

**NUTRITION, ACTIVITY BEHAVIOR AND BODY CONSTITUTION IN  
PRIMARY SCHOOL CHILDREN**

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**Abstract.** Child and adolescent obesity currently affects at least 10-25% of the paediatric population in most developed countries. The BMI value is one of the most appropriate method of defining obesity and has a strong association with body fatness and health risk. Two main environmental factors, nutrition and physical activity, could influence paediatric obesity development. This paper studies the relationship between sedentariness, snack and soft drink intake and overweight or obesity in children. 1194 primary school children (age 8-10) participated in the study. For all the subjects we measured the anthropometric data to calculate the BMI. The overweight and obesity prevalence was estimated using age-specific BMI cutoffs. A questionnaire was also submitted to all the children by a single interviewer to obtain data about: a) Weekly Physical Activity, b) Weekly Sedentary Activity, c) Alimentary Style. Spearman rank correlation and the Student's t-test were used. The data demonstrated that 23.2% of the children is overweight and the 4.8% obese. BMI is inversely correlated to the physical activity, while there is positive correlation between BMI and number of double portions. Statistically significant positive correlation is present among eating snacks and hours of sedentariness, while there is a negative correlation between physical activity and TV hours. Physical activity in the childhood could be an important tool to prevent obesity development and adult-onset chronic diseases. It is important to encourage an active lifestyle in order to reduce sedentariness.

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*Key words:* Alimentary habits - Sedentariness - Physical exercise - Body Mass Index

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## Introduction

The prevalence of obesity in industrialized countries has been significantly on the rise over the past 20 years, involving about 20% of the adult population in many countries. In the United States in particular, 60% of the population is overweight and 27% is obese. In Europe, the prevalence of obesity varies from country to country, but nevertheless tends to be lower with respect to the United States and Australia [4].

Overweight and obesity among children has followed the same trend over the past few years. In fact, in the United States, the percentage of overweight children between ages 6 and 11 has more than doubled, from 6.5% to 15.3% between 1970 and 2000. The situation in Italy seems to go along with this phenomenon [5,8]. In Northern Italy, from 2% of obese children in the 1970s, we have moved up to 5-9% in the 1980s. At the end of the 1980s, the percentages rose to 13.4 % [17,25]. Around 23% of children between ages 10 and 11 have problems with excess weight [5,8,17,18]. Among adolescents, the prevalence of obesity reaches 17% [1,14]. Childhood obesity is one of the major causes of pediatric hypertension, and in the long term, overweight children run a high risk of developing chronic diseases like diabetes, coronary diseases, and orthopedic and respiratory problems. Excess weight in childhood is hence a risk factor for morbidity and mortality in adulthood [22,23]. The level of self-esteem, which tends to be low in overweight children, is very important for psycho-social reactions that can emerge in the long term, as for example in interpersonal relations and in performance at school [16,19,29]. In adolescence, obesity can have a negative influence on the development of personality [29]. The special attention that must be devoted to diet is justified by the fact that nutrition has been drawn into relation with the development and functioning of many physiological processes and with the prevention of nutritional disorders. On the other hand, physical activity reduces the tendency to adiposity and improves mental and emotional health [19,29]. Obesity can be defined as the result of physiological processes determined by genetic factors and environmental factors and by their interrelation. Hereditary factors are certainly important in the development of childhood obesity, but the environmental aspect often seems to play a very important role nonetheless [2]. As a matter of fact, parent obesity is the most important premise for obesity in offspring, in the sense of predisposition towards obesity. When both parents are obese, 80% of their offspring are overweight; when one of the two parents is obese, 40% of their offspring are overweight, while if the parents are not obese, only 7% of their offspring are overweight [12,13,17,23]. The socio-economic status, education and occupation of



the parents have a marked influence on children's eating habits and regular engagement in physical activity, thus determining a greater or lesser risk of becoming overweight or obese [8,27,29]. In fact, being accustomed to a sedentary lifestyle characterized by the lack of regular sports activity on the part of parents, especially mothers, is highly correlated to inactivity in offspring [12].

### Materials and Methods

*Subjects:* 1194 children (610 males and 584 females) between 8 and 10 years of age participated in the study. The sample was taken from the municipal elementary schools in the northeast part of the Province of Milan.

The age of the subjects was determined by considering a relatively stable phase of growth (8-9-10 years of age), i.e., before puberty, which, especially among girls, can already take place at the age of 11. For this reason, children of the 3<sup>rd</sup> and 4<sup>th</sup> elementary levels were taken into consideration. Children from the 5<sup>th</sup> levels were excluded from the study, as were children from the 1<sup>st</sup> and 2<sup>nd</sup> because they were thought to be too small to be able to give reliable responses on the questionnaire, where they were asked to express concepts involving temporal perception that are not always developed at that age.

A single examiner had every child participating in the study fill out a questionnaire. At first, the questionnaire was illustrated to each class of children as a whole, and later, the same surveyor filled it out together with each child, trying to explain the questions aimed at collecting the necessary information in a simple, easily understandable manner. The questionnaire was designed to be filled out in 4 parts:

1. Assignment of identification cod., given to each child related to his or her school and class.
2. Survey of anthropometrical data: sex, age, height and weight of the children. Weights were measured on scales (in kg, rounded out to the 100 g), and the children only wore T-shirts and trousers (or skirts). Heights were measured in an erect, standing position, with feet together and heels resting against a vertical wall marked in centimeters (measured in meters, rounded out to the 0.5 cm). Then the Body Mass Index was calculated ( $BMI=kg/m^2$ ) [6,10,14]. The prevalence of obesity and overweight was calculated by considering the BMI cut-off point related to the average ages calculated in the sample group. Subjects with a BMI less than  $19.85 kg/m^2$  were considered normal-weight, those with a BMI between  $19.85 kg/m^2$  and  $24.05 kg/m^2$  were considered overweight and those with a BMI greater than  $24.05 kg/m^2$  were considered obese [6,10].



3. Information related to physical activity were point out to ascertain whether the children tended towards active lifestyles or not, or whether the contrary was true, by quantifying how many hours per week were dedicated to some muscular activity. Specific indicators for sedentary habits or physical inactivity (for example, hours per day or per week dedicated to watching TV or playing at the computer) were also identified. Information related to the quantity, in terms of hours, of physical and sedentary activity the children performed during one day, and hence in the course of a week were also collected. In this way, two indices of activity were established:

- WPA (Weekly Physical Activity): the sum of all of the hours of physical activity in one week. That is:

- a. Weekly hours of physical education at school
- b. Movement activities during lunch break (1 hour a day, 5 days/week): ball games, running, jumping
- c. Hours per week of extracurricular sports (swimming, soccer, basketball, volleyball, tennis, dance, skating, gymnastics). Four ranges were set up: 0, 1-2, 3-4, 5-6 hours/week
- d. Hours per day of outdoor play when lessons at school were over (cycling, playing soccer, skating). The four ranges were: 0, 1-2, 3-4, 5-6 hours/day and they were calculated for 5 days, thus determining hours/week
- e. Hours of activity during the weekend: time spent movement activities outdoors or engaged in sports activities, expressed in hours/week. The ranges considered were: 0, 1-2, 3-4, 5-6 hours/week

- WSA (Weekly Sedentary Activity): the sum of all of the hours of sedentary activity during one week. That is:

- a. Sedentary activity during lunch break, lasting one hour a day (5 days a week): talking, reading, group games, portable video games as indicators of inactivity
- b. Sedentary activity carried out during the weekend: time spent watching TV, playing at the computer, reading or doing homework. The ranges considered were: 0, 1-2, 3-4, 5-6 hours/week
- c. Hours per day dedicated to the TV, video games, and the computer. The ranges considered were: 0, 1-2, 3-4, 5-6 hours/day, calculated for 5 days
- d. Hours per day for homework and studying. The ranges were: 0, 1-2, 3-4, 5-6 hours/day, calculated for 5 days

4. Information on nutritional habits: the frequency with which certain foods were consumed was analyzed, in an effort to deal with two essential requirements: the search for reliable, significant indicators of nutritional habits and the simplicity and immediacy of the questions to use in the questionnaire.

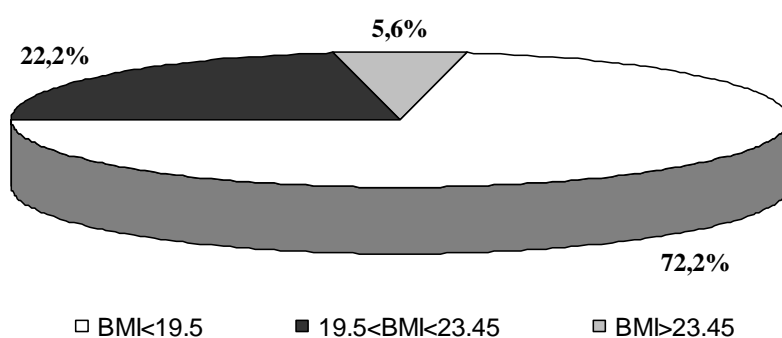


The Alimentary Style Index (ASI): an approximate and general indicator of the foods and drinks consumption (as bigger as more food and drinks taken). It was calculated, based on:

- The number of second helpings children asked for at lunch in the cafeteria or at dinner at home
- Number of snacks, drinks or pieces of fruit consumed during the day

*Statistical analysis:* The data collected were synthesized and presented with average values and respective standard deviations, or percentage values. Differences in descriptive characteristics of the population were analyzed with the Student's t-Test. The evaluation of the association between variables was carried out by applying the nonparametric method Spearman rank correlation to the data [28].

## Results



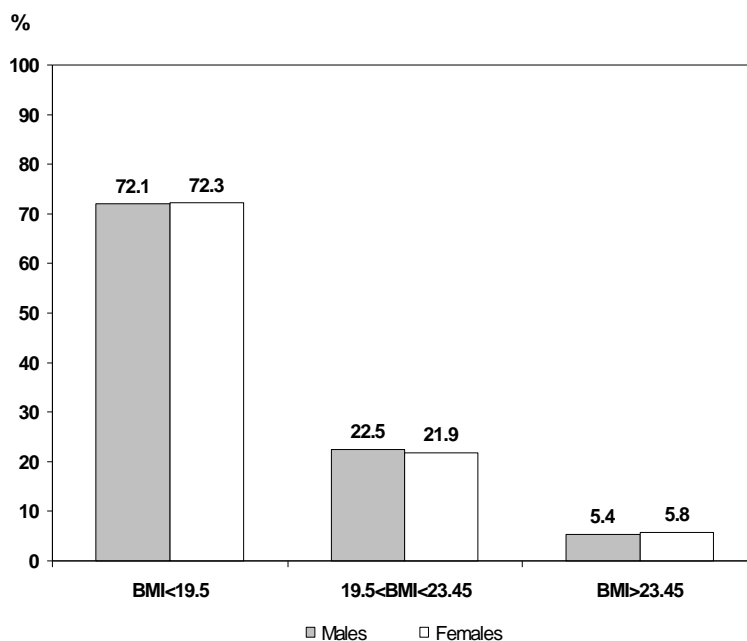
**Fig. 1**

Prevalence of overweight (22.2%) and obesity (5.6%) in the total sample of children.

The sample group involved in the study was of an average age of 9.5 ( $\pm 0.5$ ) years. There were no differences in the bodily constitution between males and



females. In fact, average weights and heights as well as the average Body Mass Index calculated in the two groups showed very uniform values: BMI=18.20 ( $\pm 2.79$ ) Kg/m<sup>2</sup> for males; BMI=18.06 ( $\pm 2.98$ ) Kg/m<sup>2</sup> for females. The prevalence of obesity and overweight was calculated by considering the BMI cut-off point for children of 9.5 years of age. On the basis of this, 22.2% of the children were overweight and 5.6% were obese (Fig. 1); among the females, 21.9% were overweight and 5.8% were obese, and among the males, 22.5% were overweight and 5.4% were obese (Fig. 2).



**Fig. 2**

Prevalence of overweight (22.2%) and obesity in males and females

*Extracurricular sports:* The children practise extracurricular sports on an average of 2.1 ( $\pm 1.46$ ) hours/week. In particular, as far as males are concerned, 19.84% don't do extracurricular sports, 42.79% dedicate 1-2 hours/week to sports activities, 33.93% dedicate 3-4 hours/week and 3.44% more than 5. The 26.71% of females did not do any type of sports, 57.36% did 1-2 hours/week, 14.56% did 3-4 hours/week and only 1.37% did more than 5 hours/week.

*Activity during break time at school:* The 53.02% of the children spent their break engaged in some sort of movement activity (running, jumping, ball games). Instead, 15.08% chose sedentary activity (talking to their classmates, playing portable video games or parlor games), while the remainder (31.90%) tended to alternate movement and sedentary activities. In particular, an active break was preferred by 57.05% of the males and 48.80% of the females, and a sedentary break by 12.46% of the males and 17.81% of the females, while both sedentary and movement activities were carried out by 30.49% of the males and 33.39% of the females. Thus, the girls tended to prefer sedentary or mixed activities (51.2%), while the males more frequently chose dynamic games (57.05%).

*Extracurricular play:* On the average, children dedicated about 3.23 ( $\pm 1.53$ ) hours per week to that type of activity. In particular, 9.63% said they did not do that sort of activity, 29.90% dedicated 1-2 hours/week to this type of activity, 39.53% 3-4 hours/week and 20.94% more than 5 hours. No difference between males and females.

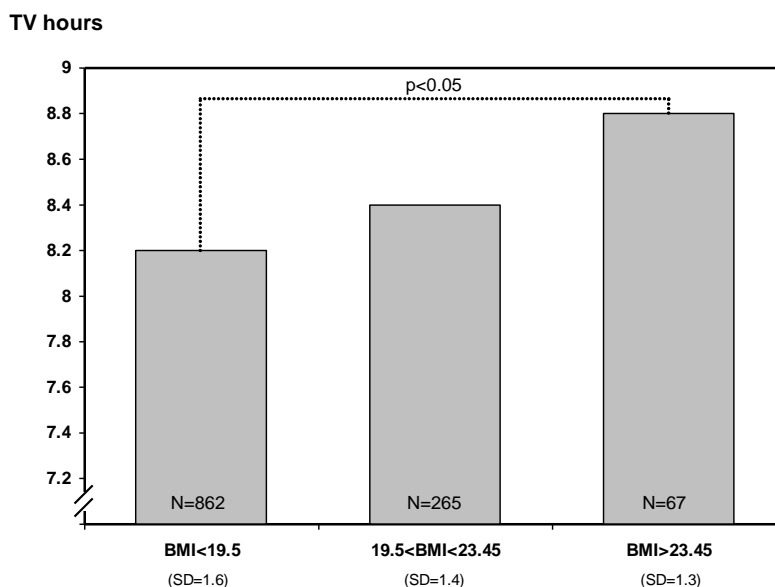
*Activity during the weekend:* As far as weekend sports activities or games in the open air are concerned, there were differences between males and females: 45.9% of the boys dedicated 5 or more hours to such activities as opposed to 30.13% of the girls.

*Television and computers:* The 42.13% of the males spent more than 4 hours a day in front of the television, computer or video games, unlike the females, who reached 27.74%. During the weekend, this percentage increased to 49.32% for the males and to 46.56% for the females; the children watch more television and dedicate more time to the computer and video games with respect to school days, especially as far as females are concerned.

Obese children ( $P < 0.05$ ) spend more time watching television than normal weight children (Fig. 3).

*Homework and reading:* Instead, the analysis of the time children spent doing their homework, reading or table games after school hours shows that 60.3% spent 1-2 hours per day at these activities. Moreover, it also turned out that it was mainly the females (5.82%) who spent 4 or more hours a day at activities of an intellectual type with respect to the males (1.48%), while there was a high number of children who said they did not engage in this type of activity at all (42.95% of the males against 28.94% of the females).





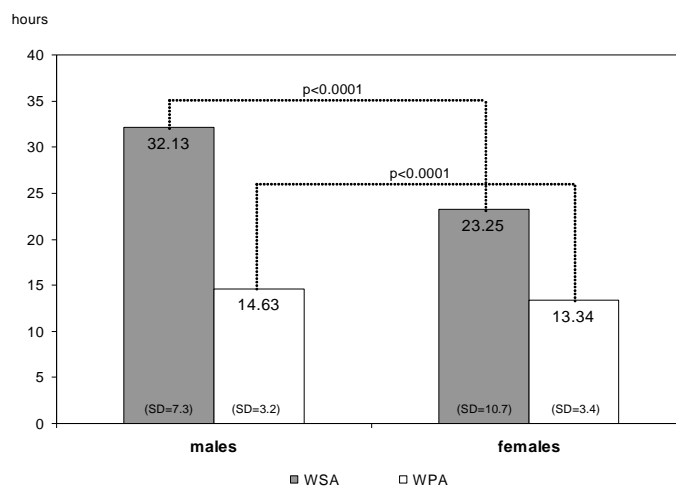
**Fig. 3**  
Relation between BMI and hours per week dedicated to watching television and using the computer. Obese children (BMI>23.45) spend a significantly higher number of hours ( $p<0.05$ ) watching television and using the computer than normal weight children (BMI<19.5)

*Indices of activity:* On the average, the males performed 14.63 ( $\pm 3.18$ ) hours of physical activity and 32.13 ( $\pm 7.34$ ) hours of sedentary activity per week; the females, 13.34 ( $\pm 3.39$ ) hours per week of physical activity and 23.25 ( $\pm 10.7$ ) hours of sedentary activity (Fig. 4). The index of Weekly Physical Activity (WPA) diminished as BMI increased. In fact, it happened that obese children, with respect to both normal weight and overweight children, were engaged in a significantly lower number ( $P<0.01$ ) of dynamic activities during the week (Fig. 5).

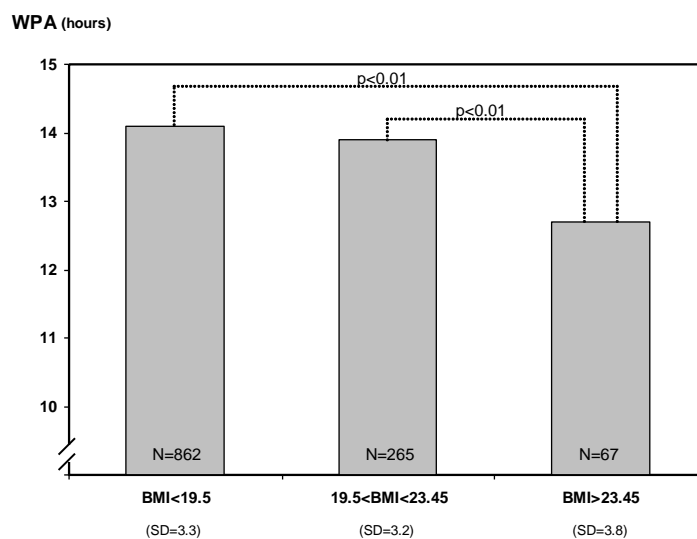
*Nutritional habits:* The males had an average Alimentary Style Index (ASI) of 6.4 ( $\pm 2.4$ ), while for the females it was 5.4 ( $\pm 2.4$ ). Both the Alimentary Style Index (ASI) and the index related to physical activity (WPA) were significantly higher ( $P<0.0001$ ) for the males with respect to the females, that is to say, the males ate more, but they were also more active and dynamic. Moreover, it was clear that the Alimentary Style Index (ASI) increased significantly ( $P<0.0001$ ) for overweight and obese children with respect to normal children (Fig. 6).





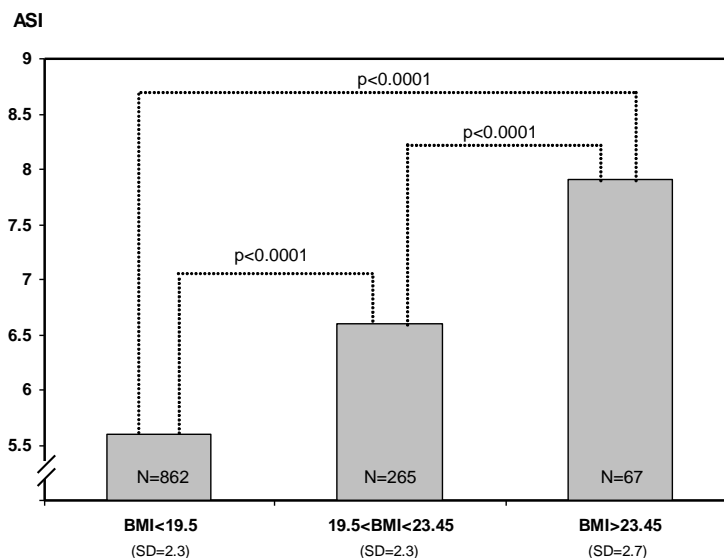


**Fig. 4**  
Comparison of Indices of Weekly Physical (WPA) and Sedentary Activity (WSA) in the groups of males (n=610) and females (n=584)



**Fig. 5**  
Relation between BMI and Weekly Physical Activity (WPA). On the average, obese children (BMI>23.45) are involved in a significantly lower number of hours of physical activity ( $p<0.01$ ) each week with respect to both normal weight (BMI<19.5) and overweight children (19.5<BMI<23.45)



**Fig. 6**

Relation between BMI and Alimentary Style Index (ASI). Obese children (BMI>23.45) have an average ASI that is significantly higher ( $p<0.0001$ ) than normal weight (BMI<19.5) and overweight ( $19.5<BMI<23.45$ ) children. A significant difference ( $p<0.0001$ ) also emerged between normal weight and overweight children

*Correlations:* The analysis of the Spearman rank correlation was carried out both by evaluating all of the subjects involved in the study, and by subdividing them in the groups of males and females.

The bodily constitution of the children, shown in the BMI, was inversely correlated to the hours of physical education at school and to the hours that the children spent playing games and doing other dynamic activities outdoors (Table 1). Moreover, the BMI is inversely correlated to weekend sports (Table 1) and, in general, to weekly hours of physical activity (WPA) (Table 2). When the BMI increases, the children's tendency to spend their break time at school in sedentary activities increases, as does their tendency to ask for second helpings at meals. On the other hand, the value of this last parameter is coherent with the other indicators of nutritional habits, like consumption of snacks and beverages, and obviously with the Alimentary Style Index (ASI) (Tables 1-2). Whoever spends

less time at sports tends to watch more television, and there is a correlation between BMI and time dedicated to TV (Tables 1, 3).

**Table 1**

Spearman rank-order correlation; total sample, males and females (n=1194)

	BMI		WPA		WSA		ASI	
	r	p	r	p	r	p	r	p
Weight	0.88	<0.0001	-0.04	n.s.	0.01	n.s.	0.24	<0.0001
Height	0.31	<0.0001	0.04	n.s.	-0.02	n.s.	0.06	<0.05
School physical activity	-0.06	<0.05	0.17	<0.0001	-0.02	n.s.	-0.02	n.s.
Active school break	-0.06	<0.05	0.58	<0.0001	-0.26	<0.0001	0.1	<0.0001
Sedentary school break	0.06	<0.05	-0.58	<0.0001	0.26	<0.0001	-0.1	<0.0001
Sport	0.03	n.s.	0.5	<0.0001	-0.11	<0.0001	0.03	n.s.
Outdoor games	-0.09	<0.01	0.52	<0.0001	-0.04	n.s.	-0.05	n.s.
Sport week-end	-0.08	<0.01	0.52	<0.0001	-0.07	<.05	-0.08	<0.01
TV week-end	0.07	<0.05	-0.17	<0.0001	0.33	<0.0001	0.21	<0.0001
Homework	-0.05	n.s.	-0.02	n.s.	0.56	<0.0001	-0.07	<0.05
Double portions	0.35	<0.0001	0.04	n.s.	0.04	n.s.	0.6	<0.0001
Snacks	0.12	<0.0001	-0.03	n.s.	0.05	n.s.	0.66	<0.0001
Soft drinks	0.13	<0.0001	0.03	n.s.	0.09	<0.001	0.70	<0.0001

The weekly hours of physical activity (WPA) diminish as time spent watching TV or playing video games increases; weekly hours of sedentary activity (WSA)



are correlated with a higher Alimentary Style Index (ASI), which is mainly linked to the consumption of beverages (Table 1).

**Table 2**

Spearman rank-order correlation; total sample, males and females (n=1194)

	WPA		WSA		ASI	
	r	p	r	p	r	p
BMI	-0.07	<0.05	0.02	n.s.	0.27	<0.0001

**Table 3**

Spearman rank-order correlation; total sample, males and females (n=1194)

	TV	VIDEOGAMES	PC
	r	r	p
Sport	-0.21		<0.0001
Outdoor games	-0.04		n.s.
Sport week-end	-0.23		<0.0001
Homework	-0.24		<0.0001
Double portions	0.17		<0.0001
Snacks	0.13		<0.0001
Soft drinks	0.13		<0.0001

Children who spend their time doing homework, reading or playing quiet games after school do less sports, but they also watch less television during the week (Table 3). There is also a direct relation between the quantity of hours spent in front of the TV and nutritional habits (ASI): in particular, more TV translates into a greater consumption of second helpings, snacks and beverages (Table 3).

Correlation analysis was also carried out by dividing the sample group into males and females.

The physical constitution of the girls, indicated with the BMI, was drawn into relation with different parameters, and it happened that the girls with higher BMIs



spent their breaks in more sedentary ways. Moreover, the higher the BMI, the lower the index of physical activity (WPA). Of course, girls who were physically bigger, with higher BMIs, also ate more, and this was mainly linked to requests for second helpings. Excessive eating was also correlated to sedentariness: little girls who dedicate more time to sedentary activities tend to eat too much.

For the females, the index of physical activity and the index of sedentary activity are inversely proportional. The index of weekly sedentary activity (WSA) is directly correlated to hours spent in front of the TV, and this is correlated to a higher alimentary style value. After school, the girls who did their homework, read or played quiet games watched less television. As for the boys, it happened that those with a higher BMI tended to ask for second helpings and consume more snacks and beverages, with a consequent higher alimentary style value. Children who had more active attitudes during lunch break also tended to be more active outside school, with a higher value of WPA and a higher ASI.

The more sports-oriented boys watched less television and spent less time on their homework, and so they had higher WPA values and, on the contrary, lower WSA values; this was true during the week as well as during the weekend. The more sedentary ones, that is, those with higher WSA values, on the contrary watched more TV during the week than on the weekend. The greater number of hours spent in front of the television translated into higher consumption rates - mainly of beverages - with higher ASI values.

## Discussion

Childhood overweight and obesity are the result of a combination of factors that, to various degrees, contribute to determining an increase in the risk of developing these conditions. These factors include the prevalence of sedentary activity to the detriment of physical activity and dynamic activity in general, the increase of time dedicated to the television and the use of the PC and excessive consumption of certain foods that are especially high in fats. Such a lifestyle, derived in large part from family habits, is already established at a very early age and generally tends to be maintained in adulthood. Hence, the conditions for a predisposition towards childhood overweight and obesity are created, and in 50% of the cases [24], these conditions are translated into adolescent and then adult obesity.

The study we conducted on a group of schools in the northeast part of the province of Milan was aimed at evaluating the prevalence of overweight and obesity in a population of children between 8 and 10 years of age, and relating it to



their nutritional habits and to the amount of physical and sedentary activity they were involved in. Identifying incorrect or unhealthy behaviors inherent in nutrition and physical activity already in childhood could be an important tool for correcting such factors and hence preventing adult obesity. In fact, various authors [2-4,14] agree on the fact that one of the most important interventions on the subject of obesity is prevention, or changing an unhealthy lifestyle.

Thus as suggested by the European Childhood Obesity Group and as already in use at the National Center for Health Statistics, the BMI is a reasonable index of adiposity for children and adolescents, and is a useful tool for comparing the study of populations in different countries [10,16,26]. For the definition of childhood overweight and obesity, we referred to studies [6,10,14,16] that have developed universally accepted definitions for such situations through the use of BMI. Starting with valid cut-off points for adults (25 and 30 kg/m<sup>2</sup>), Cole, who has then been taken up by other authors, delineated curves that have made it possible to establish specific cut-off points by sex and age that are valid between the ages of 2 and 18 [6,10,14,16].

As for ascertainties on the nutrition of children, the approach is rather complex, in that for children between the ages of 8 and 10, nutrition can be influenced by phases of development and social and family components. Children do not know exactly what the biochemical properties of the foods they eat are, much less how they are prepared, and so they need to be guided by adults in what to choose and how much to consume. Every system of assessment of nutritional habits has advantages and disadvantages that must be taken into consideration in choosing a method to use for children.

With the aim of correctly evaluating the energy quota introduced, it is worth calculating the caloric intake of each food for each child, as has been done in some studies [2,7,13,17,20]. In the present context, the calculation of calories for each food consumed would be too complex and difficult to apply to such a high number of subjects, not to mention requesting information that could not be easily obtained from the children. In any event, through several specific indicators of nutritional quality, it was possible to analyze the quantity and frequency of consumption. Consumption of certain foods is not always completely wrong, but excessive consumption can be a sign of bad nutritional habits, or at least a sign of the tendency to overeat. The approach of our study was thus to evaluate the quantity of second helpings consumed by each child during the two main meals of the day and the number of beverages and snacks consumed throughout the entire day. Even if these values were not specific in terms of the quantity of calories and the quality of foods consumed by each individual, they did, however, enable us to set up an



alimentary style index indicative of the tendency to err on the side of eating too much.

Given the great numbers of the sample group, in order to evaluate the quantity of the children's physical activity, we did not consider methods of determining heart rate, oxygen consumption ( $VO_2$ ) or Doubly-Labelled Water (DLW) which, besides being difficult to apply to such a numerous sample group, could not be easily applied to subjects who are so young. Hence the overall number of hours the subject spent in motion and in a sedentary state was evaluated.

As far as BMI is concerned, the data obtained were essentially in agreement with those in recent studies on the Italian population [5] as regards the prevalence of overweight, present in 22.2% of the population in the study, while obesity (5.6%), is prevalent at a slightly lower rate with respect to what appeared in other studies [5]. No significant differences between males and females were noted.

The sample group tended to be active both in terms of school time activity and amount of play outdoors, as well as in terms of extracurricular sports. On the average, the children did 2 hours of sports each week when they were not at school, but nevertheless, 20% of the sample group males and about 27% of the females did not do any type of sport. Engagement in extracurricular sports, in the geographical area under consideration, has reached good levels of participation in recent years, with the possibility of doing varied sports activities according to the individual's preference. Nevertheless, the fact that a considerable percentage of children in our sample group did no sports at all could represent a risk of the onset of excess weight, if associated with bad eating habits.

It happened that the females were generally less active than the males; they preferred quieter activities during their breaks at school, and spent less time at sports and played less outdoors in the afternoon. They spent more of their time doing homework or reading, while the males did sports both during the week and weekend, and often played games involving movement during their breaks. Hence, the males were more dynamic in terms of sports and games on the whole, in agreement with the data presented by Crespo and Fogelholm [7,12]. Even though they were more dynamic, they nevertheless dedicated more time to television, the computer and video games than the girls, especially during the week. During the weekend, instead, time spent in front of the television increased for both groups, in particular for the females. Almost half of the males and slightly more than one quarter of the females spent more than 4 hours a day watching television and using the PC or video games. This agrees with what appeared in the study conducted by Strass *et al.* [29], which showed that children spend an average of 6 hours a day at this pastime.



On the other hand, although the females spent fewer hours in front of the television, at the PC or video games, they spent more time than the males in doing homework and reading, which are also sedentary types of activity. In general, however, there was a statistically significant difference between the weekly hours of sedentary and physical activity in the two groups. In fact, on the average, the males were engaged in about 32 hours of weekly sedentary activity, against only about 23 hours for the females. A minor, but always significant difference also emerged, as already stated above, for hours of physical activity, which on the average were about 14 hours for males and 13 for the females. In those fewer 9 hours of sedentary activity with respect to the males, the females were probably involved in activities not foreseen by the questionnaire, since they were not busy at so-called "physical activities", like, for example, helping their mothers with housework or going with them to do the shopping.

In agreement with what has been demonstrated by Molnar *et al.* [21], from the analysis of the data, it seems that bodily constitution (BMI) is inversely correlated to school time physical education, to the hours spent in doing dynamic activities, to weekend sports activities and, in general, to weekly hours of physical activity. From our analysis, weekly hours diminished with the increase in time spent watching television or playing video games. These activities were directly correlated with alimentary style index, and thus it is clear that inactivity encourages second helpings, and more beverages and snacks, thus causing an increase in the BMI.

Putting a limit on the time that children might watch television or play video games can act as a stimulus to diversified activities that allow greater calorie consumption and hence a reduction of the BMI. A proper relation between time employed in sedentary activity and movement activity and an adequate intake of calories is fundamental to preventing the risk of overweight and obesity.

As regards nutritional habits and hence the alimentary style index (ASI), this result was directly correlated to the BMI of all of the subjects. Such data show that the validity of indicators of nutritional habits used in this study are proven as a tool for research and that they are probably well correlated to the children's total calorie intake during the entire day. In particular, more dynamic children with high WPA values are the ones that consume more snacks and second helpings, but the amount of calories is neutralized by the great amount of physical activity performed. More sedentary subjects, even if they eat less food with respect to more active ones, evidently do not manage to burn the calories they consume, and so accumulate excess weight. Moreover, it can also be observed that BMI is directly related to the amount of time spent watching television. This result is in agreement with the





tendencies that have come out of European and American studies showing how television encourages greater food consumption but reduced calorie consumption, as already claimed by other authors [7,9,11,15,27].

Guillame, Maffei *et al.* [13,17] have emphasized the role of incorrect nutrition in the accumulation of excess weight: we definitely give great importance to physical activity, which can counteract nutritional imbalances.

From the results of the present study, we can conclude that physical activity and nutrition play a key role in the problem of overweight and obesity because they can influence bodily constitution in different ways. Above all, it is necessary to aim to teach children to appreciate a dynamic lifestyle, reducing sedentary pastimes like television and video games that encourage a misuse of energy.

Hence it is clear that physical activity can be considered an important way to reduce the risk of excess weight. We think it is important to step in by orienting children towards correct physical-motorial and nutritional behavior while they are small, and in the period that precedes puberty, since that period represents a critical phase in the formation of the social dimension and in interacting with others and comparing oneself to them. Children are led to make choices related to the lifestyle that they want to adopt and that concerns their attitude towards physical activity.

The role of parents and teachers can certainly have a great impact on directing children towards behavior that favors health, with lifestyles that can be in some way protective against the problems that arise during puberty, like obesity, but also eating disorders that are increasingly more common and that can have very serious consequences.

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