PHYSICAL ACTIVITY AND SOMATIC AND FUNCTIONAL CHARACTERISTICS OF SENEGALESE CHILDREN

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Anthropometric measurements, testing of motor skills (foot race, jumping, throwing, gripping), lung function tests, a sub-maximal exercise test (step-test) and an estimation of physical activity through continuous heart-rate monitoring for 6 hours were performed on a group of 100 Senegalese children (54 girls and 46 boys) between the ages of 10 and 13. Only children in good health were selected. Nevertheless, they show clear somatic and functional deficiencies compare to European and North American children. Their spontaneous physical activity appeared moderate with more than 80% of their time spent at cardiac rates less than 125 beats.min-1. Boys were more active than girls.

Taking as a malnutrition threshold a weight/age less than -1 z-score (NCHS/WHO reference), 65 children were classified as malnourished. After adjusting for age and sex, one discerns that malnourished children always perform more poorly than the others. However there is no difference in heart-rate patterns.

These observations underline the role of malnutrition in the development and performances of children as well as its duration. They also suggest that physical activity of malnourished children could be stimulated by social peer pressure.

Introduction

- The anthropometric consequenses of protein-energy malnutrition are a deficit in tissue mass and a slowing growth rate that lead to a reduction of total muscle mass. Reduction of active muscle mass has a negative impact on motor performances. Habitual physical activity can also be decreased to balance energy requirements when intakes are low.

- These two factors, muscle mass and physical activity, are important determinants of the level of physical fitness.

- In Africa, most agricultural tasks require muscular effort and the proficiency with which these tasks are accomplished is related to the physical capacity of the individual. Children also are producers and contribute to family subsistence.

Objectives

- This study has two objectives:
  - to describe the motor performances and habitual physical activity levels of a group of Senegalese children.
  - to demonstrate the importance of nutritional statu with respect to physical fitness.

Subjects and Methods

Sample

- 100 prepubertal children between the ages of 9 and 14, in apparent good health (46 boys and 54 girls).
- Chosen after preliminary demographic census in 4 villages in northern Senegal and 2 in central Senegal.
- Age was determined in most case according to dates of Muslim religious ceremonies.

Methods

- Arnthropometric measurements of body weight, height, triceps skinfold (TSF), arm circumference (AM).
- Measurement of forced vital capacity (FVC) determined by a portable spirometer.
- Working capacity was determined after a sub-maximal step-test and expressed as power reached at heart rate 170 (PWC 170).

- The children performed 4 motor tasks:
  - hand grip strength
  - 33-m race
  - long jump
  - throwing of a softball.
- After exercise, children's pulses were recorded each minute during 6 hours with a "Sport tester" apparatus (Polar electro ky).

Protocol of the step-test

Step-test

- The children rest in sitting position during 3 min.
- then climb up and down at a fixed rhythm of 30 steps per minute:
  - . a 17 cm. bench for 3 min.
  - . a 23 cm. bench for 3 min.
  - . a 30 cm. bench for 3 min.
- finally, rest in sitting position for 5 min.

During the 17 min. of the test, heart rates were registered every 15 sec. with a "Sport tester" apparatus.

Determination of PWC 170

The differing heights of the benches allow for a continuous exercise with increasing load (figure 1), thus, for climbing one step,work performed could be calculated as:

Work (joule, J) = body weight x height of the step x 9.82.

Work for stepping down was estimated at 1/3 of work for climbing, so power reached is:

Power (watt, W) = (total work performed x number of steps)/60.

Then an idividual regression line was fitted between heart rate and work performed during exertion and the aerobic capacity expressed as power reached at heart rate 170.

Assessment of habitual physical activity through 6-hours heart rate recording.

- Children pulse were recorded each minute during 6 hours by means of a "Sport tester" apparatus. Children were asked not to modify their normal activity.

- Results are expressed in percentage of time spent in 3 different HR categories:
  - . HR < 125 beats.min-1 corresponding to an unstressfull activity.
  - . 125 < HR < 140 corresponding to a moderate activity.
  - . HR > 140 corresponding to an intense activity (about 70% of HR max.).

HEART RATES DURING STEP-TEST

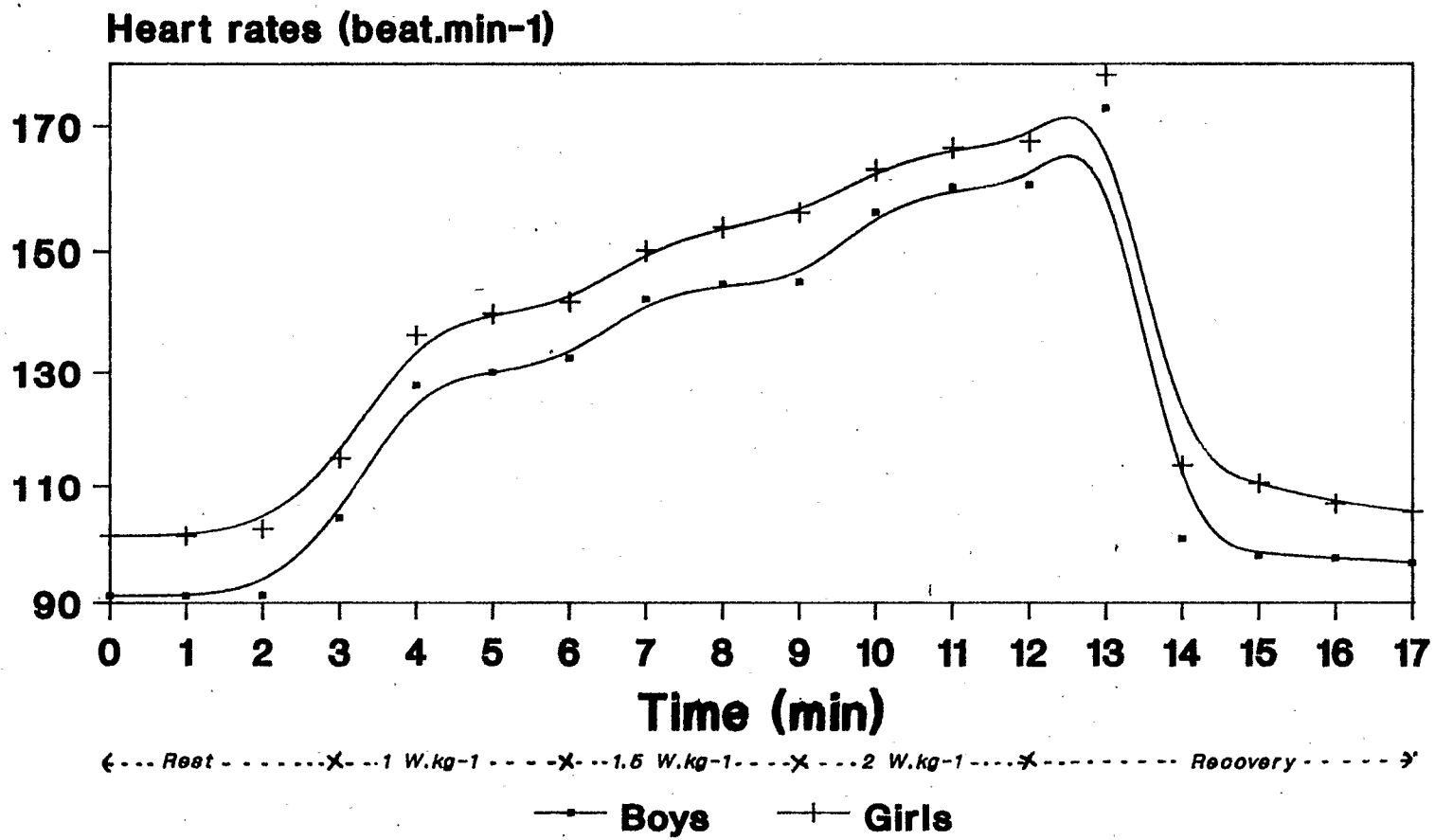
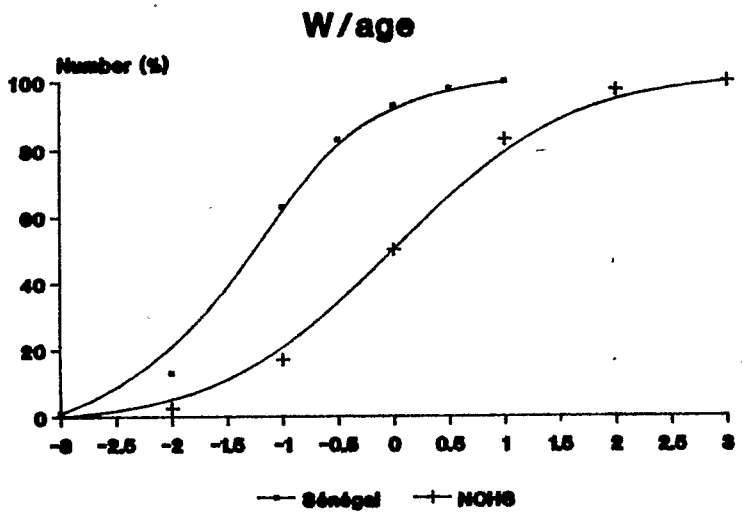
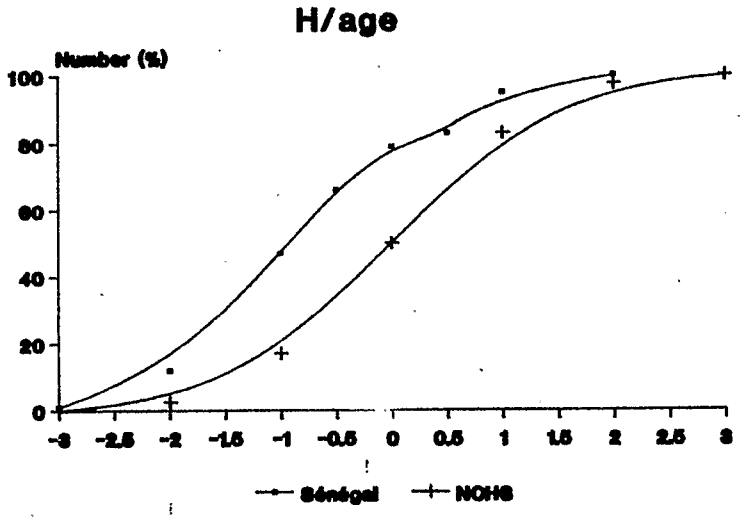


figure 1

W/age and H/age Curves





Nutritional status

- 50% of the children have a height/age less than -1 s.d. of the NCHS reference curve (WHO, 1983).
- 63% have a weight/age less than -1 s.d.

Anthropometric Characteristics

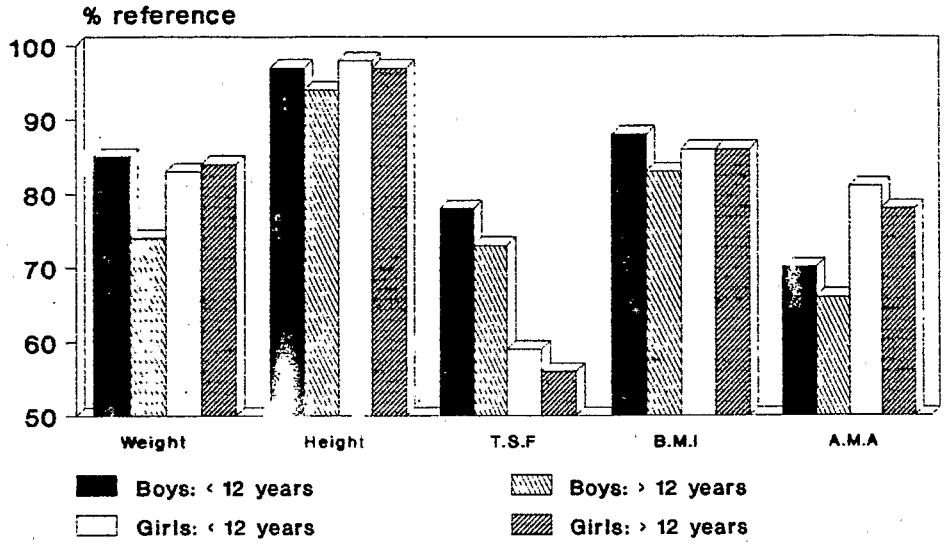


figure 3

Anthropometric Status

Values are expressed as % of the means of well-nourished children from diverse origins (WHO, 1983; Cronk et al, 1982; Frisancho, 1981).

- Deficits in height are less pronounced than those for body mass and composition variables.

Functional & Motor Characteristics

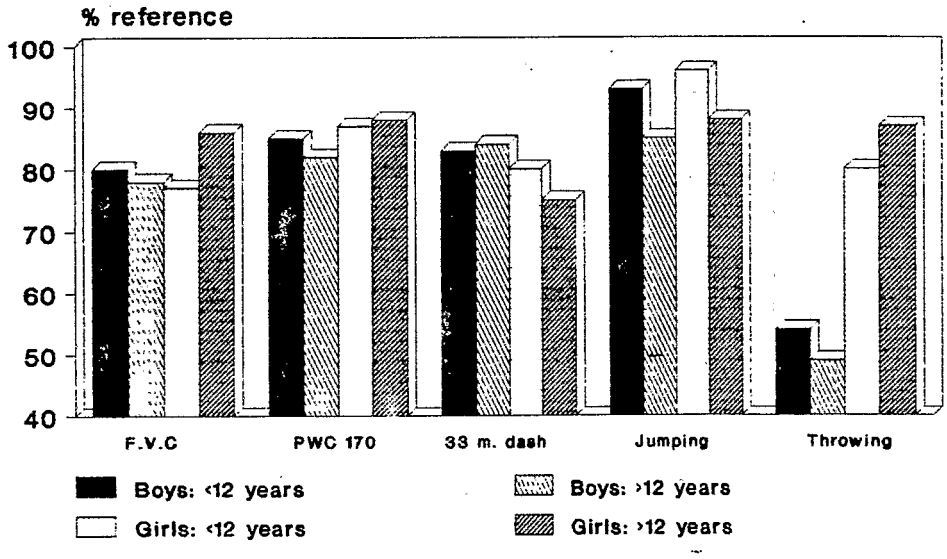


figure 4

Physical Fitness Indices

- Performances are worse than selected references for age and sex (Ciba-Geigy, 1972; Strong et al, 1978; Malina & Roche, 1983).

% Time Spent in 3 Heart Rate Categories

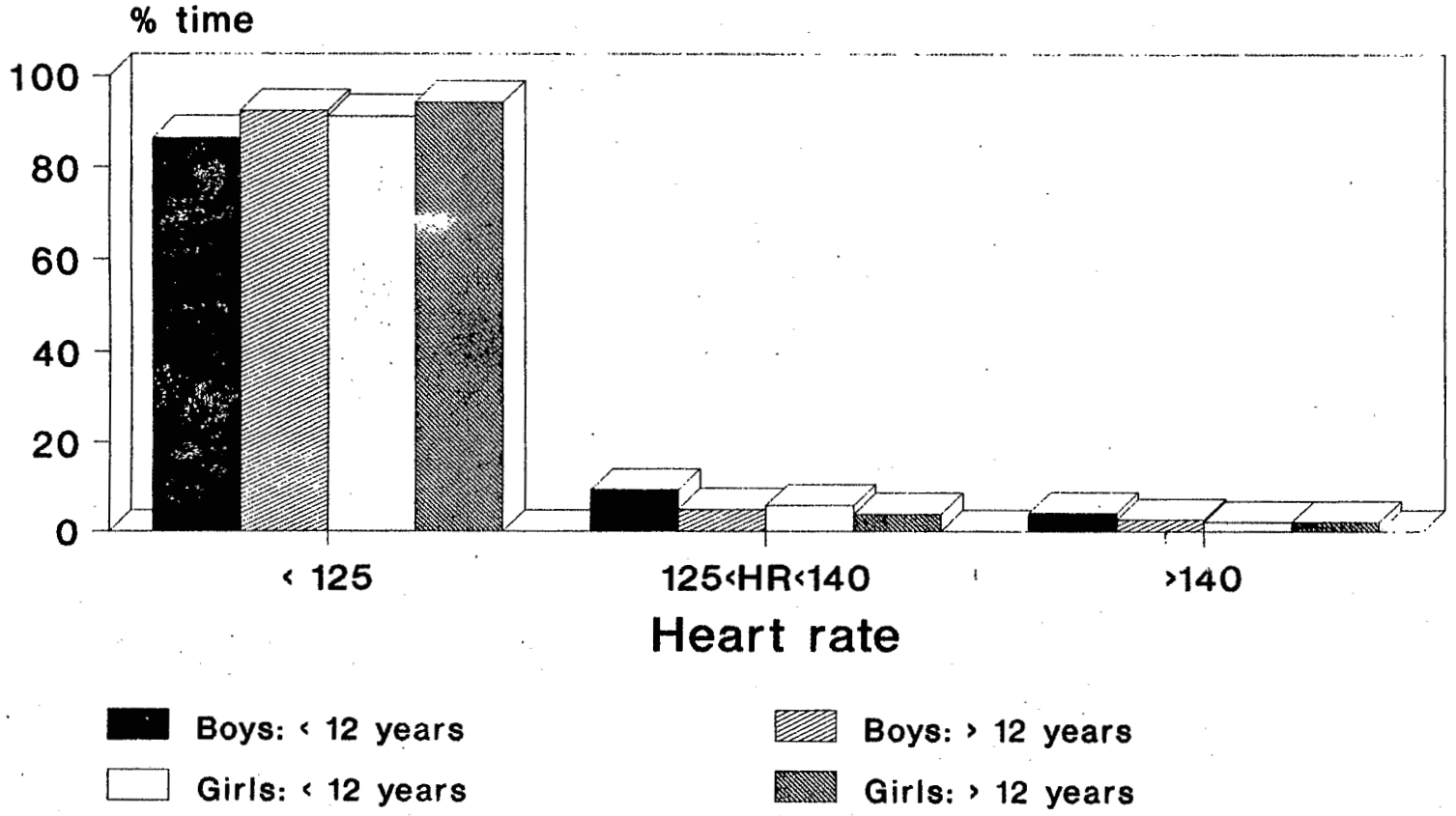


figure 5

6-Hours Heart Rate Recording

- Younger boys are more active than older ones.
- Physical activity levels are low.

Table

	Boys		Girls	
age (years)	10-11.9	12-13.9	10-11.9	12-13.9
N	17	28	31	19
% HR<125	86.4 (1)	92.3	91.1	94.1
	18.6 (2)	9.9	8.9	6.1
	Two-way analysis of variance			
Effect				
age	F = 3.5	(p<0.05)		
sex	F = 1.9	(ns)		
% 125<HR<140	9.4	5.0	5.9	3.9
	15.0	7.2	6.6	4.3
	Two-way analysis of variance			
Effect				
age	F=3.0	(p<0.08)		
sex	F=1.7	(ns)		
% HR> 140	4.1	2.6	2.1	2.1
	4.2	3.0	2.2	2.4
	Two-way analysis of variance			
Effect				
age	F=1.5	(ns)		
sex	F=3.6	(p<0.05)		

(1) mean; (2) 1 standart-deviation
ns: not significant.

Comparison of Motor Performances

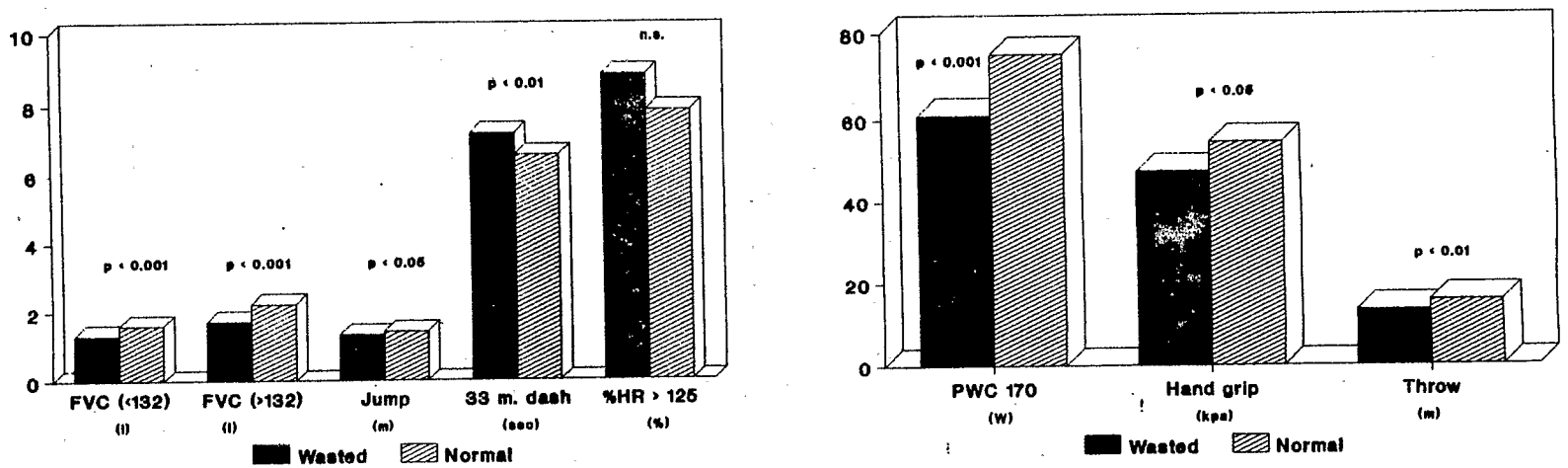


figure 6

Comparison between mild-malnourished and normal children
(adjusted means for age and sex through covariance analysis)

Children were divided into mild-malnourished or wasted, (W/age < -1 sd) and normal children (W/age > - 1sd).

- Normal children have better scores for motor tests, PWC 170 and FVC than mild-malnourished.
- There is no difference regarding the distribution of heart rates.

Table I: Summary of multiple regression analysis between age, sex, W/age, H/age and selected physical fitness variables.

Dependant variable	Step	Entered variables	Multiple R	R2	Change in R2	F to enter
AMA	1	age	0.47	0.22	0.22	27.9
	2	W/age	0.75	0.57	0.34	78.8
	3	H/age	0.79	0.63	0.06	16.9
PWC	1	age	0.44	0.19	0.19	23.2
	2	W/age	0.48	0.24	0.04	5.8
FVC	1	age	0.55	0.30	0.30	42.9
	2	W/age	0.75	0.57	0.26	58.3
	3	sex	0.77	0.59	0.02	6.4
33 m dash	1	sex	0.31	0.09	0.09	10.5
	2	age	0.38	0.14	0.05	5.7
	3	W/age	0.45	0.20	0.05	6.4
Jumping	1	age	0.28	0.08	0.08	8.9
Throwing	1	age	0.41	0.17	0.17	20.6
	2	sex	0.49	0.23	0.06	8.4
	3	W/age	0.58	0.34	0.10	15.4
Hand grip	1	age	0.22	0.05	0.05	5.1
	2	W/age	0.34	0.12	0.07	7.9
	3	H/age	0.40	0.16	0.04	4.7
	4	sex	0.45	0.20	0.04	4.9

Influence of Nutritional Indices in Motor Performances

- W/age explains 5 to 7% of the variance of motor tasks but reaches 26% for FVC.

- H/age has only a limited influence on the variance of grip strength and arm muscle area.

There is no relationship between heart rate ditribution and nutritional indices.

Discussion

- Senegalese children have poorer performances scores than children from the West and well nourished children always score higher than wasted children.

- Physical activity level appears low but there is no relationship between this fact and the nutritional status.

- Some methodological imperfections could account for these outcomes: conditions of testing (sandy track, hot environment), calculation of PWC from a step-test, age determination.

- These results conform to those from other studies which underline the importance of body dimension in determining the physical aptitude of malnourished children (Spurr et al, 1986; 1987).

- Physical activity evaluated through heart rate monitoring are very moderate compared with data concerning English (Amstrong et al, 1990) or North-American children (Gilliam et al, 1981). Is this fact related to the poorer nutritional status of Senegalese children?

- There is no difference in activity levels between mild-malnourished and normal children: are malnourished children stimulated by the social pressure of their nutritionally normal peers? The energy adjustment being made in a reduction of growth rates rather than in a decrease in physical activity (Spurr et al, 1987).

References for anthropometric and functional values.

1. **World Health Organization.** Measuring change in nutritional status. WHO, Geneva, 1983.

2. **Cronk C, Roche AF.** Race- and sex-specific reference data for triceps and subscapular skinfolds and weight/stature 2. Am J Clin Nut 1982: 35, 347-354.

3. **Frisancho A.** New norms of upper limb fat and muscle arms areas for the assessment of nutritional status. Am J Clin Nut 1981: 34, 2540-2545.

4. **Anonymous.** Tables Scientifiques Ciba-Geigy. 7 em ed., Bâle, Ciba-Geigy SA, 1972.

5. **Strong WB, Spencer D, Miller MD, Salehbhai M.** The physical working capacity of healthy black children. Am J Dis Child 1978: 132, 244-248.

6. **Malina R, Roche AF.** Manual of physical status and performance in childhood. Volume 2: Physical performance. New York and London, Plenum Press, 1983.

7. **Amstrong N, Balding J, Gentle P, Kirby B.** Patterns of physical activity among 11 to 16 year old British children. British Medical Journal 1990: 301, 203-205.

8. **Gilliam TB, Freedson PS, Geenen DL, Shahraray Behzad.** Physical activity patterns determined by heart rate monitoring in 6-7 year-old children. Med Sci Sports Exercise 1981: 13, 65-67.

9. **Spurr GB, Reina JC.** Marginal malnutrition in school-aged Colombian girls: dietary intervention and daily energy expenditure. Hum Nut Clin Nut 1987: 41C, 93-104.