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## NUTRITION AND PHYSICAL ANTHROPOLOGY

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When I was newly a graduate student of Anthropology at Harvard, rather little attention was given to nutritional status when making anthropometric measurements or in population comparisons. Even weight was ignored as being too "variable" to be of any practical use. So population comparisons were made without concern for nutritional status (even without weight or hemoglobin levels) and no particular effort was exerted in ascertaining where subjects fitted into the socioeconomic range of the "population" under study.

While tribal clan and ethnic affiliations were of considerable concern to my teachers then, direct and indirect measures of nutritional status were quite ignored. Hemoglobins and hematocrits were not determined, or lipid levels, or serum and urinary vitamins, or albumin or urinary creatinine. There was a tacit assumption that everyone was reasonably well nourished or at least resembled Rousseau's "natural man".

Lacking nutritional information, great attention was still given to body size as having taxonomic importance. The world then consisted of the tall northern Europeans and their cousins in North America, and the shorter and shorter peoples to the south, toward the east, and westward into the southern Pacific. Some human taxonomists in Europe actually built their racial classifications entirely around stature, providing detailed stature maps for Europe, Africa and South America as metric proof.

When skeletal populations were measured and compared, nutritional status was again ignored except by reference to subsistence techniques. Plains Indians were known to be taller and Puebloans shorter: maize-agriculture (and agriculture in general) seemed to be associated with dwarfing. However, dimensional differences

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between skeletal populations of the same general group were accorded taxonomic significance, the more so as the number of statistically-significant differences grew larger, among the measurements made.

The world and the world-view of Physical (Biological) Anthropology is very different today, for we know how important nutrition is to size and bodily proportions and more. Simply from caloric intake data alone we realize that the big people of the world have been able to satisfy big appetites, and that the little people of the world have been food restricted. They and we are physiologically adapted to different levels of energy intake and energy expenditure. We know now that most of the peoples of the world have not enjoyed one gram of quality protein per kilogram of body weight and for some it is much less and with limiting amino acids as well. Rather less attention has been given to dietary fat, low in most agriculturalists but incredibly high in many North Americans and Western Europeans-up to 70 percent of calories ingested.

We are also more cognizant of infectious disease which itself has strong nutritional correlates and often inseparable from nutritional status. So many of the "native" peoples of the world carry a heavy load of parasites. So many still suffer from malaria and fast and slow viruses of all kinds. Exactly what do we measure when we make anthropometric measurements in New Guinea or in Bushmen or the (remaining) Australian aboriginals when we relate parity to the size of the newborn?

We have come to appreciate the magnitude of the secular trend, which goes with westernization (though not in every instance) and that gives us solemn reason for thought. In the United States the little Napolitan and Sicilian grandparents I knew have grandchildren who approximate the North American stature means. In Japan, the after 1946 generation is far taller and Japanese school-girls in Nyoto now tower above my wife. In Italy the secular trend has gone so far that Roman and Milanese schoolboys now exceed the British norms; of course Great Britain (or the U.K.) is no longer an economically favored nation. When I note that Nisei Japanese in Seattle of my own age now stand little shorter than I do, and as I follow Japanese stature data I wonder whether (in the year 2001) the Japanese will actually exceed North Americans in stature as well as automobile and computer production.

Along with the secular or generational trend in stature, there are also marked changes in body proportions. Legs have extended,

relative to trunk length, and we have all become long-stemmed beauties. Hands and feet have become larger, so that my shoe size (once quite average) is now considered small and is more difficult to find in the stores. Faces have changed in lengths and depths and in proportions, so that we are all beginning to look like Prince Charles of Great Britain, a not entirely cheerful thought. In consequence, beds and coffins and even cemetery crypts have also become bigger. It takes more food to keep each of us alive, now that we are bigger, more fiber to cover us, more fuel to keep us hot and cool, and more space to accommodate us when we are living and when we are dead.

Given these changes in size and proportions, approximating one centimeter of stature per decade, we need to reconsider many of the accepted assumptions of the past. Were the tiny, short-legged peoples of Indonesia and Central America short and short-legged because of their genes or because of caloric and nutrient limitations from the fetal period on? When we make skeletal comparisons of different archaeological populations, are we documenting genetic differences or differences in the energy balance and the frequency of diarrhea? Are the osteometric measurements and even the morphological comparisons contained in our monographs better interpreted as nutritional anthropometry with minimal taxonomic significance?

These same questions also apply to human remains of the more distant and fossil past. Knowing now the dimensional differences between cousins in the old world and the new, Mexican migrants into Detroit and the *sedentes* who remained behind, and the socioeconomic differences in size even in the USA and Canada, how do we best evaluate differences between fossil taxa or Neanderthals in Europe, North Africa and the Middle East. Knowing how much facial proportions have changed in only one generation and within families (comparing fathers and adult sons, mothers and their third decade daughters) how do we now assess temporal and geographical differences among different fossil groups?

When we talk about nutrition (as it relates to size and growth and adult proportions) we commonly refer to the caloric intake-kilocalories or kilojoules/day-and with good reason. Body size varies the world around in direct relationship to kilocalories/day. The short peoples of the world consume the least food energy and the tall peoples of the world consume the most, even at the market-basket level. However, energy is only part of the caloric balance. There is also energy expenditure, *i.e.* energy out. The very peoples who have the most food available to eat also are spared

energy expenditure, as they are warmed (or cooled) and transported by fossil and nuclear fuels. Those in the world who have the least to eat also have to walk more and expend more energy in the acquisition of food, so they are at a double caloric disadvantage. In fact this latter group of marginal, third-world and low-technology peoples are at a third disadvantage, for they lose the benefits of much of the food they eat because of disease and diarrhea, easily amounting to one-seventh or one-fifth of calories ingested. High infant mortality is a further calorie waste for them, for each dead infant represents a waste of over 365 000 kilocalories-547 000 kilocalories per year, and a further waste of perhaps 200 000 kilocalories during gestation.

Besides the caloric intake and caloric expenditures and losses, we have come to understand the implications of protein intake and the intake of quality protein, because of the effects of low protein intakes and low-quality protein on growth, development, maturation and adult size. Since caloric intake and protein intake are intimately related, and the peoples who are low in the former tend to be restricted in protein intake. We now have to consider famine, starvation and periodic hunger whenever we measure and compare. Most of the people of the world encounter starvation from time to time as crops fail or there is drought. Many agriculturalists and most hunting peoples experience seasonal and periodic starvation. This was even true in England and Scotland and Ireland little more than a century ago, until the Corn Laws were repealed and cheap grain and cheap sugar from the outside buffered periodic grain fluctuations. Then the English and the Scottish really grew, paying for imported grain by their industrial output.

Yet even where there is stored food in sufficient quantity, and food than can be brought in from the outside, these benefits are unequally distributed. Richer individuals in Peru may achieve a caloric plateau, without severe seasonal variations. Poorer agriculturalists in the same villages live from caloric peak to food valley, eating more after the harvest and far less during the planting season, with expectable consequences to the size and growth of their children and to adult weight as well. Unless we are aware of seasonal variations in the food supply, we may measure our subject at the wrong time. In INCAP studies they actually supplemented the wrong village (Santa María B.) based on low-season dietary data! Unless we are aware of socioeconomic differences in access to food and the different food groups, we may measure the wrong

families, or mix data on the poor and the rich, obliterating differences that are there.

Besides kilocalories and protein (and protein quality) there is also fat, which may contribute from under 10 percent to over 80 percent of calories consumed. And until 1920, in the United States, fat was primarily animal fat, and it was expensive. We loved fat pork, fat beef, fat poultry and milk high in fat, and it killed us. They still fry McNuggets in beef tallow, which is another story. Yet fat is low in the diets of many agriculturalists, animal fat may be only a few grams a day in the highlands of Guatemala and in New Guinea. Still, it is difficult to separate fat intake from caloric intake, being low where it is low and high where caloric intake is high, by a 7-fold factor and more. Excepting the hydrogenated vegetable oils of recent technology and Unilever, Ltd., fats are animal fats and more available where meat is both plentiful and cheap. Even more to the point, animal fats actually encourage eating (more calories and more fat) as in the best of traditional French cuisine, and the Russian and Balkan delicacies, and the sizzling steaks of Texas.

While beef stroganoff and chicken paprikosh are not the subject of this essay, there is real need to consider fat intake of people present (in New Guinea for example) and of people past, in the valley of Mexico, the highlands of South America and in the Middle East. The land of Israel was attractive in biblical time because of milk and honey, but the biblical writers ignored the fat of the land, which we should not do. When we relate body size to climate, as D. F. Roberts has done so well, we cannot ignore the similarly direct relationship between body size and fat intake, expressed as grams per day. Kilocalories/day, protein/day and fat/day and all directly correlated with body size, and climate may only have an indirect bearing through population density and food availability per capita.

There is a common notion, dating back centuries, that the "natural" diet is a healthy diet. Greek and Roman authors said so, and Metchnikoff avowed it, as he sought the key to longevity in yoghurt. But food gatherers and agriculturalists were exposed to a variety of poisons and toxins, not from pesticides (as now) but in the foods they ate, and their food-storage techniques, and their food preparation techniques and from the vessels they used for eating and serving. Some foods contain cyanide and must be processed and washed to remove it and cyanide poisoning is ever present as a possibility. Cydad (palm nut) meal contains neuro-

toxins, a pervasive problem from Okinawa through the Pacific, slow-acting and therefore doubly-dangerous. Oxylates in many leafy vegetables bind calcium in the food. Wheat phytates, consumed in excess, may bind iron and zinc, leading to nutritional dwarfism-as in Egypt and Iran. Besides lactose intolerance, which affects most of the people of the world, there are sensitivities to wheat gluten and other glutens. The Welsh and the Irish have this genetically-determined intolerance to an excess, so that the simple availability of a given foodstuff may not be to the good of everyone.

As food is stored, there are losses due to rodents, losses due to insects and there are toxic substances derived from fungi. Aflatoxins accompany peanuts, even in Skippy Peanut Butter, and in excess they bring liver damage and worse. Similar aflatoxins derive from fungus-infected stored grains, and there are the "rusts" that affect many grains, especially rye. We are all familiar with ergotism, for it results in abortions and miscarriages, and ergotism may explain the seizures and bizzare behaviors that led to the Salem witch trials. Since most agriculturalists necessarily store grain in earthen pits and buried pottery jars, food storage may have contributed to many problems of growth and development and behavior, the world around.

When food is cooked, many metals and trace elements may enter the food, from the cooking vessels, from the glazes, from stines used in cooking, the extreme example we know of is of course hemosiderosis, due to brewing of beer in rusty petroleum tins, but many heavy metals may also be involved. The use of cooking vessels to produce earth-paints can contaminate the foods later cooked; lead can leach from the glazes and organic mercury compounds as well. Even water supplies may contribute excess nitrates, dangerous to the very young, and fluoride levels well in excess of 8 parts per million (8 mg/liter). Some techniques of cooking beans can lead to lathyrism, and the storage of cooked foods may lead to food poisoning of bacterial origin. So primitive man, or natural man, or agricultural man, may not have had such a healthy diet at all. Aflatoxins are "natural", so is ergotism, so is lathyrism and cycad toxicity. We need to review our archaeological and ethnological data so as to consider these additives. "Pure" foods may have been less available in the past than now, and we are now aware of many of the natural hazards faced by natural man. Wood ashes used as condiments in much of the Americas have been scarcely explored as to their undesirable constituents, even as they are used to flavor blue maize.

We have come to appreciate the extent to which population differences in size and proportions could be nutritionally mediated as a result of the international nutrition surveys of 1955-1970. We have come to appreciate the extent to which socioeconomic differences in growth and size and proportions are nutritionally mediated from the national surveys that still continue, combining anthropometry, food intake data and serum and urinary measurements, relevant information is still being added. We now view anthropometry, and anthropometric measurements quite differently than we did four decades ago.

The question has been raised, however, as to whether some of the population differences reflect genetic adaptations to long-experienced dietary limitations. In this view, the little people of the world are genetically adapted to lower caloric intakes and lower nutrient densities, and can therefore thrive on diets that would be inadequate for the genetically-large. This view is possible, but extremely difficult to confirm, since it would involve feeding studies of children that are both unethical in nature and nearly impossible to conduct. So-called "natural" experiments, comparing the growth status of the children of small parents and children of large parents might be revealing, though complicated by differences in maturational timing as we have come to discover.

Similar questions have been raised about the putative genetics of obesity, assuming that obesity was once adaptive (under conditions of caloric deprivation) akin to Neel's "thirsty" gene, as applied to diabetes. Indeed, the sons and daughters of obese parents are themselves obese, under conditions of food availability. However we are not able to starve children of obese parents to see if they still remain plump, and the appropriate natural experiment under famine conditions has still to be investigated.

In Westernized countries we have a further phenomenon, relating to obesity, *i.e.* the inverse relationship between socioeconomic status and fatness in adult women. In the USA, the UK, Japan, France and other countries poor women are fatter and rich women are leaner and less often obese. This is the reverse of what we find in the non-technological nations, where fatness makes more economic sense, and it is a further problem for physical anthropologists who may well need to be social anthropologists as well.

In actual fact it is difficult to imagine any aspect of physical (biological) anthropology that is uninfluenced by the caloric balance or nutrient densities or intolerances to specific foods. All skeletal dimensions are affected by the caloric balance during the



growing period and so are proportions, leaving us with the problem of separating nutritional status from genetic differences in the consideration of fossil taxa, archaeological populations and most living groups. The amount of tissue bone in the anatomical bones is certainly affected by the energy balance and protein density during the growing years, raising questions as to the extent to which bone density in adults is so determined. Sex differences in size are so influenced as we compare poorly-nourished and well-nourished populations or the poor and the rich among us, raising questions as to relative or percent differences between the sexes and proportions as well. Fatness is clearly related to the energy balance such that boys in obese families are fatter than girls in lean families, so how much of the sexual dimorphism in outer fatness is purely genetic?

We have a growing knowledge of food intolerances, not just to lactose in milk and cheese but to wheat gluten and other cereal glutes, some of them affecting entire populations and others affecting substantial numbers of people in defined populations. How much of dimensional variability in Cardiff and Galway is due to wheat-gluten sensitivity? What proportion of the small individuals in ancient Anatolia derived from a diet high in wheat? In Egypt and Iran we know of dwarfism attributable to the sequestering of iron and zinc by wheat gluten, leading us to reconsider dimensional and developmental data wherever wheat was the staple.

While agriculture gave people rewards for their efforts, and allowed larger populations and more complex cultures, it did so at the cost of nutritional quality and food safety. Beyond single-grain agriculture and excessive dependence on rice or corn or mealies, agricultural innovation improved such staples as the manioc, palm-nuts, the fava bean, and other legumes, that were poisonous under some circumstances or to some individuals or both. Food storage, often in pits or earthenware jars, added the possibility of aflatoxins and other carcinogens. The glazes on the storage containers, condiments used in cooking and the fats and oils used in cooking also added hazards. What with aflatoxins in nuts and grains, neurotoxins, from cycad nuts, cyanide in manioc, oxylates in many leafy plants, antithyroids in cabbages, and those phytates a "natural" diet is not necessarily a safe diet, however natural.

I do not mean to suggest that physical or biological anthropology is a mere subset of human nutrition or that we must all become nutritionists first in order to be anthropologists. Indeed I have

argued the reverse, and human nutrition has come to include far more of the traditional domain of physical anthropology as it has become international in scope and less the study of nutrient requirements and interrelationships. However it is clear that much or most of the traditional interests of physical anthropology are more explicable in nutritional context, including the energy balance, nutrient intakes and limiting nutrients. As we come to realize how much weight and fatness and growth and maturation have been influenced by cigarette usage, the coca leaf, the betel nut and other pharmacologically active cultivars merit similar studies as well. Energy in is part of our concern, so is energy out, so is energy lost because of diarrheas and malabsorptions and so are products that limit energy intake or heighten metabolism. In consequence ethnobotany and physical anthropology may have closer bearing on our traditional intellectual problems and concerns, because so much of physical anthropology is related to the energy-balance, food and diet, broadly construed.