CHAPTER - V

SUMMARY AND CONCLUSION

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Maintenance of erythropoiesis is one of the requisites during pregnancy when the foetus acts as a true parasite. It assures its own production of haemoglobin by drawing iron and other nutrients from the mother. As anaemia is widely prevalent in India and is the common complication during pregnancy it has created more interest in our country where social obstetrics has assumed a greater dimension. The social structural pattern (strata) of our country classified by such factors as income, occupation and education show adverse effect in complicating pregnancy. As about 75% of the population in our country belong to lower socio-economic segment and majority of them are ignorant of the haemopoietic principles of the diet, the present study, therefore, has been devised to investigate the metabolic changes and behaviour of some serum minerals and their allied erythropoietic constituents in women belonging to different socio-economic status in their late pregnancy.

The study was conducted in a teaching hospital in Calcutta. All the pregnant women under study were primigravida, that is in their first pregnancy and the investigations were done in their third trimester. For appropriate comparison a parallel study with non-pregnant subjects as controls was also carried out. All the pregnant and non-pregnant subjects were primarily divided into two age groups. Subjects of each age group were again sub-divided into two socio-economic groups — Higher (Group H) and Lower (Group L). Blood samples of these non-pregnant and pregnant subjects were analyzed for haemoglobin, serum iron, per cent saturation of transferrin,

serum copper, serum ceruloplasmin, serum zinc, serum total proteins, serum albumin, serum globulin and plasma total ascorbic acid. A diet survey was also carried out to assess the dietary intake of iron, protein, ascorbic acid, calcium and calories.

In this study, diets of both non-pregnant and pregnant women belonging to low socio-economic status of both age groups were found to be generally inadequate with regard to ascorbic acid, protein, calories, iron and calcium. The intake of caloric as well as protein (particularly animal protein) by the non-pregnant and pregnant women of both the lower and higher socio-economic groups is lower than that of the other countries. Only a very few non-pregnant and pregnant subjects of low socio-economic group fulfil the adequacy of all the nutrients as per recommendation of the Indian Council of Medical Research. A large variation (Tables 2-4, pp 50-53) was observed in the nutrient intake among the subjects belonging to the higher and lower socio-economic groups. The consumption of ascorbic acid,protein, iron, calcium and even calorie was considerably lower in the non-pregnant and pregnant subjects of the latter group than that of the former group. A possible influence of family income on nutrient intake has also been reported (Myres and Kroetsch, 1978). In the present study the mean intake of ascorbic acid and protein (particularly animal protein) showed clear and consistent increase with the rise in the income level. The dietary intake of these constituents by the subjects of lower socio-economic group during pregnancy was more unsatisfactory than that observed prior to the onset of pregnancy as because the necessary increment of the nutrients such as protein, calcium, iron and even energy during pregnancy was not significantly raised to meet the extra demands at this stage. Only

a small number of the subjects were found to have increased their dietary intake to meet the additional demand during pregnancy. The fact is that most of these women (belonging to lower socio-economic group) supplimented family income by manual work. With the onset of pregnancy it becomes increasingly difficult for them to obtain and to be engaged in such occupations. The consequent reduction in the family income is thus reflected in the budget and lead to curtailment of per capita food consumption. Thus the extremely unsatisfactory diet of pregnant women in the poor communities is mostly the result of economic factors and partly due to lack of proper education (i.e. ignorance).

Among the different minerals affecting erythropoiesis, iron play the most important role as it forms an integral part of the haemoglobin molecule. In serum, iron is bound to a transport protein, transferrin, and for the synthesis of haemoglobin molecule iron is obtained from it. The serum iron level largely depends on the body iron stores, yet it is by and large, a direct and very useful index of iron absorption and its utilization in the body. Due to limited capacity of the body to excrete iron, homeostasis of iron is maintained primarily by adjusting iron absorption rather than by excretion. The absorption of iron is affected by — a) the age, b) iron status and state of health of the subject, c) conditions within the gastro-intestinal tract, d) the amount and the chemical form of the iron ingested, and e) the amounts and proportions of various organic and inorganic components of the diet. The most important factor regulating rate of iron absorption is its availability in the diet. Iron absorption from food occurs along two pathways (Fig.13,p.75) —

the most effective pathway involves haem iron (which is taken up and catabolized by mucosal cells). Its absorption is unaffected by other dietary components. Non-haem iron, however, appears to be absorbed from a stable pool which is markedly affected by other food substances in the meal. Such iron absorption is facilitated by the presence of protein and ascorbic acid in the diet, but is reduced by substances such as phytates, phosphates etc. Availability of iron can also be improved by increasing the quantity and quality of dietary protein. Proteins of animal origin are most effective in this regard. Higher level of dietary calcium on the other hand counter balances the complexing effect of excess phosphate and phytate with the dietary iron and thus increases the availability of iron.

It appears from the present study that serum iron level of pregnant women belonging to higher socio-economic group (Group H) irrespective of their ages decreases compared to that of the corresponding non-pregnant subjects. This decrease has been ascribed to the physiological haemodilution. But this reduction in serum iron level in pregnant women does not go to the deficiency level presumably because all the subjects (non-pregnant and pregnant women irrespective of age) belonging to Group H consumed adequate amounts of iron, proteins, ascorbic acid and calcium resulting in better absorption of iron in the intestine. Pregnant women belonging to lower socio-economic status (Group L) irrespective of their ages also exhibit a reduction in the serum iron level which however falls below the deficiency level compared to that of the corresponding non-pregnant subjects. It also appears from the present investigation that all subjects (pregnant and non-pregnant) belonging to Group L (irrespective

of age) consume lesser amount of iron, proteins, ascorbic acid and calcium compared to the corresponding non-pregnant and pregnant subjects of Group H (Tables 2-4, pp 50-53). Thus the lower level of dietary iron and the associated dietary constituents in the subjects of Group L may have brought about by lower absorption of iron which in turn results in the diminished level of serum iron. As the intake of these essential dietary constituents does not increase sufficiently to combat the demand due to pregnancy, the pregnant subjects belonging to Group L exhibited significantly lower level of serum iron than the corresponding pregnant subjects of Group H. The picture is more or less the same in both the age groups. A good correlation between the body iron status and the respective socio-economic condition of the individual has been reported (Czajka-Narins et al, 1978). Present study also agrees well with the above findings and further reveals that the non-pregnant and pregnant subjects of lower socio-economic status (irrespective of their ages) are more prone to iron deficiency.

The non-pregnant women belonging to Group L have deficiency in dietary protein, ascorbic acid and iron compared to those of the corresponding subjects of Group H. This results in a state of serum iron deficiency (associated with insignificant change in serum globulin i.e. serum total iron binding capacity) leading to the reduction in the per cent saturation of transferrin in those subjects. Similarly the pregnant subjects of Group L exhibited reduction in the per cent saturation of transferrin in comparison to those of the pregnant subjects of Group H. It is further evident that per cent saturation of transferrin decreases markedly in all the pregnant subjects (irrespective of age and socio-economic groups) in comparison to that of the non-pregnant subjects of the respective groups. This reduction in the

per cent saturation of transferrin during pregnancy is brought about by two factors — the fall in serum iron concentration and the increase in serum total iron binding capacity resulting from increase in serum globulin level (Tables 5 and 6, pp 55 and 56) due to pregnancy.

The concentration of serum albumin and serum total protein of non-pregnant women belonging to Group L (irrespective of age) are much lower than those of the subjects of Group H. This occurs due to the lower dietary intake of protein by the non-pregnant subjects of Group L in comparison to those of Group H. Present study also indicates that serum albumin and serum total protein concentration of pregnant women irrespective of age and socio-economic groups are lower while concentration of the serum globulin is higher than that of the corresponding non-pregnant subjects. This reduction in serum total protein concentration during pregnancy (irrespective of age and socio-economic status) is considered as a normal physiological phenomenon resulting from hydraemia. Diet survey results indicate that even the non-pregnant subjects of Group L consume protein below the level of RDA (Recommended Daily Allowance). As the intake of this crucial nutrient is not increased sufficiently during pregnancy, the serum albumin and serum total protein concentrations undergo considerable reduction in the pregnant subjects of Group L than those of Group H.

It appears from this study that the plasma total ascorbic acid concentration of non-pregnant women belonging to Group L (irrespective of age) is lower than those of the subjects of Group H, as because the dietary intake of ascorbic acid by the non-pregnant subjects of the former group is lower than that of the latter group. A decreased level of plasma total ascorbic acid is also observed in

all the pregnant subjects irrespective of age and socio-economic groups. This reduction in plasma total ascorbic acid, even in the pregnant subjects of Group H consuming adequate amounts of dietary ascorbic acid, is possibly due to the normal physiological response to pregnancy caused by hydraemia.

Copper has the distinction of being the second trace element (iron was the first) found to be essential for mammals. The serum copper protein, ceruloplasmin, is directly involved in the mobilization of iron into plasma from iron storage cells in the liver and thus helps in the supply of iron for haemoglobin synthesis (Figs.14 and 15, pp 89 and 97). In the present investigation, the serum level of copper and ceruloplasmin of non-pregnant women belonging to Group L (both age groups) is found to be increased over those belonging to Group H. A similar change has also been observed in pregnant women. From the available information it can be suggested that subjects of Group L under study consume sufficient amount of copper in their daily diet. From the present study it is indicated that the subjects (both non-pregnant and pregnant women) belonging to Group L consume lower amount of iron, ascorbic acid and protein. Lower levels of these nutrients facilitate the intestinal absorption of dietary copper resulting in the elevation of serum copper and ceruloplasmin levels in those subjects belonging to Group L. It has also been found that both non-pregnant and pregnant subjects belonging to Group L show higher incidence of iron deficiency compared to the corresponding Group H subjects. Thus greater the incidence of iron deficiency, the higher is the level of serum copper and ceruloplasmin. Present study also indicates that the serum copper and ceruloplasmin levels of pregnant women irrespective of age and socio-economic groups increase over those of the corresponding non-pregnant women. This increase in

serum copper concentration is possibly due to the increased absorption of this mineral and also due to the increase in the ceruloplasmin bound copper, caused by an increase in maternal oestrogen level during pregnancy (Henkin et al, 1971).

The trace metal zinc has been reported to be closely related with the metabolism of copper. It also appears from the present investigation that non-pregnant subjects belonging to Group L (of both age groups) contain much less serum zinc than the corresponding subjects of Group H. Similar changes in serum zinc concentration was observed in pregnant subjects of Group H. Available informations suggest that the subjects of Group L, under study, consume sufficient amount of zinc. Thus the lower level of serum zinc in Group L subjects has been ascribed to the failure in the uptake of zinc by the intestinal mucosal cells caused by deficiency of dietary protein and also due to the failure of the intestinal cells to exchange absorbed zinc with the diminished level of albumin as observed in present investigation. Present study also indicates that pregnant subjects irrespective of their age and socio-economic groups show a lower level of serum zinc concentration than those of the corresponding non-pregnant subjects. The lower level of zinc in maternal serum at term is primarily due to decrease in zinc binding capacity presumably caused by diminished quantities of zinc binding proteins such as transferrin and albumin. Further, serum zinc deficiency was more pronounced in pregnant subjects of Group L. This has been ascribed to the physiological stress imposed by pregnancy on the subjects who consume much less nutritious food due to socio-economic problems.

Present investigation indicates that the non-pregnant subjects

of Group L show a lower level of blood haemoglobin than those of the corresponding subjects of Group H. A similar change in haemoglobin level is also observed when comparisons are made between the pregnant subjects of the two socio-economic groups. A careful examination of the results of the present study and available information suggest that the greater incidence of anaemia in the non-pregnant and pregnant subjects belonging to Group L may be caused by several factors which are summarized here:

a) Inadequate supply of iron in the diet which results in diminished absorption of iron.

b) As the dietary protein (particularly animal protein), ascorbic acid and calcium play dominant roles in facilitating iron absorption in the intestine, inadequate supply of these dietary constituents results in a decreased absorption of dietary iron.

c) Presence of higher amounts of phosphate and phylate in the diet, specially due to greater dependence on vegetal products, impairs the absorption of iron.

The above factors primarily bring about lower level of serum iron as well as deplete body iron stores.

d) Low levels of dietary protein and ascorbic acid facilitate greater absorption of copper in the intestine, resulting in the higher level of serum copper and ceruloplasmin. Moreover, there is an antagonistic relationship between zinc and copper metabolism; thus lower level of serum zinc as observed in the present study has some role in elevating the serum ceruloplasmin level. But this rise in ceruloplasmin level fails to promote the mobilization of sufficient

quantity of iron from iron storage cells to plasma possibly due to the decreased body stores of iron in the subjects of Group L. Thus availability of iron for the synthesis of haem is limited.

e) Results of the present study indicate that all the subjects belonging to Group L consume less protein and calorie than the corresponding subjects of Group H. Hence, the amino acids resulting from endogenous protein breakdown are primarily used for energy production. These conditions therefore limit the availability of amino acids necessary for the synthesis of globin.

f) Inadequacy of other dietary factors like vitamin B_{12} and folic acid may also result in diminished synthesis of globin.

During pregnancy the demand for iron by the mother is increased because she needs to expand her red cell mass and meet up the requirements of the developing foetus. This demand of iron is maximum at the last trimester. The pregnant women of Group L receive low dietary iron and other nutrients such as protein, ascorbic acid etc. which are needed for facilitating iron absorption and is also necessary for its metabolism. Moreover, they depend mostly on vegetal products for their nutrient supply. Thus all these factors cause a greater diminution in haemoglobin level in these subjects than the corresponding pregnant subjects of Group H. It is further evident that blood haemoglobin concentration of the pregnant women irrespective of their socio-economic status is shown to be decreased in comparison to the corresponding non-pregnant subjects. This seems quite reasonable as the plasma volume increases faster than the mass of red cells during pregnancy.

Age related changes in the dietary intake of certain nutrients by the non-pregnant and pregnant subjects have been observed in the present study. Intake of protein, ascorbic acid, iron, calcium and energy by the non-pregnant and pregnant women belonging to higher age group (irrespective of their socio-economic status) are shown to be decreased than that of the corresponding subjects of lower age group. The following factors have been ascribed to be related with the reduced intake of dietary constituents in the higher age group.

a) Age related loss in the sense of smell and taste;
b) Loss of B.M.R. and physical activity which controls the calorie intake;
c) Decreased abilities of digestive and absorptive functions;
and d) Dental insufficiencies.

Present investigation reveals an increase in serum globulin with concomitant reduction in the serum levels of albumin, total proteins, iron, zinc, plasma total ascorbic acid, per cent saturation of transferrin and blood haemoglobin in non-pregnant and pregnant women of higher age group than those of the corresponding subjects of the lower age group. Decreased levels of serum total proteins, serum iron and plasma total ascorbic acid in the higher age group have been ascribed to the decreased intake of those dietary constituents. Decreased per cent saturation of transferrin has been ascribed to the decreased concentration of serum iron. Decreased concentration of serum zinc has been related with the decrease in the level of serum albumin caused by decreased intake of protein. No age related change in serum copper and ceruloplasmin level have been observed in the higher age group subjects. Lower haemoglobin concentration has also

been observed in the higher age group subjects which is possibly due to the :

a) decreased level of serum iron as well as body iron stores;

b) decreased level of serum total proteins which may affect body protein and limit the amino acids necessary for the synthesis of globin; or

c) imperfection of body protein synthesis due to aging process which may impair synthesis of globin.

Thus it appears that the blood constituent, namely globulin, shows a rise in concentration with increasing age while others - serum copper and ceruloplasmin stay fairly constant, and yet others - serum levels of iron, zinc, total proteins, albumin, total ascorbic acid and blood haemoglobin progressively fall. It may be that all these trends in blood chemistry are related to aging process governed by genetic inheritance of the individual. But it is not clear whether these changes are truly physiological or due to some early pathological processes.