FITNESS OF HEALTHY SENEGALESE CHILDREN LIVING IN A SAHELIAN ENVIRONMENT

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INTRODUCTION

Africa is the continent with the largest proportion of the population affected by malnutrition: 168 million people or 33% (FAO/WHO, 1992). The visible results of malnutrition, if prolonged, are wasting and stunting in growth which can in turn contribute to a reduction of muscle mass available for exercise. One can thus except reduce motor performances in malnourished children.

Actually relatively few data exist which illustrate the effects of malnutrition on motor performances in African children, except studies on working capacity of school aged children (Areskog, 1971; Davies, 1973). Due to the high prevalence rate of malnutrition in West-Africa, for example in Sénégal, where the present study was carried out, 17.6% of 0-5 year-old children are underheight by -2 standard deviations (Garenne et al, 1986), there is a need for investigation in this topic. Hence, the present work seeks to describe the relationship between the physical growth and motor performances of healthy rural Senegalese children.

METHODS

Sampling

This study was carried out in the villages of Ndondol and Diokhane in the center of Senegal within the zone known as the "peanut basin". The inhabitants are Muslim Wolof whose principal activity is peanut and millet cultivation.

Two age-groups of children were separately studied: 3-6 and 10-12 years of age.

Preschoolers

Eighty-eight children (44 boys and 44 girls) were examined 3 times at 6 months interval during 1 year. The youngest children were 3 years old at the beginning of the study and the oldest 6.5 years at the conclusion. Subjects were chosen according to a preliminary household survey in which all children under 5 years of age were examined.

School age children

The study was carried during a 2 years period. A group of 20 boys and 20 girls aged between 10 and 11 years were examined each 6 months.

For both groups (preschool and school age children), children chosen for the study were clinically healthy. No children had received formal school education. Parents and religious authorities were informed of the objective of the study and their consent obtained. The children had to be available at all phases of the study. During the testing which was conducted publicly the children were accompanied by their mother or another family member.

Testing

Children were clinically examined in order to detect a recent illness which could impair the tests. When they were absent or ill they were revisited the following week.

Several anthropometric measures were taken, but only measures of weight (measured with an electronic medical scale) and height (Harpenden anthropometer) are reported here.

Measurement of cardiorespiratory stress:

- Preschoolers: consisted of the step test adapted by Parizkova for preschool aged children (1984). After a sitting rest period of 3 min, the child climbed up and down a two step ladder whose rungs were 23 cm in height for 5 min at a rhythm of 30 steps per minute.

The child was encouraged by an assistant who steadied him slightly by holding but not pulling his hand. The rhythm was marked by a metronome which beat every second. At the end of the test the child sat and rested for 5 min.

- School age children: The child had to climb three two-step ladders of different heights: 17, 23 and 30 cm respectively. This permitted a gradual increase in levels of effort.

The children rested sitting for 3 minutes, then started going up and down the ladders with a rhythm of 30 steps per minute, lasting 3 minutes for each ladder and giving 9 minutes of exercise in total. Then the children rested for 5 minutes.

Throughout the step-tests the heart rate was recorded every 5 sec with a "Sport tester" frequencemeter.

Motor performance

Children had to perform 3 motor tasks: a 20 m dash for the preschoolers in which they ran in pairs to stimulate reciprocal motivation and a 33 m dash for the school age children; a standing long jump with feet together; and finally a distance throw using a softball. (This was done only for the children above 4 years of age). In jumping and throwing performances, the best of 3 consecutive trials was retained.

Physical activity

Physical activity was measured by direct observation 4 times during the study in the school age group. Specially-trained investigators noted the children's activities every minute for 2 periods of 6 hours each day, totalling 12 hours per observation day. The investigators had to report the dominant activity of the minute using a simple code. Nine activity categories were set up, sorted by increasing energetic cost from resting to maximum effort

RESULTS

Preschoolers

Preschool children of the study displayed a growth in height close to the NCHS median but are delayed in weight growth. However, 17 of 88 children (18%) had an Height-for-age (H/age) deficit between -1 and -2 sd from the National Center for Health Statistics (NCHS) distribution and 32 (36%) had a Weight-for-height (W/H) deficit of the same order (WHO, 1983). Only 19 children attained the median for height and for weight for height. There were no significant differences with respect to sex and the proportion of stunted or wasted children did not change in the course of the study.

There was a significant improvement in motor performances from one visit to the next. Results in motor tasks and aerobic step-test are better for the boys than for the girls in children above 4.5 years of age. Motor performance data of the Senegalese preschoolers were compared with the Czech children studied by Parizkova and colleagues (1984). These comparisons were done to facilitate the presentation and discussion of the data and do not imply that the values represent an ideal which needs to be reach by all children in the world.

Senegalese performances in 3 motor tasks were well below those of the Czechs. However the Czechs weighed 2 to 3 kg more than the Senegaleses, and if we take into account this fact, figures become different. Figures 1 to 3 compare data of Senegalese children with those of Czech children, according to age (left side) and to unit of body weight (right side).

Czech children still ran faster than Senegalese but the difference tends to diminish after adjusting for body weight Senegalese boys jump farther then Czech after adjusting for body weight.

Finally, Senegalese boys and girls were quite equal to Czech children in throwing task after adjusting for body weight.

Figure 4 shows the cardiorespiratory endurance step-test. It indicates that HR during rest, exercise and recovery was higher in Senegalese children than in Czech. This would signify that cardiac output of Senegalese is less efficient.

School age children

There were no gender differences in height and weight of school age children during the study. Mean H/age of the children decreased fom -1.3 z-score during the first visit to -1.5 z-score at the end of the second year ($p<0.001$). The weight also deteriorated from -1.5 z-score to -1.7 z-score ($p<0.001$).

Motor performances of Senegalese children were compared with those of African American children from Philadelphia studied by Malina (1983). In the 3 tasks considered African American were more performant. Since Senegalese children were lighter than American children, comparisons were also made after adjusting for the weight (figure 4 to 6).

In this case Senegalese children were still slower at running, but they were significantly superior at broad jump. There were no longer differences in throwing.

Figure 8 shows the cardiac response to exercise of the 12 years old children: mean HR at rest and at the 3 stages of exercise are significantly lower in boys than in girls. Boys had a faster recuperation then girls. In conclusion, boys demonstrate a greater cardiac efficiency than girls.

Habitual Physical Activity

Girls expended significantly more energy per day in activity than boys (2.28 Mets versus 2.1, $p<0.00$). The energy expenditure among girls was higher in the morning (2.37 Mets) than in the afternoon (2.20), but there were no differences among boys. The major differences between the sexes was due to the domestic tasks undertaken by the girls who spent 30 minutes a day pounding millet and peanuts estimated to use 5.6 Mets/min. In fact girls spent less time on activities equal to or above 4.8 mets, except for the pounding activity, than boys.

DISCUSSION

This study shows that in average these Senegalese children had a weight and height growth inferior to the reference median of the NCHS. This suggests an inadequate coverage of nutritional requirements. A few years ago, a food consumption survey showed that this district was among the most precarious in the Senegal being subject to acute demographic pressures and soil degradation. The daily per capita energy intake was less than 2200 Kcals and two thirds of the households did not meet their daily requirements in energy, vitC, riboflavine, calcium, vit A, folates and zinc (Chevassus and Ndiaye, 1980). There is no evidence that the nutritional situation has improved since then.

Compared with well nourished children from industrialized countries motor performances of Senegalese children were also inferior. However, it should be said that the conditions of testing were not favourable to them. Psychological factors and habituation to testing may also be considered. Thus, the interest of the comparisons does not lie in demonstrating the functional inferiority of the Senegalese but rather in pointing to the importance of body weight, and active muscle mass, in the determination of physical fitness.

Active muscle mass is reduced in wasted and stunted children even at slight degree as is it the case here and this quantitatively limits their physical performance. Similar findings where found in Mexico by Malina and colleagues (1985) and in Zaïre by Ghesquiere and colleagues (1988): children from shanty town in Kinshasa compared with privileged groups turned in the best performance in certain tests after taking into account the physical differences.

Surveys of African children's physical activities are very scarce. The method used in this study expressed the physiological aspects of activity in units of basal metabolism rate according to the recommendation of the FAO/WHO/UNU joint committee (1985). If we assume an average of 8 sleeping hours and an additional 4 hours of light activities (1.4-1.6 Mets) in the evening or early in the morning, the 24 hours energy expenditure will be 1.66 (0.09) Mets in boys and 1.76 (0.1) in girls. These values are slightly lower for boys and higher for girls compared to the FAO/WHO/UNU data. Gender differences in daily energy expenditure is likely due to participation of the girls in domestic chores. Senegalese children spent an average of 42 minutes during the day in moderate to heavy activities. If the girls were not to undertake pounding

tasks, they would spend only 13 minutes in moderate to heavy activities. This relatively low level of intensity in physical activities conforms with other Senegalese surveys. Using a continuous monitoring of heart rate, we noticed that children in the northern part of the Senegal spent only 2-5% ot their time in activities resulting in HR over 140 beats per min. (Bénéfice, 1992). Diaham and colleagues (1992) found that children of an other area of Senegal spent 2.4-3% of their time on activities resulting in more than 140 beats per min., while participating in agricultural work. According to Spurr and Reina (1987), the reduction of physical activity would be the "first line of defence" to cope with insufficient food availability. However, it must be emphasized that subjects in this study maintained activity levels absolutely compatible with their social and environmental demands.

It appears then that these Senegalese children although retarded in growth by chronic malnutrition maintain a level of functional capacity in proportion with their body dimension and have physical activity profiles compatible with their way of life. A frequently arising question is that of the adaptative significance of small body size. As it is rightly said by Stinson (1992), the response is actually a matter of definition. For the nutritionists, these children are not adapted because their reduction in body size implies a reduction in functions; they are rather "accomodated" (Scrimshaw and Young, 1989). For the anthropologists this definition is too restrictive because adaptation is not free of noxious consequenses but it is relatively advantageous (Stinson, 1992): small body size would permit a greater number of people to survive and develop when food availability is scarce.

In our opinion, it would be strange to consider as normal a situation where a child is unable to develop his physical potential to the full. More research efforts are needed in the investigation of the long term consequenses of PEM. A better knowledge of this question can help us deal the problem more effectively.

Running performance relative to age and weight

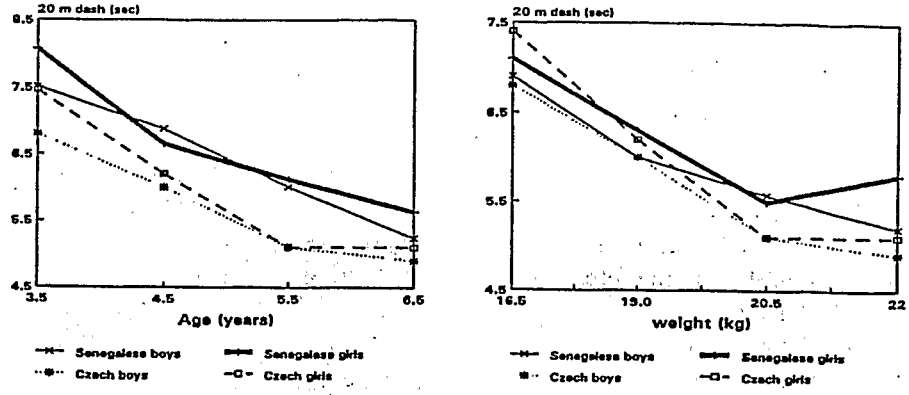

Figure 1

Jumping performance relative to age and weight

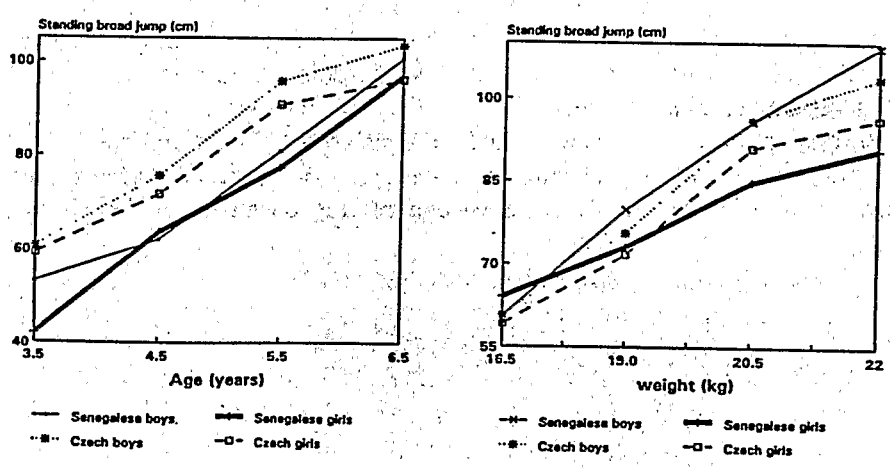

Figure 2

Throwing performance relative to age and weight

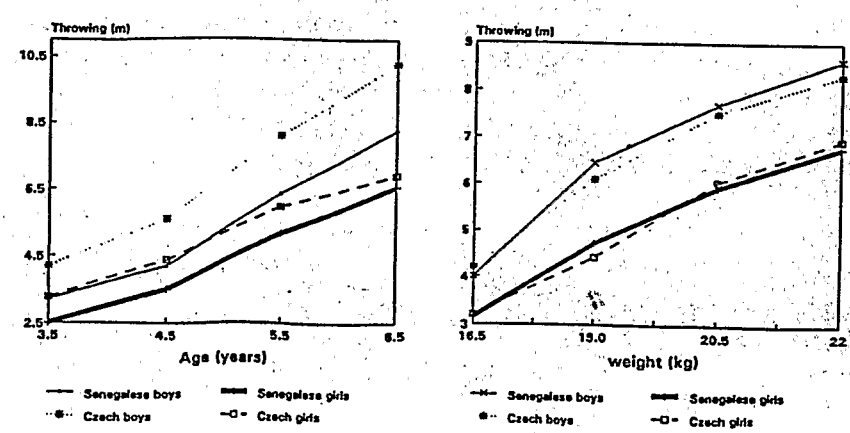

Figure 3

Step-test results of Senegalese compared with Czech children

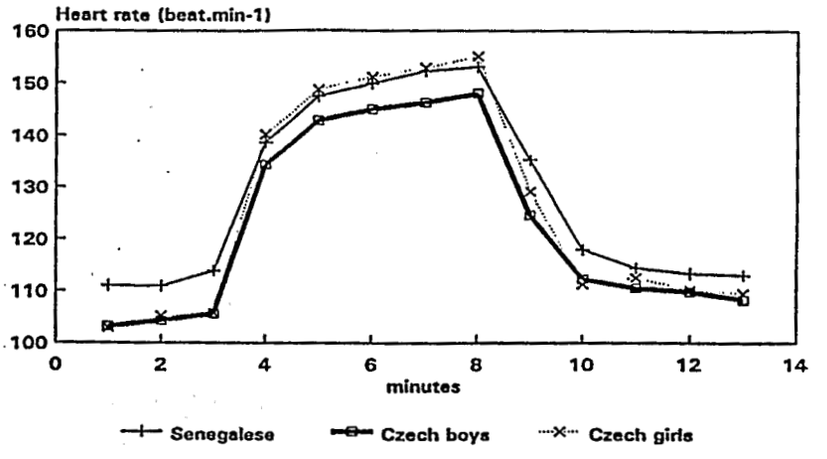

Figure 4

Running performance relative to age and weight

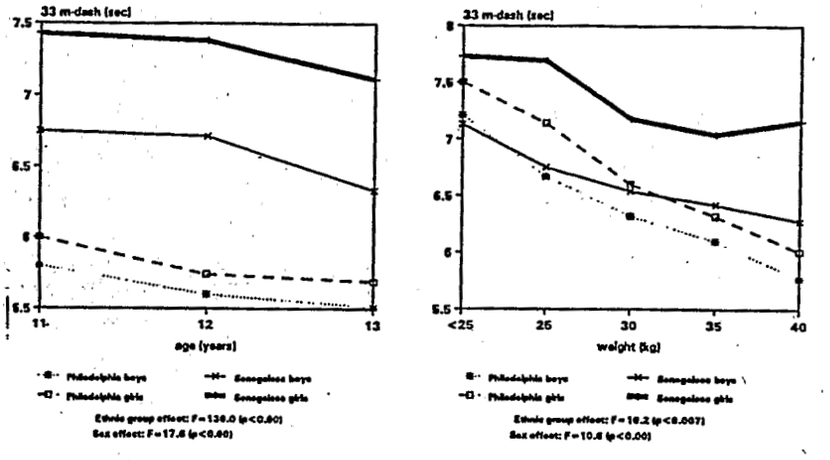

Figure 5

Jumping performance relative to age and weight

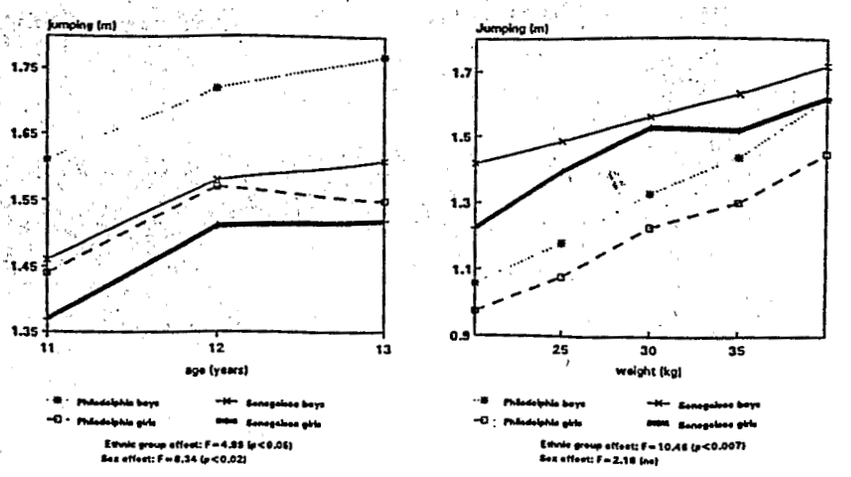

Figure 6

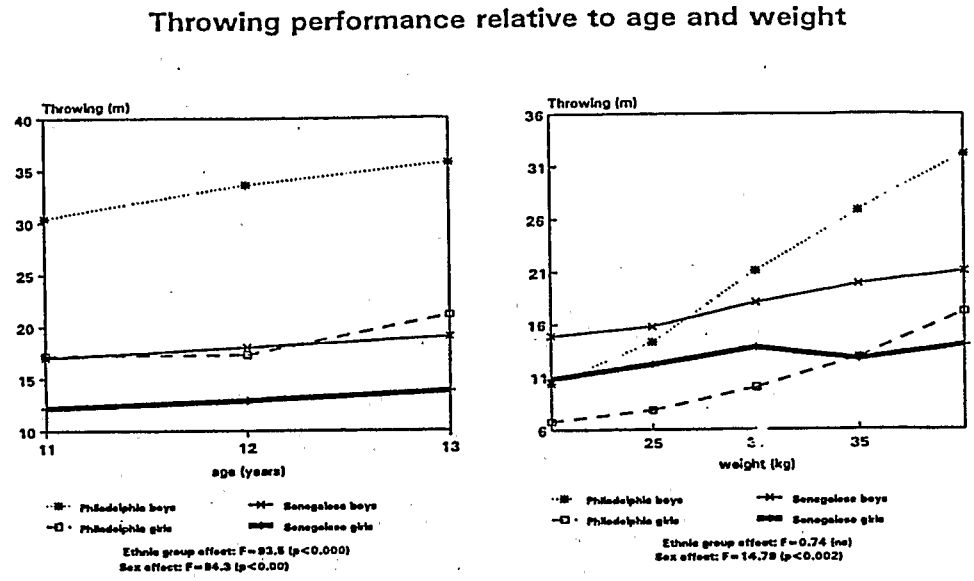

Figure 7

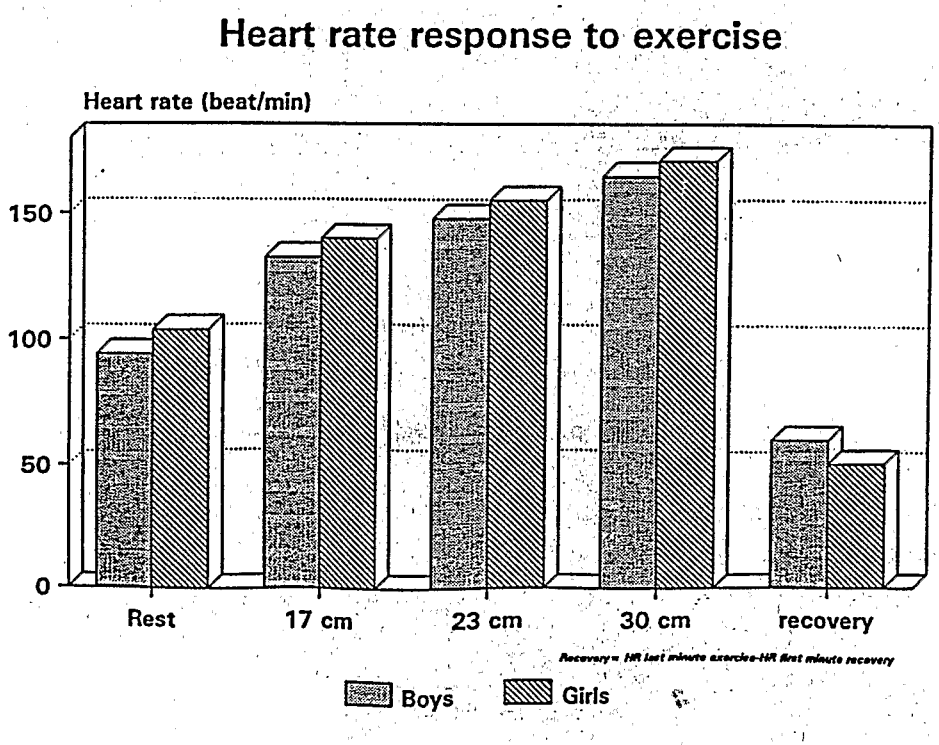

Figure 8

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