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Factors Associated with Childhood Obesity in Andalusia (Spain)

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Abstract

Background: We studied the prevalence of overweight and obesity in children from Andalusia, the southernmost county of Spain. A broad range of potential risk factors, covering lifestyles like physical exercise, eating habits and sleeping hours; individual characteristic such as age of the child and gender, as well as socio-economic and environmental factors, are considered to provide an analysis of the current situation, and enable subsequent development of counteracting programs.

Methods: We analysed data from 2,325 resident children in Andalusia aged 8-15 years from 1999 to 2007. Explorative analysis was carried out to identify key features and logistic regression models were used to quantify possible relations of overweigh/obesity with potential risk factors.

Results: Results based on logistic regression models confirm significant relations of overweight/obesity with age (odds ratio [OR]=0.76; 95% confidence interval [CI]=(0.73,0.79)) and gender (OR=1.84; CI=(1.53, 2.22) for boys). Physical activity, sleeping hours and good diet habits related to an increase of milk and yogurt consumption decreased the risk of overweight and obesity.

Conclusion: The prevalence of overweight/obesity in children aged 8-15 years in Andalusia in 2007 was 29.8% (95% CI=(26.71, 31.93)), being in agreement with other studies of developed countries. None of the environmental factors considered were significant in combination with individual factors.

Keywords: Overweight and obesity in children; Prevalence of overweight and obesity; Potential risk factors for obesity in children

Introduction

The World Health Organization (WHO) defines obesity as a disease, a complex condition with physical, social and psychological dimensions with serious health and economic consequences [1]. The worldwide growing trend of overweight and obesity in children and teenagers during the last decade is tremendous and alarming [2,3]. In Spain, the prevalence of overweight and obesity has triplicated in the last fifteen years, being around 12.4% in children in 2007, and 13.9% in young people (ages between 2 and 24 years). Spain, Italy, Malta, Greece and the United Kingdom have the highest prevalence of overweight and obesity among the countries of the European Union [4,5]. In the U.S. the prevalence of at-risk of overweight (BMI on the 85th percentile or higher) was 37.1% for children aged 6 to 11 years, and 34% for children aged 12 to 19 years [6,7].

Overweight and obesity are the result of an unbalanced energy intake from food- "input"- and energy expenditure- "output"-, where the energy "input" is higher than the "output". In most of the cases, they are the consequence of non-healthy eating habits and lack of physical exercise. The individual risk factors associated with eating habits and physical activity influence overweight and obesity in people of every age. However, multiple factors, different from those mentioned above, such as genetic, environmental, cultural and socio-economic may also influence the corporal weight. Researches on the determinants of the behaviour related to the obesity in children, before the last decade, were focused mainly on individual factors such as gender, socio-economic position, physical activity, sedentary habits and nutrition, or sleeping hours [8-10]. But, also, there is scientific evidence that suggests an influence by environmental factors on the adopted healthy habits of the person, particularly in children [11-15]. However, the scientific literature provides partial, incomplete, sometimes contradictory and, therefore, inconclusive findings about the influence of many of the individual and environmental factors on obesity. As a consequence, there is a need of new research that combines both types of factors, individual and environmental. This study aims to provide empirical evidence of the influence that some individual and environmental factors may have on overweight and obesity.

Methods

The data analysed were based on the three successive Andalusian Health Surveys carried out in 1999, 2003 and 2007. The survey was designed to collect information related to the health of the Andalusian population and the use of the health service system. Andalusia is a Spanish region of more than 8 million inhabitants with an autonomous Health Regional System, which makes its own health surveys every 4 years since 1999. The surveys had a non-experimental cross-sectional

design. The random samples for the surveys were selected from the child residential population in Andalusia, ages ranging from 0 to 15 years. The sampling design was a probabilistic, stratified and multi-stage cluster design using as sampling stage the municipalities, census sections, homes and individuals. The sample strata were determined based on the province and the urban/rural resident type. The cluster in each sampling stage was chosen with probability proportionate to size sampling of the cluster. The effective total sample size for the children in the interval 8-15 years was 2,325. The design effect under this sampling condition was 1.35. This effect will be considered when carrying out inference statistics and building up confidence intervals for the estimates.

Data collection was carried out by means of a questionnaire completed by a personal interview with each individual selected for the study and a responsible who takes care of the child (mainly the mother, in more than 75% of the cases). Data was pooled across successive surveys into a single dataset. Although not presented here, before using the pooled data as a single dataset, we checked that the independent variables behave similarly across year. Also the associations of the independent variables with respect to the outcome were compared over the three surveys, using interaction terms with time when modelling the data.

To determine whether the children were obese or had overweight, their body mass index and their percentile corresponding to their age and gender (based on the child's growth curve and z scores) were obtained [16]. In order to perform the analysis we classified children with overweight and obesity as those with body mass indices equivalent or exceeding the 85th percentile. For each child the z score based on the WHO standards was calculated. Based on the normal distribution, the area under the curve over the region to the left of z provides the relative frequency of observations bellow the z-value, which in percentage represents the percentile corresponding to the child. If the percentile was equal or exceeded the 85% then the child is classified with overweigh and obesity, cut off point used by the Spanish government [17].

Data collected from the three Andalusian health surveys measure individual and environmental variables potentially related to overweight and obesity (all included in this study): a) individual or familiar factors (gender, age group, educational level, employment status, social class, house ownership, physical activity, sleeping hours, general health perception of the child from his/her parents, chronic diseases, diary intake of milk, fruit, vegetables, meat or fish, eggs and yoghurt); b) environmental issues perceived by the person interviewed (the general quality perception of the environment in the area where the child lived, the air pollution, industrial contamination in the area, existence in the neighbourhood of disturbing noise, the amount of green areas and malodorous near their homes, as well as indices of material deprivation and rurality of the neighbourhood). All the variables and their category levels are described in Table 1.

Variables	**Overweight or obesity**			
p-value	**%**	**95% C.I. Lower limit**	**95% C.I. Upper limit**	**n**
Gender (N=2325)				
Boy	38.40	35.04	41.65	1159
Girl	27.00	24.07	30.00	1166
Age group (N=2325)				
8-10 years	48.00	43.89	52.29	737
11-12 years	31.60	27.22	36.02	582
13-15 years	22.10	19.06	25.03	1006
Educational Level (N=2286)				
No studies or Primary	33.60	29.59	37.81	690
EGB or FP	34.40	31.14	37.73	1081
Secondary studies	30.10	23.14	37.50	216
University studies	24.10	18.40	29.72	299
Employment Status (N=2295)				
Currently working	32.90	30.51	35.33	1977
Unemployed.	22.30	13.45	30.94	121
Retired/housewife	33.50	25.68	41.12	197
Social Class (N=2247)				
Managers	27.90	22.17	34.89	316
Workers	33.60	31.10	36.20	1787
Non Workers	25.00	16.84	33.52	144
Environmental factor of Noise (N=2324)				
A lot	35.00	28.49	41.47	283
Some	34.70	30.67	38.70	732
None	31.00	28.12	33.95	1309
Environmental factor of Malodorous (N=2325)				
A lot	27.00	17.50	35.68	126
Some	34.40	29.24	39.69	433
None	32.70	30.16	35.24	1766
Environmental factor of Air Pollution N=2320				
A lot	26.90	14.73	38.05	78
Some	33.60	27.77	39.73	327
None	32.80	30.36	35.25	1915
Environmental factor of Industry (N=2311)				
A lot	28.30	13.08	44.28	46
Some	33.10	24.99	41.37	175
None	32.90	30.59	35.27	2090
Environmental factor of Green area (N=2319)				
A lot	33.10	27.40	39.07	341
Some	34.20	30.82	37.62	1014
None	30.80	27.41	34.19	964
General Quality of Environment (N=2325)				

Very Good	38.40	30.80	46.01	216
Good or Regular	31.80	29.48	34.21	2020
Bad or Very Bad	38.20	26.42	50.23	89
Car (N=2325)				
One or More	33.40	31.02	35.77	2054
None	27.30	21.22	33.63	271
House (N=2314)				
Owned Property	32.30	29.93	34.61	2071
Not Owned Property	37.00	29.92	44.13	243
Physical Activity (N=2325)				
No exercises	35.80	29.67	42.06	313
Some exercises	33.00	29.85	36.23	1131
Lots exercises	31.30	27.29	35.58	654
Special Training	30.40	23.35	37.35	227
Sleeping hours (N=2325)				
8 or less hours	32.90	29.08	36.58	818
9 hours	31.80	28,16	35.33	877
10 or more hours	33.80	29.51	38.12	630
General Health perception of the child form his/her parents (N=2325)				
Excellent or Very Good	31.30	28.77	33.75	1800
Good	39.00	33.81	44.18	461
Regular or Bad	28.10	14.41	40.54	64
Chronic Diseases (N=2325)				
None	32.70	30.24	35.09	1942
One or more	32.90	27.33	38.31	383
Cup of milk per day (N=2325)				
Less than one per day	38.40	28.88	47.94	138
1 cup a day	31.50	27.04	35.92	572
2 cups a day	33.30	30.07	36.50	1120
3 or more cups a day	31.10	26.42	35.93	495
Fruit (N=2318)				
Every day	30.90	27.64	34.08	1069
5 to 3 day a week	37.10	33.14	40.96	796
2 or less days a week	29.10	24.25	34.01	453
Vegetables (N=2306)				
Every day	33.90	26.68	41.10	227
5 to 3 day a week	33.00	29.82	36.21	1126
2 or less days a week	32.30	28.85	35.76	953
Meat or Fish (N=2321)				
Every day	29.00	22.87	35.22	283
5 to 3 day a week	33.00	31.33	36.43	1781
2 or less days a week	29.60	22.88	35.92	257
Eggs (N=2314)				
Every day	38.40	25.39	51.91	73
5 to 3 day a week	30.70	27.33	34.06	977
2 or less days a week	33.90	30.91	36.99	1264
Yoghurt (N=2325)				
Every day	32.10	29.29	35.00	1389
5 to 3 day a week	34.00	29.94	37.90	739
2 or less days a week	32.00	24.34	39.59	197

Table 1: Descriptive and bivariate results for qualitative variables. N is the total number of observations per variable. The tables show the % of children with overweight and obesity for each category of the factors included in the study. The % of children with normal weight (not presented in the table) can be easily derived as 100 - % of children with overweight and obesity.

The variable "social class" was initially defined as proposed by the research group of the Spanish Epidemiology Society (SEE) [18,19]. However, due to the lack of data for some the classes defined we regrouped "social class" into the following categories: "Manager or Directors", "Workers" and "No Workers". "Managers" are defined as people with leading responsibilities at work or head of a working team; "Workers" are people belonging to a working team without leading responsibilities; "No Workers" are defined as people who do not have a paid job.

The level of deprivation and rurality were obtained for each municipality where the child lived. Deprivation and Rural indices are variables available from the Spanish Population and Housing Census [20-22]. The score for the factor of rurality ranged from -3.50 to 3.78, with the highest values for the more rural municipalities. The deprivation index has a mean of 0 and a standard deviation of 1, with the highest values for the socio-economic situations with more deprivation. The construction of the indices is described in detail on the references provided above.

A descriptive analysis was carried out for all selected independent variables with respect to overweight and obesity. For continuous variables, the descriptive statistics mean, standard deviation, and 95% confidence intervals are calculated. For categorical variables, percentages of cases of overweight or obesity within each category are shown, as well as their 95% confidence intervals.

In order to jointly analyse the relations of the different independent variables considered with respect to overweight and obesity of children, a model based on logistic regression was applied. Possible risk factors associated with overweight and obesity were included in the model, and the odds ratios were obtained. The age of the children was considered as continuous when modelling the data, since its relation to the logit of the prevalence of overweight/obesity was approximately linear. First, a logistic regression model of overweight

and obesity with respect to gender and age was fitted. Then, successively, a new variable was added in each step (using the forward method of introducing variables manually). The effect of each exploratory variable in the model and its significance was studied. If the variable was relevant to improve model fit and adequacy (based on the likelihood ratio criteria and the significance of the parameter), it was kept for the next step; otherwise, the variable was excluded. Since the level of education and employment status of the head of the family define the "social class", independent models with the "social class", "level of education", and "employment status", were fitted in order to avoid collinearity between these variables. Additionally, different models were fitted with respect to the factors related to environment. To correct the collinearity between these factors (correlation values with modulus higher than 0.7) [23], different models with individual environmental factors were fitted, taking into account age and gender.

The model was checked for pair-wise interaction between covariates. Interactions by gender and age, along with all possible interactions with predictors and year of survey, were considered. Potential confounding covariates were studied by a change of significance of the parameters in the model or a change of 30% of its value [24]. Once the model was fitted to the data, the goodness of fit of the model was assessed by the Hosmer-Lemeshow test. Standardized residuals were obtained [25,26]. The significance level was established to be 5%. The software SPSS version 15 was used to perform the analysis.

Results

The percentages of children with overweight and obesity for each category of the qualitative variables are presented in Table 1. The percentage of overweight and obesity decreases as the age of the child increases. The percentage of overweight and obesity for boys was higher than for girls. No clear tendency on the percentage of overweight and obesity was observed between the categories of the environmental factors.

In Table 2 the descriptive statistics for the quantitative index are shown. It is observed that the mean of deprivation and rural index is similar between the group of children classified with overweight/obesity and the group of children without overweight/obesity.

	Privation Index				Rural Index			
	Mean	SD	95% C.I. Lower	95% C.I. Upper	Mean	SD	95% C.I. Lower	95% C.I. Upper
Overweight/obesity								
Yes (N=856)	0.89	0.82	0.82	0.95	-1.46	0.44	-1.49	-1.43
No (N=1751)	0.88	0.82	0.83	0.93	-1.47	0.41	-1.49	-1.43

Table 2: Descriptive and bivariate results for quantitative variables. Mean, standard deviation (SD) and 95% confidence intervals for the mean of the privation and rural indices of families for the group children with and without overweight/obesity. N is the total number of cases per group.

No relevant interaction between the variables was found and none of the excluded variables behaved as a confounder. Among others, interactions between gender and age with respect to other predictors were explored and found to be not significant.

The "social class" and "employment status" were not found to be significant factors for predicting overweight and obesity. The variables "rurality and deprivation indices", environment perception and health perception were not significantly associated with overweight and obesity.

The best model found to fit the data of overweight and obesity includes all the variables shown in Table 3, where a summary of the results from the fitted model is provided. The results show significantly higher odds of overweight and obesity within the group of boys with respect to the group of girls (OR=1.84; $p<0.05$). The odds of overweight and obesity within boys is almost twice the odds of overweight and obesity among girls. With respect to age, the odds of overweight and obesity decreases as the age of the child increases (OR=0.76; $p<0.05$). That is, for each year the child is older the reduction in the odds from the previous year is 24%. For example, with extrapolation the odds of overweight and obesity for a 15 year-old child vs. an 8 year-old is exp (-0.27*7)=0.15, so there is a reduction in the odds of 85%. Children with no physical activity have more risk to be obese than children with physical activity (OR=1.30; p=0.06), although it is not significant at the 5% level.

Variables for the Logistic Model	b	S.E.	P-value (Wald test)	OR Exp(b)	95% C.I. OR	
					Lower limit	Upper limit
Gender (Baseline "Girls")	0.64	0.1	0	1.9	1.57	2.3
Age	-0.28	0.02	0	0.76	0.73	0.79
Physical Activity (Baseline "Do Exercise" with respect "No Exercise")	0.25	0.14	0.07	1.28	0.98	1.67
Sleeping hours (Baseline "8 or fewer hours")						
9 hours	-0.27	0.11	0.01	0.76	0.61	0.95
10 or more	-0.29	0.12	0.02	0.75	0.59	0.95
Yoghurt (Baseline "Every day")	0.22	0.1	0.02	1.25	1.03	1.51
Milk (Baseline "Less than one cup per day")						
One cup a day	-0.3	0.21	0.15	0.74	0.49	1.11
Two cups a day	-0.32	0.2	0.1	0.72	0.49	1.1
3 or more cups a day	-0.52	0.21	0.02	0.59	0.39	0.9
Intercept	2.55	0.34	0	12.82		

Table 3: Results from the logistic regression model.

The lack of sleep increases the risk of overweight and obesity. In particular, the odds of overweight and obesity for children who sleep 9 or more hours are approximately 1.33 times lower than the odds for children who sleep 8 or fewer hours. Consuming yogurt on a daily basis decreases the risk of overweight and obesity. The odds of children who do not consume yogurt every day is 1.26 times the odds of children who do so on a daily basis. Children who consume 3 or more cups of milk a day have lower risk of overweight and obesity than children who consume less than one cup a day. Families with higher level of education are less likely to have children with overweigh and obesity. The odds of overweight and obesity in families with an education level lower than university studies are 1.49 times higher than the odds in families with university studies.

The goodness of fit of the model was measured by the Hosmer-Lemeshow test (HL=8.439; 8 degrees of freedom, p-value=0.392). Based on this test we concluded that the model fits the data well. Furthermore, in logistic regression modelling, if the model fits well to the data we expect to have 95% of the standardized residual between the values -2 and 2. The cut-offs for the 95% center percentiles of the standardized residuals were obtained. The 2.5% cut off value was -1.2 and the 97.5% was 1.9. The mean was -0.004 and the standard deviation 0.993, indicating that the model was fitting well to the data.

Discussion

The present study provides information on the factors associated with the prevalence of overweight and obesity among children aged 8-15 in Andalusia. The last health survey in 2007 showed a prevalence of overweight and obesity of 29.80% (with a 95% C.I. (26.21, 32.27)) for children aged 8 to 15 years. For these children, the frequency of obesity and overweight decreases with rising age, and this frequency is lower among girls than among boys. This percentage is similar to developed countries, as we have mentioned. In the U.S. the prevalence of overweight and obesity was 37.1% for children ages ranging 6 to 11 years and 34% for children aged 12 to 19 years [6].

In accordance with the majority of scientific relevant literature in this area, this study shows the association between obesity and overweight with variables related to physical activity, where the latter are important factors of the energy balance within the human body. A growing body of evidence shows that the main causes of the worldwide increase in obesity and overweight are the reduced daily physical activity [1,2]. Our findings show that children carrying out physical activity on a regular basis are less prone to suffer from overweight and obesity than those with rather sedentary habits. This result is independent of gender, socio-economic status or any other variable. This shows that the conclusion drawn from the main effects are robust.

On the other hand, our data show that children sleeping less than eight hours per day are more likely to suffer from obesity and overweight than those sleeping more than eight hours a day. Due to the effect that hours of sleep has on the energy body balance, it is common to find this information in many related studies [3,27-29].

Currently, despite all the epidemiologic studies carried out in this field, there are controversial opinions about the relative influence of the main metabolic factors (such as fat, carbohydrate, and protein) on overweight and obesity [30]. Nevertheless, some food and drinks (like sugar-sweetened soft drinks, snacks, fatty food and diet with low vegetable and fibre consumption) are clearly related to overweight and obesity [31,32]. Our study shows that children who take yogurt every day and drink one or more glasses of milk per day have lower odds of overweight and obesity than those who did not follow those habits. It is possible that these eating habits show something more important than their effects on the energy body balance, which may indicate a positive attitude and/or a special care from the parents with respect to the healthy eating habits of their children.

Certain environmental factors are widely related as relevant factors for the development and prevention of obesity problems. They influence, directly or indirectly, the motivation of children for practicing physical activity. They also influence the quantity and quality of the diet, due to the availability of opportunities and places for the consumption of healthy or non-healthy food [33-37]. This study checked the association of some environmental factors with overweight and obesity, by using a multivariate logistic regression model taking into account the possible confounders or modifying effects of individual variables. The findings show no association of the environmental factors with overweight and obesity. One possible reason is that the environmental variables, considered in this study, are measured in a subjective and perceived way, with a potential significant distortion from reality (if measure by a objective way). Another explanation could be that the environmental factors influence indirectly the behaviour related with obesity and overweight through the individual variables. Whatever is the reason of why environmental factors were not significant in the study, it is out of reach from this research.

There are many controversies regarding the relationship between the different measures for the socio-economic status and obesity [38-40]. Some studies carried out in developed countries have included a wide range of socioeconomic indicators. In those countries, particularly in the U.S., the association between socio-economic status and obesity is complex. Most European studies generally report an inverse association with obesity across several socio-economic indicators. A literature review of cross-sectional studies from 1989 to 2005, which explore the association between socio-economic status and adiposeness in primary school age children (5 to 8 years old) from occidental countries, was carried out [39]. This information was extracted from a total of 45 reviewed studies; in 19 of them the socio-economic factors were inversely associated with the adiposeness (42%). In our study different measures of socio-economic status were considered. None of them were statistically significant in the multivariate models. Perhaps the socio-economic status may affect directly people´s knowledge, attitudes and lifestyles. This includes access to food and physical activity behaviour, which may influence their energy balance indirectly. So, when we controlled food and physical activity, the direct effect of the socio-economic variables included in the multivariate model for overweight and obesity disappeared. Though, we should keep in mind that the marginal classes are not included in the health surveys. In addition, children who belong to the lower (but non marginal) social classes enjoy a great protection from the public policies of the Spanish and Andalusian welfare state.

Rural and urban differences on overweight and obesity were not found to be significant. Those results are supported by the findings in most developed countries where the rural-urban differences in living standards (access to food, health care services, lifestyles, and so on) are small [41].

With respect to the findings about child-health perception from parents, it was found that children whose parents perceived a good health of the child have lower risk of overweight and obesity than children whose parents perceived the child-health as “excellent or very

good" or "regular or bad". Several studies, in accordance with our findings, showed the discrepancy of the perceptions of the parents about their child's complexion and weight with the real status of those [42,43].

We cannot forget that for this study, as well as in other cross-sectional studies, the interpretation of data is hampered because the temporal relationship and the direction of association cannot be determined. One obvious problem in this kind of epidemiologic studies is the possible reverse causation. Thus, cross-sectional associations may reflect the joined intervention of the true effects of a particular factor as well as artificial effects due to reverse causation and confounding by other variables. Nevertheless, the results in this paper provide relevant information to be considered when developing public health policies and professional care in the area of childhood overweight and obesity. We identify as areas for public health policies and further research potentially modifiable factors such as physical activity, sleeping hours and diet habits.

In conclusion, the prevalence of overweight/obesity in children aged 8-15 years in Andalusia in 2007 was 29.8% (95% CI = (26.71, 31.93)), being in agreement with other studies of developed countries). Physical activity, sleeping hours and good diet habits, related to an increase of milk and yogurt consumption, decreased the risk of overweight and obesity. None of the environmental factors considered were significant in combination with individual factors.

What is already known about this subject

Individual factors such as gender, physical activity, sedentary habits, nutrition and socio-economic position are related to overweight and obesity.

Scientific evidence suggests an influence of environmental factors on the healthy habits of the person.

There is no research in Andalusian (based on population sample) that combines individual and environmental factors to study possible associations with overweight and obesity.

What this study adds

Using data of resident children from the official public health survey of Andalusia from 1999 to 2007, we considered a broad range of potential risk factors, individual and environmental factors: individual characteristics of the children, environmental factors of the area of living, eating habits, socio-economic level of the family, and physical activity conditions.

This enabled a comprehensive and broad analysis of the situation of overweight and obese children as well as an analysis of potential factors related to obesity in children within Andalusia.

Key Points

- The paper gives insight to the prevalence of overweight and obesity in Andalusia, Spain.
- Using data of resident children from the official public health survey of Andalusia from 1999 to 2007, we considered a broad range of potential risk factors: individual characteristics of the children, environmental factors of the area of living, eating habits, socio-economic level of the family, and physical activity conditions.
- This enabled a comprehensive and broad analysis of the situation of overweight and obese children as well as an analysis of potential factors related to obesity in children within Andalusia.

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