources of sugar consumption and amount of added sucrose consumed in Thai undergraduate students. This study was carried out at Khon Kaen University, Thailand, between the years 2004-2005. A complete 3-day record of items and amounts of sweet consumption were obtained from 202 individuals - 38 male and 164 female students. Added sucrose content of each sweetened food and drinks referred to in the record was determined by an enzymatic method. Mean intakes of sucrose were calculated from the sucrose content. The average of sucrose consumption in all subjects was 69±38 g/day, ranged from 4 to 182 g/day or 17 teaspoons of added sucrose per day. This amount accounted for 13.8% of total daily energy intake. There was a record of 337 kinds of sweetened foods and drinks found. The major source of added sucrose consumption was sweetened beverage, which was consumed 118 g/day averagely, or 60% of daily sugar consumption. Intake of sucrose per day in both male and female was not statistically difference, neither among different BMI groups. Intake of added sugar in the students was higher than the recommendation of the World Health Organization. These data would be helpful in a health promotion campaign aimed at a reduction of sugar consumption in Thai undergraduate students.

Key Words: dietary sucrose, energy intake, undergraduate students

Introduction

Overweight and obesity are the major health problems.[1] An increasing magnitude of this problem has been documented worldwide. The prevalence of overweight among US adolescents was 15.5%, while 7.3% of Malaysian school children were overweight.[2-4] This problem has been reported not only in children and adolescent, but also in adults. Twenty percent of Japanese age 30 and over were classified as overweight.[5] Overweight or obesity has been associated with various health problems such as dental caries in pre-school children, dyslipidemia, bone loss and fracture, poor quality of life, and a risk factor of cardiovascular disease and degenerative arthritis.[6-8] Higher body weight is associated with an earlier onset of type 1 diabetes in children.[9] Obesity is known to be a principal accelerator of β-cell destruction leading to type 1 diabetes. It has been documented that consumption of sugar higher than 18% of total daily energy intake resulted in a lower mean intake of micro-nutrients, vitamin A, C, B-12, folate, calcium, phosphorus, magnesium and iron.[10] Furthermore, it has been suggested that diet high in added refined sugar might be associated with an increased risk of colorectal cancer, breast cancer, and pancreatic cancer.[11-13] The possible mechanism is that a diet high in added sugar could affect the level of insulin and insulin-like growth factor.[14]

An intake of diet high in added sugar inevitably causes weight gain due to various biochemical changes. Diet high in added sugar has been associated with an increase of obesity in children.[15] A high dietary content of carbohydrate , primarily made up of monosaccharide, is more problematic for hypertriglyceridemia than those of oligo- and polysaccharide. Added sugar consumption is proven to be associated with an increased body mass index (BMI). It has been reported that an increased BMI, even within non-obese level, could raise a risk for type 2 diabetes in middle aged. Although BMI is affected by multiple factors such as eating behavior, total energy intake, food pattern, an intake of non-basic foods such as added sugar, and sweet snacks is very likely to influence BMI.

It had been reported that BMI of US adolescents age 12-19 years in the year 2000 were higher than those of the year 1988-1994 at the same age group.[2] Coincidentally, a consumption of added sugar has increase steadily from 27 tsp/person in 1970 to 32 tsp/person in 1996. This represented a consumption of 82 g of carbohydrate, which accounted for 16% of total daily energy intake.[16] The major source of eaten sugar was non-diet soft drink, which increased from 200 ml/day in 1989 to 280 ml/day in 1995. Moreover, it had been found that the prevalence of obesity in adults was different between those who did and did not consume soft drink. The prevalence of obesity in adults who consume and do not consume soft drink ranged from 16-24% and 12-18% respectively.

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Added sugar, exclusively sucrose, is defined as sugar that is eaten separately at a table or used as an ingredient of food such as cake, cookies, soft drink and ice cream. Added sugar includes natural sugar, for instance, white sugar, brown sugar, raw sugar, corn syrup, malt syrup, or lactose also known as milk sugar, fructose, known as fruit sugar.[17] Added refined sugar is defined as sugar added to food or drink in commercial or domestic food preparation. It includes sucrose, lactose, glucose, maltose and fructose. World Health Organization refers free sugar to monosaccharide and disaccharide added to food by manufacturer, cook, or consumer, plus sugar naturally presenting in honey, syrup and fruit juice. The present study focused on added sucrose in food and drink either domestic or processed food. Therefore, only added sucrose was examined. Thus, a term added sucrose would be used throughout this study for more specificity.

Unlike other food groups, a dietary guideline for sugar does not give a certain amount of sugar constituting moderation. However, consumers have been advised to use added sugar sparingly.[18] WHO recommended that an intake of added sugar should not exceed 10% of total daily energy intake.

Even though there is a report of an increased prevalence of overweight and obesity in conjunction with an increasing of added sugar consumption, to the best of author's knowledge, there is no study regarding the magnitude of added sucrose consumption in Thai undergraduate student. The purpose of the present study was to examine sources of sugar consumption and amount of added sucrose consumed in undergraduate students at Khon Kaen University, Thailand, and to compare average amount of added sucrose consumption among different BMI groups.

Materials and methods

Subjects

Two hundred and two undergraduate students of Khon Kaen University, Thailand (164 women and 38 men, age 18-22 years, enrolling between the year 2004 to 2005) volunteered in this study. All volunteers gave their written consent form after the study procedure had been explained orally. Basic data such as weight, height, were collected. Body mass index (BMI) was calculated by dividing body weight (kg) by height^2 (m). BMI was then grouped into 3 categories according to WHO criteria; low (BMI<18.5 kg/m^2), medium (BMI 18.51 to 24.99 kg/m^2), and high (BMI≥ 25 kg/m^2).

Design

Volunteers completed 3-day daily record of items and amount of sweetened foods and drinks consumed. All recorded items were grouped into 5 categories according to their ingredients; candy, snack, bakery, sweetened beverage and traditional Thai sweet. Added sucrose in each and every recorded sample was analyzed as described below. Average amount of sucrose consumption per day was calculated. An overall response rate for 3-day record was of 40%.

Principle of sucrose determination

Sucrose was digested to glucose and fructose by β-fructosidase. Free glucose (tube A) and total glucose (tube B) were reacted with glucose oxidase and peroxidase. Intensity of quinoneimine dye was measured for optimal density (OD) at the wavelength of 540 nm. Free glucose was subtracted from the total glucose, therefore, the intensity of glucose from added sucrose was OD_B-OD_A. Glucose solution of 300 mg% was used as a standard reference. Total amount of sucrose (mg%) in the sample was calculated from (OD_U/OD_S) x 300 mg% x (342/180). Sucrose content of each recorded item was summarized for 3 days, the average of sucrose consumption per day per person was calculated.

Digestion of the sample by Carez II solution was needed for turbid samples to prepare a clear sample before measurement.

Data analyses

Averages of added sucrose consumption were expressed as mean ± standard deviation (SD), and range. A one-way analysis of variance (ANOVA) was used to compare averages of sucrose consumption among BMI groups for both genders. For statistical analysis, the statistical package for Social Sciences (SPSS) 12.0 was used. p value were two tailed and $p<0.05$ was considered as statistically significant.

Results

Two hundred and two voluntary Thai undergraduate students participated in this study; 164 of (81.2%) female and 38 (18.8%) of male. Demographic data of the volunteers are described in Table 1. The averaged BMI was 20.3±6.4 kg/m^2 (mean±SD), ranged from 15.2 to 38.9 kg/m^2. BMI of male and female volunteers were 20.0±6.2 kg/m^2 and 25.1±6.0 kg/m^2, respectively.

There were 337 kinds of sweetened foods and drinks (Table 2). After placing each of them in one of five categories; candy, snack, bakery, sweetened beverage, and traditional Thai sweet, we found that ninety-four varieties of sweetened beverage represented the largest source of sugar consumption. They were accounted for 27.8% of a total. An averaged sucrose content of sweetened beverage was 24.0 g/bottle ranged from 0 to 112 g/bottle. Secondly, eighty kinds of bakeries were accounted for 23.7% with an averaged sucrose content of 13 g/piece. Sixty-four kinds of traditional Thai sweets were accounted for 20% of the total. An averaged sucrose content of tradi-

Table 1. Demographic data of the subjects

Type of subjects	All	Male	Female
N	202	38 (18.8%)	164 (81.2%)
Age (years)	20.1±3.2 (17-29)	20.4±2.3 (17-29)	20.0±2.5 (17-28)
Body weight (kg)	53.0±17.1 (29-110)	59.0±2.3 (47-110)	51.0±15 (37-83)
Height (m)	1.6±0.4 (1.45-1.8)	1.63±0.4 (1.60-1.8)	1.58±0.4 (1.45-1.7)
BMI (kg/m^2)†	20.3±6.4 (15.2-38.1)	20.0±6.2 (15.2-38.1)	25.1±6.0 (15.6-32.8)

†BMI, Body Mass Index, is referred as weight (kg) divided by height (m^2)

Table 2. Sugar-sweetened foods and beverages categories and sucrose contents

Sugar-sweetened food categories (n = 337)		Sucrose contents (g) per pack	
		Range	Mean±SD
Candies (n = 52, 15.4%)	Candies, candy with chocolate, jellies	0.1-24.7	6.0±5.9
Bakery (n = 80, 23.7%)	Cakes, Cookies, pies, doughnuts, crackers, slide bread	0.1-37.3	13.2±9.1
Snacks (n = 43, 12.7%)	Chocolate bar, squid, potato ship, pop corn, grain-based snacks	0.0-52.8	9.5±11.0
Sweet drink (n = 94, 27.8%)	Non-diet soft drink, fruit juices, lemonade,	0.0-111.9	24.0±20.0
Thai sweets (n =68, 20.1%)	Lod chong, roti with egg (banana), sweets topping with coconut milk	0.9-117.3	24.6±25.4

Table 3. Sugar consumption in all subjects

BMI Parameters	All (n= 202)	Male (n=38)*			Female (n=164)		
		Low** (n=7)	Medium (n=27)	High (n=4)	Low** (n=41)	Medium (n=109)	High (n=14)
Averaged Sucrose consumption (g/day)	69±38 (4-182)	56±31	72±40 72±37 (7-161)	71±32	75±44	60±38 68±39 (4-182)	65±31
Energy intake from sucrose per person/day (kcal)	276		288			282	
Added sucrose in term of dry weight (tsp)††	17		18			17	
Sucrose consumption according to sweetened food (g/day)							
1.Candy	9		11			9	
2.Bakery	38		31			40	
3.Snacks	7		7			7	
4.Sweetened beverage	118		135			114	
5.Thai sweet	26		22			27	

††1 tsp = 4 grams dry weight. *Not statistically difference between genders; **not statistically difference in three groups of BMI

tional Thai sweets was 25 g/pack. Fifty-two kinds of candies were accounted for 15.3% with an averaged sucrose content of 6.0 g/piece ranged from 0.1 to 24.7 g. Lastly, forty-three kinds of snacks were accounted for 12.7% with an averaged sucrose content of 9.5 g/piece ranged from 0.0 to 52.8 g.

An averaged amount of daily consumption of added sucrose for all subjects was 69±38 g/day, ranged from 4 to 182 g/day (Table 3). Averaged added sucrose consumption for male volunteers was 72±37 g/day, ranged from 7 to 161 g/day. Meanwhile, female volunteers consumed added sucrose 68±39 g/day, ranged from 4 to 182 g/day. An average of daily energy intake derived from added sucrose of all subjects was 276 kcal/day (1 gram of sucrose = 4 kCal). In average, volunteers consumed 17 tsp/day added sucrose daily (1 tsp equal to 4 g of dry weight).

The data revealed that the largest source of added sucrose consumption was sweetened beverage with an average of 118 g/day, accounting for 59% of daily added sucrose intake (Figure 1). Other sources of added sucrose in ranked order were bakery, contributing 38 g/day, Thai sweets, contributing 26 g/day, candy, contributing 9 g/day, and snack, contributing 7 g/day. Collectively, the last four categories accounted for only 40% of the total intake of added sucrose consumption.

Although, mean daily added sucrose intake was a little greater in male volunteers, there was no gender difference. Also, there was no difference of average daily added sucrose consumption among groups of low, medium, and high BMI in each gender (Table 3).

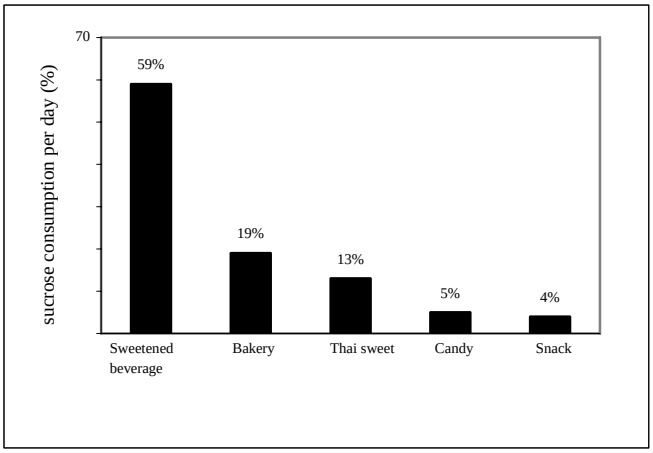

Figure 1. Sources of sucrose consumption per day (%) in the students

Discussion

Our research is the first study determining the intake of sucrose in Thai undergraduate students. The average of added sucrose intake in all volunteers was 69±38 g/day or 17.25 tsp/day. This number is close to averaged sugar consumption of the united state adolescents in the year 1989 to 1996 which was 15.7-20.5 tsp/day.[18] It is also comparable to the refined sugar intake in 18-year old Australian.[19] However, this figure is higher than those found in the children aged 9 to 11 years, which consumed 61 g daily.[5] Added sucrose consumption in this study is lower than consumption of added sweetener in American, which was 82 g/day between the years 1994 to 1996.[16] However, it should be pointed out that added sucrose consumption in the present study may not reflect the actual amount of sugar intake because only added sucrose was determined in this study. There were other forms of added sugar which were not examined in this study, for example corn syrup and honey. Therefore, it is likely that an actual intake of added sugar consumed in these volunteers would be higher than our result.

The major source of added sucrose intake found in this study was sweetened beverage, which accounted for 59% of total added sucrose intake or 118 g daily. This finding was in accordance with previous studies. Although, we did not categorize the substantial source of sweet drink, presumably, a group of soft drink was the most prominent source.[19] This amount of 118 g daily intake in this study is remarkably higher than those found of 36.2 g in adolescent girls and 57.7 g for boys reported in the year 2000.[16]

Although our results showed no difference of added sucrose intake among different BMI groups, highly added sugar intake, especially sugary drink, may promote obesity. Presumably, sugary drink causes excess energy consumption resulting in a lesser intake of subsequent meals and leading to less variety of food groups.[17] Additionally, excess sugar consumption could promote negative changes in bodyweight by involving hunger and rate of metabolism.[21]

The World Health Organization recommends that refined sugar consumption should not exceed 10% of total energy intake per day.[1] In the present study, total energy intake of 2,000 kcal per day recommended by Thai RDI was used for calculation. According to this criterion, energy intake from added sugar should not surpass 200 kcal, or 50 g/day or 12.5 tsp/day. Unfortunately, added sucrose consumption of 69 g/day found in the present study did exceed the WHO recommendation. Furthermore, this amount contributes of 13.8% total daily energy intake, and it is not far different from the report found for adolescent of America and Spain[8,22-24].

Strikingly, we found 41 of 164 female subjects with BMI ≤ 18 kg/m^2. This was an unexpected result. This result may be an interesting point of the eating habit of Thai undergraduate students. Nowadays, being thin is recognized as a superior body figure. Therefore, this group of our volunteers may control their diet intentionally resulting in a low BMI. Furthermore, life style of these volunteers may affect their BMI. All volunteers were living in university dormitory. It is known that dormitory residents usually skipped their breakfast in order to attend class on time. This result is in accordance with other study reporting that nibbling or omitting breakfast was associated with lower BMI.[25] Only 14 of 164 female subjects (8.5%) felt into overweight category, BMI ≥ 25 kg/m^2. This prevalence is higher than those found in Malaysian school children, but lower than those of united state adolescent.[2,4] Although several reports have showed that sugar-sweetened intake is an important contributing factor of body weight gain[15], the present study found that added sucrose consumption was not significantly different among three BMI groups for both genders. Therefore, added sucrose consumption may not play a significant role in weight gain in this population. Other causes such as eating habit, carbohydrate intake, and physical activity may take part in weight gain.

However, our result indicated that added sucrose consumption in Thai undergraduate student exceeded of WHO recommendation. This amount of daily sugar intake is remarkably higher than those found in the year 2000. The major source of added sucrose consumption was sweetened beverage. Knowing of preferred source of added sucrose may help dietitian provide appropriate nutrition education or campaign to reduce added sugar intake in this aged group.

Underreporting of sweet intakes is a serious pervasive problem in dietary survey research. It is possible that the recorded intake of sweetened foods and drinks in this self-report study may be underestimated. We noted that the third day of the daily record generally showed lower sucrose consumption than the first two days. Thus, the amount of added sucrose consumption reported in this study may not truly reflect the actual intake of the subjects. Furthermore, the present study measured only sucrose contents in foods or drinks, omitting other sweeteners added during manufacturing process such as glucose, fructose, or corn syrup. Taken together, it is expected that the actual sugar consumption of our volunteer are underestimated. Even being underestimated, the reported amount of added sucrose consumption was already higher than recommended by WHO.

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