NUTRITION AND PHYSICAL PERFORMANCE IN SCHOOL AGE CHILDREN

Prema Ramachandran

Director, Nutrition Foundation of India
Demographic transition and school age children

Nutrition transition in school age children

Nutrition and physical performance – adults and children – effect of supplementation

Physical fitness testing – adults and children
School age group (5-18 yrs) spans the period between preschool years and adult life. In 2001 this age group formed a very large proportion of the population.
Population projections indicate that over the next decade this age group will show by far the largest increase in numbers.
School age children have relatively very low morbidity and mortality rates.

Growth rates of Indian school age children are comparable to the growth rates of school age children in developed countries.

It is assumed that school age children have overcome their earlier nutrition and health problems. They therefore received very little attention from nutrition and health sectors.
Nutritional and health status during school age are determinants of nutritional and health status in adults.

It is therefore essential that over the next decade efforts should be focused on improving health and nutritional status of school age children, (irrespective of the fact whether they are studying in school or school dropouts) so that they reach adult life with optimal nutrition and health status.
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Nutritional status of preschool children

About half of the preschool children are stunted. Over 40% are underweight but if BMI is used as the criterion only 16% are undernourished. Even in preschool children about 2% are overnourished.
Over the last three decades there has been a slow but steady decline in undernutrition both in women and men. Prevalence of under-nutrition is about 30% and over-nutrition in adults is about 10%. There has been a rise in both under and over-nutrition in preschool age and adult years. This rise could be prevented/minimised by appropriate interventions in school age children.
Nutritional status of school age children

School age is a period of rapid growth with the growth spurt in peri-pubertal years; 80% of adolescent growth is completed in early adolescence.

Nutritional status during infancy and childhood are major determinants of nutritional status during adolescence and adult life.

However, adequate dietary/nutrient intake and appropriate levels of physical activity can ensure optimal adolescent growth spurt which might mitigate some of the adverse consequences of undernutrition during childhood.
### Time trends in energy intake of early school children and adolescents

<table>
<thead>
<tr>
<th>Girl’s Age</th>
<th>Total Dietary Energy Intake (Kcals)</th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>NNMB</td>
<td></td>
<td></td>
<td></td>
<td>INP</td>
</tr>
<tr>
<td></td>
<td>‘79</td>
<td>‘96</td>
<td>‘01</td>
<td>‘05</td>
<td>‘96</td>
</tr>
<tr>
<td>10-12</td>
<td>1394</td>
<td>1635</td>
<td>1500</td>
<td>1389</td>
<td>1482</td>
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<tr>
<td>13-15</td>
<td>1566</td>
<td>1848</td>
<td>1689</td>
<td>1566</td>
<td>2097</td>
</tr>
<tr>
<td>16-17</td>
<td>1704</td>
<td>2030</td>
<td>1856</td>
<td>1630</td>
<td>2327</td>
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<td>Adults</td>
<td>1698</td>
<td>2106</td>
<td>1878</td>
<td>1738</td>
<td>2293</td>
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</table>

Energy intake of all age groups including children and adolescents improved till nineties and then showed a decline. Energy gap in school age children is lower than the gap in preschool children but larger than the gap in adults from the same households.
There are substantial interstate difference in energy intake.

But micronutrient intake in all age groups in all states is low.
Between 1975-79 and 2005-06 increase in weight (2-6 kg) is more than the increase in height (2.5-6 cms); consequently there was a greater increase in BMI.

Stunting and underweight continue to be major problems in rural India; over-nutrition is emerging as a problem, especially in urban affluent segments.
Numerous studies in India, including NFI’s studies in school children in Delhi, have shown that while undernutrition is the problem in children from lower income group, overnutrition is the problem in high income group children.

Studies from “Delhi cohort” have shown that infants with low BMI, who gain BMI in childhood become overweight adults, and face high risk of non communicable diseases.
There are ethnic differences in body fat mass. Indians have a higher fat mass for a given BMI as compared to Caucasians. Body fat mass in Indian high income group (HIG) children is far higher than the fat mass in US children.
There are ethnic differences in body fat free mass.

Body fat free mass in Indian HIG children is far lower than the fat free mass in US children.

Low muscle mass and high fat mass are associated with poor physical fitness.
Physical activity patterns in India
Indians used to spend a lot of energy in occupational, domestic chores and getting from one place to other without mechanised transport. So they did not have any necessity to take up discretionary physical exercise during leisure time.
In India there has been a steep increase in investment in mechanisation of transport and household chores.

Investment in TV for entertainment has resulted in many of us becoming couch potatoes.
Occupational and household activities have become sedentary.

Discretionary exercise has not yet become a routine.
With mechanisation of household chores, overnutrition in women is becoming common. With low occupation-related and discretionary physical activity, overnutrition rates in men is increasing. Sedentary men and women have higher BMI.
Over half of the women in lowest income group are undernourished.

About a third of women in the highest income are overweight.

But overnutrition is also seen in poor women.
Anaemia
Prevalence of anaemia Source: WHO

<table>
<thead>
<tr>
<th>Global Developed Developing</th>
<th>India Urban</th>
<th>India Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children&lt;5 yrs</td>
<td>43</td>
<td>12</td>
</tr>
<tr>
<td>Children &gt; 5yrs</td>
<td>37</td>
<td>7</td>
</tr>
<tr>
<td>Men</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>Women</td>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>Pregnant Women</td>
<td>59</td>
<td>14</td>
</tr>
<tr>
<td>Pregnant Women</td>
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</tbody>
</table>

- Prevalence of anaemia in India is the highest in the world.
- Anaemia is the most common nutritional deficiency disorder in India.
- Anaemia is seen both in undernourished and overnourished school children because in both the groups micronutrient intake is low.
Anaemia status among children in India
DLHS-RCH:-Children age below 72 months

<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
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<tbody>
<tr>
<td>RURAL</td>
<td>3</td>
<td>49.1</td>
<td>52.7</td>
</tr>
<tr>
<td>URBAN</td>
<td>3</td>
<td>39.8</td>
<td>52.7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3</td>
<td>39.2</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>37.5</td>
<td>49.1</td>
</tr>
</tbody>
</table>
Both prevalence and severity of anaemia increase in school age children especially adolescent girls.
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Five decades ago a majority of individuals from poorer segments of the population in rural and urban areas were undernourished; most of them were manual labourers.

Poor work capacity in occupations involving manual labour would adversely affect wages.

Low wages and consequent low purchasing power, would lead to low dietary intake and undernutrition in all members of the family, thereby setting up a vicious cycle of undernutrition and poor work capacity.

Between 1960 and 1980 several investigators explored the effect of nutritional deficiencies (mainly undernutrition and anaemia) on work capacity in different settings.
Nutritional deficiencies and work performance

In normally nourished individuals in whom there was good correlation between bodyweight and muscle mass, work output was higher in persons who were heavier. This was partly due to higher rate of work and partly to higher endurance.

However if work output per unit weight was taken as the criterion, there was no difference in work output.

Low dietary intake, and undernutrition leading to low body weight and low lean body mass were associated with reduced work output in adults and children.

Work output was also lower in anaemic persons.

Work output was lowest in undernourished and anaemic persons.

The reduction in work output was seen in occupations involving strenuous labour (eg coal miners, farmers) or moderate activity (eg jute and coir workers).
In an effort to improve work output many industries provided subsidised food to workers in factories. Impact of this intervention on work productivity has not been systematically evaluated.

A study carried out by NIN showed that even in workers whose current dietary intake and nutritional status was satisfactory, weight, height, and lean body weight were significantly correlated with work output. The rate of work was also higher in persons with higher body weight. However, when unit weight was used as the criterion, there was no difference in work output.
Compared to the data on the effect of chronic undernutrition on work capacity, there is limited information about the impact of low intakes of vitamins/minerals and micronutrient deficiencies on physical performance.

Most studies deal with iron deficiency with or without anaemia.

Iron deficiency and iron deficiency anaemia limit maximal physical performance and submaximal endurance. Reduction in work output has been reported in farmers, plantation workers, and even in those involved in the relatively less strenuous work in a jute factory.

Iron supplements improved iron status and work performance in iron deficient or anaemic persons.
Both iron deficiency and anaemia in school-age children impair work capacity. Dr Gera had reviewed randomized controlled trials and shown that iron supplementation in anaemic children had a positive effect on physical performance as assessed by post-exercise heart rate, blood lactate levels and treadmill endurance time. A randomized, double blind, placebo-controlled trial in Filipino schoolchildren who received either the fortified or non-fortified beverage with or without de-worming showed that consumption of a multiple-micronutrient-fortified beverage for 16 weeks had a significant impact on iron status and iodine status, and improved the physical fitness of iron- and/or iodine-deficient children. Dr Vaz had presented their data on multiple micronutrient supplements on physical fitness in school children.
Iron deficiency anaemia often coexists with chronic energy deficiency.

Combined deficiencies of energy and iron in children had a greater adverse effect on physical work capacity than energy deficiency or iron deficiency alone.

In such children work performance improved with iron and food supplementation.

Improvement in performance was greater in the group that was iron- and energy-deficient and received food supplementation and iron tablets.
With increasing mechanization of transport and work domains, undernutrition and reduced work capacity may not be major determinants of earning capacity in modern society.

There is an emerging problem of obesity with high fat mass and poor lean body mass, associated with poor work capacity and higher risk of non-communicable diseases.

Micronutrient deficiencies coexist with both under-nutrition and over-nutrition.

There is an urgent need to intensify in-depth investigations of the adverse impact of existing and emerging nutritional problems on work performance during school age itself, introduce appropriate interventions for improving nutritional status and work performance, and lay the foundation for a healthy adult life.
Strenuous physical activity as in sports training may increase the requirements for both macro- and micronutrients.

Micronutrient requirements may increase due to infections, loss of nutrients, increased turnover, biochemical adaptations associated with intensive physical training, increased concentration of mitochondrial enzymes that require these nutrients as cofactor, and increased need for tissue maintenance and repair.

Under these circumstances there may be a need for increased dietary intake of micronutrients. Depending upon the situation, these additional needs may have to be met through increased food intake, food fortification or medicinal supplementation.
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Reason for increasing interest in physical fitness

Over decades there has been a global decline in physical activity & fitness in children, adolescents and adults.

Low levels of physical activity and fitness have been related to overnutrition, increased risk of developing CHD, diabetes, CVD and osteoporosis in adult life.

Low levels of physical activity are associated with higher CHD and perhaps also all-cause mortality in both men and women.
Physical fitness testing in school age children

Physical fitness testing include: assessment of body composition (muscle mass and fat mass); adiposity is associated with risk of hypertension, diabetes, CVD and some malignancies;

measurement of cardio-respiratory endurance (aerobic capacity); poor performance is associated with a higher risk of hypertension, diabetes and CVD;

measurement of muscle strength (ability to exert force against resistance) and endurance; reduction in muscle strength is associated with risk of musculoskeletal injuries; and

flexibility (range of movements); reduction in flexibility is associated with risk of musculoskeletal injuries.
Over the last few decades there has been a global decline in physical fitness, but the decline is not across the entire spectrum of tests.

Since 1970s there has been a 4-5% decline per decade in performance under cardiovascular endurance tests but no decline in power and speed tests.

Physical fitness is a key marker for health at any age; but fitness tests are not being widely used as a part of assessment of health status either in adults or in children.

There are very few reports of the outcomes of physical fitness tests in Asian children, partly because the importance of these tests has been realized only recently, and partly because of lack of adequate infrastructure and manpower. There are substantial inter-country differences in fitness and decline in performance within Asia.
So far fitness tests have been used in India mainly for selection and monitoring of athletes in sports academies.

A few studies have reported the aerobic and anaerobic performances of trained and untrained school children and compared them with international standards.

With increasing awareness about the importance of physical fitness in school children, it is hoped that as a part of the school health check up screen school children and interventions be initiated to improve physical fitness in those whose performance is suboptimal.
Physical activity and fitness in school age are major determinants of physical activity and fitness in adults.

Continued moderate physical activity throughout life
- prevents overnutrition,
- maintains muscle mass,
- reduces the prevalence of cardiovascular diseases and
- ameliorates the adverse effects of ageing on musculo-skeletal and cardiovascular systems.

By improving physical activity and fitness in school age children, we will be able to add years to life and add quality of life to the years
THANK YOU