

Perspective

Prevention of non-communicable diseases requires a life course approach: A case study from Kerala

Introduction

Kerala is the most advanced Indian State in terms of epidemiological transition and has the highest prevalence of most of the non-communicable diseases (NCD) and risk factors^{1,2}. It is the diabetic capital for India with a prevalence of 14.8 per cent in the age group of 15-64 yr and the age adjusted cardiovascular mortality is twice that of the United States^{3,4}. The men: women ratio of acute coronary syndrome (ACS) admissions in Kerala decreased from 23:1 in 1967 to 4:1 in 2007 indicating an increase of ACS among women^{5,6}. Similarly, age-adjusted breast cancer incidence has shown an increasing trend in pre-menopausal women⁷. As this could be a harbinger of what will happen in the future to the rest of India and similar developing countries, it is important to understand the NCDs and their risk factors in this south Indian State.

Onset of risk factors is early in life

In Kerala, NCD risk factors start early in life. Despite good maternal and child health care services, Kerala reported 16.1 per cent low birth weight babies and 26.5 per cent childhood stunting below the age of three years in 2005-2006⁸. Kerala also has the highest prevalence of overweight and obese women in the reproductive age group in India⁸. In a community based study, all the 2.9 per cent people detected with diabetes in the age group of 15-24 yr were women². Normal weight children in Kerala were reported to have the highest mean systolic and diastolic blood pressure globally⁹. More than 50 per cent of children at 16 yr had high density lipoprotein (HDL) cholesterol less than normal (45 mg/dl)¹⁰.

Obesogenic environment in Kerala

Kerala with its high population density of 859 people per square kilometers ranks low in agricultural productivity and compared to the rest of India,

consumes double the marketed products high in salt, sugar and saturated fat¹¹. The majority of these marketed products are also rich in trans-fats¹². The unique secular nature of this Indian State encourages participation in religious and family functions where energy dense fried foods, rich in sugar, salt and meat products, are offered free and consumed in large amounts¹³. Only 54.8 per cent of Kerala consume green leafy vegetables more than once a week while 82.8 per cent of the people consume at least one non-vegetarian dish a day¹⁴. The nutrition transition in Kerala over the last three decades is characterized by a positive energy balance driven by marketed products¹⁵. Per capita calorie consumption in Kerala increased from 1600 Kcals to more than 2200 Kcals per day over this same period, when energy needs steadily declined because of mechanization at the work place and increasing sedentary lifestyle¹⁵. Kerala now leads all the Indian States in consumer product consumption (television, motor vehicles, *etc.*)¹⁶. Control of infectious diseases (*e.g.* acute diarrhoeal diseases and vaccine preventable diseases) reduced the energy cost of infections¹⁵. In Kerala (being in the tropical equatorial zone) less energy is needed to maintain body temperature. The decline in total fertility rate from 2.27 in the year 1962 to 1.7 in 2003 further increased the positive energy balance in women¹⁷.

In a statewide study among 2.3 million school children aged 10-15 yr, where only 11.5 per cent of girls could finish the recommended health related physical fitness test compared to 16.58 per cent in boys¹⁸. The high prevalence of cardio-metabolic risk factors in women in the reproductive age group is detrimental to their future health as well as to their children because of the *in utero* programming of adult onset diseases¹⁹. Vitamin D deficiency is reported to be universal in Kerala and India²⁰. The need for exposure of 40 per cent of body to the sun for two hours daily to maintain

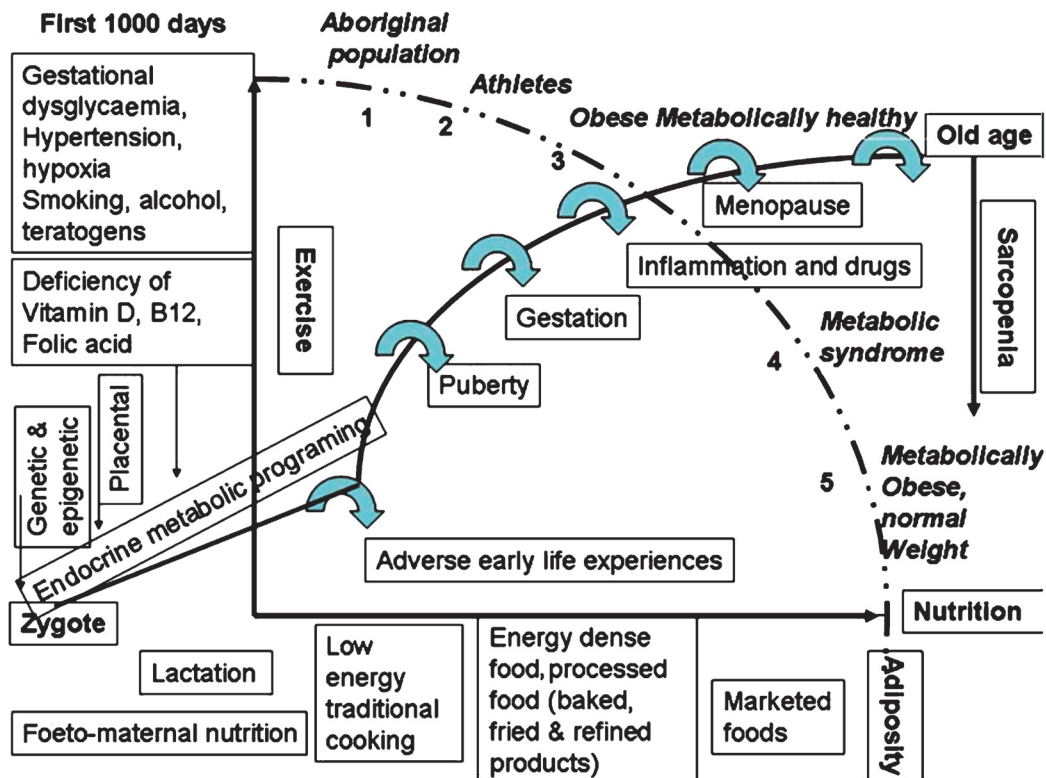


Fig. Body response to obesogenic environment across the life cycle. The dark line connecting the zygote to old-age represents the endocrine metabolic programming. The X axis represents the various sources of nutrition. Exercise the major modulator of response after the first 1000 days is represented in the Y axis. The six major factors favouring sarcopenia (less skeletal muscle) are depicted by broad curved arrows. The five major outcomes are labelled along the dotted line with bold italic letters. Adverse early life programming manifests as metabolically obese normal weight individuals (5).

adequate vitamin D levels is not easy because of the socio-cultural practice of covering almost the entire body with clothes and restricting outdoor physical activity in girls²¹. These factors have contributed to a double jeopardy of vitamin D deficiency and declining bone (osteopenia) and muscle mass (sarcopenia)²¹.

The pathway leading to a vicious cycle of high NCD risk factors

Survival of low birth weight (LBW) babies in Kerala is substantially higher compared to the rest of India¹⁵. Infant mortality rates in Kerala were the lowest in India. It reached a level of 10-15 per 1000 live births in the early 1990s and has remained in that range over the past 20 years²². The LBW babies were exposed to the obesogenic environment and were often overprotected by their educated parents who fed them more energy rich foods and restricted physical activity. LBW babies, at birth are known to have less beta cell potential, muscle mass, nephron numbers, and more endothelial dysfunction and higher proportion of

body fat making them more susceptible to NCD risk factors²³.

The restriction of outdoor physical activity in girls and women decreases endogenous vitamin D synthesis and imparts a low body skeletal muscle mass and high fat body composition. Skeletal muscle constitutes the best insulin sensitive tissues in the body²⁴. This has resulted in increasing metabolic risk factors in women in the reproductive age group through increasing blood pressure, dysglycemia and declining vitamin D levels. Like maternal dysglycemia, micronutrient and vitamin deficiency is a documented precursor of adult onset diseases in the offspring as demonstrated by follow up studies in south India^{25,26}. Some normal weight children, when abnormally programmed *in utero* due to maternal dysmetabolism, are predisposed to developing NCD risk factors in later life at a rate similar to that of LBW babies¹⁹. Persistence of high level childhood stunting, irrespective of positive energy balance in the society, is an important indicator that factors other than

undernutrition, like maternal dys-metabolism could be responsible for the abnormal growth pattern of children in Kerala^{8,15,19,23}. This Kerala case study is a good illustration of how the early onset of NCD risk factors in the reproductive age group adversely affects the health status of women and their children. Low birth weight babies are thin, not because of lack of fat, but because of less skeletal muscle²⁷. Encouraging sun exposure and adequate physical activity in adolescent girls is the best prescription to break this vicious cycle of maternal dysmetabolism predisposing to early onset of NCD risk factors in their children²². The interaction of nutrition and physical activity along the life course of metabolic endocrine programming is depicted in the Figure. The six major factors which can tip the balance towards sarcopenia (less skeletal muscle) and metabolic syndrome are early life programming, puberty, pregnancy, inflammation/drugs, menopause, and old age. The five major outcomes in the spectrum are represented along the dotted line labelled with bold italic letters. The best adapted people are the aboriginal people followed by athletes, and then the obese metabolically healthy people. But the majority of the population moves to metabolic syndrome, and those who are abnormally programmed in early life evolve into metabolically obese normal weight individuals.

Future directions

NCD prevention should be paid particular attention in adolescents to achieve a balanced body growth and composition focusing on physical activity and a healthy diet. The mother and child health programmes need to be redefined to achieve a healthy mother with good body composition and metabolic milieu. Women's heart is more vulnerable to behavioural risk factors such as tobacco, alcohol and physical inactivity which formed the basis for the "Go Red for Women" by the American Heart Association²⁸. Although this campaign started in the west for adult women, it is also pertinent for women in the reproductive age group in places such as Kerala. The fruits of better women's education in Kerala that paved the way for the Kerala model of "good health at low cost" need to be expanded to include physical activity and a healthy diet²². Another factor that might arise at a later time is tobacco use. Although current tobacco consumption is negligible among adolescent girls in Kerala, control programmes are essential to prevent the initiation of this unhealthy practice. The Political Declaration of the UN High Level Meeting on NCDs in September 2011 provides an excellent opportunity to address

these issues²⁹. Since a life course approach is required for the prevention and control of NCDs, healthy diet, physical activity and tobacco control may need to be integrated into the already existing maternal and child health programmes.

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