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Nutritional dilemmas of long term health: implications of evolution and ageing for policies and food industry practices affecting chronic diseases

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In terms of the ancestral genome of *Homo sapiens*, 90% of our genetic adaptation has come in the context of various hunter-gatherer settings, in which food variety was diverse and balanced between the Animal and Plant Kingdoms, and life-expectancy was short. Only recently, during the past century, when the human life-span began to elongate, have "long-term" health concerns truly been important. Reproductive health and child-rearing skills were the primary primeval concerns of evolutionary humans. With the number of persons over 60 years of age increasing at a rapid rate, chronic diseases threaten to cause suffering and disability for an increasing segment of the population while bankrupting health-care systems with the costs of therapeutic and custodial care for the elderly. How a society eats from birth and throughout the lifespan has a major determining effect for either more or less health and function. The meat-based fare of the caveman is probably not the recommended food pattern for healthy aging and compression of mortality, but neither is heavy exposure to the newer foods (dairy foods; cereals; refined sugars; vegetable oils; alcohol; salt; and fatty meats) which the agricultural and technological revolutions have made abundantly available. Taken in a lifespan perspective with an assumption of median survival through seven decades, a micronutrient-dense, but primarily plant-based intake reduces the risk of non-transmissible diseases. A concern going forward is how governmental policies and food-industry practices can contribute to making the most healthful diets and physical activity patterns accessible, available and appealing to persons throughout both the affluent and developed and the low-income and developing societies of the world.

Key Words: diet, aging, evolution, health, chronic disease

Chronic diseases are the largest causes of death in the world, led by cardiovascular disease (17 million deaths in 2002...) and followed by cancer (7 million deaths), chronic lung diseases (4 million deaths), and diabetes mellitus (almost 1 million).

Yach *et al.*[1]

Introduction

It is an honor to receive the 2003 Asia Pacific Clinical Nutrition Society award, especially as it is a tribute from a part of the world that I do not call home. In fact, I only first visited Asia in 1975, to attend the 10th International Nutrition Congress (ICN) of the International Union of Nutrition Sciences (IUNS) in Kyoto, Japan. My second visit was in 1989, again for an ICN, this time for the 14th in Seoul, Korea. As a member of the IUNS Committee on Urbanisation and Nutrition, chaired by Rainer Gross, I attended the I Asian Workshop on Urban Nutrition outside of Kuala Lumpur, just prior to the IV Asian Congress of Nutrition the Federation of Asian Nutrition Societies (FANS) in Kuala Lumpur in 1991. I have subsequently attended the quadrennial FANS-sponsored Congresses in Bejing, China (1995), Seoul, Korea (1999), and New Delhi (2003). More importantly, introduction to Southeast Asia in K.L. led to a six-year involvement with the Regional Community Nutrition Program of SEAMEO-TROPMED and the German Agency for Technical Cooperation (GTZ) at the University of Jakarta in Indonesia. During this time, I really became familiar with Asia, and the nutritional issues of Southeast Asia. My familiarity with Australia developed concurrently in the 1990s, beginning with attendance the ICN in Adelaide in 1993. I also took as many opportunities to route my travel into or out of my Jakarta teaching phase with a visit to the Monash University in Melbourne, and have served on the Editorial Board of the *Asia Pacific Journal of Clinical Nutrition* since its inception in 1992. In recent years, I have had the pleasure of participating in the Sanitarium International Symposia, in Sydney in 2000[2] and in Melbourne in 2002[3], but this award ceremony introduces me to Queensland and the city of Brisbane.

As the Chair of IUNS Task-Force on Long-Term Health for the 2001-2005 term, it is appropriate to be called upon to address a related challenge, namely that of addressing the topic of "Nutritional Dilemmas of Long-Term Health." It seemed prudent to be as clear and transparent in addressing this discourse, beginning with a systematic parsing of the title, itself.

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On "Dilemmas": The word *dilemma*, of course, derives from the Greek words for "two horns," conjuring up the image of divergence and bifurcation and being torn apart in a course to be taken. A dictionary definition of "dilemma" is: "a situation involving an unpleasant or undesirable choice".[4] These choices within dilemmas are driven by "paradoxes," which are defined as: "a statement that seems to be contrary to common sense, and yet is true".[4] As a biologist viewing and studying the natural world, I am increasingly convinced of the pervasiveness of apparent paradoxes in which a single common exposure or action can result in multiple (and apparently competing and contradictory) effects. I have come across many that relate to both short- and long-term health issues. A selection of these are summarized in Table 1.[5-23] It almost seems that Nature has created a "zero-sum game", in which tucking-in on one side produces some bulging out on the other.

On "Long-Term": *Long-Term* can be addressed in the simplistic notions of "as long as it lasts," or "as long as it takes," or "as long as one shall live." The life-span commences at conception and transits fetal life, infancy, childhood, adolescence and various stages of adulthood (young, middle, older age). In an evolutionary sense (below), it was only at the beginning of the 20th Century that people regularly survived beyond those stages leading through young adulthood. If long-term is relative, as suggested above, then it has increased in an absolute sense by about four decades over the last 100 years.

It is important to dissect this issue, and consider whether our concern for "long-term" is referenced to the life of an individual -- or to that of the species. Outside of the individual and individualistic sense, there is an alternative (collective) connotation for "long-term," one which has to do with the survival of the species, *Homo sapiens*, and its projection to the future and our permanence on the planet.

Table 1. Selected litany of contemporary paradoxes whose resolution presents dilemmas for public health or clinical medicine

Balancing Macronutrient Contribution to Total Energy Intake Reducing the contribution of fat to total energy increases the contribution of carbohydrate to total energy; reducing the contribution of carbohydrate to total energy increases the contribution of fat to total energy.[5]
Micronutrient Density and Preventive Dietary Patterns Increasing the number of serving portions of fruits and vegetables in an individual's daily diet is associated with reduction in risk of obesity, manifestations of the metabolic syndrome and a number of cancers.[6,7] The trade-off is that dietary intake for certain nutrients (vitamin D, vitamin B12, niacin, calcium, iron, zinc) will be diluted and reduced with increasing substitution of fruits and vegetables for foodstuffs of animal, cereal, tuber and leguminous origins [Montenegro G, Solomons NW, Unpublished findings, 2004].
Energy Conservation versus Energy Restriction In evolution (short individual survival), having additional adipose reserves was potentially advantageous in evolution to provide a nutritional margin to survive through recurrent infections and to provide the hormonal milieu for fertility.[8] But, in current age (long longevity), life-long calorie restriction (without micronutrient malnutrition) is now being touted as a potential intervention for delaying the aging process, strengthening immune regulation and reducing cancer risk.[9]
Dietary Sodium Insufficiency and Excess Consumption of less than 1.5 grams of sodium daily is considered to be insufficient whereas intake of over 2.3 grams of sodium is considered to be an excess.[10]
Vitamin A Insufficiency and Excess Consumption of less than 800 micrograms of preformed vitamin A daily can lead to manifestations of hypovitaminosis A,[11] but chronic intake of over 1500 - 2000 micrograms produces bone loss[12,13] and fracture risk and over 3000 micrograms risks congenital deformities in human embryos.[14]
Body Composition and Iron Deficiency In the USA, obesity in children is associated with iron deficiency[15], in Lima Peru slums, obesity of women is associate with iron adequacy.[16]
Iron Exposure, Nutrition Health Iron deficiency produces adverse pregnancy outcomes (mothers-fetuses)[17] and cognitive developmental delay (anemic infants).[18] BUT therapeutic iron supplements[19] and infant-formula fortificants produce tissue oxidation in the recipients [Friel J: Personal Communication, 2004].
Folic Acid's Influence on Colonic Dysplasia Folic acid prevents initiation of colonic dysplasia[20], but accelerates progression of already dysplastic cells.[21]
Factors of Skeletal (Bone and Joint) Health Heavy weight bearing and overweight are protective factors against osteoporosis[22] and are at the same time risk factors of osteoarthritis, and vice versa.[23]

Hominids (bipedal primates) have shared the Earth with its other species for over three million years,[24] but the lineage that represents contemporary humans dates from an estimated mere 300,000 to 400,000 years.

In a paradoxical sense, what we do to positively favor long-term in given individual lifespans can theoretically have negative repercussions for the long-term situation of the species. Genetic mutations involving gamete cells are considered to be the "opportunities" for natural selection for the human species[25]; mutations in somatic cells, on the other hand, are the mechanism for development of certain degenerative disease in one's own life-time.[26] If we were to follow procedures to stabilize our genome to avoid mutations (as is promised by excessive intake of folic acid [27]), we might produce life-long -- but short-term -- gains for individuals, with detrimental effects for the vigor and adaptability of humankind over the evolutionary long-term.

Finally, in this regard, the way we obtain and select foods for our diet will have some impact on both the external environment and on the genetic evolution and reproduction of humans.[28,29]

On "Health": The newest *The Merriam-Webster Dictionary*[4] provides two definitions for "*health*." The first definition is: "Sound physical or mental condition." The second definition is a synonym "WELL-BEING." The term "health" connotes, to a great extent, the absence of disease. However, the United Nations agencies have long since ascribed to the concept, from the Alma Ata Declaration of 1978 that: "The Conference strongly reaffirms that health, which is a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity, is a fundamental human right and that the attainment of the highest possible level of health is a most important world-wide social goal whose realization requires the action of many other social and economic sectors in addition to the health sector." Adding "long-term" as a modifier, we are confronted with a final definitional issue. *Long-term health* implies adequate function and lack of debilitating illness through each of the phases. This span of individual survival has only become really "long" in the past century.

A synthetic approach to the title terms: It was only when humans entered into a "risk of chronic disease" conditions that the implications of cumulative and present nutritional status or of dietary elements that promote disease (noxious) or retard pathogenesis (preventive) emerged with any legitimate focus.

Longevity in evolution: The imperative of Nature is reproduction and renewal. The Giant Sequoia evergreen trees of the Pacific coast of North America can survive centuries approaching a millennium. The Galapagos tortoises are animal species with a life-span that is over a century. Certain species of marine whales are also long-lived. Aside from rare examples such as these, seldom do individuals of any living species survive long into their reproductive years in the wild. They, themselves, become part of the food-chain. This was true for human beings dedicated to a hunter-gatherer lifestyle and living in various wilderness habitats. Throughout human evolution, median survival was low because many individuals died in childhood, victims of infections, predation or infanticide. For those who survived to adulthood, infections ever remained a lethal threat. For the men, the perils of the hunt, accidents, predation and inter-clan encounters were the mortal dangers. Within the tribe, reproduction posed mortal dangers for both sexes; for women, it was the complications of childbirth, and for men, the intra-clan conflicts for procreative dominance, which led to patricidal and fratricidal struggles. Interestingly, for both of the aforementioned generations, fossil records suggest that it would not have been atypical for an individual to be in robust health and vigorous physical condition up to the time he or she succumbed to one of the aforementioned mortal threats and lethal perils.[30]

All of this sudden death made "old age" a rare condition in human evolution. For those who survived beyond the peak reproductive years, infections never ceased to threaten life and the "wear and tear" of such exhausting pursuits as frequent hunts and incessant migration might have approximated chronic illness. Various forms of active (euthanasia) or passive (neglect, starvation) geriacide were probably a practice within evolutionary tribal groups. So, at the basis of the dilemmas of long-term health is the Evolutionary Imperative: that few members of any species, including humans, were ever meant to be survivors for that long.[31]

Cultural evolution of dietary practices: The ecological niches inhabited by humans determined exactly what they hunted and gathered, but it is prudent to conclude that diets were diverse and omnivorous to a fault[32] and, in the absence of scarcity, the selection was nutritious.[33] The alternatives to hunter-gather fare represent distortions of prehistoric ancestral patterns that are less diverse in variety of edible items and less dense and diverse in nutrient content. The first departure from the lifestyle of nomadic hunters came some 40,000 years ago,[34] when ungulate animals were domesticated as beasts of burden and dairy animals and some clans became nomadic herders. The pastoralist diet had a dominant cultural "superfood," (milk and its fermented derivatives), which represented the first "dietary staple." Of course, in their wanderings, herders did not cease to forage through the flora for edible plants nor eschew opportunities for hunting, fishing or poaching nests for eggs. The contribution of hunted and gathered foods, however, was less in deference to what the pastoralists' dairy animals could provide to the clan.

Some 10 millennia ago, when humans learned to domesticate plants, the wandering stopped for some of our ancestors, and settlements arose. Wild grasses were turned into cereal grains such as rice, millet, wheat, barley, corn, oats and rye.[33] More succulent seeds gave rise to legumes. Roots and rhizors became edible tubers such as cassava, potatoes, yams and sweet potatoes. All sorts of animate species including the porcine, feline and avian were domesticated and corralled. Crops and livestock on settled terrain represented the food supplies for the agriculturalist, with a grain or tuber representing the major staples for distinct groups. Farmers pushed back the wilderness and hunted, fished and foraged even less. Nutrient variety and density took another quantum decline, and deficient intakes of iron,

zinc, vitamin A and phytochemicals became chronic. This was especially true for individuals in the various classes of non-food-production pursuits (warriors, artisans) that societies could support with the excess production of agriculturalists. These groups subsisted on a monotonous diet, based heavily on the more stable and hearty of the agricultural staples prepared as gruels, porridges and unleavened breads. Even more micronutrient deficiencies could arise in the non-agrarian classes.

The goal of compressing morbidity over the long run: The problem of living longer and growing older was not that life ends in death; this has been accepted as a universal imperative. It was in part that no social roles existed for older survivors, especially males[35] but more so that lingering functional disability and suffering from chronic illnesses disrupted the life of the individual and his relatives. The modern context of long-term health has to consider longevity through eight decades or more. The consequences of excess weight and insulin resistance for glucose tolerance, vascular patency, arterial pressure, and lipid metabolism (metabolic syndrome) and of altered control of cellular proliferation and immune vigilance (neoplasia), as well as senescent changes in ocular, osseous and muscular tissues, are increasingly incident with advancing age.[1]

Gerontological biology's adopted mandate: "Add life to years, not years to life," is typified by the work of Fries.[36,37] His seminal hypothesis is the "The Compression of Morbidity paradigm" which maintains that if the average age at first infirmity, disability, or other morbidity is postponed and if this postponement is greater than increases in life expectancy, then cumulative lifetime morbidity will decrease - compressed between a later onset and the time of death." This would approximate the goal of living a productive, active and healthy life almost to the moment of one's demise. In fact, we now use the quantitative term of DALYs (Disability Adjusted Life Years) to evaluate the impact of chronic disease on societies and the strategic approaches to extend long term health.[38]

Dilemma: what is the appropriate food selection pattern for humans, in a context of long-term health?
The human is an omnivore. In the context of an analysis of long-term health in the 21st century, we have a dietary choice quandary. What selection between foods of animal and plant origin should we choose, and which items within these food groups should we emphasize in the context of the public health burdens of longevity and the search for long-term health? Do we look to physical and genomic evolution or cultural evolution for the solution?

The Hunter-Gatherer diet and lifestyle*:* In evolving hunter-gatherer societies, scarcities of food could exist when the clan had exhausted the bounty of flora or fauna in their roaming area, or when migratory patterns of their prey changed. However, when food was available and abundant, nutrient imbalances were unlikely. With consumption of the whole carcass of small and large animals, the Stone-Age hunter's diet was high in protein content and nutrient densities. This was complemented by nutrients and phytochemicals in the flora they foraged as well.[33] So intense, and linked to subsistence and survival was the physical activity of the migrating hunter-gatherer tribes that over-nutrition was also not a problem.[33] No one had the luxury of sedentarism in a nomadic existence.

In this perspective, it would induce us to pause and speculate as to what would be the consequences of a sedentary society with a median survival through eight decades of reverting to the Stone-Age diet? Should we consider the restoration of a caveman lifestyle? From what contemporary hunter-gatherer groups tell us about that fare, the traditional hominid-evolutionary diet had many too many calories for maintaining energy-balance. Moreover, current studies suggest that relative caloric restriction may further increase longevity and resist immunological decline and cellular dysplasia.[39] The cave-man diet had too much red meat for colonic health and prudent iron balance. Bingham *et al*.,[40] have clearly demonstrated the gradient of increasing colonic carcinogen production with increasing consumption of red meat. Moreover, iron reserves should probably be ample -- but not abundant -- as epidemiological evidence suggests that higher iron reserves are associated with increased chronic disease.[41] The Paleolithic diet had too much cholesterol and saturated fat for cardiovascular health, as consumption of both of these lipid substances should be limited.[42] The viscera of animals, fowl and fish is rich in preformed vitamin A which can reach intakes at which risks for bone loss[12,13] and even teratogenesis[14] emerge.

We can concede that, for the rigors of a hearty and active -- but typically short -- life in hunter-gather communities, the evolutionary diet was appropriately adapted and adaptive. The modified aphorism, *Eat drink and be busy, for tomorrow you may die* may aptly summarize the adaptive justification of the typical, varied, high-meat fare of evolutionary ancestors of modern humankind. For today, however, it is not only ecologically and environmentally non-sustainable, and imprudent but unhealthful for the myriad of reasons outlined above.

Contemporary affluent-society diet and lifestyle*:* Since the advent of the Agrarian Age, through passage through the Industrial Age to the present Technological Age, both undernutrition and overnutrition have become problems, often co-existent.[43,44] In the United States, the portion of mortality rates attributable to tobacco use as the primary cause is running neck-in-neck with deaths related to diet and lifestyle.[45]

Cordain[24] has pointed to the roles of both pastoralist and agricultural transformations, and technology (notably food technology) in producing or introducing food items that are unprecedented in evolutionary history. These include: dairy foods; cereals; refined sugars; refined vegetable oils; ethanolic beverages; salt; and fatty domesticated meats. Drewnowski[46] sees a preference for these foods driven by the hedonic (pleasure producing) signals produced by the odors and flavors of these items. In an evolutionary sense, these have ascended in consumption in a short fraction of the overall evolution. Eaton *et al*.,[47] has described contemporary humans as the "Stone-Age in the fast lane." Avoiding most of the pitfalls to survival that stalked the caveman (above), modern humans have the option of unprecedented longevity, with the new pitfalls being chronic diseases. The modified aphorism, compatible with the new reality of reduced childhood and increasing

longevity, could be: *Eat and drink as if your life depended on it*.

Opposite the rock of the Stone-Age diet, we have the *hard place* of the typical dietary and lifestyle fare within the affluence of contemporary, industrial society. Present intake patterns are too calorie-dense for achieving energy balance at low expenditures.[48] They provide too much sodium for normotensive health.[49] They have too much red meat for colonic health and prudent iron balance, and too many *trans* fatty acids for cardiovascular health.[50] We consume too much refined sugar for dental health,[51] and normal glucose tolerance[52] while the glycemic load of the current diet is too high for glucose tolerance,[53] adaptive satiety[54] and insulin action.[55] Consumption of few servings of fruits, vegetables and whole grains leads to insufficient intake of phytochemicals for adequate prostatic health,[56] ocular function,[57] and hormonal balance.[58] The modern diet contains adequate folic acid for normal nutriture, but too little to prevent neural tube defects in susceptible women.[59] Processed foods produce too many phosphates for renal stone prevention. So there is clearly attributable harm that derives from consuming excessive calories from foods that are overly concentrated in certain noxious constituents and insufficiently varied and diverse.

Going forward with the right (correct) horn of the dilemma

The derivation of "dilemma" is two horns. We clearly need to take the bull of the pandemics of expanding overweight and expensive ill health by the horns. For a successful harmonization of the expected long length of individual survival with the goals of a productive, healthy and disability-free life, however, the dichotomous choice between return to a Stone-Age menu or proceed with the contemporary food selection is a false proposition. If dilemma's definition is about hard choices, we need to focus on the third horn (a third way) which emerges from the evidence-based on the patterns of dietary intake that are most compatible with the health goals across the lifespan.

Coming to grips with the nutritional aspects of long-term health involves three principles: 1. recognizing those elements that are novel, unprecedented and poorly understood; 2. understanding that a nexus of associations and interactions have woven all cultural and environmental considerations into an intertwined web; and 3. that human and naturalistic values must be joined to strictly utilitarian values, first to define the problems and then to disentangle the dilemmas toward actions towards solutions. Applying these principles, it would seem that the solution needs to based on a varied diet, but it is not the dietary pattern that conditioned our genome[24] that will take us forward. Rather it is one based on a lower-energy and less energy-dense fare based on a primarily plant-based pattern of food selection. Fortification and supplementation might be needed, moreover, to fill in any gaps and deficits in micronutrient intakes to satisfy our evolved requirements.[60]

Beyond the aforementioned generalities of principle, moreover, there are some specifics. Humans are evolved omnivores, and should remain as such, especially when it comes to the consumption of marine fish. But, the choice that needs to be emphasized is on foods of plants origin; their type, constitution and content of phytochemicals and macro- and micronutrients are the dietary bases to the solution. The evidence is widely documented. For instance, in terms of lowering the risk of malignancies, the first recommendation of the 1997 WCRF report "*Food, Nutrition and Prevention of Cancer: A Global Perspective*" is to consume a diet "largely based on plants".[61] More recently, researchers at the Harvard School of Public Health have commented: "Cumulative evidence supports the great potential of diets that are primarily based on minimally processed plant foods to lower the risks of chronic diseases. The benefits are probably due to the ample amounts of essential fatty acids (both n-3 and n-6), amino acids, fiber, minerals, antioxidant vitamins, and phytochemicals in these diets. However, no single diet is optimal for everyone. Instead, various options are open for designing a palatable and healthy plant-based diet, with varying amounts of fat and carbohydrates, as long as the diet includes healthy types of fat and carbohydrates and provides an appropriate balance between energy intake and energy expenditure".[62] They were commenting on a paper from Steffen *et al.,*[63] which had shown, in the Atherosclerosis Risk in Communities (ARIC) Study, the protective effects of higher intakes of whole-grain, and of fruits and vegetables against risks of all-cause mortality and an inverse relationship of incident coronary artery disease and fruit and vegetable intake in blacks, but not in whites.

Just in the July, 2004 issue of the Journal of Nutrition were three seminal articles relating the pattern of diet to either mortality or morbidity in the North American population.[64-66] It was a plant-rich and varied diet that reduced specific risk in each instance. In a review article on the topic "Food intake patterns and body mass index in observational studies," Togo *et al*.,[67] identified over a dozen recent original articles in which certain dietary patterns, generally those in accordance with dietary guidelines, were associated with reduction of risk of a specific chronic infirmity or of enhanced survival.

Confirming the general tenets of this evidence for a plant-based pattern are longitudinal studies on Seventh Day Adventists. This religious sect practices a life-long lacto-ovovegetarian dietary pattern, as well as avoiding ethanol, tobacco and illicit drugs. The epidemiological record is one of longer survival, lower morbidity, and better independence and function in later life.[68]

Aging and ethnicity matter

Given this audience in the Asian region, it is important to emphasize that a great deal of the nuances for understanding long-term, diet and nutrition depend on both age and aging, and ethnicity. With respect to aging, in Japan in 2000, one in four persons was over 60 years of age.[69] By 2020, this percentage will rise to 31%, whereas it will be 17% throughout all of east Asia, and 10% in southeast Asia. In that year, the persons over 60 years of age across Asia will number 231 million (China), 145 million (India), 29 million (Indonesia), 18 million (Pakistan), and 14 million (Bangladesh).[70] It is clear that the aging of populations will have major impacts on the health patterns and public health responses throughout the Asian segment of the Pacific Rim.

Aging is associated with a process called senescence.[71] The physiology of senescence has implications for nutrient requirements and dietary guideline recommendations.

Table 2. Potential policy options to induce healthy dietary choices for protecting populations from non-transmitted diseases

On the demand side:
Increase the relative price of unhealthy choices
Provide clearer information about product contents
Promote better awareness about the consequences of a poor diet
Supply side interventions:
Invest in technology to deliver high-productivity, low-cost vegetables and fruits and low-fat livestock products to poorer consumers.
Eliminate price incentives on growing high-fat foods and relax quantity restrictions on growing healthier foods
Evaluate food trade policy from a health perspective
Impose stricter standards on fat content of food away from home and in schools
Reduce malnutrition in utero

modified after Haddad 2003[83]

Through the issuance of the 1989 Recommended Dietary Allowances,[72] nutrient requirements were undifferentiated beyond age 51 years. In the current estimations, the following nutrients have different recommended nutrient intake levels for persons over 50 years of age compared to younger adults: Higher intakes of vitamin D, phosphorus, and calcium[73] and lower intakes of sodium[74, 10] are recommended with increasing age. In addition, greater discretional intake of water is recommended as a buffer against dehydration and to improve bowel function in the Third Age.[74,75]

Several nutrients in levels beyond the dietary range stimulate immune function for older persons. This is true for vitamin E which enhances immune performance for healthy older people when consumed in amounts from 200 to 800 mg daily.[76] Similar effects were found over the short term when intakes of zinc, several fold higher than the RDA levels, were prescribed to healthy elders.[77,78]

With respect to ethnicity, the Pacific Rim has the most diverse array of ethnic groups in the world if we consider the AmerIndians, Spanish, Northern Europeans, and Eskimos as one ascends from Patagonia to Alaska on the American edge. We then encounter East Asian, Southeast Asians, and South Asians as we descend from Siberia via Japan and Korea and down China and over the waterways to the west and south. Among the first peoples of island nations of the Pacific, we have Polynesians, Melanesians, Moari, Australian Aborigines, Okinawans and native Formosans.

Body composition differs markedly at constant body mass indices across ethnic groups as shown for Whites, Blacks, Asians and Hispanics in New York[79] and for Chinese, Malays and Hindus in Singapore.[80] A study by Stevens *et al.,*[81] showed, furthermore, that the risks of dyslipidemias, hypertension and total mortality at a common BMI were markedly disparate between black and white women in a longitudinal study in the United States. Ethnic diversity extends to issues of metabolism, as shown in the recent findings that folic acid metabolism is distinctly different in U.S. blacks and whites.[82]

Conclusions

As asserted by Yach *et al.,*[1] "Chronic diseases have not simply replaced acute infectious ones in developing countries. Rather, such countries now experience a polarized and protracted double burden of disease." Illness and incapacity incur suffering for the individual, and impose social and economic costs on the society. As this discussion has emphasized, human longevity is historically unprecedented and we are far short of having a firm grasp on all of the scientific questions relevant to long-term health. "Evidence deficiency" notwithstanding, it would be evasive and irresponsible not to address, at least the framework, of policy implications.

Evolution -- physical and cultural -- determines the most suitable diet and life-style for a given species. Human evolution, however, did not account for our survival beyond the reproductive and offspring-rearing phase of the life-cycle. Science needs to provide the insights and technology the means to extend long-term health and adequate functioning into the later decades of current longevity. Policies and programs need to derive themselves from the emerging scientific evidence.

With increasing understanding of diet and lifestyle measures for prevention, on the one hand, and with genomic research revealing gene-lifestyle interactions, on the other hand, the dilemma becomes the tension between individualized solutions (based on genetic prescription) which, as policy, could be *laissez faire* and collective redress (based on collective action in lifestyle education and commercial and environmental regulation) which falls firmly into the perspective of policy, leading to program.

A noted academic gastroenterologist recently concluded the 2004 International Research Conference on Food, Nutrition and Cancer in Washington with a discourse entitled "Diet and cancer prevention: Evidence-based medicine to genomic medicine".[83] This is an updated reiteration of considerations earlier advanced by Childs and Simopoulos.[84] This school of thought derives from yet another self-gift bequeathed to humankind by its own technological ingenuity. The Stone-Age comes into a very fast lane confronting individual therapeutic treatments to treat his or her phenotype based on genotypic diagnoses!

The challenge, then, to those who feel that public health policy should work for the common good in a collective and equitable manner must understand the prevention of chronic disease and the extension of adequate physical and mental functioning. Buekens *et al.,*[85] in an article entitled "Evidence-based global health," identified certain impediments to creating public health policy: the failure to provide key decision makers with up-to-date evidence on the burden of chronic diseases; a lack of understanding of the economic factors that influence chronic diseases risks; and the current orientation of health systems toward acute care.

From the perspective of the research communities' contribution, they then identified three levers to overcome these impediments in: elevating chronic diseases on the health agenda of key policymakers; providing them with better evidence about risk factor control; and persuading them of the need for health systems change. In the context of national and international food policy, and its effects on a quality diet, Haddad[86] provides suggestions on how policy leverages can be exercised either on the demand side (mobilizing the population to behave in a certain manner) or on the supply side (restricting or promoting the availability of certain options) (Table 2).

All of these policy initiatives must be created and implemented in an ethical manner, in which the rights of all ages and all states of vulnerability to or resistance to chronic illness are taken into consideration.[87] The public health measures must, at the same time, preserve and restore the physical and natural environment within the overall strategies.[29]

Common sense principles that can be derived from these considerations are various. Firstly, life-expectancy is vastly expanded, and practices and habits compatible with long-term health have a cumulative effect, and must be begun in early life, albeit when it is hard to motivate individuals to eschew the more hedonistic indulgences. Certain patterns of consumption are epidemiologically associated with lower cumulative risks of the non-transmissible diseases of interest. Dietary and lifestyle practices that optimize performance and suppress pathogenesis in one decade or phase of life may compromise health in subsequent years.

Moreover, a limited number of edible species are in the human diet, and total energy expenditure is too low to support high intakes of diverse fruits, vegetables and sources of phytochemicals from natural sources. Thus, food technology and industry must produce safe natural and processed foods that please the palate while conveying the fullest benefits of plant-based diets for health and function through aging. The most important principle is that in favoring the long-term health of the world's population, one size may not fit all.[29] The ethnic and age-distribution characteristics of a regional population should be considered, and more local and adapted (environmentally-friendly) tactics and strategies must be devised.

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