CHAPTER - IV

S U M M A R Y

SUMMARY

In many poor countries, food resources are scarce and their distribution inequitable, leading to a wide prevalence of undernutrition. The major deficiencies in poor diets in this and other similar regions are of food energy, protein, calcium, iron and vitamin A. Evidence for these deficiencies is manifest in the form of stunted growth, poor productivity, skeletal retardation, anemia, night blindness, xerophthalmia etc.

On the other hand, the performance of the undernourished individual is not as bad as might be expected. Children continue to grow in intakes that are barely above levels assumed to be required for basal metabolism. The gestation and lactation performance of the poor woman on a low plane of nutrition compares favourably in many respects with that of the upper class woman. Most of the production of material goods in poor countries is accomplished by apparently undernourished individuals.

This raises questions about the short term responses and long term adaptation to globally poor diets and to diets lacking in one or other of the nutrients. The response of the organism may vary with the nature of the deficiency and the age of the animal. Studies in this direction are important as they may help provide a more realistic appraisal of the consequences of undernutrition.

The present studies were designed in this context, on rats, and are concerned with selected aspects of the problem.

The first experiment was concerned with the effects of subjecting rats to different degrees of preweaning and/or early postweaning food restriction on growth rate, feed efficiency, subsequent activity, reproductive performance and maternal behavior.

Neonatal undernutrition was induced by manipulating litter size, and early postweaning undernutrition, by feeding animals restricted amounts of a qualitatively adequate diet for 8 weeks. Thereafter, all animals were rehabilitated on ad lib food supplies.

The animals responded to postweaning food restriction by improving their feed utilization efficiency, as measured by weight gain per unit food intake, giving evidence of adaptation to nutritional stress. Females adapted better than males to mild undernutrition.

Tendency for catch-up growth was seen on rehabilitation. This catch-up appeared to be associated not with significantly greater food intake compared to controls, as one would expect, but with improved feed utilization efficiency. An increase in feed utilization efficiency in the face of food shortages is understandable, but it is remarkable that this is maintained even when food is available in plenty.

In order to study the impact of early undernutrition on subsequent activity the male rats were tested after 5 weeks of rehabilitation. Results confirm previous findings that nutritional stress may result in reduced voluntary activity as measured in an open field, and increased activity under stress, as measured in the activity wheel.

The reproductive performance of animals undernourished in early life and rehabilitated thereafter was not impaired but maternal behavior, as observed in the maternal behavior maze, was affected adversely. However, the growth of their progeny was not affected, suggesting normal maternal behavior in their ordinary cages. It appears that the maternal behavior maze may be a stressful situation for the mother.

Thus early undernutrition does not seem to have any appreciable effect on the long term functioning of the animal.

In the second experiment, comparative studies on two generations of rats fed diets simulating those consumed by different population groups with regard to reproductive performance, nutritional status and nitrogen balance were conducted. Diets were composed so as to resemble the low income Gujarati (LIG), the high income Gujarati (HIG) and Western (British (W) diets.

The gestation performance of the LIG group was almost as good as that of the HIG and W groups. This was achieved by an improved efficiency of food utilization during this period

compared to that in the pre-gestation period. This was associated with a large increase in per cent of absorbed nitrogen retained during this period. No such increase was observed in the HIG and W groups.

Some impairment in lactation performance of the LIG group was seen. This was accompanied by some decline in the efficiency of food utilization and in per cent absorbed nitrogen retained over gestation values. But a concomitant increase in food intake allowed for a net retention of nitrogen in the LIG group, which was comparable to retentions in the HIG and W groups. In this period, the W group seemed more prone to adipose tissue deposition while the LIG and HIG groups laid down tissue containing more nitrogen.

These studies underline the importance of adaptive mechanisms to meet nutritional stress during gestation and lactation as distinct from those seen in the non-pregnant, non lactating animal. The poorly nourished pregnant and lactating animal seems to display a remarkably efficient utilization of available nutrients.

The third experiment was conducted to study the effects of feeding for prolonged periods, different levels of dietary protein, and to see whether previous dietary history alters the response of an organism to a specified level of dietary protein in later stages. Animals fed a low or high protein diet in early life were switched to diets providing a moderate protein diet.

Growth deficits of the low protein fed animals as compared to high protein fed controls tended to decline with the progress of treatment, suggesting the intervention of adaptive mechanism. When protein deficiency was mild, deficits were less in the case of females compared to males.

Animals switched from a low to a moderate protein diet displayed a more efficient and rapid adaptation to the switch than those switched from a high to a moderate protein diet, as judged by data obtained on growth, nitrogen balance, nutritional status and incorporation of labelled leucine into serum protein. Adaptive mechanisms that come into play during periods of protein deprivation appear to persist later when stress is reduced.

Lysine requirements are known to change with age. The fourth experiment was designed to study the effect of lysine supplementation to wheat at different ages and the effect of prolonged feeding of a wheat based diet or the same supplemented with lysine to young animals.

Younger animals were more adversely affected by lysine deficiency than the older animals as judged by growth and nutritional status. Growth was permanently impaired as a result of prolonged lysine deprivation. The older animals seem to adapt better to lysine deprivation by reduced turnover of protein or increased reutilization of amino-acids.

Calcium requirements also change with age. In the fifth experiment, the response of bone composition to low and high levels of dietary calcium at different ages and to a switch

to a moderate calcium diet was studied.

The response of the animal to very low or high calcium diets is age dependent. There seems to be a regulatory mechanism to preserve bone composition as near normal as possible The recovery from adverse effects of low dietary calcium on feeding of a moderate calcium diet may be dependent on age as well as nutritional status of the animal.

A 1 : 6 conversion ratio for vitamin A to carotene has been adopted by the Foods and Agriculture Organization. However, in populations where carotene forms the major source of vitamin A in the diet, a higher conversion ratio is indicated. The question arises whether previous exposure to carotene has any effect on the animal's subsequent ability to convert carotene to vitamin A. The sixth experiment was conducted to investigate the utilization of carotene in rats depleted of vitamin A in relation to dietary vitamin A source (vitamin A or carotene) in early life.

Results suggest a more efficient utilization of carotene instead of vitamin A in early life.

In conclusion, the present studies suggest a high degree of adaptability of the organism to situations of nutritional stress. When nutritional stress was mild, this adaptability appeared to be more in females than in males. Pregnant and lactating females were markedly superior to the non-pregnant and non-lactating females in this regard. In many situations,

metabolic patterns acquired during periods of nutritional stress seem to persist even when the stress is removed. There are indications that even if short term nutritional stress causes some adverse effects, there is no gross impairment with regard to growth, development or reproduction in chronic but not too severe stress conditions.