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Nutrition and lifestyles in children and older adults

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INTRODUCTION

«The childhood shows the man
As morning shows the day.»
So wrote John Milton in Paradise Regained.

The health of the child is the key to the health of the adult. I do not think many people here would question that the environment during the early years of life affects the individual's health and wellness during the adult years and during old age. Unfortunately, not enough attention has been given to education and prevention in childhood of specific health problems for adults and the elderly.

I want to consider the early environment during infancy and childhood, specifically nutrition and lifestyles. «Lifestyle» is a term rather freely used today. What do we mean by it—and do we all mean the same thing? Some people equate it with «behavior». Although behavior is a large part of lifestyle, it is more than behavior. It includes habits, attitudes, and values. It reflects the national culture, the educational level and the family of the individual. It reflects the socioeconomic conditions, too, which interact with all the others. It includes diet and activity levels, and such personal habits as smoking, drug and alcohol use. It includes items that are not easy to modify in people. Food habits, for example, are one of the most difficult behaviors to change, although they can change rather quickly in groups that have migrated to different cultures, but they usually change slowly over time, sometimes with education targeted to new habits.

Today, I do not intend to cover all of this. I plan first to discuss undernutrition in childhood and adult size; second, overnutrition, obesity, morbidity and mortality in adults; third, caloric restriction and longevity; fourth, dietary calcium, growth and osteoporosis; and finally, exercise.

Undernutrition

Children

Children who suffer from undernutrition in poor, developing countries are very likely as adults to live in a state of continuing undernutrition (Gopalan & Rao, 1980). Children may receive numerous insults during growth and yet survive. They make adaptations which result usually in a smaller body size and slower tempo of growth. Stunting in children leads to a reduction in adult size. If conditions improve, catch-up growth can occur and the body size of both children and adults increases (Eveleth & Tanner, 1990). Frequently in poor developing countries conditions do not improve and there is no catch-up growth to bring the child back to his regular growth curve. Catch-up growth is characterized by a higher than normal growth velocity requiring greater energy intake than for normal maintenance. It means that when conditions are favorable, adult height should not be affected by growth retardation in early life.

Infants born to mothers starved during the last trimester of pregnancy in the Dutch Famine of 1944-45 averaged lower birth weights by 9% and lower lengths by 2.5%. The men were measured at age 19 and were found to be indistinguishable in height from Dutch from parts of Holland that had not been subjected to famine (Stein et al, 1975).

In impoverished societies with prolonged periods of undernutrition, adult body size is affected as are mental function and physical activity. Smaller adults are seen to have a reduced work capacity with a subsequent effect on the local economy (Spurr, 1987). In view of this Martorell and his colleagues (Martorell, 1993; Pollitt et al. 1993) did a follow up in 1988-89 of the Guatemalan villages where in the 1970's nutritional supplements had been given to mothers and young children up to 7 years of age. In this unique study, researchers found that the benefits of the protein supplement given during only the early years of life continued into adolescence and adulthood. In summary, they were taller and had more lean body mass than those who had received the non-protein control beverage. This effect was greater in women. Men, in addition, showed an increased work capacity. Both groups scored higher on some psychoeducational tests. These results indicate that specific short-term nutritional programs could be effective in improving not only the health, but the intellectual and economic status of a country.

Adolescence

Adolescence is the second period when children may be especially sensitive to poor nutrition. Undernutrition results in a delayed pubertal spurt, later menarche for girls and delayed skeletal maturation (Eveleth & Tanner, 1990). The effects of poor nutrition on adolescents are not obvious from anthropometry as during early childhood. [Table 1] The amount of height gained, on average, by a population appears not to be reduced. Most stunting in height that we observe in adults seems to occur before puberty. As seen here, adolescents from disadvantaged populations gain as much or more height during the pubertal years as do well-off populations (Eveleth, 1985). A longitudinal study from India showed similar results (Satyanarayana et al, 1989). It is not clear whether nutritional intervention given to adolescents before the skeleton matures would be effective in increasing adult stature.

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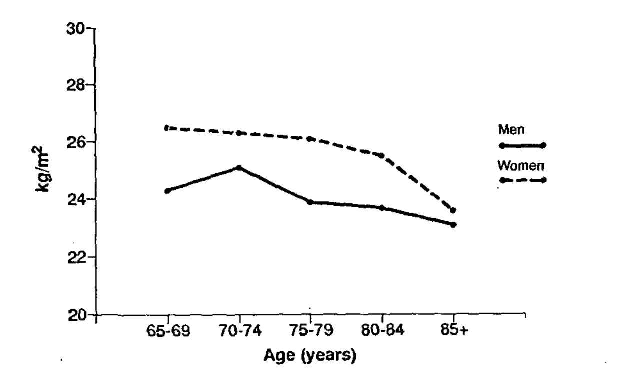
TABLE 1
Total height gained during adolescence

		Boys		Girls	
Place	Status	Amount gained from 10-18 yrs (cm)	Amount gained as percentage of height at final age	Amount gained from 10-18 yrs (cm)	Amount gained percentage of height at final age
Poland	urban	36.7	21.0	23.3	14.5
	rural	37.1	22.5	27.1	17.4
Costa Rica	urban	35.3	20.9	30.9	19.5
	rural	34.6	21.1	28.7	18.9
Cuba	urban	35.0	20.7	27.0	17.2
	rural	35.7	20.0	29.0	16.6
Jamaica	urban	36.5	20.9	23.5	14.6
	rural	33.5	20.4	33.8	21.0
Hongkong	well-off	35.8	21.2	23.9	15.2
	poor	35.9	21.6	25.1	16.2
Tunis	well-off	32.1	19.4	30.4	19.2
	poor	31.3	19.5	32.3	20.7
Istanbul	well-off	34.6	20.0	27.9	17.5
	poor	35.9	21.2	26.5	17.3
India	well-off	27.8	16.5	20.0	14.8
	poor	31.4	24.4	24.3	16.4

BIM in adults in industrialized countries.

Body Mass Index (BMI), weight divided by height squared, increases with advancing age, but mostly this does not occur in developing countries nor in traditional societies. BMI is not a fatness index, however, since body mass includes bone, muscle, internal organs, as well as adipose tissue. Among the elderly worldwide, BMI declines around 50-60 years in men and 60-70 years in women (Burr & Phillips) [FIG. 1].

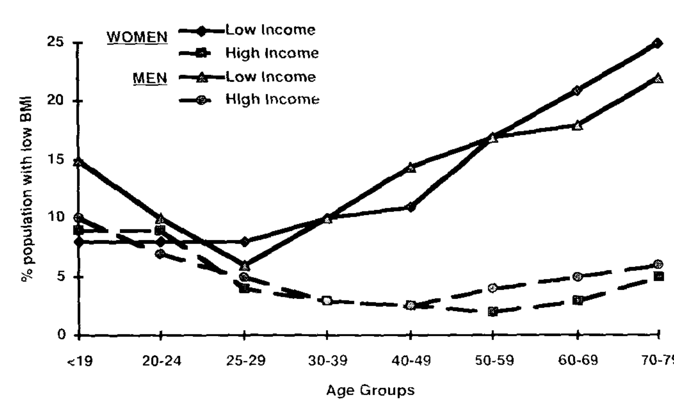
FIGURE 1
Decrese in body mass index in South Wales with advancing age.



Redrawn from Burr and Philliips, 1984

BMI is used as a measure of chronic energy deficiency (Shetty & James, 1993). BMI can also be used to predict the socioeconomic status and the level of development of the community in developing countries. [FIG. 2] As an example let us look at findings from two Brazilian surveys, Estudo Nacional da Despesa Familiar carried out in 1974-75 and the Pesquisa Nacional de Saude e Nutrição in 1989. This shows the percentage of people with low BMI (<17.5, women; <18.5, men) by income level. After the age of 30 years, the number of individuals with low BMI at the lowest income increased with age. At the higher income level the number with low BMI decreased with age until around 50-60 years, which is what one would expect since median BMI increases in middle age (Shetty and James, 1993). Adults appear to adapt to low BMIs by restricting discretionary activities and focusing on work. However, their work output is lower; their days of illness are more numerous.

FIGURE 2
Prevalence of low BIM (<18.5 kg/m in men and <17.5 kg/m in women) by age and income level in Brazil.



Redrawn from Shetty and James, 1993

Weight-for-Height in Children

BMI is not generally used for children since the index changes with age. Instead we use weight-for-height. A puzzling finding among Latin American children of Amerindian ancestry or mestizos who have low height-for-age and low weight-for-age, is that they appear to have weight-for-height means which falls within the 50th to 75th percentiles of the United States NCHS standards (Eveleth & Micozzi, 1988). That is, their weight-for-height is appropriate. To illustrate, I have plotted weight against height for 6 year-olds. At the lower left are mestizo populations from Peru, Bolivia, Guatemala and Mexico. At the top upper right are black, white and mulatto populations from the United States, Jamaica, Haiti, Aruba and the well-off in Guatemala City. Children from Brazil, Argentina, Venezuela, Bermuda, Cuba, Costa Rica, Dominican Republic and Canada are in the lower section of the upper group. Even though they have been described as having a «short, plump physique», it does not indicate that they are overweight or even well-nourished (Martorell, 1987). It does describe their different body proportions, i.e. broad trunk and relatively short legs. In a project to identify Mayan infants and children for nutritional intervention in the Yucatan, this problem was addressed by changing the cut-off for malnutrition to <-1SD weight/height of the NCHS from <-2SD (Balam and Gurri, 1994). Many Mayan children who were classified as normal using <-2SD W/H showed clinical signs of malnutrition.

Overnutrition and Obesity

Now I want to consider the other end of the weight scale. High weight-for-height or high BMIs in adults are associated with increased mortality, and increased prevalence of many chronic diseases:

cardiovascular disease, non-insulin dependent diabetes, gall bladder disease and some site-specific cancers. Overweight and obesity have been increasing throughout the 20th century, not only among the high income groups, but among low income groups in industrialized countries and some sectors of developing countries, such as urban populations and higher income groups and females. Dietary patterns have changed among the less well-off in industrialized countries; today we see that many are consuming a high-energy and high-fat diet.

Childhood Obesity

Childhood obesity is a major health problem in North America; it is a growing problem among some segments of Latin American populations. Obesity in childhood is unhealthy (Johnston, 1985) and leads to future health risks. Immediate health risks in children are related to some of the following: sleep apnea, bowing of the tibia and femur, hyperinsulinemia, hypertension and psychological stress concerning body image. Actually we need to improve our understanding of childhood obesity and its interaction with normal growth and development. Advice for children to go on weight-reduction diets may be not be beneficial and may restrict their growth due to protein deprivation during large weight loss. The fact is we do not know.

Dietary Styles

There may be other alternatives for children than dieting and we need to look for them. Food habits are established early. Young children follow their parents and older siblings in eating patterns. Food can be prepared with less fat, and more whole grains, fruits and vegetables can be offered. Children should have regular exercise such as in school or neighborhood games and less television viewing which often is accompanied by high calorie snacking. One study reported that the number of hours of television viewing was directly associated with prevalence of obesity when socioeconomic status was controlled for (Dietz, 1985).

Another path has been the encouragement of breast feeding in industrialized countries, not only for the immune and growth factors that the infant receives but to reduce overweight in childhood. The breast-fed infant grows more slowly and is smaller that the formula-fed one (Dewey, 1992). The infant's protein-energy requirements may be less than formerly thought. As an aside, among malnourished infants, breastfeeding is associated with a reduction in mortality, not necessarily for nutritional reasons.

Vegetarianism is a possible alternate dietary life style. Low cholesterol levels, low prevalences of hypertension, cardiovascular disease and some cancers among Seventh Day Adventists has spurred much interest in research on these groups and on others who follow a vegetarian diet. For us auxologists, the major concern is whether such a diet is nutritionally adequate for child growth. In the Netherlands a study was carried out on children on a macrobiotic diet (Dagnelle and van Staveren, 1992). Mothers breast fed until an average of 13.6 months and began complementary feeding at 4.8 months. Products of animal origin were not given and fats and oils were avoided. After 6 months of age average height and weight declined below the Dutch reference median. In families who were regular users of some dairy products children had higher weight and height than in those families who never used them. The conclusion is that young children on a vegetarian diet are mildly malnourished and do not show catch-up growth before 10 years of age unless fats, fish or dairy products are given. The major reason is that young children cannot consume the large quantity of food that adults can in order to give them all the necessary nutrients on a macrobiotic diet. However, children on a lacto-ovo vegetarian diet seem to growth satisfactorily (Sanders and Reddy, 1994).

Relationship of Child Weight to Adult Mortality

Next I want to consider the relationship of growth in children with adult mortality. [Table 2] In a large population-based study in Maryland, USA growth parameters in children were investigated for associations with adult mortality (Nieto et al. 1992). Relative weight before puberty and after puberty was positively associated with total adult mortality. The odds ratio increased in a linear fashion with prepubertal and postpubertal weight. The relationship persisted after adjustments were made for education and height. No association of mortality with height was found but children growing the fastest in the prepubertal period had half the odds for middle age mortality than those growing the slowest.

TABLE 2
Mortality odds ratio according to relative weight. Washington County, Maryland 1963-1985

Relative Weigh	Quintile	N° of Cases	Odds Ratio
Prepubertal	1	40	1.0
	2	47	1.2
	3	38	1.0
	4	49	1.4
	5	48	1.5
Postpubertal	1	43	1.0
	2	38	0.9
	3	50	1.3
	4	43	1.2
	5	54	1.6

From Javier Nieto et al, 1992

Similar results were obtained in another study from the United States. Subjects from the Harvard Growth Study, a longitudinal study conducted from 1922-1930, were followed-up 55 years later. Surviving subjects who had been lean (25-50th percentile) or overweight (>75th percentile) during adolescence were interviewed and measured (Must et al. 1992). The investigators looked at all-cause and cause-specific mortality. [Table 3] Men who had been overweight in adolescence had 2 times the relative risk for death than those who had been lean. Relative risks of mortality from colon cancer and cereebrovascular disease were also higher. A surprising result is that for women who had been overweight as adolescents, there was no increase in relative risk. These women only reported some difficulty in carrying out the activities of daily living once they became elderly.

TABLE 3
Relative risk of mortality for group overweight in adolescence compared to lean group. Harvard growth study subjects

Cause of	Men		Women	
	N° deaths	Rel. risk	N° deaths	Rel. risk
All causes	93	1.8	68	1.0
Coronary heart disease	51	2.3	19	0.8
Atherosclerotic cerebro-vascular disease	8	13.2	7	0.4
Colorectal cancer	6	9.1	4	1.0
Breast cancer	0	-	8	0.9

From Must et al. 1992

Persistence of Overweight

The question that remains to be answered is whether fat children or adolescents will be fat as adults. In the Harvard Growth Study just mentioned, the investigators reported that 52% of the surviving subjects who had been overweight in adolescence were still overweight at a mean age 73 years. This is not 100%; it means that 48% were not overweight. In another longitudinal growth study in the United States (Iowa), 31% of the fat children (upper quintile of BMI) became substantially leaner adults (Clarke & Lauer, 1993). Other longitudinal studies from Paris and Prague showed that most fat infants did not stay fat, but twice as many fat than non-fat infants became fat adults. Dr. Rolland-Cachera and her coworkers in Paris (1987) believe that an indicator of adult obesity is the timing of what they call the «adiposity rebound» or the increase in adiposity in childhood. The earlier the increase in adiposity, measured by BMI or subscapular skinfolds, the higher the subsequent adiposity. The findings from Prague are in agreement (Prokopec & Bellisle, 1993).

Another group using the Harvard Growth Study data, carried out an analysis on whether BMI tracks over a 50 year period, from childhood to middle age (Casey et al.1992). «Tracking» means maintaining the same relative position over time. While BMIs during adolescence were good predictors of BMI at 30, 40 and 50 years of age for men, women again were different. Only BMI's after maturity (2 y after PHV) were good predictors of BMI in middle aged women. In females normally there is an increase in fat at puberty, while males either remain stable or lose fat. Another point is that, of course, BMI does not measure fat; in many adolescent males much of the tissue that comprises the weight factor is lean body mass which generally increases in boys at puberty.

TABLE 4
Pearson correlations of BMI from childhood to 50 years of age. Harvard growth study subjects

	Men		
	Late adoles.	30 yrs	50 yrs
Childhood	0.5	0.41	0.41
Late adolescence		0.70	0.55
	Women		
	Late adoles.	30 yrs	50 yrs
Childhood	0.70	0.21	0.05
Late adolescence		0.55	0.26

From Casey et al. 1992

There have been numerous other analyses based on BMI or skinfolds. Generally, the conclusion is that although fat children or adolescents will not absolutely remain fat as adults, they are at greater risk for obesity and for obesity-related chronic diseases in the future than are lean children.

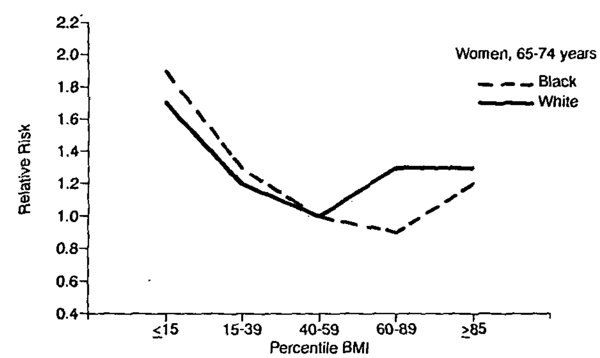
Elderly

I do not think it necessary in this group to reiterate the large number of studies that deal with health risks of overweight and obesity in adults. Moreover, there is a session planned later on this topic. But I do want to discuss whether overweight and obesity in the elderly, especially those over 70 years of age, carry the same risks as in middle-aged adults. This has been a controversial topic with researchers arriving at different answers for different data sets from large population studies or for the same data set using different methods of analysis.

There is a normal decline of BMI with aging which I mentioned earlier. In all populations that my committee looked at for the WHO report on the elderly, average BMI was lower in the age groups 70-79 and still lower >80 years (WHO, 1994).

In the elderly, the question is whether low BMI carries a greater risk for death than high BMI. Waaler (1984, 1988) has reported on the association of mortality in Norway with weight and BMI for 10-year age groups. The relation was U-shaped with greatest mortality at the upper and lower ends of the scale. Two studies from Finland reported U-shaped association for men but not older women who showed little variation in mortality with BMI. [FIG 3] In the United States National Epidemiological Follow-up Study, investigators found a moderate increased risk of death associated with weight in older men, but not women (Cornoni-Huntley et al, (1991). Women only are shown here. In the Framingham (USA) study, the relationship was positive for nonsmoking men and women; however, those who gained weight between 55 and 65 years had a reduced risk of death compared to those who lost weight (Harris, 1988). The conclusion is that although the health risk of overweight among individuals over 70 years remains unclear, both overweight and underweight carry risk for mortality. But moderate overweight at older ages may be protective and generally is associated with lower mortality (Andres, 1985).

FIGURE 3
Relative risk of mortality of black and white women in the United States by percentile BMI from the National Epidemiologic Follow-up Study of NHANES I.



Drawn from data from Cornoni-Huntley et al, 1991

Caloric Restriction and Longevity

Controlled weight gains through an energy restricted diet which is satisfactory for nutrients has been found to increase life span and reduce tumor incidence in laboratory animals. Caloric restriction slows tempo of growth, delays puberty and results in lower body weight. The onset of diseases that occur late in life is delayed (Walford, 1986; Weindruch & Walford, 1988). The increase in life span was greater when restriction was begun immediately after weaning, but even begun at 6 months in rats, it was very effective. The greater the restriction, the longer the life extension.

For ethical reasons it is not possible to carry out a clinical trial on caloric restriction in humans, and so our systematic data are only for laboratory mice and rats. Studies using rhesus monkeys are currently underway in the United States at the National Institute on Aging and the University of Wisconsin.

In spite of this, Dr. Roy Walford, a pioneer in this research, has recommended the diet for humans and even has developed a computer interactive diet planner. There is some anecdotal evidence from individuals of life extension and from very few «natural» laboratories. One of the latter is in Okinawa. Schoolchildren consumed only 62% of the recommended caloric intake for Japan but had adequate vitamin and animal protein intakes. The population has lower heights and weights and far lower mortality rates from cerebrovascular diseases, cardiovascular disease and cancer than other Japanese (Walford, 1986). I do not believe that decrease in ultimate body size through restricting growth in children is a feasible option for humans. Thus, Walford's recommendation is for intermittent (every other day) low calorie meals (800/day) beginning at adulthood.

Lifestyle and Osteoporosis

Children and Adolescents

Now I want to turn to lifestyle and bone development early in life and osteoporosis late in life. Childhood and adolescence are critical periods for bone mineralization. Calcium intake and physical activity are important lifestyle factors. However, deficient calcium intake during childhood or adolescence is unlikely to produce symptomatic disease until late in life.

TABLE 5
Optimal calcium requirements

Group	Optimal Daily Intake (in mg of calcium)
Infant	
Birth-6 months	400
6 months-1 year	600
Children	
1-5 years	800
6-10 years	800-1,200
Adolescents/Young Adults	
11-24 years	1,200-1,500
Men	
25-65 years	1,000
Over 65 years	1,500
Women	
25-50 years	1,000
Over 50 years (postmenopausal)	1,500
Over 65 years	1,500

From NIH Consensus Development Conference Statement, June 1994

Infants and children have a high calcium requirement for growth, ranging from 600 mg/day for 6 month-old infants to 800-1200 for 6 to 10 year old children. The age varies with individual maturation and the timing of peak height velocity. Adolescents (9-17 years) have still greater needs than infants and children (1200-1500 mg/day). Increase in bone mineral density is greatest during puberty, especially in trabecular bone (Slemenda et al, 1994). During the pubertal spurt the average gain in height and weight is positively associated with increases in bone mineral density. When calcium intake is adequate, bone formation depends upon the programmed growth process.

Genetic factors play an important role. Children and adolescents with low calcium intakes, are not able to achieve their genetically predetermined peak bone mass (Matkovic, 1994). This is particularly important because young adult peak bone mass is the most important factor in determining later bone mineral density and fracture risk (Johnson, 1994).

Perhaps there is potential for some bone gain after puberty through some minor changes in lifestyle. Young female university students under 30 years who were followed for up to 5 years continued to gain bone and this was influenced by calcium intake, protein intake, oral contraceptive use and physical activity (Recker, 1992, 1994).

Bone Loss

Bone loss may begin as early as the third decade of life but is most commmon around the time of menopause in women and somewhat later in men. It occurs in all populations studied around the fourth or fifth decade of life, and thus may be considered a universal characteristic of aging (Cummings et al. 1985). Bone loss that increases susceptibility to fractures is called osteoporosis. Fractures occur most commonly at the hip, vertebrae, distal forearm, humerus, and pelvis.

The incidence of fractures increases greatly after age 50 and is almost twice as high for white women as for white men. Older men do have osteoporotic fractures but studies are few and results of calcium intake and fracture incidence are inconsistent. There are some puzzling race as well as sex differences. We know that blacks in the United States and in South Africa have greater bone mass than whites beginning in childhood even though they have lower calcium intake. They have a lower incidence of fractures in late life (Bell, 1994). It appears that they retain more calcium by conserving urinary calcium. Asians in the United States and Japan have lower bone mass than whites but they do not have a high incidence of fractures. Calcium balance studies in Japanese women indicate that 550-650 mg/day is sufficient for zero balance in postmenopausal and osteoporotic women. Another puzzling finding is that while Mexican-Americans have a low calcium intake, they have lower fracture incidence that whites. (I do not know whether consideration was given to the use of lime in making tortilla flour).

The period of greatest bone loss in women is just before and after menopause with the decrease of estrogen. Increasing calcium intake in postmenopausal women may modify bone loss but research shows that it is not a substitute for estrogen replacement therapy. Over the age of 65, calcium absorption declines along with vitamin D production.

Physical activity

There is no good evidence that mild exercise in the elderly increases bone mass, although many studies have been carried out (Marcus, 1994). On the other hand, immobilization, such as in astronauts and bedfast individuals greatly increases bone loss. There is some indication that higher physical activity, especially weight-bearing exercise, among young adults protects against bone loss. Resistance training for the elderly has been shown to increase muscle mass, improve function (Meredith et al, 1992) and maintain flexibility of the arteries. It might also prevent the falls that cause fractures by improving strength and balance. In any case, regular exercise has many health benefits both in the young and old.

Exercise training is well-recognized to favorably influence growth and development in children. Strength increases with age and follows a curve not unlike that for height and weight. Girls increase in strength until menarche while boys can continue to improve until 25-30 years. Young athletes are usually more mature than nonathletes but much of this is a factor of size (Bailey et al 1978). Physical training is seen to increase lean body mass and decrease fat, frequently with no change in body weight. Physical activity helps to regulate the level of fatness, especially when initiated early in life (Bailey et al, 1978). Furthermore, the skills acquired by exercise training in youth should continue to enhance an active life style in adulthood.

CONCLUSIONS

Not only will lifestyles developed during the childhood years influence us for the rest of our lives, but childhood nutrition in the sense that it affects growth and development is key to health in adulthood and old age. Young children who are stunted by poor nutrition will remain small as adults. It is unlikely that any or much catch-up growth will occur during adolescence even if nutrition improves. Children who are overweight and obese will not necessarily be overweight and obese adults, but they will be at a greater risk for obesity-related chronic diseases as adults. Children who are taller and mature earlier than their peers, are most likely not to be taller adults since the growth plates of their long bones close early. Interpolating from animal studies, it appears that children who have a diet reduced in energy but nutritionally adequate will be smaller adults, but they may have a reduced risk for many adult chronic diseases. It is something to consider.

Since bone development in childhood is associated with osteoporosis in the elderly, we may assume that adolescents with high peak bone mass will have a lower risk for fractures in old age. Therefore, public health policies focusing on infant and child growth and nutrition, and education for families in healthful life styles, benefit not only the child but ensure a healthier adult population.

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