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Nutrition and exercise in children

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Summary. - Various surveys and research studies carried out in the scientific world have expressed general consensus on the preventive role of regular physical exercise associated with a correct and adequate diet. A sedentary style of life is the common etiopathogenetic basis of "paramorphism" of the different organs and system that generate the hypokinetic syndrome. Therefore it is important to adopt a correct life style from childhood. For this purpose 1208 subjects aged between 6 and 14 years, in an Italian rural area, have been studied for nutritional habits, anthropometric parameters, nutritional state and motor abilities (Di.S.Co. project: experimental community project for preventing chronic-degenerative diseases). The population was divided in: subjects participating to organized sport activities and sedentary subjects; and then subjects of different ages between 9 and 14 years; results regarding anthropometric parameters, body composition and the predominance of overweight and obesity are given. Our study has shown widespread tendency to incorrect nutrition habits, also in those doing organized sports, and a low attitude to volontary physical activity. School represents a privileged institution for releasing and promoting correct life style beginning from the younger age.

Key words: age of development, nutrition, skinfold, BMI (body mass index).

Riassunto *(Nutrizione e sport in età evolutiva)*. - Numerosi studi e ricerche in Italia e nel mondo concordano sull'efficacia preventiva della pratica regolare di una attività fisica, unita all'adozione di regimi alimentari adeguati e corretti. La sedentarietà infatti rappresenta la base eziopatogenetica comune ai quadri clinici della sindrome ipocinetica, definiti "paramorfismi" dei vari organi ed apparati. Risulta importante quindi che gli stili di vita corretti, vengano adottati a partire dall'età infantile. Nell'ambito del progetto Di.S.Co. (progetto sperimentale di intervento comunitario per la prevenzione delle malattie cronico-degenerative) gli autori hanno studiato, in una zona rurale italiana, le abitudini alimentari, i parametri antropometrici, lo stato nutrizionale e le capacità motorie di 1208 soggetti, in età compresa fra i sei e i quattordici anni. Vengono riferiti i risultati relativi ai dati antropometrici, di composizione corporea e di prevalenza del sovrappeso corporeo/obesità, dopo aver distinto il campione in soggetti attivi e non, suddividendoli per fasce di età. Lo studio ha dimostrato la diffusa adozione di scorretti regimi alimentari anche nei ragazzi attivi ed inoltre la generale scarsa abitudine al movimento spontaneo. La scuola viene considerata pertanto come l'istituzione privilegiata ove diffondere e promuovere stili di vita congrui a partire dalle fasce di età più giovani.

Parole chiave: età evolutiva, nutrizione, sport, pliche cutanee, IMC (indice di massa corporea).

The benefits of regular physical exercise

Surveys and researches carried out in Italy and elsewhere have for some time expressed general consensus on the great preventive effectiveness of a healthy and correct diet and of regular and continuative physical exercise. Despite this, the socio-demographic evolution of the last decades has had a negative influence on the motor and nutritional habits of the population of all ages. Many of the risk factors for cardiovascular and metabolic disorders (hypertension, dyslipidemia, obesity, etc.) are already evident in childhood and adolescence [1].

The changes occurring in the age of development referable to sedentary life can be classified as specific "paramorphisms" of the different organs and systems. They should be considered as an authentic indication of the hypokinetic syndrome, with the common feature of being able to be either prevented or treated with regular physical exercise (Table 1) [2]. As to metabolic paramorphisms, physical exercise can improve the weight-height ratio, and especially that of body composition. There is some controversy on the effects of exercise on the lipid pattern in childhood and adolescence. Studies carried out on trained children have shown an increase in the HDL cholesterol/total cholesterol ratio. Less frequently, a reduction in total cholesterol and triglycerides has been observed. The variations are linked to age, and are more evident in subjects aged between 12 and 16 years, a period during which physical activity is organized into proper training in most sports [3, 4].

In literature, research on lipid tracking from childhood to maturity clearly shows that - without any kind of preventive care - the lipid pattern of childhood is maintained in adolescence and maturity without

Table 1. - Paramorphism: clinical pictures of "hypokinetic disease" affecting various organs and systems

Paramorphism of the musculoskeletal system	Paramorphism of the cardiocirculatory system
Cervicodorsal kyphosis Functional scoliosis or scoliotic attitude Lumbard hyperlordosis Knock knee and bowleg (*genu valgum* and *varum*) *Pes valgus* Flat feet	Tachycardia from exercise Reduced systolic range Inadequate peripheral circulation on demand Inadequate arterial pressure on demand
Paramorphism of the respiratory system	**Metabolic paramorphism**
Reduced static and dynamic pulmonary volume Tachypnea from exercise Reduced respiratory efficiency	Unfavorable weight-light ratio Overweight Changed body composition Early appearance of hematochemical or dysmetabolic changes

prevention. This confirms the need to acquire active motor habits early on to forestall the major risk factors for degenerative diseases as soon as possible [5].

Early sedentary habits also encourage the onset of predisease state or paramorphisms of the bones (scoliotic attitude, lumbar hyperlordosis, cervicodorsal kyphosis, etc.), with a tendency towards diseases caused by overloading the spine and lower limbs in maturity and osteoporosis in old age [6].

Motor habits and sports activities in the age of development

Sedentary habits are now also widespread among children and adolescents, and their leisure time is increasingly less devoted to games involving movement. It is common opinion of sports operators, also confirmed by surveys on the habitual level of physical activity, that the psychomotor abilities of the new generations are often quite low [6-11]. Numerous authors have pointed out that, both in Italy and in the other industrialized countries, a high predominance of obese and/or overweight children is considered a reliable indicator of a sedentary lifestyle and incorrect dietary habits [8, 12-16].

However, alongside the reduction in spontaneous movement, an increase in the number of children who approach sport also takes place. Numerous authors have studied their somatic and functional features and the ways in which they develop their different motor qualities, in order to define "when", "why", "how much" and "how" they organize their sporting activity [7, 17].

Normally, six is the age when they start practicing sport, and whatever the discipline, the activity is initially multilateral, that is, aimed at the development of all the various physical qualities, whether coordinative (dexterity, etc.) or conditional (strength, speed, resistance, etc.); particular emphasis is placed on the former qualities for which, in relation to the stages of the child's neurosensorial development, the sensitive stage is between 6 and 10-12 years [7, 18]. In this stage, sporting activity is basically an organized game. Only later on can we speak of a real approach to a specific sport and modern training methods [7].

Sporting activity at a very early age does not submit children to high work loads, but has mainly the function of stimulating a harmonious development of the organism and preparing it for the subsequent training stages.

Albeit young athletes undoubtedly demonstrate better characteristics of body composition with regular exercise than the sedentary young [19, 20], in childhood sport alone is not enough to prevent the effects of little habitual movement. However, engaging in a sport in childhood and adolescence helps to develop a positive attitude towards an active lifestyle which will also be more easily maintained as an adult [21].

Nutritional requirements of exercised children

The stresses and adjustments ensuing from training in the different sports disciplines are caused by the bioenergetic characteristics of the specific technical gesture of each discipline. This is why the different sports can be classified with relation to metabolic and muscular involvement and the duration of the performance in different categories.

According to Dal Monte and Matteucci [22] six categories can be defined:

1. activities of a mainly anaerobic involvement;
2. activities of a great aerobic-anaerobic involvement;
3. activities of a mainly aerobic type;
4. activities with an alternating aerobic-anaerobic involvement;
5. activities involving strength;
6. activities involving dexterity.

For example basketball, football and water-polo are sports with an alternating aerobic-anaerobic involvement, the specialties of high-jump in athletics and weight-lifting are activities involving strength.

Each category contains several distinct disciplines; target-shooting, fencing and sailing are activities involving dexterity, with skill in the execution of the gesture or in conducting a means in common, but with a very different bioenergetic and muscular component. But even high-level athletes of more "sedentary" sports, such as car racing, speedboat racing and target shooting, have specific and demanding basic physical preparation regimes.

The energy consumed in the specific sports disciplines varies in relation to the functional model of the sport and its training method; moreover, a balanced diet with regards to quantity and quality is an authentic means of training for high-level athletes, and should therefore be correctly dosed.

Daily intakes of 5-6000 kcal are common among athletes of some disciplines (rowing, for example), mainly provided by carbohydrates (60-65%). These high calory intakes are justified both by the body size and the training methods, involving 12-13 sessions a week of two or three hours each. In team gymnastics, and particularly women's, and sports with weight classes (wrestling, martial arts) the daily energy requirement is lower.

Sometimes it can be helpful for those doing sports with a high athletic value to follow special nutritional regimes which are not advisable for all. During the early stages of a sports activity (up to 10-12 years) it is never necessary to increase the child's calory intake. But later on the energy expenditure must be properly calculated for each sport. For example, playing football continuously for an hour consumes 300 kcal, an hour of gymnastics 150 kcal, and an hour of tennis 240 kcal; consumptions which can be compensated by small quantities of food and which often are overestimated by families and by the young athletes themselves [23].

In a study we carried out on the dietary habits of a group of children during their day of training, most of them said they ate more after doing sport. We cannot say if the calory intake was also higher than needed because our study focused on behaviour, but it is likely that this kind of habit leads to an excess in daily calory intake[24].

As regards the quality of the diet, the recommended protein requirement for growing people (1.5 - 1.7 g of protein/kg of body weight/die) must be respected. It is also important to check that the liquid intake is correct and to encourage it during training. Water is to be preferred to ready-made drinks containing minerals and vitamins, since the work load of the very young does not justify the addition of these nutrients in liquids.

Particular attention must be paid to the distribution of meals over the day in relation to training times, concentrated in the afternoon because of school attendance. The "pre-training" meal should mainly consist of compound carbohydrates and should be eaten two-three hours before the sporting activity.

Anthropometric assessment, body composition and nutritional intake in exercised children

To support what we have said about the spread of sedentary habits in the age of development and the tendency in the family to overestimate the amount of energy consumed in sport, we present the results of some investigations we did on anthropometric and nutritional aspects in the very young.

Dating back to the beginning of the 80s is an investigation on the nutritional habits of 199 children aged between 11 and 12 years on their training day for various sports. The anthropometric results are given in Table 2. The body mass index (BMI) is between 50° and 75° percentile of the reference values according to age (Nicoletti 1992 [25]) with the exception of the team gymnastics group, whose value is between 25° and 50° percentile in relation to the specific morphological biotype of this sport.

Table 2. - Anthropometric data of 199 subjects aged 11 years engaged in organized sports in 1980

Sport	Height (cm)		Weight (kg)		BMI		no.
	Mean	SD	Mean	SD	Mean	SD	
Soccer-males	146.4	3.4	38.7	4.7	18.0	2.7	50
Tennis-males	143.9	5.1	39.3	5.0	19.0	3.4	63
Tennis-females	146.2	4.9	40.7	4.5	19.0	2.9	22
Gymnastics-males	142.7	3.5	36.6	4.7	17.6	2.5	28
Gymnastics-females	140.0	3.2	33.2	3.6	16.9	2.4	36

The analysis of dietary habits revealed an excessive calory intake in the football and girls' tennis teams with respect to theoretical values (Table 3). The percentage distribution of the various caloric nutrients is reasonable. On the day of training, 55% of the children had a different meal before training, and of these 54% ate a correct meal, that is mainly carbohydrates.

In 1984-'85 we assessed the nutritional state and dietary habits of a group of young Roman footballers aged between 8 and 11 years [23] attending a youth sports centre of the Federazione Italiana Gioco Calcio (Tables 4, 5). The weight by height ratio according to the Reference data for weight and height of children (WHO, 1983) averaged (107± 14 %) with a minimum of 82 and a maximum of 160 % with respect

Table 3. - Nutritional intakes *(*)* of 199 subjects aged 11 years engaged in organized sports in 1980

Sport	Energy intake (kcal)	CHO (%)	Protein (%)	FAT (%)
	Mean ± SD			
Soccer-males	2628 ± 235 *(**)*	50	18	32
Tennis-males	2290 ± 220	52	18	30
Tennis-females	2235 ± 197 *(**)*	51	18	30
Gymnastics-males	2218 ± 250	51	17	32
Gymnastics-females	210 ± 156	49	18	33

(*) Data assessed by "recall method" on the former week.
(**) Energy intake higher than LARNs (recommended daily intakes of energy and nutrient for the Italian population) (rev. 1987 11 years aged: females 1976 kcal, males 2257 kcal).

Table 4. - Anthropometric data of 143 children soccer players. (Soccer school, Rome, 1984-1985)

Age	Height (cm)		Weight (kg)		BMI		Triceps (mm) skinfold		Subscap. (mm) skinfold		no.
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
≤ 8.11	131.8	5.5	29.8	4.1	17.1	1.9	9.5	2.9	5.7	1.6	53
9.0-9.11	137.7	6.1	34.1	6.6	17.9	2.5	10.5	4.4	6.9	3.0	66
≥ 10.00	138.3	5.6	34.0	7.6	17.6	2.8	9.9	3.8	7.0	3.5	24
Tot. group	135.6	6.5	32.5	6.3	17.5	2.5	10.0	3.8	6.5	2.7	143

Table 5. - Nutritional intakes *(a)* of 143 children soccer players. (Soccer school, Rome, 1984-1985)

Age	Energy intake (kcal)	CHO (%)	FAT (%)	Protein (%)	Protein g/kg/body weight/die
	(Mean ± SD)				
≤ 8.11	2544 ± 275 *(b)*	51	34	15	3.2 ± 0.5 *(c)*
9.0 -9.11	2683 ± 286 *(b)*	50	35	15	3.0 ± 0.6 *(c)*
≥ 10.00	2707 ± 315 *(b)*	51	34	15	3.1 ± 0.5 *(c)*
Tot. group	2635 ± 294 *(b)*	51	34	15	

(a) Data assessed by "recall method" on the former week.
(b) Energy intake higher than LARNs (1987: 8 years aged - 2325 kcal, 9 years aged - 2490 kcal, 10 years aged - 2190 kcal).
(c) Protein intake higher than recommended requirement (1.5 g prot/kg body weight/die).

to ideal weight, which means that the group is slightly overweight; the predominance of overweight and obesity is shown in Fig. 1.

The total energy intake is higher than the amount recommended for the Italian population (LARN 1987) in all three age levels. The protein quota (in grammes per kg of body weight) is almost twice the values recommended; the fat intake is also high (Table 5).

In 1992 we started a programme for assessing motor abilities and nutritional state in a state school in an Italian rural area. The sample population we studied was selected from that of the Di.S.Co. ("Distretto Sezze Controllo Comunitario", Community Control Sezze District) Project, an experimental Community project for preventing chronic-degenerative diseases begun in 1983 in the province of Latina [26].

In our study we assessed lifestyle, physical qualities and nutritional state. On the first evaluation (1992-93 school year) the sample consisted of 1208 subjects aged between 6 and 14 years. We give the results regarding anthropometric parameters (Figs 2, 3), body composition (Tables 6-9) and the predominance of overweight and obesity (Fig. 1) of the sample, divided up into those doing organized sports and those not, for the age ranges between 9 and 14 years.

In Figs 2 and 3 it can be noted that the anthropometric parameters in both sexes are identical in the two groups. The average value of the body mass index is greater than the reference values in all the age ranges (Figs 4, 5). The average values of the tricipital and subscapular skinfolds are above 50° percentile of the reference population, or corresponding to it, in all age ranges and in both sexes (Figs 6, 7). The comparison of the averages of the two groups (Student t test, level of significance at 5%) did not show statistically significant differences.

The predominance of overweight and obesity is high in the entire group. The percentage of normal-weight subjects was never above 50% and the percentage of obese subjects (weight by height ratio 120% above the ideal weight) is over 30% in both those doing sport and not.

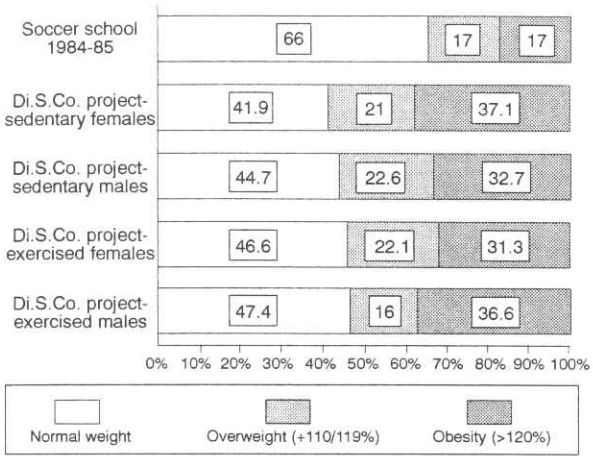

Fig. 1. - Predominance of overweight and obesity.

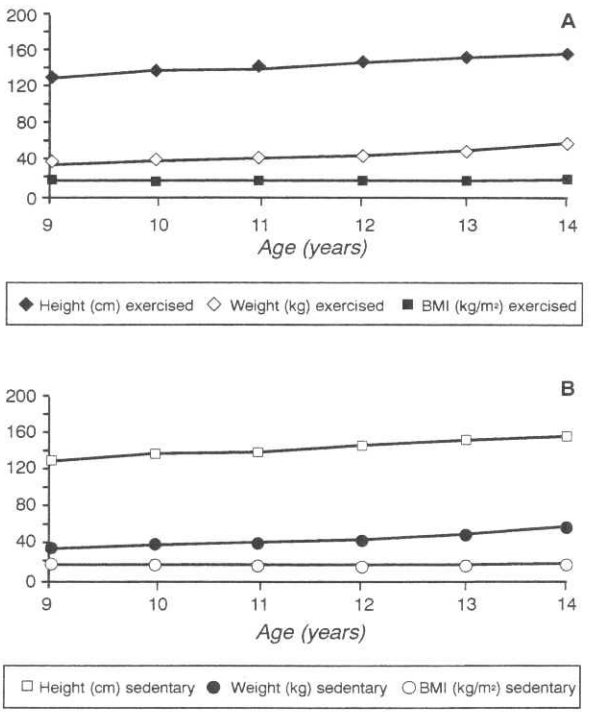

Fig. 2. - Anthropometric data. A) exercised females, B) sedentary females. Di.S.Co. project.

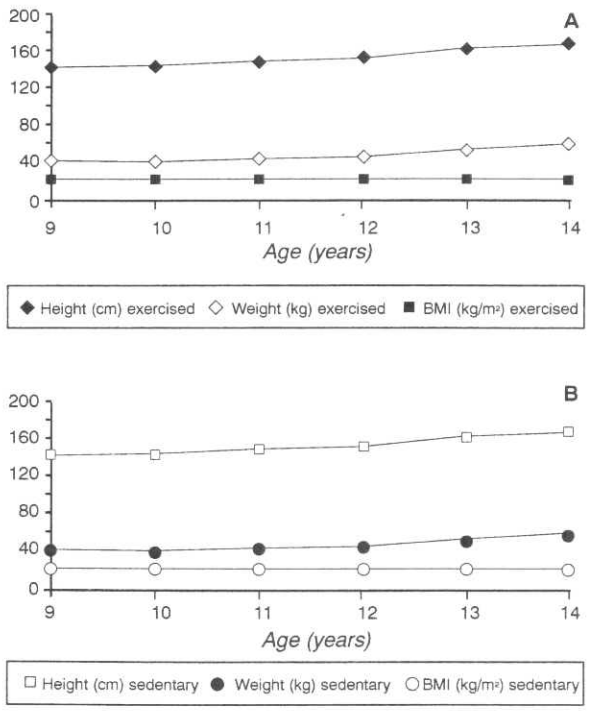

Fig. 3. - Anthropometric data. A) exercised males, B) sedentary males. Di.S.Co. project.

Table 6. - Skinfold thickness (mm) in a school population of an Italian rural area. Di.S.Co. project. Females, sedentary group

Age	Triceps		Subscapular		Σ (*)		no.
	Mean	SD	Mean	SD	Mean	SD	
9	15.9	6.0	11.1	6.0	49.7	21.2	59
10	16.2	8.8	12.7	8.8	51.8	23.2	50
11	16.2	5.5	11.6	5.5	52.4	21.5	57
12	15.9	8.3	13.2	8.3	52.7	21.5	57
13	15.8	6.4	11.8	6.4	49.5	19.9	51
14	15.5	4.8	11.8	4.6	49.1	17.9	34

(*) Σ = biceps + triceps + suprailiac + subscapular.

Table 7. - Skinfold thickness (mm) in a school population of an Italian rural area. Di.S.Co. project. Females,exercised group

Age	Triceps		Subscapular		Σ (*)		no.
	Mean	SD	Mean	SD	Mean	SD	
9	14.5	5.3	8.6	4.2	43.0	20.0	10
10	16.1	5.5	12.7	8.8	51.6	24.3	26
11	16.2	4.5	12.6	6.5	52.9	19.9	25
12	15.0	6.1	10.9	5.2	49.5	20.7	16
13	14.8	3.5	11.5	6.4	45.5	18.4	19
14	16.3	5.1	11.6	4.1	49.2	17.1	16

(*) Σ = biceps + triceps + suprailiac + subscapular.

Table 8. - Skinfold thickness (mm) in a school population of an Italian rural area. Di.S.Co. project. Males, sedentary group

Age	Triceps		Subscapular		Σ (*)		no.
	Mean	SD	Mean	SD	Mean	SD	
9	13.3	5.1	9.5	6.3	41.9	20.8	62
10	14.9	5.3	10.1	5.8	45.2	19.7	39
11	15.9	7.0	11.3	8.4	51.8	17.7	38
12	15.2	5.7	10.2	5.6	47.7	23.4	54
13	16.3	7.0	12.5	7.8	44.5	19.3	53
14	11.7	5.9	10.0	7.0	40.2	24.2	38

(*) Σ = biceps + triceps + suprailiac + subscapular.

Table 9. - Skinfold thickness (mm) in a school population of an Italian rural area. Di.S.Co. project. Males, exercised group

Age	Triceps		Subscapular		Σ (*)		no.
	Mean	SD	Mean	SD	Mean	SD	
9	15.5	7.0	10.8	7.4	48.7	26.6	18
10	14.2	6.1	10.8	8.8	47.5	26.6	34
11	15.9	6.1	10.6	6.9	48.7	22.9	37
12	13.8	5.9	9.6	6.9	41.8	22.5	22
13	13.6	5.2	9.9	4.7	41.8	18.9	31
14	12.0	6.1	10.5	7.2	42.0	24.9	18

(*) Σ = biceps + triceps + suprailiac + subscapular.

However, we cannot consider the sample of the Di.S.Co. Project to be representative of the general population, since assessments carried out previously on the adult population of the same rural area also revealed a high predominance of overweight subjects [26]. It is interesting to see, moreover, that the body composition in the very young does not seem to be influenced, at least in the short term, by sports activity, and that also in young footballers, in whom the predominance of overweight obesity is lower, the values of the tricipital and subscapular folds are not lower than those of the reference population (Figs 6, 7).

Very young top-quality athletes in the higher age ranges, with more frequent and more intense training programmes, have a better body composition. But our aim was to assess the nutritional state of the majority of those doing sport in the age of development.

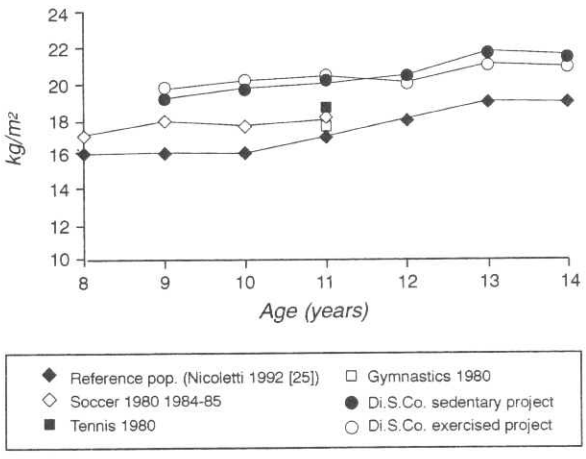

Fig. 4. - Body mass index for age and physical activity. Males.

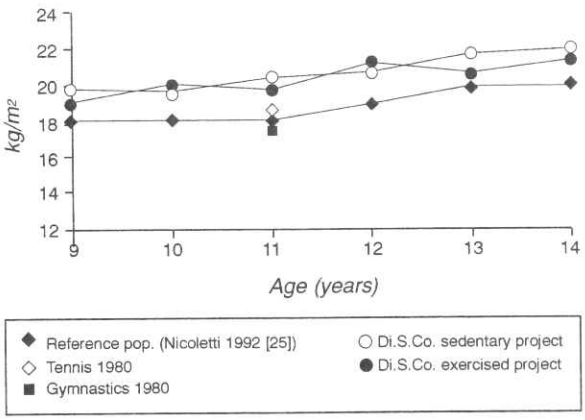

Fig. 5. - Body mass index for age and physical activity. Females.

Conclusions

Our investigations have shown that there is a widespread tendency to incorrect dietary habits and little spontaneous movement among children in all stages of the development age. The harmful effects of sedentary habits cannot be averted solely by physical/sport activity, even when begun at an early age.

In addition, the increased energy expenditure produced by physical exercise can be counteracted by an excessive food intake, the origin of which is to be attributed to the insufficient information of people costituting the child's environment; hence the importance of correct information on the relationship between physical activity and nutrition, both for families and the young themselves. This is why sports operators, together with the school, can represent an important laboratory of "motor and nutritional

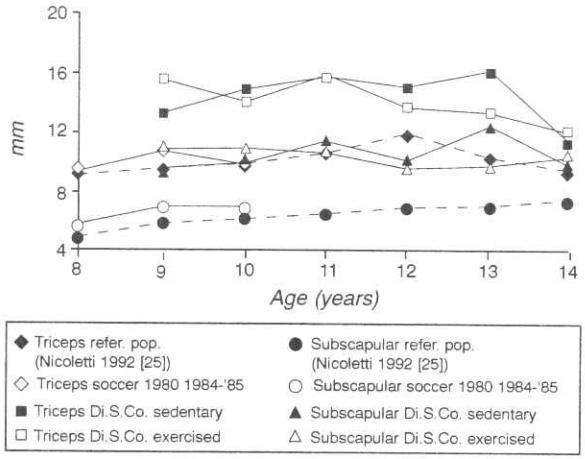

Fig. 6. - Skinfold thickness for age and physical activity. Males.

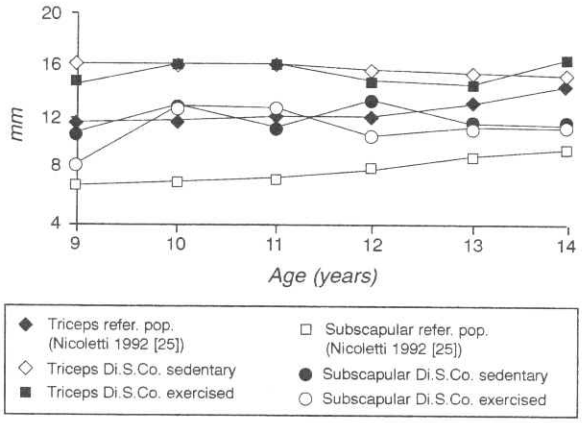

Fig. 7. - Skinfold thickness for age and physical activity. Females.

education" at this age, stimulating and fostering the adoption of correct food and motor habits, that will prove invaluable for later life.

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