Dietary recommendations and guidelines which take into account maintenance, prevention and survival

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There is a growing interest in nutritional and non-nutritional factors which affect the various stages of life in different ways and how these factors, operative in one stage, have their consequences in later stages. To address these questions has required the command of large and longitudinal data sets about human populations, an understanding of and ability to manipulate gene expression, and the sophistication of detailed food component chemistry. Moreover, it is now clear that there are more fields of food-health relationship than heretofore presumed, such as those that relate to menopause, immune function and cognitive function. Nutritional factors may operate antenatally, in early childhood, during the growth spurt, in the reproductive phase of womanhood, and in much later life. The contextual framework for nutritional thinking is changing in relation to stage of life, including biological as well as chronological age, and in relation to other non-nutritional variables. For example, modest increases in physical activity allow more flexibility in the human diet. Avoidance of substance abuse (tobacco, alcohol, unnecessary medication, meganutrient intakes), allows marked improvements in health in some populations, whilst others continue to be at great risk and require related food intake recommendations. Also of importance throughout life are social, anthropological, economic and educational factors. For example, social activity can stimulate the preferred use of food, and a function of eating is to stimulate social activity-- this interactive bidirectionality between nutritional and non-nutritional factors for health has been appreciated through the modelling of food-health relationships in studies of the aged and cross-culturally. To minimize adverse nutritional effects, a lifespan and contextual approach to nutrition is required.

Value of lifespan approach

Risk-benefit trade offs-- the necessary separation of various life long nutritional considerations

The quest for common nutritional approaches to all stages of the lifespan is a reasonable one and there are some generalisations which appear to be sustainable. For example, if hunger has not been subverted, enough food to satisfy it appears conducive to health at any age. However, that it may be satisfied in the first weeks or months of life by human breast feeding alone is crucially different to the ways in which hunger may be satisfied in adolescence as individual identity, independence and social needs (competing with nutritional needs) develop, or how, later, it might be dependent on the kind of occupation (with differing worksite catering opportunities[1]; with differing levels of physical activity; with differing environmental exposures), and ultimately how one addresses ageing with a decline in physical activity and the development of complex disease patterns. Although energy restriction may prolong life[2], the penalty in childhood by way of morbidity and mortality may not be a reasonable risk to take for a benefit to survivors later in life. Indeed, a more thorough understanding of preferred planes of energy nutrition indicates that a higher plane of energy throughout (more energy intake from high nutrition quality food, accompanying a greater level of physical activity) is to be preferred through adulthood for longevity[3,4,5]. It is necessary to evaluate the relative risks and benefits in the short and long term when considering preferred food and food component (nutrient and non-nutrient) intakes.

Concordances and Discordances

Aside from the satisfaction of hunger (for energy or calories), the human species has, concordantly, always to reckon with the need for essential nutrients and, discordantly in its world-wide habitat, to live in a wide range of geographical and environmental situations (for example, rural and urban; coastal and mountainous).

Only in the first months of life is one food alone, namely human breast milk, possible for human survival. Thereafter, the need to eat a wide range of foods becomes increasingly apparent. This is the case across all age groups, although not all populations achieve the same food diversity[6,7], and it may decline again with the social isolation often experienced in later life (Figure 1).

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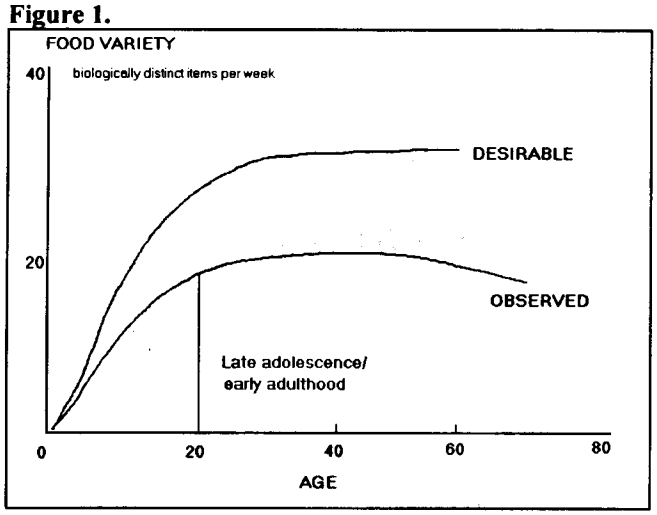
Figure 1.



Vulnerability in early life and later life

Most attention has been directed towards the vulnerability of the human species perinatally and in the first five years of life, when it has not been uncommon for mortality to be as high as 50% by the fifth year in developing countries or in the earlier history of industrialized nations. The increases in life expectancy at birth have mainly been attributable to a drop in early childhood mortality. However, during the latter part of the 20th century, life expectancy from the age of 65 or 70 onwards has also been increasing[8]. The problem of statements about life expectancy at birth at any one point in time is that it is the cumulative experience for separate age groups at that point in history and not the experience of particular individuals throughout life. Thus, it is possible that the factors now improving life expectancy in early life might not have the same beneficial effect in later life when we review the present childhood cohort in 70 or 80 years time. These insights need to temper food-health thinking at all times.

Genes and gene expression

The appreciation of the relationship between genes and environment is only apparent once the genes are expressed. Otherwise, the genetic problem may not be known to exist and it may emerge as a food supply changes. So far, a consideration of genes and nutrition has had more to do with the management of inherited diseases of metabolism like phenylketonuria, where a specific manipulation of diet, often an exclusion of a nutrient like phenylalanine has been undertaken; this rather clear-cut separation of genes and food environment applies to only a minority of human health problems. Even inherited disorders of metabolism may be evident or non-evident-- evident genes in the case of PKU (phenylketonuria) or non-evident genes, as in the case of G6PD (Glucose-6-Phosphate-Dehydrogenase-Deficiency). Much more common appear to be the expression of genes under certain environmental conditions and these probably include genes which contribute to obesity, non-insulin-dependent diabetes mellitus and various forms of hyperlipidaemia, for which the LDL receptor defect is the most studied. Homocysteinaemia, with vascular toxicity, due to folic acid, pyridoxine or B_{12} deficiency, would be yet another example. It means that there are likely to be a number of, as yet, unexpressed genes[9].

Table 1. Examples of gene status

A. Expressed
1. Evident at birth -- PKU
2. Non-evident but fully expressed -- G6PD deficiency (only evident when fava beans ingested, for example)
3. Expression dependant on affluent diet
   - obesity and abdominal obesity
   - NIDDM (non-insulin dependent diabetes)
   - hypercholesterolaemia-- certain forms of LDL (low density lipoprotein) receptor defect
   - homocysteinaemia
   - iron storage

B. Non-expressed

Genetic is not, however, to be non-nutritional or non-environmental in pathogenesis. Furthermore, genotype may not be important unless ultimately expressed. A particular phenotype may also have several different contributory genotypes and/ or environmental factors. It is possible for a health problem to be entirely genetic and environmental, and rarely one without the other, although one thinks for example, of eye colour or colour vision as solely genetic.

Table 2. Estimated percentage variance in disease occurrence which can be attributed to genetic or environmental. particularly nutritional factors.

	Estimates of % varience accounted for by predictors	
Nutritionally related disease	Genetic	Nutritional
Cancer	20-70	20-70
Macrovascular disease	5-10	10-70
Obesity	13-30	60-80
Non-insulin-dependent diabetes mellitus	10-20	60-70
Alzheimer's disease	20-30	?

Survival genes which confer survival in one environmental situation may reduce it in another. The best known example of this must be the conferrence of survival advantage in malarious areas in those of sickle trait of red blood cells or thalassaemia. Nutritional examples of change in survival value of genotype are probably seen in the following situations:

(i) increased efficiency of energy utilization where food supply is limited. This translates into a risk for overfatness where there is a surfeit of food or physical inactivity. This phenomenon has been described as the "thrifty gene" hypotheses, although precisely which genes are involved is yet to be unravelled[10-14].

(ii) the conservation of ingested iron in those populations prone to nutritional anaemia may then allow iron storage disease when there is an adequate supply of iron or increased bioavailability of iron for the majority of the population. It is reckoned that in industrialized countries, the risk of excessive iron storage is in evidence for about 10% of the population[15].

(iii) lipoprotein transport, which is directed at the delivery of fuel by way of triglyceride to the periphery and of cholesterol for cell membrane integrity, is a vehicle for transport of the antioxidant carotenoids and vitamin E isoforms, and for transport of lipid soluble pesticide

residues, and may, with excessive dietary fat, be misdirected, with cholesterol presentation to the arterial wall and the development of atherosclerosis.

Antenatal period

It is generally appreciated that intrauterine development may be affected by nutritional factors. But, in turn, it may lead to lifelong nutritional and metabolic problems. Examples of this phenomenon include:

(i) the contribution of maternal folate deficiency to neural tube defects (NTD) [16-18].

(ii) contribution of maternal energy deficiency to low birth weight and, later, to stunting[19]. Stunting is likely, as well, to predispose to abdominal obesity in adulthood if the food supply is in abundance at that stage of life[20].
the maternal ingestion, at a critical stage in pregnancy, of cured meat may be toxic to pancreatic beta cells with the ultimate development of insulin dependent diabetes mellitus[21,22]. Early consumption of dairy products in infants may be a similar problem[23].

Table 3. Relationship between stature and BMI and WHR in Melbourne Chinese

	BMI (kg/m^2)		Waist to hip ratio	
	Men (n=268)	Women (n=269)	Men (n=268)	Women (n=269)
Stature (cm)	-0.08	-0.09	-0.20*	-0.22*
Body weight (kg)	0.83	0.86	0.50**	0.43**

(iv)the ingestion of hormonally-active compounds in food may also affect fetal development, although it is at present speculative as to how this may take place. Nevertheless, there is growing evidence that weakly oestrogenic compounds in foods (lignans, coumestans and flavonoids) can affect health in later life, pre-menopausally as far as menstrual cycle length is concerned and, especially post-menopausally in so far as bone health, sexual function, and protection against breast cancer in women are concerned, and, in men, protection against prostatic cancer[24,25]. There is the distinct possibility that women, during the reproductive years, who ingest such compounds, may have offspring affected, whether favourably or unfavourably, by such food-derived oestrogenic compound.

Early childhood rearing

Several lines of investigation are now revealing effects of early childhood rearing on health in later life.

(i) *Combined twin-adoptive studies in later life metabolic phenomena.*
The Swedish twin-adoptive studies have provided a unique opportunity to look at long term, even later life, consequences of early childhood rearing. Surprisingly, HDL cholesterol concentration in later life is determined by early childhood rearing, when it might have been regarded as genetically based[26]. What may, therefore, be operative within and between families, may also be operative at the community, or even national, level and reflect a general overstatement of purely genetic, without environmental, contributions to nutritional and metabolic status, decades after childhood.

(ii) *The expression of Lp(a) phenotype.*
This can change during childhood, as evidenced by the work of Wilcken and colleagues in Sydney[27]. This then seems to persist with major risk factor potential for macrovascular disease in later life.

(iii)*Post-menopausal effects.*
It is clear that, since ovarian failure signals the onset of the menopause, ovarian function earlier in life, and its determinants, will affect women's health post-menopausally. It is interesting, therefore, that the length of menstrual cycle can be influenced by foods containing oestrogenic compounds[25].

Another example derives from lipoprotein studies as to how phenotype in early life may affect post-menopausal metabolic status. These are studies of apolipoprotein E phenotype. The apo E2 allele is associated with lower LDL cholesterol concentrations in post-menopausal women, and this effect is not in evidence in pre-menopausal women. It presumably reflects an interaction between apo E genotype and hormonal status, which could be both endogenous and exogenous hormonal status.

(iv)*Adult mortality data linked to infant welfare records decades earlier.*
It has been possible to show that infant nutrition, judged by body length or head circumference in the first year of life, is a predictor of macrovascular disease during adulthood, in a way that is not the case for chronic respiratory disease[28-32]. We have yet to learn the extent to which it is possible to reduce these adverse consequences of infant nutrition by nutritional and other lifestyle interventions later in childhood and in adolescence.

Growth spurt

The growth spurt between the ages of 11 and 14, are the most deterministic periods of body development for later life. This particularly applies to achieved height and to bone accretion. Bone mass achieved serves as a reserve which may or may not be sufficient to allow for decline in later life without risk of fracture[33]. But the factors affecting bone accretion are increasingly realized to be more than simply calcium intake. They include non-nutritional lifestyle variables such as physical activity and substance abuse (alcohol, tobacco, caffeine). They also include a range of food components (not all nutrients) including those that are adverse, namely sodium, caffeine, probably excessive intake of protein, and those that are favourable, like vitamin D, vitamin K, ascorbic acid, copper and boron, along with phytoestrogen.

Over 40 years, in New Zealand, the hip axis length (distance from medical aspect of pelvis to lateral aspect of femur along axis of femoral neck) has increased sufficiently to account in large measure for the increase in age adjusted hip fracture rate in women[34]. Thus, one outcome of increased height achieved during the growth spurt, much later in life, may not be favourable. But it is possible, and may be required, to offset this effect by maintenance of lean mass and strength, so reducing the likelihood of falls and fracture. Thus, those who grow tall may need to be even more attentive to the maintenance of physical activity with advancing years.