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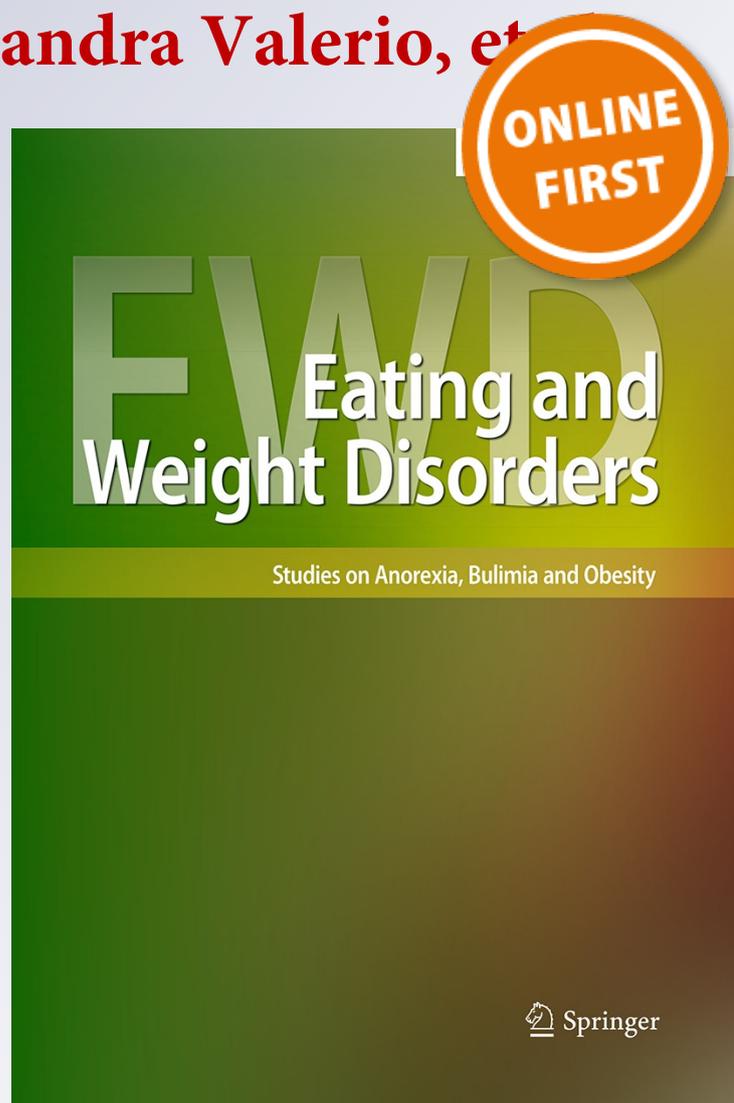
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## Family lifestyle and childhood obesity in an urban city of Northern Italy

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### Abstract

**Purpose** Over the last decades, the prevalence of overweight and obesity in elementary school children has steadily increased worldwide. This phenomenon is also linked to food habits. The main purpose of our study was to understand the role that environmental factors may play in this context; in particular, we investigated how and to what extent family food habits and children lifestyle are associated with the spread of children obesity.

**Methods** One hundred and nine primary schools, with 6–11-year-old children ( $n = 14,500$ ), were recruited for this cross-sectional study in Milan (Italy). Children anthropometric data were measured and reported by parents; citizenship, fruit and vegetable consumption data of both parents and children were collected. Time spent watching television and doing physical activity was also investigated in children.

**Results** The study revealed that children's vegetable (not fruit) consumption was positively associated with physical

activity, while negatively associated with time watching TV; in particular, fewer hours spent watching television were a stronger protective factor than more hours spent doing physical activity. Moreover, the parental feeding style was associated with children's attitudes toward consumption of fruit and vegetable. Family characteristics (family size and level of parents' education) and children gender were associated to the risk of being overweight/obese.

**Conclusions** Our findings support the relevance of environmental factors in childhood food consumption and BMI distribution among children in an urban city. This is the reason why we stress the need to design ad hoc interventions, which should be developed in accordance with the socio-economic peculiarities of a cosmopolitan city suburb.

**Keywords** Fruit and vegetable consumption · Physical activity · Children · Parents · Obesity · Television watching

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## Introduction

Overweight and obesity are recognized as health risk factors in childhood and adolescence [1]; in particular, these statuses are considered as an epidemic disease in children that cause psychological, social as well as physical consequences, such as cardiovascular, endocrine, musculoskeletal and gastrointestinal complications, often persisting during the lifetime [2, 3]. In fact, childhood obesity is a risk factor for the onset of chronic disease in adulthood population [4]; this trend is reported also in the ethnic community living in the European countries [5].

The etiology of overweight/obesity is multi-factorial, including genetic factors and environmental influences [6, 7]; several studies show significant associations between the family environment and the children body mass index (BMI) [8] defined as the ratio between body weight (kg) and squared height (m<sup>2</sup>). In particular, parents' habits and mass media play crucial roles in the process by which children acquire skills, knowledge, and attitudes towards food [7]. As far as children lifestyle is concerned, prolonged children daily television (TV) watching seems to play a relevant role in the obesity onset [9], in addition to a limited vegetable consumption [10] and a limited physical activity [2]. On the opposite side, increasing evidence demonstrates important benefits for health, in terms of decreased risk of obesity, which are derived from daily consumption of adequate amounts of fruit and vegetable [11, 12]. Research in this field confirms the above-mentioned relevance of appropriate parental practices in shaping healthy food habits in children; in particular, the level of parents' education can make a difference on children's fruit and vegetable consumption [13]. An increasing literature on ethnicity indicates cultural aspects as an additional factor that can influence, among other, physical activity and food habits [14]. In particular, research suggests that parental feeding practices differ across ethnic groups, and that the level of education may contribute to the differences in the prevalence of child obesity in multi-ethnic population [15].

The social context, where children live in, can impact differently on children obesity according not only to the ethnic, but also to geographical aspects [16]. In particular, the urban setting can be identified as an obesogenic environment compared to the rural one [17–19]. However, a recent research carried out in a Mediterranean country [20] revealed that the prevalence of obesity in children is found among those that live in rural settings rather than in the cities. A paradigmatic example of the complexity of this phenomenon is the Italian context, where childhood obesity is distributed differentially across the country (north, center and south), and where the prevalence in the southern regions is two times higher compared to the north [21].

Previous research carried out in the urban area of Milan suggests that the city is not an obesogenic environment [22, 23]. Hence, considering the cited literature and the mixed evidence, which reflect the complexity of the phenomenon, it seems interesting to us to deepen the understandings of the role that environmental features can have on children BMI. Particularly, the high levels of migration and education among the urban population of Milan can represent an original context, wherein to investigate the peculiar manifestation of overweight/obesity among pupils. The research question can be seen as: "Which role do socio-demographic features and lifestyle habits play in the risk to become obese children in Milan?" Therefore, the aims of our study were to investigate children's weekly vegetable consumption and children's (H1) daily watching TV time (measured in minutes); (H2) weekly physical activity (measured in minutes); (H3) and evidence of association between parents' and children's food habits; moreover, we investigated the risk of being overweight/obese vs normal; (H4) with no regard to parents' citizenship; (H5) among Italian; and (H6) among non-Italian.

## Subjects and methods

### Subjects

The survey was carried out in all primary schools via the service of "Milano Ristorazione", a public catering service, which is a provider of lunchtime meals, in March 2008. The questionnaire was delivered to the students' families after the authorization of the Italian Department Educational School, presentation of the project by a letter of information and upon approval of the Regional School of Lombardy. In this survey design, we carried out a clustering sampling on 109 given 938 public primary schools in Milan. The final units were families with school-age children (aged 6–11 years). A total of 45,000 questionnaires were consigned to children to be filled out by their parents; 23,275 questionnaires were returned, and only 16,588 of them were correctly completed. Since we neglected the severe thin and thin groups because it would need a more exhaustive investigation, 14,500 questionnaires were analyzed. The study involved about 47 % of the total population of children enrolled in public primary school in Milan; in relation to all the children in Milan, in both public and private schools, the report referred to 36 % of the target population.

### Survey method

The questionnaire, completed by parents, included the following information: parents' and children's age, gender

and citizenship; the level of parents' education; parents' and children's fruit and vegetable consumption frequencies; children's anthropometric measures, physical activity frequency and the TV watching time.

Researchers gave information and instructions on how to fill in the questionnaire to parents and how to measure children's anthropometric data. Self-reported weight and height have been described as being acceptable measurements for the determination of BMI when adjusted for variables that are predictive for misreporting [24]. With reference to children's BMI, the cutoff points for 'overweight' and 'obese' were sourced from Cole et al. [25].

Methodologies

The ANOVA was applied to investigate H1 and H2, the last three hypotheses were tested with multinomial regression, where the dependent variable consisted of three categories: normal, overweight and obese.

Results

Parents and children's characteristics are shown in Table 1 on total respondents ( $n = 14,500$ ); in detail, according to children BMI, there were normal ( $n = 11,399$ ; 78.6 %), overweight ( $n = 2,444$ ; 16.9 %) and obese

( $n = 657$ ; 4.5 %). Non-Italian families represented 20.6 % of the respondents, in accordance with the prevalence of immigrants in the metropolitan area of Milan (data not shown). The two groups of parents were comparable for all parameters reported in Table 1, except for age: in fact, while the majority of Italian parents are in the age range 40–49 (female, 52.8 % and male, 61.5 %), non-Italian parents are younger (30–39; 47.7 %); in particular, parents were female Italians with bachelor for a 33.8 %. As reported in [23], obesity is more prevalent both in parents and children of non-Italian families than of the Italian ones.

We can affirm through ANOVA: H1) children's TV watching time negatively depends on vegetable consumption [ $F(4,14038) = 170.215, p < 0.001$ ] (Fig. 1a); (H2) physical activity positively depends on vegetable consumption [ $F(4,14136) = 41.042, p < 0.001$ ] (Fig. 1b); (H3) there is a positive association between children's and parents' vegetable consumptions (Kendall Tau  $c = 0.568, p = 0.000$ ; data not shown). However, there is no significant association between children's lifestyle factors and fruit consumption (data not shown).

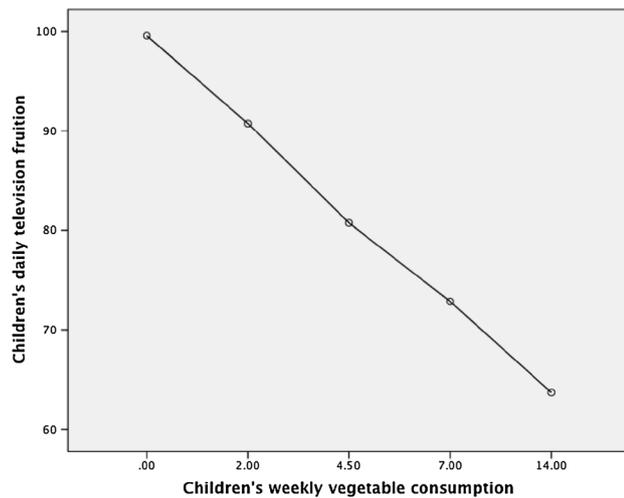
Multinomial regression allows testing the three hypotheses, after controlling other factors in the multinomial model. The results can be observed in Tables 2 and 3 in which odds ratio values with  $p$  values, likelihood ratio test and classification ratio are reported.

**Table 1** Parents' and children's parameters according to the citizenship

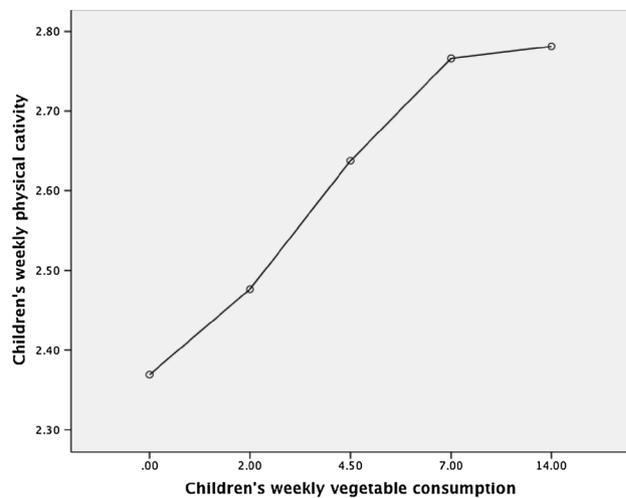
Parents' parameters	Italian		Non-Italian	
	Male ( $n = 1,944$ )	Female ( $n = 10,125$ )	Male ( $n = 600$ )	Female ( $n = 1,831$ )
Age (range)				
20–29	0.7	2.2	5.2	13.8
30–39	28.2	43.7	47.7	57.0
40–49	61.5	52.8	42.5	28.8
≥50	9.6	1.3	4.7	0.5
Level of education				
Degree	4.61	25.09	0.75	3.25
Bachelor	6.16	33.77	1.6	4.74
Secondary school diploma	2.46	9.39	0.91	2.61
None	0.07	0.30	0.32	0.79
Other (elementary school)	0.26	9.39	0.91	2.61
Children's parameters				
Gender	Italian	Female	Non-Italian	Female
	Male ( $n = 6,238$ )	( $n = 6,101$ )	Male ( $n = 1,097$ )	( $n = 1,064$ )
Age (years)	7.92 ± 1.49 [5–11]	7.97 ± 1.49 [5–11]	8.13 ± 1.58 [5–11]	8.29 ± 1.55 [5–11]
BMI	17.33 ± 2.49 (14.05–38.00)	17.15 ± 2.46 (13.85–37.02)	18.56 ± 3.34 (14.05–36.36)	17.94 ± 2.83 (13.86–34.47)

Data are expressed as mean ± SD and minimum–maximum values (in brackets) BMI body mass index ( $\text{kg}/\text{m}^2$ )

(a) ( $F(4,14038)=170.215$ ,  $p<0.001$ ) ( $y$ =minutes per day;  $x$ =children's weekly frequencies of vegetable consumption)



(b) ( $F(4,14136)=41.042$ ,  $p<0.001$ ) ( $y$ =hours per week;  $x$ =children's weekly frequencies of vegetable consumption)



**Fig. 1** Relationships among means, analyzed by ANOVA, between children's daily watching TV time and children's weekly frequencies of vegetable consumption (a); and between children's weekly physical activity and children's weekly frequencies of vegetable consumption (b)

(H4) Normal vs overweight (1) and normal vs obese (2) children—no regard to parents' citizenship

We can affirm that the risk for children of being obese increases: (1) by 1.2 times every additional 30 min of children's TV watching; (2) by 1.3 times if children are male; instead, the risk for children of becoming overweight slightly decreases (by 0.9 times) as the family scales up; however, this risk increases (1) by 1.4 times if parents have low level of education; (2) by 1.2 times if children eat vegetable only 1–3 times per week; (3) if children do physical activity twice per week (by 0.7 times) and three times per week (by 0.8 times) (Table 2).

With reference to the risk for children of being obese, we can identify some similarities with the previous description. We found that the obesity risk increases: (1) by 1.3 times for every additional 30 min of children's TV watching; (2) by 1.2 times as the family size scales up; (3) a mean of 3 times for children between 6 and 9 years; (4) by 1.6 times if children eat fruit only once a day; (5) by 1.7 times if children eat vegetable 1–3 times per week. Protective factors against obesity could be the level of the parents' education and physical activity: the risk of being obese for children that do physical activity 3 times per week decreases by 0.6 times (Table 3).

(H5) Normal vs overweight (1) and normal vs obese (2) children—Italian parents

It emerged that the risk of being overweight increases (1) by 1.2 times every additional 30 min of children's TV watching time; (2) by 1.3 times if the children are male; (3)

by 0.9 times as the family size scales up; (4) by 1.5 times if children have parents with a low level of education; (5) and it decreases if children do physical activity twice per week (by 0.6 times) and three times per week (by 0.7 times).

With reference to the risk of being obese, it appeared that the obesity risk increases: (1) by 1.3 times for each 30 min of the children's TV watching; time (2) by 1.3 times as the family size scales up; (3) being male increases once again the odds for children of being obese (by 2.2 times); (4) 1.5 times if children eat fruit only once per day; (5) and it decreases when parents have a higher level of education (bachelor by 0.3 times; degree by 0.4 times); (6) and when children do physical activity 3 times per week (by 0.4 times).

(H6) Normal vs overweight (1) and normal vs obese (2) children—non-Italian parents

Within this hypothesis, we found that the obesity risk increases (1) by 1.1 times every additional 30 min of children's TV watching time; (2) by 1.3 times if children are male; (3) moreover, never eating vegetable or eating it only 1–3 times per week does not protect from being overweight (by 2.2 and by 1.7 times, respectively); (4) children aged under 6 years are at higher risk of being obese (by 2.6 times).

Finally, the obesity risk increases (1) by 1.2 times every additional 30 min of the children's TV watching time; (2) by 1.6 times eating fruit only once a day; (3) by 3.2 times eating vegetable 1–3 times per week; (4) and decreases by 0.6 times with higher level of parents' education; (5) children aged between 6 and 9 years have a higher risk of being obese (<6 years old, by 5.6 times; 6 years old, by 6.7 times; 7 years old, by 4.3; times 8 years old, by 3.2 times; 9 years old, by 2.4 times).

**Table 2** Multinomial regression: normal vs overweight

Factors/covariates	All H1	Italian H2	Non-Italian H3
Watching TV time (minutes)	1.194**	1.21**	1.081**
Family size	0.929**	0.921**	0.944
Male children	1.266**	1.448**	1.331**
Weekly fruit consumption			
Never	0.816	0.854	0.817
1–3 times	0.924	0.928	0.966
4–6 times	0.945	0.89	1.178
7 times	0.998	0.918	1.245
Once per day	–	–	–
Weekly vegetable consumption			
Never	1.067	0.883	2.221**
1–3 times	1.229**	1.122	1.698**
4–6 times	1.057	0.992	1.368
7 times	1.046	1.043	1.089
Once per day	–	–	–
Level of parents' education			
Degree	0.754**	0.794	0.82
Bachelor	0.987	1.052	1.044
Secondary school diploma	1.369**	1.472**	1.37
None	1.165	1.193	1.091
Other (elementary school)	–	–	–
Children age			
<6 years old	1.122	0.953	2.551**
6 years old	1.023	0.949	1.143
7 years old	1.087	0.999	1.184
8 years old	1.267	1.15	1.769
9 years old	1.261	1.351	1.295
10 years old	1.091	1.183	1.034
>10 years old	–	–	–
Weekly physical activity			
Once	0.857	0.847	0.794
2 times	0.737**	0.596**	1.258
3 times	0.796**	0.694**	1.244
4 times	0.89	0.793**	1.24
5 times	–	–	–
Likelihood ratio test	647.712**	536.319**	165.23**
df	50	50	50
Classification rate (%)	78.7	80.4	69.7

\* \*\**p* value ≤ 0.05, \* *p* value ≤ 0.10

**Discussion**

The results show that the most important environmental factor of childhood overweight and obesity is the time spent watching TV; second, physical activity, vegetable consumption and the level of education of parents are other important factors. The high response rate is a strength of the present study, which allowed us to better delineate the

**Table 3** Multinomial regression: normal vs obese

Factors/covariates	All H1	Italian H2	Non-Italian H3
Watching TV time (minutes)	1.322**	1.323**	1.184**
Family size	1.162**	1.25**	0.991
Male children	0.882**	2.218**	0.863
Weekly fruit consumption			
Never	1.007	1.137	0.513
1–3 times	1.069	1.109	1.039
4–6 times	1.103	1.009	1.289
7 times	1.575**	1.446**	1.558**
Once per day	–	–	–
Weekly vegetable consumption			
Never	1.428**	1.322	1.199
1–3 times	1.682**	1.184	3.234**
Once per day	–	–	–
Level of parents' education			
Degree	0.349**	0.273**	0.586*
Bachelor	0.483**	0.451**	0.648
Secondary school diploma	1.201	1.33	0.947
None	1.079	0.996	1.014
Other (elementary school)	–	–	–
Children age			
<6 years old	3.848**	2.368	5.825**
6 years old	4.01**	1.528	6.676**
7 years old	3.348**	1.469	4.328**
8 years old	2.311**	1.288	3.208**
9 years old	2.141**	2.317	2.392*
10 years old	1.349	1.42	1.712
>10 years old	–	–	–
Weekly physical activity			
Once	0.495**	0.254**	0.913
2 times	0.399**	0.303**	0.598
3 times	0.552**	0.433**	0.944
4 times	0.722**	0.561**	1.243
5 times	–	–	–
Likelihood ratio test	647.712**	536.319**	165.23**
df	50	50	50
Classification rate (%)	78.7	80.4	69.7

\*\**p* value ≤ 0.05, \**p* value ≤ 0.10

above-mentioned factors in a metropolitan area. Moreover, as we will discuss later, the novelty of our research refers to the role of fruit and vegetable consumption: while in the literature is known that eating inadequate amount of fruit and vegetable is a risky factor in developing children overweight and obesity, we found that eating larger amount of fruit and vegetable does not necessarily protect from becoming overweight or obese.

The present study was carried out in Milan, a city with a high presence of immigrant people, in fact, 20.6 % of

respondents is non-Italian [23]. This city may be an interesting context, since it is an urban area where there is a steady process of acculturation of non-Italian people. To follow the reasons why we propose that a special focus should be given to the process of acculturation of immigrants and the way in which the development of new and different family lifestyles can shape children habits. As we can see from the data following our hypotheses, many behaviors are similar between the Italian and non-Italian families.

In general, previous research [22, 23] conducted in Milan revealed a better health situation than the Italian mean with regard to both overweight and obesity levels [21]. The present study was designed to examine the role that children's lifestyle and family food habits may play in this peculiar setting.

In relation to food habits, we focused on fruit and vegetable consumption. Children who eat vegetable just rarely or in "small amounts" have a more sedentary lifestyle, and tend to spend much more time watching TV (Fig. 1a). The low vegetable consumption is widely described as playing a relevant role in the development of obesity, particularly in children [10].

Physical activity has always been a key strategy in the treatment of childhood obesity [16, 19]; this is the reason why we investigated the relationship between the consumption of vegetable and the different levels of physical activity in children (Fig. 1b). In our previous observation [23] we found a relationship between physical activity, TV watching and BMI. In the present ANOVA results, it emerges that eating vegetable is a crucial variable in a healthy lifestyle: prepubertal subjects who eat more frequently vegetable during the week do more physical activity (Fig. 1b), as pointed out in another recent study [26].

A systematic review [27] corroborates the fundamental role of parents in shaping food choice within the children socialization process. Based on the evidence, we analyzed the association between parents' and children's vegetable consumption: children's vegetable consumption reflect the parental consumption, confirming the relevance of the family environment in shaping food habits [7, 8] (Kendall Tau  $c = 0.568$ ,  $p = 0.000$ ; data not shown).

Since children's lifestyle includes multiple variables, of which weight does depend not only on individual but also on environmental issues, we used the multinomial regression to understand what was the load of each factor in a cosmopolitan area considering both Italian and non-Italian families. Although our epidemiological survey was not so recent and the protocol based on a different methodology compared to that used for national studies [21], our data reflect findings reported in the current literature [22].

In general, it emerges that fruit consumption does not play any role as a protective factor against overweight and

obesity, neither for Italian nor for non-Italian children; particularly, eating fruit once a day increases the risk of being obese (by 1.6 times). Eating vegetable is not significant among Italians; however, if non-Italian children never eat vegetable there is a risk of becoming overweight (by 2.2 times). Moreover, in children who never eat, or rarely eat vegetable (1–3 times per week) it increases the risk of being obese (by 1.4 times). These data are unusual and still not well investigated in literature [27].

As in our ANOVA and in the literature [9, 28], watching TV and doing physical activity are the most relevant factors. In general, children are at lower risk of becoming obese if they do physical activity, and doing it only 2 or 3 times per week is a protective factor against overweight (by 0.7 and 0.8 times, respectively). However, watching TV is the most risky factor; the strong negative impact of screen viewing on the prevalence of childhood obesity may depend on reduced physical activity but also on increased consumption of junk food and a consequent unhealthy lifestyle [29].

To investigate the role that other factors can play in becoming overweight or obese, we analyzed the level of parents' education. Lower levels of education increase the risk for children of becoming overweight, in particular among Italians, as it already appeared elsewhere [21, 30]. Since the socio-demographic patterns seem to play a fundamental role, we investigated other environmental factors: the children's age and gender and family size. Children aged between <6 and 9 years have a higher risk of being obese, in particular non-Italian are at risk if they are <6 - years (by 5.8 times). Being male increases the risk of overweight, but it is a protective factor as far as obesity is concerned. With reference to the Italian family size: the bigger is the family the lower is the risk of overweight (by 1.5 times), while the higher the risk of obesity (by 2.2 times). Since the last two aspects have ambiguous meanings, there conceivably exist other factors, such as family income that we did not take into consideration and that could be explored in future research.

Our study confirms and extends the findings of previous research on the consequences of unhealthy family dietary habits [25]; the prominence of living in a cosmopolitan city is confirmed in our previous study [23] showing once more how environmental factors may play a different role depending on the socio-cultural and geographical area in which it is observed [19].

Unfortunately, a couple of limitations of our cross-sectional study concerning the methodology can be identified; the first is the impossibility of determining direction of causality in the association between the investigated variables and the children BMI; the second refers to the impossibility of investigating how children's habits change during the lifespan. Last, our research design reflects a

widespread limit in the literature, which is the absence of common and shared methods in collecting data on family food habits.

## Conclusions

In conclusion, to prevent overweight and obesity, a single type of healthy behavior is not sufficient; since the etiopathogenesis of overweight and obesity is multi-factorial, the concomitance of multiple protective factors should be considered.

Environmental interventions such as reduction in TV watching time, increase in physical activities, and nutritional education during the school time, appear to be relevant strategies to prevent obesity [20, 27] and improve children positive attitude towards fruit and vegetable [31]. Prevention programs, which are targeted to primary-school children, should be encouraged also in this setting, despite the low prevalence of overweight and obesity [29], as compared to that of the Italian national mean.

Further studies are needed to understand better whether the residence area in the city (i.e., city center vs suburb) and the ethnicity influence food consumption and the prevalence of obesity among children living in cosmopolitan area. Moreover, comparison among Italian cities should be carried out, as well as a deeper epidemiological study on underweight children, a critical and novel aspect in the Italian society.

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**Conflict of interest** The authors declare no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

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