Malnutrition and peak expiratory flow rate

R. Primhak*, F.S. Coates**

ABSTRACT: In order to assess the effects of malnutrition on the growth of lung function, 376 Indian schoolchildren aged 6–12 yrs were studied. Peak expiratory flow rate (PEFR) was measured with a Wright peak flow meter, and nutritional status assessed by calculation of the percentage predicted height for age (HFA) and weight for height (WFH) using Harvard standards. After standardizing for height and sex, the PEFR of 30 wasted children (WFH below 80%) was significantly reduced (p<0.01), but that of 135 stunted children (HFA below 90%) was higher than average (p<0.05). It is concluded that current malnutrition has a negative effect on PEFR, possibly due to impaired muscle function, but that past or chronic malnutrition affects growth of lung function less than it affects somatic growth.


Malnutrition may have lasting effects on body growth [1, 2]. It is unclear whether lung growth is affected by acute or chronic malnutrition independent of the effect on skeletal growth. Previous studies have come to conflicting conclusions regarding the effects of wasting or stunting on peak expiratory flow rate (PEFR) in children [3–5]. We have studied a sample of Indian schoolchildren of differing socioeconomic backgrounds in an attempt to resolve this problem.

Methods

A random sample of schoolchildren aged 6–12 yrs living in the Bangalore area was studied. The children were attending one of three schools: a village school 18 miles north of the city, an urban slum school or an expensive private school within the city. Each child was questioned and examined prior to the study and children who gave a clear history of serious lung disease or asthma were excluded, as were those with signs of bronchospasm or lower respiratory tract infection. A history of recent cough or rhinitis was not considered grounds for exclusion [6]. Height and weight (barefoot and lightly clothed) were measured and PEFR was measured using a Wright peak flow meter, taking the best of five attempts with the head erect. Height for age (HFA) and weight for height (WFH) were calculated as percentage predicted from Harvard standards [7] as described by WATERLOW [8]. The widely used definitions of stunting and wasting suggested by Waterlow were used in this study: wasting was defined as WFH below 80% predicted, and stunting as HFA below 90% predicted. These cut-off points approximate to 2 standard deviations below the mean. Wasting was taken as an indicator of acute malnutrition, while stunting was assumed to signify a past history of malnutrition.

Statistical comparisons between the means of two samples were made using Student's unpaired t-test, and relationships between variables were analysed using standard linear regression techniques.

Results

A total of 404 children were studied. Thirteen were excluded due to poor co-operation and 15 because of chest disease, leaving 376 children whose results were analysed. Thirty (8%) were wasted and 135 (36%) were stunted, six of the children being both wasted and stunted. The prevalence of malnutrition in the different schools is shown in table 1. Stepwise linear regression analysis revealed that height and sex but not age were significant predictors of PEFR giving the equation:

PEFR=3.85-Ht(cm)−10.2·Sex−264.0

where Ht is height in cm and sex is denoted by boy=1, girl=2. Using this equation the percentage predicted PEFR was calculated for each child.

The mean (±sd) percentage predicted PEFR in children of normal height was 98.8±14.7% while that of stunted children was 102.3±15.2%, which was significantly higher (t=2.16, p<0.05). In contrast the mean percentage predicted PEFR of wasted children, 92.1±14.6%, was significantly lower than that of better
nourished children, 100.7 ± 14.8% (t = 3.1, p < 0.01). No difference in standardized PEFR was found between the three schools studied.

Table 1. — Prevalence of stunting and wasting in the study population categorized by school; numbers (percentages) are shown

<table>
<thead>
<tr>
<th></th>
<th>Urban rich</th>
<th>Urban poor</th>
<th>Rural</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stunted</td>
<td>21 (19)</td>
<td>82 (68)</td>
<td>23 (16)</td>
<td>129 (34)</td>
</tr>
<tr>
<td>Wasted</td>
<td>2 (2)</td>
<td>3 (2)</td>
<td>18 (13)</td>
<td>24 (6)</td>
</tr>
<tr>
<td>Both</td>
<td>1 (1)</td>
<td>3 (2)</td>
<td>2 (1)</td>
<td>6 (2)</td>
</tr>
<tr>
<td>Neither</td>
<td>87 (78)</td>
<td>35 (27)</td>
<td>101 (70)</td>
<td>221 (39)</td>
</tr>
<tr>
<td>Total</td>
<td>111 (100)</td>
<td>121 (100)</td>
<td>144 (100)</td>
<td>376 (100)</td>
</tr>
</tbody>
</table>

Discussion

We set out to study the effects of malnutrition on lung growth because a definite conclusion could not be reached from the published data available. In one of the earliest reports of forced vital capacity in children Emerson and Green [9] did not find that malnutrition affected lung volume. A more recent study in Tanzania [3] reported lower age-standardized PEFR values in malnourished children without correcting for height. A study of urban and rural children in the Punjab [4] found that urban children were better nourished, taller and had higher PEFR values than rural children, but when the PEFR was standardized for height it did not differ between groups. In contrast a study in Jamaica [5] found that height-standardized PEFR was higher in rural children, who were shorter than urban children at a given age. The effect of rural or urban environment will obviously differ from one area to the next, depending on the terrain and the economic factors prevailing locally.

In the present study PEFR was used as a crude index of lung growth as it is a simple and reproducible method suited to field studies. We found that acute malnutrition manifested as wasting caused a significant reduction in PEFR. Since past malnutrition, evidenced by stunting, appeared to reduce height more than lung function it is unlikely that acute malnutrition causes a reduction in lung growth itself, but more probably has an effect on muscle power and voluntary lung inflation. In practical terms the effect of wasting on PEFR is not great: further stepwise regression analysis revealed less than 5 l/min\(^{-1}\) decrement in PEFR for every 10% reduction in WFH.

The reason for stunted children having a relatively higher PEFR for height cannot be determined from the data in the present study. It may indicate a difference in body proportions in stunted children, with a relatively greater sitting height and shorter leg length.

The effect of height on PEFR is well described [10] although sex differences are not always found [6, 11]. We did not use a power transformation since we have not found it improved the prediction of PEFR in the past [6]. Although age has been found to be a further predictor of PEFR in previous work [6] this is largely attributed to puberty [12]. Since the age of onset of puberty varies with nutrition and would have been a confounding influence in our study we restricted the study to children aged 12 and under, resulting in a population which was almost entirely prepubertal or in early puberty. This appeared to remove the confounding effect of age satisfactorily as we did not find age to be a significant predictor of PEFR in stepwise regression.

The pattern of nutritional deficit varied from school to school. Stunting was present in one third of all children, even in those in the affluent school. This observation underlines the fact that malnutrition is a multifactorial disease, related as much to early weaning, recurrent diarrhoeal disease and other infections as it is to available diet. Indeed, if affluence results in a lower rate of breast feeding, infantile nutrition can actually be worsened by improved economic status [13].

In conclusion this study has demonstrated that in children without overt chest disease, acute malnutrition has a small but significant negative effect on PEFR, but chronic or past malnutrition has less effect on PEFR than on linear growth.

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References

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RÉSUMÉ: Afin d’estimer les effets de la malnutrition sur le développement de la fonction pulmonaire. 376 écoliers indiens, âgés de 6 à 12 ans, ont été étudiés. Le débit expiratoire de pointe (PEFR) a été mesuré à l’aide d’un “Wright peak flow meter” et l’état nutritionnel a été calculé selon le pourcentage établi taille pour âge (HFA) et poids pour taille (WPH) selon les normes de Harvard. Après normalisation pour taille et sexe, le PEFR des enfants en état de marasme (WPH<80%) était diminué de manière significative (p<0.01), mais celui des enfants chétifs (HFA<90%) était plus élevé que la moyenne (p<0.05). Il faut en conclure qu’une malnutrition courante a un effet négatif sur le PEFR, peut être par affaiblissement de la fonction musculaire mais que la malnutrition chronique ou passée affecte moins le développement de la fonction pulmonaire que la croissance somatique.