Special Section
Maternal & Child Nutrition
Coined two decades ago, ‘dual nutrition burden’ refers to the ongoing nutrition transition in low- and middle-income countries characterized by persistent under-nutrition and micronutrient deficiencies and the emerging problem of over-nutrition. Epidemiological, clinical and biochemical studies undertaken in developed and developing countries during last two decades have shown that there is yet another dimension of dual nutrition burden: under and overnutrition can affect the same individual and have trans generational impact. For example, maternal undernutrition and anaemia as well as hypertension during pregnancy can result in undernutrition of the foetus in utero. Maternal obesity with gestational diabetes can result in foetal macrosomia; intrauterine growth retardation is seen in diabetic women with pregnancy induced hypertension. Several Indian scientists have reported that low birth weight and under-nutrition in childhood and adolescence may be risk factors for over nutrition and non-communicable diseases in adult life. The Nutrition Foundation of India’s Symposium on "Maternal and child nutrition - a life cycle perspective" explored the fascinating interactions between macro- and micronutrient deficiencies and the intergenerational dimensions of the dual nutrition burden and the possible clinical and public health interventions to minimize the burden.

Twenty years ago Barker published his findings that in England and Wales mortality from cardiovascular diseases was higher in persons who whose birth weights were low. These findings have been subsequently confirmed in several developed countries. Barker hypothesized that intrauterine undernutrition programmes the metabolic pathways in the foetus, so that the foetus is thrifty in nutrient utilization. The foetus prioritises utilization of available limited nutrients: brain is protected so that its growth is unaffected; growth of abdominal organs and musculo- skeletal system is compromised; however fat deposition may be higher than normal – the so called thin fat neonate. The studies by Lubchenko and Ghosh that low birthweight neonates belong to two distinct categories - preterm and mature intrauterine growth retarded and that they had different mortality and growth characteristics were published only in the nineteen seventies. Therefore, in these studies on cardiovascular diseases (CVD) in low birthweight infants from developed countries, it was not possible to assess what proportion of the low birthweight neonates were preterm and growth retarded but mature. However, going by the prevalence of these two groups in mid twentieth century, a majority were likely to be preterm neonates.

Long term follow up studies on the “Delhi Cohort” had shown that birthweight is an important determinant of growth; mature low birthweight infants have a lower trajectory of growth during infancy, early childhood and adolescence as compared to the infants with normal birthweight. Under nourished children who had accelerated gain in BMI in early childhood as compared to the rest of the cohort were found to be at higher risk of developing hypertension and diabetes. Studies from Pune have shown that low birth weight infants who gained weight in early childhood, had higher plasma glucose levels at 4 yr of age and at 8 yr of age had higher LDL cholesterol, systolic blood pressure and insulin resistance. It appears that in countries undergoing nutrition transition, the same individual may have face dual nutrition burden during his/her life time and incur health hazards associated with both.

Epidemiological studies in India and studies in experimental animals reviewed in this issue, indicate that maternal macro and micronutrient
Prevalence of underweight rates in Indian preschool children is higher than underweight rates in sub-Saharan Africa; however under five mortality rates in India are far lower than the Sub-saharan Africa the so called South Asian enigma. It is possible that the South Asian enigma is mainly due to the differences in rates of preterm births and mature low birthweight neonates between Asia and Sub Saharan Africa. In Sub Saharan Africa preterm births constitute most of the low birthweight neonates; neonatal and infant mortality rates are high due to lack of access to adequate health care. The high under five mortality rate and undernutrition in the predominantly normal birthweight survivors might be due to low dietary intake and poor access to health care during infections. Majority of Indian low birth weight infants are born at term and survive if essential new born care was provided. There has been an improvement in access to essential neonatal and child care in India. Mature low birth-weight children survived but had a lower growth trajectory as compared to children with normal birth weight. Therefore, undernutrition rates in Indian infants and children are high but infant and under five mortality rates are lower. Further studies are needed to explore this hypothesis.

Soon after independence the prevalence of marasmus and kwashiorkor in young children was quite high. Studies carried out in India showed that contrary to the earlier belief, both are manifestations of severe protein energy deficiency. The theory that differences in children’s response to nutritional stress, led to some children developing kwashiorkor and others marasmus has not been proved with conclusive documentation of the differences in mechanisms of adaptation to nutritional stress. Oedema due to alteration in fluid homeostasis and consequent accumulation of fluid in the extracellular space is the hall mark of kwashiorkor; the pathogenesis of oedema in kwashiorkor has been reviewed.

The impact of optimal nourishment on undernourished is yet not well known. Follow-up studies on girls of Indian origin adopted by Swedish parents showed that these children, who were undernourished at the time of adoption, gained weight rapidly after adoption, had earlier pubertal growth and attained menarche earlier than both their Swedish counterparts and Indian siblings.

The WHO has provided the standards for BMI in children and adolescents for use by member

deficiencies can have short and long term impact on the nutrition and health status of the offspring. In the second half of the last century maternal undernutrition and anaemia were considered to be the major factors associated with an increased risk of low birth weight. The prevalence of anaemia in India is among the highest in the world. Anaemia is seen even among higher-income, educated segments of the population. The studies reported in this issue demonstrate that it is possible to use the school system for weekly administration of iron and folic acid tablets to all adolescent girls, thereby improving their haematological status. This approach to supplementation, combined with efforts to improve dietary diversification, and the promotion of the use of double-fortified salt, may produce a substantial improvement in iron status both in adolescent girls.

Maternal micronutrient deficiency can lead to poor intrauterine growth and low stature of the offspring in adult life, and may also lead to low birth weight in the third generation. Micronutrient restriction in experimental animals, mimicking human situations during pregnancy and lactation, result in altered body composition, dyslipidemia and altered insulin sensitivity associated with modulated insulin production in the offspring. While these changes in utero or during early postnatal life serve as essential adaptations to overcome adverse conditions, they persist and subsequently set the stage for obesity and type 2 diabetes in adult life.

Data from Sweden reported in this issue show that foetal weight depends on maternal glucose production, which in turn is related to parameters associated with maternal fat mass. Infants born to diabetic mothers had hyperinsulinaemia; but lipolysis was unimpaired, perhaps as a compensatory mechanism for the reduction in the rate of glucose production in these infants. Small-for-gestational-age neonates as well as large-for-gestational-age neonates were at risk for metabolic disease later in life. Due to a high fat mass, the large-for-gestational-age neonates had a high rate of lipolysis; this might be one of the reasons for reduced insulin sensitivity seen right from the first day of life. Even in well nourished women, there is a two-fold increase in maternal lipolysis, providing energy for maternal activities and sparing maternal glucose for the foetus. Pregnant women with IUGR foetuses had lower rates of lypolysis but unaltered glucose production. Insulin played a regulatory role in maternal energy substrate production in pregnancies with normal foetuses, but not in IUGR.
countries for detection of both under and over nutrition. Analysis of data from the National Family Health Survey -3 reported in this issue indicate that that low BMI for age and wasting, which take into account the weight for height have a more consistent association with infection in Indian preschool children as compared to weight for age\textsuperscript{19}. If the findings from this study are confirmed by other prospective studies, it might lead to use of a single indicator (BMI for age) for assessment of both under and overnutrition. Use of BMI-for-age for monitoring nutritional status children might help in early detection of children having low or high BMI and effective management of both under and overnutrition; such interventions could result in reduction in the immediate risk of morbidity due to infections and long term risk of non communicable diseases. Early detection of energy deficit using BMI for age and expeditious correction of it is likely to be the most effective intervention for preventing stunting. Prevention of stunting especially in girls will result in better stature of women and improvement in the birthweight of offspring- the trans-generational impact of prevention of stunting.

Among the South Asian countries, Sri Lanka has the best health and nutritional status, though their primary health and nutrition programmes similar to India\textsuperscript{20}, and despite relatively slow economic growth, inadequate food production, civil strife etc. Perhaps effective implementation of programmes by service providers and the optimal utilisation of available services by the users of health services could be the reason.

Overall, the Special Section on "Maternal and child nutrition - a life cycle perspective" contains articles covering a wide range of existing and emerging problems in maternal and child nutrition. The diverse dimensions and inter-generational impact of macro- and micronutrient deficiencies and excess may help sensitising all the stakeholders to try and improve the implementation of appropriate interventions to enable India achieve the national and global goals set for reduction in undernutrition\textsuperscript{21,22} and prevention of overnutrition.

Prema Ramachandran  
Guest Editor  
Nutrition Foundation of India  
New Delhi 110 016, India
premaramachandran@gmail.com
nutritionfoundationofindia@gmail.com

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