EFFECTS OF ENVIRONMENT ON THE GROWTH OF CHILDREN

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SUMMARY

A child's growth achievement depends on his genetic endowment and the environment in which he lives. Comparative studies of children of similar racial origin but growing under different environmental conditions have shown differences in their body size and shape. In general higher income families produce offspring with higher mean birth weight. This is largely due to better nutrition and care of mothers during pregnancy and childhood. Children from higher socioeconomic groups are on an average larger in size in terms of weight, height, head circumference, mid-arm circumference, crown-rump length and leg length. This is largely due to a better home environment including sanitation, nutrition, health and care enjoyed by the better-off children. Generally urban children are larger than rural children mainly due to economic differences between the two areas. In most countries the secular trend to children getting larger still continues reflecting an improvement of living conditions with time. Unlike body size, body shape is less influenced by the environment and the change in body proportion brought about by environment is not permanent. In developing countries, children from higher socioeconomic families have generally thicker skinfolds. On the average, infants and preschool children of European ancestry have thicker triceps skinfolds compared with Negroes and Asians living in comparable environments. It is possible that this is due to long term adaptation to different climatic conditions.

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INTRODUCTION

A child's growth achievement depends on his genetic endowment and the environment in which he lives. Comparative studies of children of different races, growing under similar environmental conditions have shown that population differences in body size and shape exist. For example, Eveleth and Tanner[1] in their worldwide comparison of body size, concluded that Afro-American children growing up under favourable conditions are a little taller and heavier than Europeans and Euro-Americans living in the same cities. This is partly or wholly because they are a litte more advanced in maturity. Asians, on the other hand, under equally favourable circumstances are smaller despite being still further advanced in maturity.

Comparative studies of children of similar racial origin but growing under different environmental conditions have shown differences in their body size and shape. Among the more important environmental influences on growth are nutrition, disease, socioeconomic status and climate. Most of these, when analysed, are seen to be directly or indirectly related to nutrition.

DIFFERENCES IN BODY SIZE

Birth weight

In most countries, higher-income families produce offspring with higher mean birth weights as shown in Table I. The incidence of low birth weight is higher among the less developed areas of the world. Poor maternal nutrition and ill health, smoking and complications of pregnancy are some of the causes of low birth weight. The relationship between maternal nutrition during pregnancy and subsequent birth weight is not clear. Studies of humans in situations of acute starvation suggest an effect of maternal nutrition on birth-weight, but less clear results appear under non starvation situations. In some developing countries weight at birth is found to be dependent on maternal nutrition. For example in the INCAP research in rural Guatemala,

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TABLE I

MALE BIRTH WEIGHT MEANS AMONG DIFFERENT SOCIOECONOMIC GROUPS

Place		Well-off (kg)	Poor (kg)	Source
Teheran, Iran		3.43	3.27	Hedayat *et. al.*, 1971[2]
Shiraz, Iran		3.18	3.02	Serram and Saadatnejadi, 1967[2]
Lebanon		3.50	3.40	Hasan *et. al.*, 1969[2]
Delhi, India		3.16	2.74	Banik *et. al.*, 1969[2]
Campinas, Brazil		3.41*	3.18*	Martins Filho *et. al.*, 1974[2]
Baltimore, USA : Black		2.97*	2.91*	Penchaszadeh *et. al.*, 1972[2]
White		3.27*	3.13*	Penchaszadeh
Kuala Lumpur, Malaysia :	Malay	3.23	3.05	Thomson, 1962[3]
	Chinese	3.21	3.12	
	Indian	3.18	2.85	
Kuala Lumpur, Malaysia :	Malay	3.14*	2.91*	Yusof and Yusof, 1979[4]
	Chinese	3.17*	3.14*	
	Indian	3.13*	2.84*	

*Both sexes.

Lechtig *et. al.*,[5] found that supplementing the diets of pregnant women with a high-calorie drink reduced the incidence of babies with birth weight of 2.50 kg or less.

Population differences in size at birth may reflect not only the environment of the infants and their mothers, but also the nutrition of the mother while she was growing up. Geefhuysen *et. al.*,[6] found that maternal stature was closely linked with her early socioeconomic status and that short women of less than 155 cm were more likely to produce small babies. This is also evidenced by the phenomena of catch-up growth during infancy, when a reassortment of relative sizes among children comes about, namely babies with genes making for large size but born to small mothers, move upwards through the centiles and babies born large, but with genes making for small adult size, slide gently downwards.

Therefore proper nutrition of mothers during childhood and pregnancy, together with good antenatal care, are essential in the prevention of low birth weight babies.

Growth during childhood

Effect of Socioeconomic level on growth. Children from families belonging to the higher or middle socioeconomic groups of any country are on an average larger in body size than their peers in the lower socioeconomic groups. Means of weight and height of upper socioeconomic groups, in different cities, are higher than those of the lower socioeconomic groups.

In Kuala Lumpur, elite Malay pre-school children were found to be heavier, taller and had bigger head circumference than the less privileged Malay children. Further, the weight curve as well as the length curve of the less privileged children deviate progressively with age from those of the elite children, such that the difference at six months of age was 0.3 kg for weight and 1.1 cm for length while the difference at two years of age was 1.1 kg weight and 3.5 cm for length.[7]

The elite children lived in homes with good environmental sanitation, received adequate nutrition and care (including medical care) and suffered from only minor illnesses of an average of 3.6 episodes per person-year consisting mainly of upper respiratory tract infections. On the other hand, children of the lower income Malays would have received a satisfactory diet only during the first few months of life, since most Malays breast-feed their babies.

However, the weaning diet of lower income families as a whole is often unsatisfactory consisting mainly of starch and very little protein, vegetable and fruit. The transition from milk to adult diet is sometimes abrupt and the young child is offered bulky adult meals that are overspiced, difficult to masticate, indigestable and spaced out over long intervals. As a result the young child is only able to obtain a largely carbohydrate (rice) meal together with a little sauce or gravy from the main dishes – a diet that is often deficient in protein, vitamins and minerals.[8]

To compound this difficulty, a variety of food taboos often operate that deny these children essential protein

and other food during the period when they most need them. For example, in Malaysia, the rural Malay toddler is often denied fish, one of the few sources of protein available to him, in the mistaken belief that it is the cause of ascaris.[9] It is likely that the slowing down of growth of the less privileged children is largely due to a poor weaning diet and a lack of proper transitional diet.

Besides nutrition, infections could have contributed to the slow growth rate as infections are common among the undernourished. The interactions between infection and undernutrition are well known but difficult to quantify. Morley[10] has shown the effect of measles on the nutritional status of African children. He showed that 90% of these children lost weight as a result of measles and it took an average of seven weeks for them to regain their former weight. In Malaysia, even among the higher income well nourished children, measles had an adverse effect on the nutritional status of 42% of those who developed measles and it took 10–21 months before their weight returned to their previous centiles.[11]

Studies[12-15] among school children in Kuala Lumpur and Petaling Jaya showed that for boys and girls, the Malaysian Chinese were heavier and taller than the Malays and the Indians. However, when household income was taken into consideration, the study showed that irrespective of ethnic group, higher income children were heavier, taller and had larger mid-upper arm circumferences than those of the lower income group. Further, irrespective of ethnic group, children with a larger number of siblings had a significantly higher rate of underweight and stunting compared to those with less than four siblings (Table II). Similar effects were found among British children.[1]

Effect of locality on growth; rural – urban comparison. Children in urban areas are usually larger than children in the surrounding rural areas. Eveleth and Tanner[1] in their worldwide comparison of human growth concluded that urban children and adults are generally taller than their rural counterparts except in some developed countries like USA and Australia and some urban slums in developing countries. The urban – rural differences reflect primarily an economic differential between town and rural areas. In general, urban families are better off than rural when it comes to food supply, medical services and sanitation facilities.

Secular trend. Over the past 100 years in industrialised countries and recently in some developing countries, children have been getting larger and growing to maturity more rapidly. For example in Malaysia, rural Malay boys in the 1970's were found to be taller than those in the 1950's.[16] In some upper and middle class families in the United States, this secular increase has stopped. Improved nutrition, control of infectious diseases through immunization and sanitation, more widespread health and medical care, and population mobility appear to be responsible for this secular trend.

Effect of psychosocial stress on growth. There is now clear evidence that in some children, psychological stress causes relative failure to grow. It does this by affecting the secretion of growth hormone. When the stress is removed secretion of growth hormone occurs again, and in clinical cases, a catch-up occurs.

DIFFERENCES IN BODY SHAPE

There are population differences in body shape. For

TABLE II

FREQUENCY DISTRIBUTION OF SCHOOL CHILDREN BY ETHNIC GROUP, NUMBER OF LIVING SIBLINGS, EXPECTED WEIGHT FOR AGE AND EXPECTED HEIGHT FOR AGE

Ethnic group	No. of siblings	Expected weight for age Less than 70%			Expected height for age Less than 90%		
		No.	%	"p"	No.	%	"p"
Malay	Less than 4	85	29	$.02 < p < .05$	95	33	$.02 < p < .05$
	4 and above	178	38		194	41	
Chinese	Less than 4	51	9	$< .001$	50	9	$< .001$
	4 and above	93	20		79	17	
Indian	Less than 4	42	26	$< .001$	26	16	$< .001$
	4 and above	186	32		144	36	

example, the population with the longest legs relative to sitting height is the Australian Aborigines who far exceed the African and African-descended population. The Africans in turn have relatively longer legs than the Europeans or the Asians who have relatively the shortest legs.[12]

Unlike body size, body shape is less influenced by environment. For example comparison between Malaysian and Hong Kong children showed that the lower income Malay boy and girl were lighter than their Hong Kong counterparts. However, when comparison is made between a group of elite Malaysian Malay boys and girls, aged from birth to two years, with that of less privileged Hong Kong children, it showed that the average elite Malay boy and girl were heavier, taller, had bigger head and mid-arm circumferences, longer crown-rump length and leg length.[7] However, the body proportion i.e., leg length relative to crown-rump length was similar.[7] This demonstrates that differences in socioeconomic conditions result in differences in body size but not in body proportion.

Improvement of environmental conditions could alter body proportion as demonstrated by Greulich's[17] data of longer legs to trunk during growth of Japanese children living in California. However, Greulich,[18] on remeasuring his original subjects, reported that adult leg length to trunk length did not differ from that of Japanese adults in Japan. Thus environment acting alone is apparently not sufficient to cause permanent difference in body shape.

DIFFERENCES IN AMOUNT OF SUBCUTANEOUS FAT

In developing countries, children from better off families have, on an average, thicker skinfolds than their poorer peers. For example, studies in Malaysia[7,15] showed that better off Malaysian preschool and school children had thicker skinfolds than their poorer peers.

Population differences in skinfolds exist. For example, the mean triceps skinfold curves of the elite Malaysian boys and girls were similar to those of the British till three months of age when the Malaysian curves of both sexes reached their peaks while the British curves continued to rise and reach their peaks at about six months in boys and 12 months in girls, so that the Malaysian peaks at the 50th percentile are 2 mm lower.[7] The duration of peaking among the Malaysians was about two months while that of the British was longer, six months in boys and one year in girls. This pattern of early peaking followed by a rapid drop of skinfold thickness seen among Malaysian children is also seen among children in developing countries such as Singapore, Hong Kong, Taiwan, Guatemala, Nigeria and New Guinea.[7]

Available data indicate that in general, infants and preschool children of European ancestry have larger skinfolds compared with Negroes and Asians. Could the racial differences be due to socioeconomic differences since non-whites are generally less well-off and subcutaneous fat is at least partially controlled by nutrition?

Eveleth and Tanner[1] stated that most available evidence show Afro-American children as having smaller triceps skinfolds than Euro-American children living in roughly comparable circumstances. Harsha *et. al.,*[19] confirmed previous findings that white American children had generally thicker skinfolds than American children of African origin of the same body weight but that the subcapular skinfold was relatively thicker in those of African origin.

They suggested that this difference in distribution of fat may be evidence of a genetic trait developed under circumstances demanding both an energy reserve and a facilitation of heat loss in tropical climates. Therefore, one cannot dismiss the possibility of the long term adaptation of non-whites living in hot tropical areas for thousands of years resulting in smaller triceps skinfolds compared with whites living in cold temperate areas.

CONCLUSION

As growth is influenced by many environmental factors, the prevention of malnutrition requires a holistic approach of raising the socioeconomic status and educational level of the community; improving medical and health care to the community, including maternal and child health; control of communicable diseases and educating parents on family planning, sanitation, child nutrition, immunization and the use of health facilities.

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