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# Perinatal and parental determinants of childhood overweight in 6-12 years old children

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**Abstract**

***Introduction & aims:*** **The identification of determinants of childhood overweight is crucial to early diagnosis and prevention. The aim of this study was to assess perinatal and parental related risk factors concerning children for having excessive body weight.**

***Methods:*** **Cross-sectional study involving 3,101 children participating in the programme "Alimenta su salud" conducted in Castilla-La Mancha (Spain). Anthropometric and sociodemographic data were obtained from a general questionnaire. Analysed factors as potential predictors of childhood overweight were sex, age, birth weight, infant feeding, number of siblings, as well as parental marital status, educational level and obesity. Prevalence of overweight stratified by potential determinants was assessed. Univariate and multivariate logistic regression analyses were used to examine the associations between variables and the likelihood of being overweight.**

***Results:*** **The overweight prevalence (including obesity) was 30.3% in boys and 28.3% in girls, according to the IOTF criteria. Higher rates in younger subjects and some gender differences were observed. Parental obesity was the most important predictive variable for childhood overweight in both sexes and birth weight over 3,500 g in girls (OR 1.8, 95% CI 1.3-2.3). Having one or more siblings (OR 0.7, 95% CI 0.5-0.9) and higher paternal education (OR 0.8, 95% CI 0.6-0.9) in boys, and older age in girls (OR 0.7, 95% CI 0.5-.09), resulted protective factors against childhood overweight. No independent effects of marital status, maternal education and infant feeding patterns on childhood excess weight were identified.**

***Conclusions:*** **Perinatal and parental factors could contribute to predict the risk of being overweight/obese in children aged 6 to 12 years, which should be considered when formulating obesity prevention and intervention strategies, stressing the importance of targeting obese parents with young children.**

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Key words: *Overweight. Obesity. Determinants. Children.*

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## DETERMINANTES PERINATALES Y PATERNOS ASOCIADOS AL RIESGO DE SOBREPESO EN NIÑOS DE 6 A 12 AÑOS

**Resumen**

***Objetivos:*** **Identificar los determinantes del sobrepeso infantil resulta clave para la prevención y diagnóstico precoz. El objetivo de este trabajo fue evaluar factores perinatales y paternos asociados al riesgo de sobrepeso y obesidad infantil.**

***Métodos:*** **Estudio transversal en 3.101 niños participantes en el programa "Alimenta su salud" llevado a cabo en Castilla-La Mancha. Los datos antropométricos y sociodemográficos fueron obtenidos mediante la aplicación de una encuesta. Las variables consideradas como potenciales predictores de sobrepeso infantil fueron sexo, edad, peso al nacer, lactancia recibida y número de hermanos de los niños, así como estado civil, nivel educativo y obesidad en los padres. El estudio analizó la frecuencia de sobrepeso estratificada por los potenciales factores de riesgo y se empleó regresión lineal univariante y multivariante para estudiar la asociación entre las variables candidatas y la probabilidad de tener sobrepeso.**

***Resultados:*** **La prevalencia de sobrecarga ponderal (incluyendo obesidad) fue del 30,3% en los varones y el 28,3% en las niñas, de acuerdo con los criterios de IOTF. Los mayores porcentajes de exceso de peso se observaron en edades más tempranas con diferencias en función del sexo. La obesidad en los padres resultó el factor de riesgo más importante de sobrepeso y obesidad infantil en ambos sexos y en las chicas además, un peso al nacer mayor de 3.500 g (OR 1,8 IC 95% de 1,3-2,3). Por otro lado, tener uno o más hermanos (OR 0,7 IC 95% de 0,5-0,9) y un mayor nivel educativo paterno (OR 0,8 IC 95% de 0,6-0,9) resultaron factores protectores frente al sobrepeso infantil en chicos. La probabilidad de tener sobrepeso fue menor en las chicas de mayor edad (OR 0,7 IC 95% de 0,5 a 0,9). No se identificó un efecto independiente del estado civil, la educación materna o la lactancia recibida asociado al riesgo de sobrepeso infantil.**

***Conclusiones:*** **Ciertos factores perinatales y paternos pueden contribuir a predecir el riesgo de sobrepeso/obesidad en niños de 6 a 12 años, por lo que deberían ser considerados en el diseño de estrategias orientadas a la prevención e intervención precoz, haciendo hincapié en aquellas dirigidas a los padres obesos con niños pequeños.**

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Palabras clave: *Sobrepeso. Obesidad. Determinantes. Niños.*

## Abbreviations

BMI: Body Mass Index.
CI: Confidence Interval.
IOTF: International Obesity Task Force.
OR: Odds Ratio.

## Introduction

Ten percent of the world's school-aged children are estimated to be overweight or obese. Since obesity prevalence continues to increase, monitoring and early interventions are needed to reverse anticipated trends.[1] In this context, Spain has reached one of the highest rates of childhood obesity in Europe.[2] Unfortunately, obesity is showing alarming figures at younger ages,[3] which is an additional burden for diverse adulthood diseases.

The aetiology of obesity is multifactorial and involves complex interactions among genes, dietary intake, physical activity, environmental and individual factors.[4,5] However, the observed increase in the prevalence of childhood obesity is a likely consequence of obesogenic lifestyles, being key environmental contributors unhealthy eating habits and sedentary patterns.[6]

Some determinants of childhood overweight and obesity remain unclear while arising risk factors need to be confirmed both at the individuals as well as at the population levels. Thus, on the basis of reported associations with overweight and obesity, the following risk factors have been involved: birth weight, gestational age, infant feeding, age of introduction of complementary feeding, postnatal growth rate and sleep duration as well as prenatal programming and epigenetic processes.[7] In regard to parental influences, potential determinants are: maternal parity, mother's age at child's birth, parental weight status, marital status, family income, educational level and socioeconomic status.[8,9]

Obesity in childhood affects virtually every organ system in an adverse manner and it is associated with complications in the short and in the long term, including early puberty and menarche in girls, type 2 diabetes and metabolic syndrome in youth and in adulthood, cardiovascular disease, several types of tumors and premature death.[10]

The identification of determinants of childhood obesity is crucial to early diagnosis and prevention, but while many factors have been identified, their relationships including confounding or cumulative effects are mostly unknown as well as the potential impact of overcoming these risk factors remains to be evaluated.[11]

The aim of the present study was to assess certain perinatal and parental risk factors for childhood overweight and obesity in a sample of Spanish children aged 6-12 years, participating in the programme "Alimenta su salud".

## Methods

### *Study population and data collection*

"Alimenta su salud" is a childhood obesity prevention programme carried out in Castilla-La Mancha with the collaboration of the University of Navarra and supported by the Pharmacists Council and Regional Council of Health and Social Welfare.[12] This programme sought to assess weight status, dietary habits and physical activity among children aged 6 to 12 years, by the application of a general questionnaire, containing also information about perinatal issues.[13]

This cross-sectional study was conducted between April and November 2008 where data collection was obtained from previously trained pharmacists. The examination took place in pharmacies and a signed consent form from parents or guardians was required for each child to participate. On the 3,705 filled questionnaires received, 604 were excluded because of missing data on variables of interest. Thus, the study population consisted of 3,101 children (1,569 boys and 1,532 girls).

### *Outcome variables: overweight/obesity*

The Body Mass Index (BMI) was calculated from directly measured height and weight (kg/m$^2$). The binary outcome variable distinguishes between obese/overweight children and non obese/overweight children, using criteria suggested by Cole et. al (2000) as recommended by the International Obesity Task Force (IOTF).[14]

### *Potential predictors*

In the present study, personal, perinatal and familiar factors considered as potential predictors of childhood overweight/obesity were: sex, age, birth weight, infant feeding, number of siblings, marital status, parental educational level and parental obesity. Information on these factors was obtained from the questionnaires received.

The recruited population was categorized by age into two groups 6 to 9 years (1,876 children) and 10 to 12 years (1,225 children). Birth weight was classified into two categories: less than 3,500 g and over 3,500 g. Infant feeding practices from birth to six months, included: formula, mixed (combination of formula and breast milk) and breastfeeding (considering duration: 3 months or 6 months).

On the other hand, self-reported height and weight of parents included in the questionnaire were used to calculate their respective BMI. A parent with a BMI ≥ 30 kg/m$^2$ was defined as obese. Educational level of parents was divided into two categories: none or primary school and secondary school or university degree. Parents were also asked how many siblings their child had at the moment of the survey. From this information, a new variable was created: single child (no siblings) and at least one sibling. Finally, marital

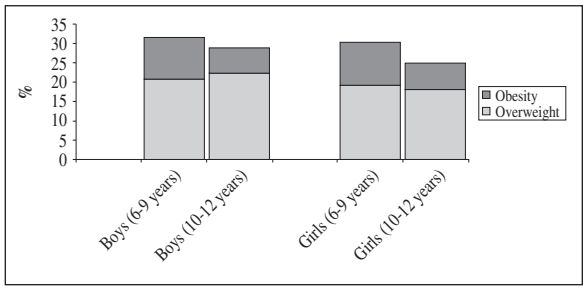


*Fig. 1.—Prevalence of overweight and obesity in children aged 6-12 years old.*

status was categorized into married and others (single, widowed and divorced).

### *Statistical methods*

Frequencies of overweight (including obesity) stratified by potential determinants were analysed. Chi-square tests were used to assess differences in proportions between groups. Logistic regression analysis was conducted to develop the best model to assess the association between potential predictive factors and risk of overweight.

Any variable found to be significantly associated or with a trend in univariate analyses was considered as a candidate for the multivariate model. Multivariate logistic regression analyses were performed to identify independent risk factors for overweight. Separated analyses were performed with regard to sex.

Odds Ratios (ORs) and 95% Confidence Intervals (95% CIs) were determined from these analyses. An OR greater than 1 expresses a higher risk of childhood overweight, whereas OR lower than 1 means a protective effect. Data analyses were performed using SPSS 15.0 (SPSS Inc, Chicago, IL, USA). All P values presented are two-tailed and the statistical significance was defined *a priori* at $P < 0.05$.

## Results

Prevalence of overweight and obesity according to gender and age group is illustrated in figure 1. The overall prevalence of overweight (including obesity)

**Table I**
*Prevalence of overweight (including obesity) according to perinatal and parental characteristics*

| *Condition* | *Percentage of overweight participants (n)* | | |
|---|---|---|---|
| | *All (n = 3,101)* | *Boys (n = 1,569)* | *Girls (n = 1,532)* |
| *Birth weight** | | | |
| ≤ 3.5 kg | 27.3 (655) | 28.8 (329) | 26.0 (326) |
| > 3.5 kg | 35.8 (253) | 34.5 (147) | 37.9 (106) |
| *Infant feeding‡* | | | |
| Formula | 31.6 (227) | 31.1 (115) | 32.1 (112) |
| Breastfeeding 3 months | 26.6 (178) | 30.0 (98) | 23.4 (80) |
| Breastfeeding 6 months | 28.6 (301) | 27.2 (145) | 30.2 (156) |
| Mixed | 30.5 (202) | 34.9 (118) | 25.9 (84) |
| *Number of siblings†* | | | |
| 0 | 38.2 (130) | 36.3 (73) | 29.2 (57) |
| ≥ 1 | 28.8 (778) | 29.5 (403) | 28.0 (375) |
| *Father's marital status* | | | |
| Married | 29.4 (833) | 30.3 (432) | 28.6 (401) |
| Single, widowed, divorced, others | 27.7 (75) | 31.2 (44) | 23.8 (31) |
| *Mother's marital status* | | | |
| Married | 29.4 (831) | 30.2 (432) | 28.6 (399) |
| Single, widowed, divorced, others | 28.2 (77) | 32.1 (44) | 24.3 (33) |
| *Father's educational level** | | | |
| None or Primary school | 32.7 (498) | 34.4 (256) | 31.0 (242) |
| Secondary school or University degree | 26.0 (410) | 26.7 (220) | 25.3 (190) |
| *Mother's educational level** | | | |
| None or Primary school | 32.2 (478) | 33.8 (251) | 30.7 (227) |
| Secondary school or University degree | 26.6 (430) | 27.2 (225) | 25.9 (205) |
| *Father obese** | | | |
| No | 26.3 (662) | 28.2 (362) | 24.3 (300) |
| Yes | 42.2 (246) | 40.0 (114) | 44.3 (132) |
| *Mother obese** | | | |
| No | 28.1 (800) | 29.2 (421) | 27.1 (379) |
| Yes | 41.9 (108) | 44.0 (55) | 39.8 (53) |

*P < 0.05 between all groups (all, boys and girls).
†P < 0.05 between boys.
‡P < 0.05 between girls.

observed in the present study was 30.3% in boys and 28.3% in girls. Higher values were observed at younger ages (from 6 to 9 years). Rates of overweight children according to perinatal and parental characteristics among boys and girls are reported in table I. A birth weight over 3,500 g was associated with a higher proportion of overweight. Single children were also more often overweight comparing to children having one or more siblings. Furthermore, some gender differences in relation to infant feeding and marital status were found. Among boys, the highest prevalence of overweight was found in those who received combination of formula and breast milk, whereas girls fed with formula, were more often overweight. In regard to parental characteristics, only boys whose parents were not married were more frequently overweight. Children whose parents were obese, showed the highest frequencies of overweight. On the other hand, prevalence of overweight was lower in those whose parents had higher levels of education.

**Table II**
*Univariate OR (95% confidence interval [CI]) for being overweight/obese according to perinatal and parental factors among boys and girls*

| | *Boys* *OR (95% CI)* | *Girls* *OR (95% CI)* |
|---|---|---|
| *Age* | | |
| 6-9 years | 1 (ref) | 1 (ref) |
| 10-12 years | 0.9 (0.7-1.1) | 0.8 (0.6-0.9)* |
| *Birth weight* | | |
| ≤ 3.5 kg | 1 (ref) | 1 (ref) |
| > 3.5 kg | 1.3 (1.1-1.7)* | 1.7 (1.3-2.3)** |
| *Infant feeding* | | |
| Formula | 1 (ref) | 1 (ref) |
| Breastfeeding 3 months | 0.9 (0.7-1.3) | 0.6 (0.5-0.9)* |
| Breastfeeding 6 months | 0.8 (0.6-1.1) | 0.9 (0.7-1.2) |
| Mixed | 1.2 (0.9-1.6) | 0.7(0.5-1.0) |
| *Number of siblings* | | |
| 0 | 1 (ref) | 1 (ref) |
| ≥ 1 | 0.7 (0.5-0.9)* | 0.9 (0.7-1.3) |
| *Father's marital status* | | |
| Married | (ref) | 1 (ref) |
| Single, widowed, divorced, others | 1.0 (0.7-1.5) | 0.8 (0.5-1.2) |
| *Mother's marital status* | | |
| Married | 1 (ref) | 1 (ref) |
| Single, widowed, divorced, others | 1.1 (0.8-1.6) | 0.8 (0.5-1.2) |
| *Father's educational level* | | |
| None or Primary school | 1 (ref) | 1 (ref) |
| Secondary school or University degree | 0.7 (0.6-0.9)** | 0.8 (0.6-0.9)* |
| *Mother's educational level* | | |
| None or Primary school | 1 (ref) | 1 (ref) |
| Secondary school or University degree | 0.7 (0.6-0.9)* | 0.8 (0.6-0.9)* |
| *Father obese* | | |
| No | 1 (ref) | 1 (ref) |
| Yes | 1.7 (1.3-2.2)** | 2.5 (1.9-3.2)** |
| *Mother obese* | | |
| No | 1 (ref) | 1 (ref) |
| Yes | 1.9 (1.3-2.8)** | 1.8 (1.3-2.6)** |

*P < 0.05, **P < 0.005.
ref: Reference.

**Table III**
*Multivariate OR (95% confidence interval [CI]) for being overweight/obese according to perinatal and parental factors among boys and girls*

| | *Boys* *OR[a] (95% CI)* | *Girls* *OR[a] (95% CI)* |
|---|---|---|
| *Age* | | |
| 6-9 years | 1 (ref) | 1 (ref) |
| 10-12 years | – | 0.7 (0.5-0.9)** |
| *Birth weight* | | |
| ≤ 3.5 kg | 1 (ref) | 1 (ref) |
| > 3.5 kg | – | 1.8 (1.3-2.3)** |
| *Number of siblings* | | |
| 0 | 1 (ref) | 1 (ref) |
| ≥ 1 | 0.7 (0.5-0.9)* | – |
| *Father's educational level* | | |
| None or Primary school | 1 (ref) | 1 (ref) |
| Secondary school or University degree | 0.8 (0.6-0.9)* | – |
| *Father obese* | | |
| No | 1 (ref) | 1 (ref) |
| Yes | 1.6 (1.2-2.0)* | 2.4 (1.8-3.1)** |
| *Mother obese* | | |
| No | 1 (ref) | 1 (ref) |
| Yes | 1.6 (1.1-2.4)** | 1.5 (1.1-2.2)* |

[a]Adjusted for all independent variables included in the table.
*P < 0.05, **P < 0.005.
ref: Reference.

The univariate analysis with perinatal and parental variables (table II) showed that the risk of overweight was significantly associated with birth weight, parental educational level and parental obesity in both sexes, with number of siblings in boys, and with age and infant feeding, in girls.

Therefore, separate multivariable logistic regression models were fitted for boys and girls because the potential predictors differed between them. Marital status did not confer any significant risk of overweight.

The results for the multivariable models are shown in table III. Father and mother obesity were independent predictors of childhood overweight for boys and girls. However, sex of child and parent influenced the strength of the relationship between childhood overweight and parental obesity and was greatest for the father-daughter relationship (OR 2.4, 95% CI 1.8-3.1).

In boys, having one or more siblings (OR 0.7, 95% CI 0.5-0.9) and higher paternal education (OR 0.8, 95% CI 0.6-0.9) were found to be protective factors against childhood overweight.

The likelihood of being overweight was significantly lower in girls aged 10 to 12 years (OR 0.7, 95% CI 0.5-0.9) comparing to 6 to 9 years group. On the contrary, girls who reported a birth weight over 3,500 g

were 1.8 (95% CI 1.3-2.3) times more likely to be overweight. No independent effects of marital status, maternal education and infant feeding patterns on childhood overweight were found in both groups.

## Discussion

The current survey shows a high prevalence of excessive weight-for-height in the studied population using Cole et al. criteria.[16] Among Spanish children and young people, those at younger ages (from 6 to 13 years) and particularly boys, have been previously identified as a group at higher risk. However, this international BMI reference seems to underestimate prevalence of childhood obesity, so it is recommended to refer to overweight instead of obesity.[15]

Previous studies determining risk factors of overweight and obesity in Spanish children and adolescents, have already found relationships with age, birth weight, infant feeding, parental educational level and family history of obesity.[3,16-20,21] In line with other investigations,[18,22] we observed an inverse association between age and overweight, which pointed out that higher prevalence in younger children may be related to secular trend in overweight increase.[23] However, older age was a significant protective factor only for girls. A possible explanation for this, may be the fact that girls face greater social pressures and are more concerned about body image than boys.[2]

In regard to perinatal factors of childhood overweight, children with birth weight over 3,500 g have been reported to be more frequently overweight or obese at ages 6 to 13 years.[3] The association between high birth weight and later risk of obesity may be explained by an altered body composition at birth, including higher body fat and lower lean body mass, which persists during postnatal life.[24] In our study, the multivariate analysis showed a positive correlation only in girls as already reported in other studies.[25]

We were not able to detect protective effects of breastfeeding on obesity in our final model, despite an univariable association in girls. Nevertheless, a recent review[26] concludes that breastfeeding seems to have a modest protective effect against obesity in children, but confounding is possible, so it is unwarranted that breastfeeding causally reduces the risk of overweight or obesity in all cases. We found an independent protective effect of having one or more siblings, but only in boys. Proposed mechanisms for this association include better socioeconomic profile and a closer monitoring of the child's health behaviour and more opportunities to engage in physical activity in larger families.[27]

Regarding to parental factors, no independent effect of the family structure on childhood overweight was found in our sample. Family characteristics, like marital status, have been previously reported to be weak predictors of weight status of children.[28]

The inverse association between parental education and higher adiposity in childhood may have several explanations, including relation with lower socioeconomic status and its influence on knowledge and beliefs key to healthy lifestyles.[29] Although other studies[3,16] found a stronger association between maternal educational level and childhood overweight, we did not identify such outcome. Furthermore, only father's educational level remained significant in our multivariable analysis for boys. A reason that may explain this result, is the fact that mothers have usually more responsibility and influence in feeding practices of infants and very young children.[30]

Consistent with existing evidence,[31,32] we found that parental obesity was the factor most highly associated with childhood overweight. The association between parental obesity and risk for offspring overweight, is in agreement with other studies in different countries[16,17,22,25,27,33]. Both paternal and maternal obesity were independently associated with childhood overweight in our sample and gender affected this association. There is also some evidence that among children aged 6 to 11 years, parents are less likely to encourage sons to lose weight.[34]

This parent-child association of weight status may be explained by genetic,[35] as well as environmental and behavioural factors.[36] In fact, a recent review suggests that genetic factors explain 40-70% of BMI.[37] Despite genetic resemblances, family members show also similarities in behavioural risk factors associated with overweight, which display a configuration of dietary and activity patterns that are likely to promote the development of obesity among family members, particularly children.[38] In addition to genetic and environmental factors, Salcedo et al.[2] reported that in Spain, a large percentage of parents did not correctly perceive the weight status of their overweight children, specially at younger ages. This parental misperception of overweight may be also a major risk factor for childhood obesity.

Differences between males and females in vulnerability to risk factors and obesogenic environments were found in the present study, which highlight the importance of reporting not only overall prevalences, but also the socio-demographic patterning of overweight separately for boys and girls, as has recently been recommended.[39]

Our study has certain limitations. First, the choice of cut-offs points according to IOTF criteria might have reduced the power to detect some associations, since the number of obesity cases is relatively small using this definition, as explained before. Second, the voluntary participation in this study may have resulted in selection bias. Third, another possible weakness was the use of self-reported weights and heights of parents. However, a reasonable validity of these variables has been shown.[40] Finally, the cross-sectional design of the investigation does not strictly allow to infer causality on childhood overweight development. Despite these

limitations, the sample size and potential benefits arising from local prevention programmes for childhood obesity are large, since Castilla-La Mancha is a region with overweight rates within the mean of Spanish values.

In conclusion, our results suggest that overall prevalence of overweight in children aged 6-12 years is high with gender differences in associated risk factors. Parental obesity is the most important predictive variable for childhood overweight, and birth weight over 3,500 g in girls. On the other hand, having one or more siblings and higher paternal education (in boys) and older age (in girls) are protective factors against childhood overweight. No independent effects of marital status, maternal education and infant feeding patterns on childhood overweight were found. These findings support the hypothesis that certain perinatal and parental factors could contribute to predict the risk of later overweight/obesity in children aged 6 to 12 years, which should be considered when formulating obesity prevention and intervention strategies, stressing the importance of targeting obese parents with young children.


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