

MALNUTRITION: HUNGER AND SATIETY, ANOREXIA AND OBESITY

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Summary

What people eat and how they obtain their food has been an evolutionary process throughout the 400 000 years that homo sapiens has been evolving. Humans are constituted to be omnivores, deriving substances from both plants and animals. From hunter-gatherers in the wild to nomadic pastorals to agriculturalists, the domestication of animals and plants has provided more food security, more leisure, and greater reliance on technology.

Human energy balance is achieved at the point at which the amount of energy expended in metabolism and activity is equally matched by the amount consumed from the diet. In sedentary circumstances, balance is achieved only by voluntary food restriction (appetite control) or when a huge body mass has accumulated. With famine or eating disorders leading to scant energy intake, a loss of both lean tissues and body fat precedes the accommodation to energy balance with a low reserve for any physical exertion. If lifestyle demands high physical effort, however, one can consume correspondingly high amounts of energy and maintain balanced body composition and fitness. The regulation of energy balance is a complex interplay of signals that initiate food-seeking behavior feeding, determine meals, intervals between meals, and the metabolism of macronutrients for energy or their conversion into lean tissue or adipose (fat) reserves, and all of this is conditioned by the usual degree of energy expenditure in physical activity.

Both underweight and excess weight are diagnosed by indicators based on the measurement of mass (weighing balance) and height (stature), and adjusting them to a reference index (body mass index) in relation to reference norms. Conditions of overweight and obesity are diagnosed on the high side, and various grades of chronic energy deficiency on the lower extreme.

Famine, restricted access to food, and eating disorders are conditions in which energy undernutrition is a common denominator. Short-term provision of food supplies and

adaptation of social and economic organization in harmony with the environment are the redress for the first to situations. The solution for eating disorders is social and psychological, and the safe management of refeeding is an important clinical topic.

The challenge of overweight and obesity as public health problems is only now being appreciated. Genetic predisposition interacts with changes in food composition and availability and more sedentary lifestyles to increase the number of persons with excess weight (and excess risk of chronic disease) throughout the world. Prevention and therapy for obesity involves modifying eating behavior, increasing physical activity, and occasionally drugs and surgery will be adjuncts.

1. Critical Contrasts

*Jack Spratt could eat no fat, his wife could eat no lean.
And so, betwixt them both you see, they licked the platter clean.*
Traditional English folk rhyme

The poem about the dietary peculiarities of the Spratt Family, and the traditional illustration that appeared in the books of rhymes, is apocryphal of the theme of this chapter. The husband and wife in the famous (infamous) pair had a contrast in body habitus and dietary practices. The illustrator inevitably depicts a hefty Mrs. Spratt and a svelte Mr. Jack Spratt. English folk tradition, moreover, seems to have associated the consumption of fat with fattiness and that of lean with leanness.

These are extreme conditions, and conventional wisdom—and the generalized notion of a bell-shaped distribution—would suggest that the great majority would be found between the two extremes. In fact, at one time in human evolution, each would have represented a rare extreme in an otherwise homogeneous general population in energy balance on an omnivorous diet. The conventional presumption, however, is that the condition that predominated throughout most of prehistory, antiquity, and in developing nations was that of overly lean (underweight) populations. Fossil evidence, however, suggests that hunter-gatherers were taller and better-nourished than the rural peasants of today. Underweight people and general malnutrition were an artifact of unequal distribution of foods from the agrarian transition. The Henry VIII phenotype, moreover, was undoubtedly rare in the sixteenth century and confined to the aristocracy and the clergy. What the present era has wrought has been a wider variation in body size, with increasing polarization of body habitus.

The following heading caption in a weekly magazine characterizes the current state of the world's body composition distribution.

A UN report shows that about 50 percent of the world's population is malnourished. Of those, half are too fat and half too thin. Per cent of underweight children: Bangladesh, 56 percent; India, 53 percent; Ethiopia, 48 percent; Vietnam, 40 percent; Nigeria, 39 percent; Indonesia, 34 percent. Per cent overweight adults: United States, 55 percent; Russia, 54 percent; Britain, 51 percent; Germany, 50 percent; Colombia, 43 percent; Brazil, 31 percent.

(The Skinny on World Health, *Newsweek* **135** (7), February 14, 2000).

As we shall see, we may be approaching a situation worldwide in which those who are in the extreme categories will outnumber those in the range of ideal weight.

Hunger and Satiety, Anorexia and Obesity, the title of this article, is based on a series of contrasts: Hunger and satiety, anorexia and obesity. In literature, poetry, and graphic arts, there is an interplay between an homage for the stark polar extremes on the one hand, and adoration of the balance and equanimity on the other. In the context of black and white, or day and night, the terms gray or twilight (dusk) are considered boring. The philosophical principles under which most traditional health systems are built conceive of health as balance. The classical example is Yin and Yang, a system of opposing forces. So, in a theoretical way, good health is the gray area between black and white extremes.

With respect to the contrasts in the title, however, a careful analysis of the syntax would suggest that these are not strictly parallel juxtapositions. At the physiological level, implying regulatory mechanisms are at play, hunger and satiety are antipodes. Hunger is defined in one medical dictionary as “uneasy or painful sensation, exhausted condition, caused by lack of food.” According to one researcher “Satiety, defined as an internal state of energy repletion after a meal, has been measured in terms of fullness, reduced hunger, reduced intent to consume a meal or a snack, or a lower amount of food consumed. Satiety has measured in terms of reduced palatability.”

The latter two elements in the title are contrasting syndromes or pathological conditions, viewed as eating disorders. Anorexia can represent either: 1) an abbreviation for anorexia nervosa, a condition defined as “a personality disorder manifested by a severe aversion to food,” or 2) anorexia is an appetite disorder in which the desire to eat is dampened. A more reasonable parallelism might be “Hunger and Satiety, Anorexia and Overeating.” Here we have framed the latter element of the phrase as a process. On the other hand, we can take the title into the public health domain, where availability and accessibility of food and healthcare replace physiology. In the public health domain, hunger has been equated to food insecurity or lack of access to food. Here the appropriate parallelism might be: “Hunger and Surfeit, Cachexia and Obesity.” In this framing and phrasing, we have looked at the results or the product. In this article, we have tried to deal with both formulations, but in the concept of ecological and evolutionary biology including modern and emerging data.

2. Food and Food Systems

The foods that can support the life of individuals of a species are a product of evolution of the species, and, indeed, co-evolution of plants and animals in the environment (see *Domestication and the Development of Plant Cultivars and Animal Husbandry, Nomadic Breeding, and Domestication of Animals*). To understand the contemporary situation confronting humankind, the perspective of evolutionary biology is the fundamental standpoint. Both instinct and digestive and metabolic apparatuses determine which foods can support the growth, health, and reproduction of a given animal. Some species are strict herbivores, subsisting entirely on plants. Others are strict

carnivores, predators, or scavengers subsisting on flesh and viscera. Finally, a set of species, so-called *omnivores*, of which most primates are classical examples, fulfill their nutritional needs with both plants and animals in their diet. From the dentition, size of mouth, and structure and strength of the jaws, to the partition and secretion of digestive enzymes and bile, to the length and anatomy of the alimentary tract, the adaptations to a vegetarian diet, a carnivorous fare, or a mixed diet are characterized. Another intrinsic factor of the evolution of a diet relate to the absence of substances within the foods that can be toxic to the consumers (toxins) or interfere with their nutrition (antinutrients) (see *Antinutritional Factors in Food*).

Food systems for humans cannot be separated from the physical and cultural aspects of evolutionary biology. *Homo sapiens* emerged from other hominids between 400 000 and 200 000 years ago. Much of our genetic makeup, homologous with contemporary small race gibbons, comes to us from the common primate ancestor. For most of our evolution, *homo sapiens* was just another wild animal. The theory of Darwin tells us that the natural order seeks biological diversity of species, and that the survival of a species is based on reproduction by the individuals who are most fit and adapted to maximize on those characteristics most suitable for survival in the ecological niche. Survival to reproductive age, survival to reproduce, and (for males) dominance in becoming the progenitor of more offspring in the group, are the indicators of superior genetic fitness. The genetic makeup of *homo sapiens* and its ethnic subgroups around the world is the product of this process of rigorous life-and-death selection forces over millennia.

Acceptability of foods, that is the selection chosen for consumption, has derived from cultural evolution and is particular to geographical and religious groupings (see *Regional and Cultural Differences in Nutrition*). Once determined what is edible for a group, the availability of foods in the environment and the ability of consumers to get the food in to their pots, sets the table of the food system, and for the issues of feeding behavior and energy balance that determine human body composition.

2.1. Acceptability of Foods

Culture has assisted humans in their selection of diets. This ranges from the processing of foods, from soaking or dissection for discarding the less edible or damaging components, to the invention of fire and thermal treatments (cooking) that often destroy or inactivate toxins, antinutrients, and pathogens that would be dangerous if the food were consumed in the raw state (see *Antinutritional Factors in Food*) along with certain essential nutrients, too. Development of weapons allowed humans to roam in the open, defending themselves from their natural predators, while hunting more efficiently and slaying ever larger beasts as prey. Culture and oral tradition directed groups living in specific ecosystems toward the selection of the wild flora and fauna apt for consumption by the tribe (see *Ethnographic Aspects of Human Nutrition*).

2.2. Availability of Food

The history of food systems recognizes three distinct (but overlapping) eras, beginning through the evolution of hominoids to humans some 400 000 years ago with the

hunter-gatherer lifestyle. In this epoch, availability was a function of that which could be found through foraging and hunting. Obviously, the number of human individuals the Earth that could be supported by a hunter-gatherer lifestyle is intrinsically limited by the intimate dependence on a food supply that cannot be expanded—and can only be contracted—by the intervention of humans.

Some 40 000 years ago, humans domesticated grazing mammals for their milk and fur, and to a lesser extent for their hides and meat. This gave rise to the pastoralist lifestyle (see *Animal Husbandry, Nomadic Breeding, and Domestication of Animals*). Availability of food became a function of the ratio of the herd to the nomadic herders. Both of these forms of subsistence involved constant migration to follow their prey, to open new hunting territories, or to find new grazing ranges.

Only 10 000 years ago, humans domesticated wild seeds to form grains, with wheat and barley the most ancient, followed by rice and maize some 7000 years ago, and legumes, oats, rye, millet, sorghum and tubers, orchard fruits, and vegetables later (see *Historical Origins of Agriculture*). The agrarian lifestyle required the defense of specific territory against the incursion of other humans, of predatory and grazing animals, of vermin, and of plagues. Livestock other than dairy animals were incorporated into the system, but foraging and hunting and fishing for wild game continued. For the first time, relative food security was established along with the luxury for some individuals of not having to participate in food gathering as their dominant activity. These were the preconditions, within the agricultural age, for the development of civilization and advancing technology. Hence, the agrarian lifestyle has a division of subsistence farming which is all-consuming for the farm families, and for whom the availability of food depends upon access to land and the vagaries of weather, soil fertility, and crop health.

Agriculture has a more contemporary division of agroindustry in which availability of food for the nonfarmer depends upon what produce, animal carcasses, live animal and animal products the food-producers produce and bring to the market. It is only with agriculture—and intensive agriculture—that food can be made available to feed 6 billion human beings.

Other nonfood derivatives of technology that enrich human existence are travel, medical care, and communication. Interestingly, the best hope for the preservation of companion species in the sea, on the land, and in the air in coexistence with the human population is the rational and skillful management of resources (see *Food, Agriculture, and the Use of Natural Resources*).

2.3. Accessibility of Food

Accessibility represents the constellation of factors that allows individuals to consume the food that is available in their environment. For the primary food producers, this represents a pecking order within the household group governed by tradition. Working men, fertile-aged women, older adults, adolescents, and children receive differential distribution of the family food based on established norms. For those households that do not produce food, before the distributional aspects can operate, food must be brought into the home from primary producers or the marketplace. This accessibility is based on

the exchange of goods and services (barter) or the purchase with money (monetary commerce). Individual and family wealth can determine the ability to convert the available food in the environment to accessible food in the cooking pot or on the table.

One of the goals of agriculture as reflected in agribusiness is to make food abundant to the consumer. In the era of urbanization, there are greater distances between people and their food. It must be commercialized through a complex system of intermediaries in transport, processing, wholesaling, and retailing and the commercial nature makes the promotion of food in the marketplace supersede the distribution of sustenance.

3. Human Energy Imbalance

Food is one part of the equation and consumption is the other. With the exception of situations of extreme famine or food restriction, the human organism can achieve energy balance. However, the cost of imbalance is both distorted body composition and reduced mental and physical capacity. It is the regulation of food intake into harmony with energy expenditure at the point of appropriate and healthful maintenance of skeletal, muscular, visceral, and fatty tissues which is the goal of avoiding extremes of obesity or underweight.

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Biographical Sketches

Noel W. Solomons, MD., graduated from Harvard Medical School in 1970, and did specialization training in internal medicine and infectious diseases at the University of Pennsylvania in Philadelphia, and in gastroenterology, intestinal physiology, and clinical nutrition at the University of Chicago. He held faculty positions at the University of Chicago and the Department of Nutrition and Food Sciences of the Massachusetts Institute of Technology. Resident in Guatemala since 1975, he worked as an affiliated investigator at the Institute of Nutrition of Central America and Panama (INCAP) for 10 years before founding the Center for Studies of Sensory Impairment, Aging and Metabolism in 1985. He is the author of 120 chapters in books or proceedings and 300 publications.

Manuel Ruz, Ph.D., graduated from the University of Chile in 1977. He did graduate work at the Institute of Nutrition of Central America and Panama (INCAP), Guatemala (M.Sc. in Nutrition and Health), and the University of Guelph, Ontario, Canada (Ph.D. in Applied Human Nutrition), was a United Nations University Fellow, and is author of 46 scientific papers and 14 book chapters on topics related mainly to human nutrition and minerals. He is Chair of the Department of Nutrition, Faculty of Medicine, University of Chile, former and President of the Chilean Nutrition Society.