The European Journal of Public Health, Vol. 28, No. 2, 289–295

doi:10.1093/eurpub/ckx095 Advance Access published on 4 August 2017

Social vulnerabilities as determinants of overweight in 2-, 4- and 6-year-old Spanish children

Isabel Iguacel[1,2,3], Juan M. Fernández-Alvira[1,4], Idoia Labayen[5], Luis A. Moreno[1,2,3,6], María Pilar Samper[3,7,8], Gerardo Rodríguez[1,2,3,7,8], on behalf of the CALINA study

1 GENUD (Growth, Exercise, NUtrition and Development) Research Group, Faculty of Health Sciences, University of Zaragoza, Zaragoza, Spain
2 Instituto Agroalimentario de Aragón (IA2), Zaragoza, Spain
3 Instituto de Investigación Sanitaria Aragón (IIS Aragón), Zaragoza, Spain
4 Fundación Centro Nacional de Investigaciones Cardiovasculares Carlos III (CNIC), Madrid, Spain
5 Departamento de Nutrición y Bromatología, Universidad del País Vasco, UPV/EHU, Vitoria, Spain
6 Centro de Investigación Biomédica en Red de Fisiopatología de la Obesidad y Nutrición (CIBERObn), Madrid, Spain
7 Red de Salud Materno Infantil y del Desarrollo (SAMID), RETICS ISCIII, Spain
8 Departamento de Pediatría, Radiología y Medicina Física, Universidad de Zaragoza, Zaragoza, Spain

Correspondence: Isabel Iguacel, Edificio del SAI, C/Pedro Cerbuna s/n, 50009 Zaragoza, Spain, Tel: +34 876 55 37 53, Fax: +34 976 76 17 52, e-mail: iguacel@unizar.es

Background: Differences in obesity prevalence among vulnerable groups exist in childhood but it remains unclear whether these differences may be partly determined by socioeconomic status (SES), parental body mass index (BMI) and early life risk factors. We aimed to explore (i) longitudinal associations between belonging to a minority group and being overweight/obese at age 2, 4 and 6 and (ii) associations between accumulation of social vulnerabilities and being overweight/obese at age 6. **Methods:** In total, 1031 children (53.8% boys) were evaluated at birth and re-examined during a 6-year follow-up in a representative cohort of Aragon (Spain). Children from minority (vulnerable) groups included Spanish Roma/gypsies, Eastern Europeans, Latin Americans and Africans. Two more vulnerable groups were defined at baseline as children whose parents reported low occupation and education. Ethnicity, SES and parental BMI were collected via interviews. We used logistic mixed-effects models and adjusted for parental BMI, SES, mother's tobacco use, maternal weight gain, birth weight, infant weight gain and breastfeeding practices. **Results:** Regardless of confounders, Roma/gypsy children (OR = 4.63;[1.69–12.70]95%CI) and with Latin American background (OR = 3.04;[1.59–5.82]95%CI) were more likely to be overweight/obese at age 6 compared with non-gypsy Spanish group. Children with three vulnerabilities (OR = 2.18;[1.31–3.64]95%CI) were more likely to be overweight/obese at age 6 compared with children with no vulnerabilities. No associations were found between belonging to a minority group and overweight/obesity in children under 6. **Conclusion:** Interventions should target Roma/gypsy children, Latin American children and those who accumulate more vulnerabilities as they are at higher risk of being overweight/obese at age 6.

Introduction

Childhood obesity is considered one of the 21st century's most serious public health challenges.[1] Consequences of this condition include cardiovascular diseases, type 2 diabetes, musculoskeletal alterations and psychological disorders.[2] Prevalence of overweight and obesity in Spanish children is among the highest in Europe and varies among minorities and socioeconomic groups.[3,4] Particularly, disadvantaged socioeconomic circumstances and some minority groups present increased obesity-related health problems.[5]

Socioeconomic status (SES), including family income, parental education and occupational status, has been associated with a range of health, cognitive and socioemotional outcomes in children, with effects beginning prior to birth and continuing into adulthood.[6]

Most studies attempting to describe socioeconomic factors and differences among minority groups of childhood obesity epidemic have been conducted in the United States (US).[7] Results have showed a higher prevalence of overweight and obesity among Black and Hispanic children compared with non-Hispanic white children.[8] In Europe, studies have also examined ethnic variations in childhood overweight/obesity. Ethnic minority children (particularly Moroccan, Turkish, Latin American, Black African and black Caribbean) have proven to be more prone to overweight and obesity than non-minority children in some European countries.[9–11] Other minorities, such as Roma population (also known as Romani and Gypsies) present higher obesity rates than non-Gypsies.[12,13] Parental overweight and obesity, excessive weight gain during pregnancy, maternal smoking, rapid infant weight gain, low/high birth weight, poor breastfeeding practices and low SES are risk factors in prenatal period and early childhood.[14,15] Disparities in these risk factors due to differences in lifestyle behaviours, economic disadvantage and genetic characteristics could explain observed gaps in overweight and obesity rates between minority groups.[16]

Seemingly no studies in Spain or Europe have examined minority group differences as a risk factor of childhood obesity independently not only from classical SES indicators but also from pregnancy and infancy risk factors. Moreover, Spain has become a significant hub for international migration mainly consisting of medium-to-low income populations from Africa, Latin America and Eastern Europe of low SES, hence the interest in studying these groups.[12] A better understanding of childhood obesity will help guide intervention efforts and develop effective programmes and policies to avoid future diseases.

The present paper aims to explore (i) longitudinal associations between belonging to a minority group and being overweight or obese at three time points (ages 2, 4 and 6) in a cohort of children from Spain participating in the Growth and Feeding during Infancy and Early Childhood in Aragon (CALINA) study,

(ii) the extent to which differences in overweight and obesity prevalence in early childhood are explained by parental body mass index (BMI), SES, pregnancy and infancy risk factors and (iii) the association of accumulated social vulnerability (belonging to multiple vulnerable groups) at baseline and being overweight or obese at age 6.

Methods

Design and study population

CALINA is an ongoing birth cohort study whose sampling design is described elsewhere in detail.[17] CALINÁs study main objective was to assess growth patterns, body composition and feeding aspects in this population and to examine prenatal, postnatal and socio-cultural factors which may influence them. The cohort was randomly drawn from births occurring from March 2009 to February 2010 in different localities located in northeastern Spain in the autonomous community of Aragon, recruited from Primary Care Centres that had permanent trained pediatric staff conducting the Spanish Child Health Program at least in the last 2 years before participating in the CALINA study and with compliance and attendance over 80% of the population living in this area. The study sample is a representative cohort of Aragonese population in Spain[18] which presents similar childhood obesity rates to that of the average reported by other northern regions in Spain.[19] 1630 families were contacted to participate in the CALINA study, of which 1602 accepted to participate (acceptance rate 98%), 1540 having basic information on sex, birth weight, length at birth, and date and place of birth of the child. These 1540 new-born infants without any malformation, diseases or physical disabilities were examined at birth and periodically re-examined in Primary Care Centres at 2 weeks, monthly (after 1, 2, 4, 6 and 9 months) and yearly (1, 2, 4 and 6 years later). After 6-year follow-up 323 children did no longer participate in our study, thus the retention rate was 79%. Children with missing values in any of the exposures, covariates or outcomes at baseline or follow-up were excluded. Moreover, Asians were not included due to the small size of the sample. Finally, the analysis included 1031 children (54.2% boys; Supplementary figure S1). An analysis was conducted on participants who were not included in the analysis either because they were lost after 6-year follow-up or they were excluded from the analysis based on missing values. Results confirmed children who had a migrant background, lower parental education and occupation were more likely to not participate in follow-up examinations.

Parents or legal guardians gave written informed consent for examinations for their children. Ethical approval was obtained from Aragon's Committee of Ethics in Clinical Research (CEICA).

Measurements

Outcome measure

Height and weight were obtained by trained staff using the homologated measuring SECA® device. Child length at age 2 was measured using a recumbent board. For children older than 2 years barefoot body height was measured to the nearest 0.1 cm and body weight in kg to the nearest 10 g standing up in a fasting state and wearing light clothes. We calculated age- and sex-specific BMI z-scores using World Health Organization (WHO) reference data.[18] Children with excess body weight included overweight children (BMI-for-age > 1 z-score from the median) and obese children (BMI-for-age > 2 z-score from the median.

Potential confounding factors

We recorded the following variables for all children as confounding factors:

Maternal and paternal BMI: We calculated paternal and maternal BMI from fathers' and mothers' (pre-pregnancy) weight and height reports. This information was obtained by a face-to-face interview with parents.

Early Life Risk Factors: Pregnancy and early infancy factors potentially related to overweight/obesity risk in children were included according to existing literature[14,20]):

Pregnancy: (i) *mother's tobacco use during pregnancy*, mother was considered as smoker if she smoked over pregnancy, regardless of the number of cigarettes, and (ii) *maternal weight gain during pregnancy*, obtained from the obstetric medical history.

Early infancy: (i) *birth weight*, obtained from hospital records; (ii) *rapid infant body weight gain*, considered as an increase in body weight above +0.67 standard deviation (SD) from birth to 6 months of age[21]; and (iii) *exclusive breastfeeding for at least 4 months* i.e. giving maternal milk as the only infant food source according to WHO.[22]

By an individual face-to-face interview with parents we collected data regarding their educational and occupation level and the country of birth.

Socioeconomic factors: Maternal and paternal educational level: parents were asked to indicate their highest level of education. Particular response categories were coded according to International Standard Classification of Education (ISCED 1997)[23] and re-categorized into three categories: low (0–2), medium (3–4) and high (5–6) ISCED educational levels.

Occupation: parents were further asked to specify their occupation which were later transformed into three-categories according to the European Socioeconomic Classification (ESeC): working class (sales and clerical occupations, lower services and technical occupations, routine occupations, non-employed) intermediate (intermediate occupation, small employers and self-employed in non-professional occupations, lower supervisory and technician occupations) and salariat (large employers, higher grade professional, administrative, managerial occupations and lower grade professional, administrative and managerial occupations and higher grade technician, supervisory occupations).[24]

Minority groups and social vulnerabilities

All children considered in this study were born in Spain. However, to classify children according to their minority status, we created four mutually exclusive groups defined as minority (vulnerable) groups based on ethnicity (Spanish Roma/gypsies) or parents' origin: Eastern Europeans, Latin Americans (Central, South America) and Africans (North Africa, Sub-Saharan Africa). Non-gypsy Spanish children, whose parents were both non-gypsies born in Spain, were defined as non-vulnerable.

In 94% of children, the category of both parents was the same and, then, was used as the child's minority group category. In those cases in which the minority group status of the 2 parents differed, it was based on motheŕs origin/ethnicity.

Social vulnerability score was calculated by adding up the number of social vulnerabilities a child was exposed to. In all, three vulnerability indicators (belonging to a minority group; children of parents with low education levels and low occupational status) obtained from a parent-reported questionnaire were considered. For occupation and education, the mother's or father's highest level was taken into account. Vulnerability score ranged from 0 (no vulnerabilities) to 3 (all three vulnerability indicators) and was divided into four categories (three, two, one and no vulnerabilities).

Statistical analyses

Sociodemographic information was compared using *t*-tests for continuous variables and chi-square statistics for categorical

variables. Logistic mixed-effects models were applied to assess longitudinal associations between exposure (minority groups) and each outcome (overweight/obesity in children aged 2, 4 and 6). The reference category used was the normal BMI. All models included a random Primary Care Centre and random location of residence (region) to account for the study design. Three levels then were modelled: individuals (level 1), nested within Primary Care Centres attended at baseline (level 2), nested within regions (level 3).

Moreover, to explore the association between accumulation of social vulnerability at baseline and overweight/obesity in children aged 6 an additional longitudinal analysis was conducted.

To adjust for possible confounders, four different models were run. Model 1 was adjusted for sex. We also adjusted multivariable models for potential confounders at baseline, including maternal and paternal BMI, maternal weight gain during pregnancy and maternal smoking status (model 2). In subsequent models, we adjusted for birth weight, infant weight gain and breastfeeding practises (model 3) and socioeconomic variables including maternal and paternal education and occupation (model 4 or fully adjusted model). Each subsequent model includes adjustments in the prior model, with further adjustments.

Due to the likelihood of a non-random subset of respondents with missing socioeconomic information,[25] missing values of socioeconomic data were coded as a separate category.

Before model building, correlations among classical SES indicators were checked, however no collinearity problems were detected and both education and occupation were added.

Significance level was set at 0.01 to account for multiple testing. Analyses were performed using the Statistical Package for the Social Sciences (version 22.0; SPSS, Inc.).

Results

Table 1 summarizes descriptive characteristics of children and parents according to weight status (normal weight vs. overweight/obesity) of children at 6-year follow-up. For continuous covariates, mean and standard deviation (SD) are shown. The percentage of children presenting normal weight at age 6 was 68.4% (28.9% of the total number of children were underweight, data not shown). The percentage of children presenting excess body weight at age 6 was higher in those whose mothers reported having smoked during pregnancy (41.0%) compared with non-smokers (29.2%), and in those who used any kind of formula feeding (34.5%) compared with those who exclusively breastfed during at least 4 months (28.1%). Regarding minority group status, Roma children presented the highest percentage of overweight/obesity (72.4%) compared with non-gypsy Spanish children, who had the lowest percentage (28.6%). Children whose parents reported low SES (low education and working class) had a higher percentage of overweight/obesity compared with those from high SES (high education and salariat). Finally, children with a higher number of vulnerabilities had a higher percentage of overweight/obesity (50.5%) compared with those who reported no vulnerabilities (26.0%).

Table 2 shows odds ratio (OR), 99% confidence interval (CI) and *P*-values for models assessing longitudinal associations between minority group status and overweight/obesity in children aged 6 (see Supplementary table S1 for children aged 2 and Supplementary table S2 for children aged 4). No significant associations were found between belonging to a vulnerable group and excess body weight in children aged 2 or 4. However, Roma children (OR = 4.30;[1.13;16.23]99%CI) and children with Latin American background (OR = 2.93;[1.26;6.79]99%CI) were more likely to be overweight or obese at age 6 compared with non-gypsy Spanish children regardless of confounders (model 4).

Longitudinal associations between accumulation of social vulnerability indicators at baseline and being overweight/obese at age 6 are shown in table 3. Children with three vulnerabilities (OR = 2.08;[1.08;4.04]99%CI) were more likely to be overweight or obese at age 6 compared with children with no vulnerabilities regardless of confounders (model 4). Figure 1 shows normal weight vs. overweight/obesity prevalence in children aged 6 by the number of vulnerabilities the child was exposed to at baseline.

Discussion

This study aimed to explore longitudinal associations between belonging to a minority group and being overweight/obese at age 2, 4 and 6 and to investigate associations between accumulation of social vulnerabilities and being overweight/obese at age 6, independent from perinatal and infancy risk factors, SES status and parental BMI. This study found belonging to Roma (gypsy) and Latin American groups increased the risk of overweight/obesity 4-fold and 3-fold, respectively, in children aged 6 compared with those from non-gypsy Spanish group after adjusting for parental BMI, weight gain during pregnancy, maternal smoking during pregnancy, birth weight, weight gain in the first 6 months, breastfeeding practices and SES.

Few studies have examined the association between belonging to Roma population and being overweight and obese. Conforming to our results, investigations have shown Roma/Gypsy children had a higher prevalence of obesity,[26,27] while one study in Macedonia found Roma children had a higher risk of being underweight than non-Roma children.[28] Regarding the Latin American group, similar results were found in studies conducted, mainly in the US, in which it was at higher risk for obesity than non-Hispanic white children.[29,30] However, no statistically significant associations in children under 6 were found, which differs from the conclusions of Kimbro, Brooks-Gunn & McLanahan, who observed Latin American children aged 3 were nearly twice as likely as non-Hispanic white children to be overweight or obese. This outcome suggests that the effect of belonging to a minority group on childhood overweight problems begin earlier[31] even though the effect seems to be higher in children who spend more time exposed to vulnerabilities.

Genetic and cultural diversity in minority groups and those related to SES could result in differences in Energy balance-related behaviours (EBRBs). These groups are at higher risk of adopting an unhealthy diet, insufficient physical activity and sedentary behaviours, explaining differences found in overweight and obesity prevalence among these groups.[28] Minorities groups (particularly, Roma/gypsies and Latin Americans) are more exposed to a higher number of vulnerabilities possibly leading to inadequate adaptation in obesogenic environments characterized by low levels of physical activity, high energy density diets and a sedentary lifestyle compared with non-vulnerable groups.

Children whose parents came from Africa and Eastern European countries did not present a significantly increased risk of being overweight/obese compared with non-gypsy Spanish group up to 6 years old. However, different results can be found in literature depending on the country the study took part in. Particularly, African migrant children in Europe and Australia presented higher prevalence of overweight and obesity than native children,[32] especially girls.[33,34] Previous analyses showed similar growth patterns and infant feeding practices in children whose parents were born in North Africa or in Sub-Saharan Africa. These findings could result from a shared cultural and religious background. Therefore, we finally decided to include children whose parents were born in North African and Sub-Saharan countries in the same minority group.

Since the mid-1990 s, Spain has received a large number of immigrants, mainly searching for better jobs and economic security. In general, these groups, usually members of low status occupations,[35] accumulate more social vulnerability than natives, which has been associated with a higher prevalence of overweight and obesity in this population.[5] Likewise, we observed the rate of overweight and obesity in children aged 6 was more than two times

Table 1 Descriptive characteristics of the study population stratified by children's weight status (normal vs. overweight/obese) at last follow-up (6 years old)

		Excess body weight at 6 years old		
		Normal weight (*n* = 706)	**Overweight/obese (*n* = 325)**	***P*-value**
Categorical variables	*N* (%)	%	%	
Sex of the child				
Male	555 (53.8%)	68.1	31.9	0.783
Female	476 (46.2%)	68.9	31.1	
Maternal smoking				
Yes	200 (19.4%)	59.0	41.0	**0.001**
No	831 (80.6%)	70.8	29.2	
Exclusive breastfeeding[a]				
Yes	463 (44.9%)	71.9	28.1	**0.028**
No	568 (55.1%)	65.5	34.5	
Parental origin/Ethnicity				
Spanish Roma (Gypsy)	29 (2.8%)	27.6	72.4	**< 0.001**
Eastern European	40 (3.9%)	62.5	37.5	
Latin American	55 (5.3%)	47.3	52.7	
African	39 (3.8%)	69.2	30.8	
Non-gypsy Spaniard	868 (84.2%)	71.4	28.6	
Region				
Zaragoza	721 (69.9%)	68.9	31.1	0.461
Huesca	201 (19.5%)	69.7	30.3	
Teruel	109 (10.6%)	63.3	36.7	
Primary care centres				
Valdefierro	131 (12.7%)	69.5	30.5	
Actur	181 (17.6%)	70.1	29.3	
Torrero	64 (6.2%)	68.8	31.2	
Huesca	111 (10.8%)	73.0	27.0	
Sagasta	97 (9.4%)	69.1	30.9	0.914
Las Fuentes	70 (6.8%)	71.4	28.6	
Delicias	93 (9.0%)	67.7	32.3	
Teruel	109 (10.6%)	63.3	36.7	
Jaca	91 (8.8%)	65.9	34.1	
Tarazona	50 (4.8%)	64.0	36.0	
Borja	34 (3.3%)	61.8	38.2	
Maternal occupation				
Missing	118 (11.4%)	67.8	32.2	**0.002**
Working class	455 (44.1%)	63.3	36.7	
Intermediate	197 (19.1%)	69.5	30.5	
Salariat	261 (25.3%)	77.0	23.0	
Paternal occupation				
Missing	123 (11.9%)	72.4	27.6	**0.001**
Working class	504 (48.9%)	63.1	36.9	
Intermediate	189 (18.3%)	69.8	30.2	
Salariat	215 (20.9%)	77.7	22.3	
Maternal education				
Missing	10 (1.0%)	80.0	20.0	**< 0.001**
Low	258 (25.1%)	58.1	41.9	
Medium	349 (33.9%)	71.3	28.7	
High	414 (40.2%)	72.2	27.8	
Paternal education				
Missing	19 (1.9%)	73.7	26.3	**0.001**
Low	534 (32.0%)	59.7	40.3	
Medium	431 (41.8%)	71.5	28.5	
High	251 (24.3%)	74.5	25.5	
Accumulation of vulnerabilities[b]				
No vulnerabilities	411 (39.9%)	74.0	26.0	**< 0.001**
Missing	34 (3.3%)	70.6	29.4	
1 vulnerability	279 (27.1%)	69.5	30.5	
2 vulnerabilities	204 (19.8%)	65.2	34.8	
3 vulnerabilities	103 (10.0%)	49.5	50.5	
Continuous variables	Mean (SD)	Mean (SD)	Mean (SD)	*P*-value
Paternal BMI (kg/m^2)	26.29 (3.44)	25.86 (3.33)	27.23 (3.49)	**< 0.001**
Maternal BMI (kg/m^2)	23.53 (4.33)	22.98 (4.05)	24.75 (4.68)	**< 0.001**
Weight gain during pregnancy (kg)	11.80 (5.03)	11.90 (4.93)	11.66 (5.23)	0.569
Birth weight (g)	3230 (485)	3206 (471)	3283 (512)	**0.018**
Rapid infant weight gain (z-score)	0.16 (1.11)	0.01 (1.03)	0.49 (1.20)	**< 0.001**

Notes: BMI, Body Mass Index; SD, Standard Deviation. Statistical analyses were undertaken using *t*-Student (for continuous variables) and chi-square tests (for categorical variables); significant values at $p < 0.05$.

a: Exclusive breastfeeding was defined as giving maternal milk at the only infant food source for at least 4 months with no other liquids or food given.

b: A total social vulnerability score was calculated by adding up the numbers of vulnerabilities a child was exposed to: belonging to a minority ethnic group; parental low-occupation and low-education were considered. The vulnerability score ranged from 0 (the child had no vulnerabilities) to 3 (the child had all three vulnerability indicators).

Table 2 Longitudinal associations between belonging to a minority group and excess body weight in children at 6 years old (reference: normal weight) for the four models[a]

Parental origin/Ethnicity	Excess body weight (Overweight and obesity) at 6 years old											
	M1[b]			M2[c]			M3[d]			M4[e]		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Spanish Roma (Gypsy)	6.77	2.94–15.57	**<0.001**	5.90	2.51–13.88	**<0.001**	5.18	2.03–13.17	**0.001**	4.63	1.69–12.70	**0.003**
Eastern European	1.51	0.78–2.92	0.221	1.56	0.78–3.11	0.205	1.19	0.50–2.27	0.829	1.16	0.51–2.63	0.713
Latin American	2.79	1.61–4.85	**<0.001**	3.26	1.84–5.77	**<0.001**	3.05	1.64–5.67	**0.001**	3.04	1.59–5.82	**0.001**
African	1.12	0.56–2.25	0.752	1.27	0.61–2.61	0.521	1.00	0.45–2.21	0.991	0.84	0.39–2.08	0.805
Non-gypsy Spaniard	1.00			1.00			1.00			1.00		

Notes: Results from the logistic mixed-effects models: odds ratios (OR), 95% confidence intervals (CI) and *P*-values are shown. Statistically significant results are shown in bold font.
a: All models include random effects (province and Primary Care Centres) to account for the study design.
b: M1 were adjusted for sex.
c: M2 were additionally adjusted for maternal BMI, parental BMI, weight gain during pregnancy and maternal smoking.
d: M3 were additionally adjusted for rapid infant weight gain, breast-feeding practices and birth weight.
e: M4 were additionally adjusted for parental (maternal and paternal) education and occupation.

Table 3 Association between the accumulation of social vulnerabilities and excess body weight in children aged 6 years old (reference: normal weight) for the three models[a]

Number of vulnerabilities	Excess body weight (Overweight and obesity) at 6 years old								
	M1[b]			M2[c]			M3[d]		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Missing	1.17	0.42–3.23	0.688	1.16	0.52–2.57	0.703	1.42	0.61–3.30	0.404
Three vulnerabilities	2.89	1.85–4.50	**<0.001**	2.32	1.45–3.71	**0.001**	2.18	1.31–3.64	**0.003**
Two vulnerabilities	1.52	1.05–2.17	0.024	1.27	0.87–1.88	0.200	1.08	0.72–1.63	0.699
One vulnerability	1.25	0.89–1.74	0.202	1.02	0.72–1.46	0.913	0.98	0.68–1.43	0.942
Non-vulnerable	1.00			1.00			1.00		

Notes and Sources: Results from the logistic linear mixed model: odds ratios (OR) and 95% confidence intervals (CI) are shown. Statistically significant results are shown in bold font. A total social vulnerability score was calculated by adding up the numbers of vulnerabilities a child was exposed to: (belonging to a minority ethnic group; low-occupation and low-education) were considered. The vulnerability score ranged from 0 (the child had no vulnerabilities) to 3 (the child had all three vulnerability indicators).
a: All models include random effects (province and Primary Care Centres) to account for the study design.
b: M1 were adjusted for sex.
c: M2 were additionally adjusted for maternal BMI, parental BMI, weight gain during pregnancy and maternal smoking.
d: M3 were additionally adjusted for rapid infant weight gain, breast-feeding practices and birth weight.

higher in those with an accumulation of three vulnerabilities (children belonging to a minority group, with parents from low occupation and educational level) than in children with no vulnerabilities. This is consistent with previous studies that have demonstrated than an accumulation of social vulnerabilities increases the risk of unhealthy lifestyle patterns.[36]

Some limitations of this study should be acknowledged. Firstly, the CALINA study is not representative of the Spanish population since Aragon covered a limited geographic area within the country and results might not be extrapolated to the whole population. Secondly, an analysis of further confounders highly associated with obesity levels such as family income, dietary patterns, sedentary behaviours, physical activity and sleep duration was not included in this study. Thirdly, another limitation is reliance on self-report measures for parents (such as parental weight and height and their education and occupation). Moreover, a selection bias cannot be precluded as there were participants (mainly children whose parents were originally from Eastern European countries, Africa and Latin America and had lower parental education and occupation) who did not complete all information required or did not continue the study at follow-up. A special strength is the fact that to our knowledge, no previous research has investigated the association between minority groups and accumulation of social vulnerabilities and childreńs overweight and obesity in Spain. The prospective collection of data on a wide range of risk factors extending from pregnancy through infancy and the ability to adjust for several important confounding socioeconomic factors are among the strengths of this study.

Conclusion

Despite reported stabilization of prevalence rates of overweight and obesity in children in Spain and other developed countries, children from vulnerable groups (those who belong to minority groups and from low SES) have not benefited from this trend. This study suggests associations between belonging to a minority group and presenting overweight/obesity at age 6 regardless of parental BMI, SES, pregnancy and infancy risk factors. Mainly children with Latin American and Roma (gypsies) background were at a disadvantage compared with non-gypsy Spanish group. These findings suggest public health strategies for obesity prevention should pay special attention to these vulnerable groups as they are at higher risk.

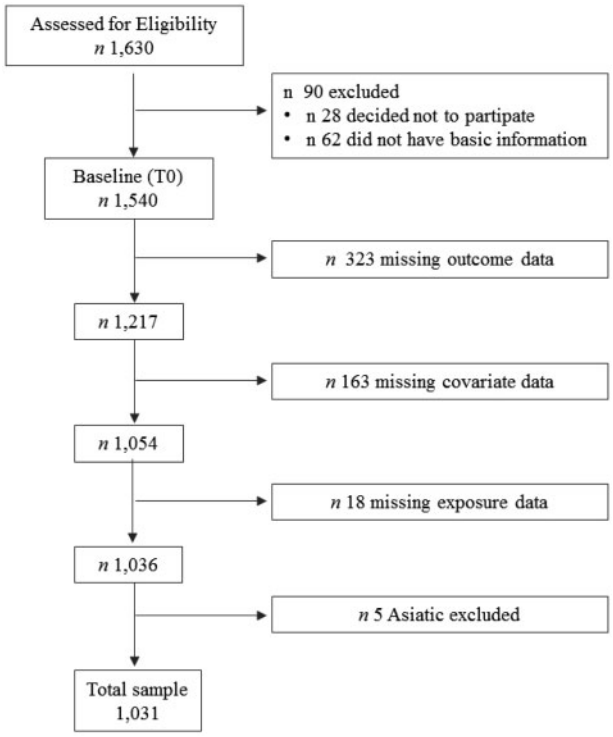

Figure 1 Selection of the final study sample

Acknowledgements

This study has been supported by three grants from the Carlos III Health Institute: (i) PI08/0559: Aragon Health Sciences Institute for the project Growth and Feeding in Infants from Aragon (CALINA); (ii) PI13/02359 Environmental factors influencing early development of obesity during childhood and body composition programming and (iii) RD12/0026: Maternal, Child Health and Development Network (Retic SAMID) RETICS funded by the PN I+D+I 2008-2011 (Spain), ISCIII-Sub-Directorate General for Research Assessment and Promotion and the European Regional Development Fund (ERDF). I.I. was supported by the FPU Predoctoral Programs (grant reference FPU014/00922) of the Spanish Ministry of Education and Science. We thank the CALINA children and their parents who generously volunteered and participated in this project.

Supplementary data

Supplementary data are available at *EURPUB* online.

Conflicts of interest: None declared.

Key points

- Significant associations between minority groups and childhood obesity have been found in children.
- Most studies have been conducted in the United States and have not considered either early risk factors of childhood obesity or socioeconomic status (SES).
- The accumulation of social vulnerabilities has been rarely explored in literature and has yielded inconsistent results.
- Spanish gypsies' children and children whose parents are of Latin American origin had 4-fold and 3-fold higher risk of overweight/obesity respectively compared with non-gypsy Spanish children.
- Results were independent of parental BMI, weight gain during pregnancy, maternal smoking during pregnancy, birth weight, weight gain in the first 6 months, breastfeeding practices and SES.

References

1 Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public-health crisis, common sense cure. *Lancet* 2002;360:473–82.

2 Sahoo K, Sahoo B, Choudhury AK, et al. Childhood obesity: causes and consequences. *J Family Med Prim Care* 2015;4:187–92.

3 Ahrens W, Pigeot I, Pohlabeln H, et al. Prevalence of overweight and obesity in European children below the age of 10. *Int J Obes (Lond)* 2014;38 (Suppl 2):S99–107.

4 Caprio S, Daniels SR, Drewnowski A, et al. Influence of race, ethnicity, and culture on childhood obesity: implications for prevention and treatment. *Obesity (Silver Spring)* 2008;16:2566–77.

5 Gupta RP, de Wit ML, McKeown D. The impact of poverty on the current and future health status of children. *Paediatr Child Health* 2007;12:667–72.

6 McLoyd VC. Socioeconomic disadvantage and child development. *Am Psychol* 1998;53:185–204.

7 Kumar BN, Meyer HE, Wandel M, et al. Ethnic differences in obesity among immigrants from developing countries, in Oslo, Norway. *Int J Obesity* 2005;30:684–90.

8 Wang Y, Beydoun MA. The obesity epidemic in the United States–gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. *Epidemiol Rev* 2007;29:6–28.

9 Fredriks AM, Van Buuren S, Sing RA, et al. Alarming prevalences of overweight and obesity for children of Turkish, Moroccan and Dutch origin in The Netherlands according to international standards. *Acta Paediatr* 2005;94:496–8.

10 Karlsen S, Morris S, Kinra S, et al. Ethnic variations in overweight and obesity among children over time: findings from analyses of the Health Surveys for England 1998-2009. *Pediatr Obes* 2014;9:186–96.

11 Juliusson PB, Eide GE, Roelants M, et al. Overweight and obesity in Norwegian children: prevalence and socio-demographic risk factors. *Acta Paediatr* 2010;99:900–5.

12 Martinson ML, McLanahan S, Brooks-Gunn J. Race/ethnic and nativity disparities in child overweight in the United States and England. *Ann Am Acad Pol Soc Sci* 2012;643:219–38.

13 Gualdi-Russo E, Zaccagni L, Dallari GV, Toselli S. Anthropometric parameters in relation to glycaemic status and lipid profile in a multi-ethnic sample in Italy. *Public Health Nutr* 2015;18:438–45.

14 Taveras EM, Gillman MW, Kleinman KP, et al. Reducing racial/ethnic disparities in childhood obesity: the role of early life risk factors. *JAMA Pediatr* 2013;167:731–8.

15 Salbe AD, Weyer C, Lindsay RS, et al. Assessing risk factors for obesity between childhood and adolescence: I. Birth weight, childhood adiposity, parental obesity, insulin, and leptin. *Pediatrics* 2002;110(2 Pt 1):299–306.

16 Cossrow N, Falkner B. Race/ethnic issues in obesity and obesity-related comorbidities. *J Clin Endocrinol Metab* 2004;89:2590–4.

17 Oves Suarez B, Escartin Madurga L, Samper Villagrasa MP, et al. Immigration and factors associated with breastfeeding. CALINA study. *An Pediatr (Barc)* 2014;81:32–8.

18 World Health Organization. Multicentre Growth Reference Study Group. WHO child growth standards: length/height-for-age, weightforage, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Geneve, 2006.

19 Serra-Majem L, Aranceta Bartrina J, Perez-Rodrigo C, et al. Prevalence and deteminants of obesity in Spanish children and young people. *Br J Nutr* 2006;96 (Suppl 1):S67–72.

20 Yu Z, Han S, Zhu J, et al. Pre-pregnancy body mass index in relation to infant birth weight and offspring overweight/obesity: a systematic review and meta-analysis. *PLoS One* 2013;8:e61627.

21 Ong KK, Loos RJ. Rapid infancy weight gain and subsequent obesity: systematic reviews and hopeful suggestions. *Acta Paediatr* 2006;95:904–8.

22 The World Health Organizatioń s infant feeding recommendation. 2017. Available at: http://www.who.int/nutrition/topics/infantfeeding_recommendation/en/ 15 October 2016.

23 UNESCO, Statistics. *International Standard Classification of Education (ISCED)*. Montreal, QC: UNESCO, 1997.

24 Harrison E, Rose D. *The European Socio-Economic Classification (ESeC) User Guide*. Colchester: University of Essex, 2006.

25 Kim S, Egerter S, Cubbin C, et al. Potential implications of missing income data in population-based surveys: an example from a postpartum survey in California. *Public Health Rep* 2007;122:753–63.

26 Macekova S, Bernasovsky I, Gabrikova D, et al. Association of the FTO rs9939609 polymorphism with obesity in Roma/Gypsy population. *Am J Phys Anthropol* 2012;147:30–4.

27 Hujova Z, Alberty R, Ahlers I, et al. Cardiovascular risk predictors in central Slovakian Roma children and adolescents: regional differences. *Cent Eur J Public Health* 2010;18:139–44.

28 Spiroski I, Dimitrovska Z, Gjorgjev D, et al. Nutritional status and growth parameters of school-age Roma children in the Republic of Macedonia. *Cent Eur J Public Health* 2011;19:102–7.

29 Flores G, Fuentes-Afflick E, Barbot O, et al. The health of Latino children: urgent priorities, unanswered questions, and a research agenda. *Jama* 2002;288:82–90.

30 Thorpe LE, List DG, Marx T, et al. Childhood obesity in New York City elementary school students. *Am J Public Health* 2004;94:1496–500.

31 Kimbro RT, Brooks-Gunn J, McLanahan S. Racial and ethnic differentials in overweight and obesity among 3-year-old children. *Am J Public Health* 2007;97:298–305.

32 Toselli S, Zaccagni L, Celenza F, et al. Risk factors of overweight and obesity among preschool children with different ethnic background. *Endocrine* 2015;49:717–25.

33 Renzaho AMN, Swinburn B, Burns C. Maintenance of traditional cultural orientation is associated with lower rates of obesity and sedentary behaviours among African migrant children to Australia. *Int J Obesity* 2008;32:594–600.

34 Gualdi-Russo E, Zaccagni L, Manzon VS, et al. Obesity and physical activity in children of immigrants. *Eur J Public Health* 2014;24 (Suppl 1):40–6.

35 Reher D, Requena M. The National Immigrant Survey of Spain: a new data source for migration studies in Europe. *Demographic Res* 2009;253–78.

36 Iguacel I, Fernandez-Alvira JM, Bammann K, et al. Associations between social vulnerabilities and dietary patterns in European children: the Identification and prevention of Dietary- and lifestyle-induced health EFfects In Children and infantS (IDEFICS) study. *Br J Nutr* 2016;116:1288–97.

The European Journal of Public Health, Vol. 28, No. 2, 295–300

doi:10.1093/eurpub/ckx143 Advance Access published on 23 September 2017

Prevalence of adult overweight and obesity in 20 European countries, 2014

Adilson Marques[1,2], Miguel Peralta[3], Ana Naia[3,4], Nuno Loureiro[5], Margarida Gaspar de Matos[3,6,7]

1 Centro Interdisciplinar de Estudo da Performance Humana, Faculdade de Motricidade Humana, Universidade de Lisboa, Lisboa, Portugal
2 Centro de Investigação em Saúde Pública, Escola Nacional de Saúde Pública, Universidade Nova de Lisboa, Lisboa, Portugal
3 Faculdade de Motricidade Humana, Universidade de Lisboa, Lisboa, Portugal
4 Centro de Investigação em Arquitetura, Urbanismo e Design (CIAUD), Faculdade de Arquitetura, Universidade de Lisboa, Lisboa, Portugal
5 Escola Superior de Educação, Instituto Politécnico de Beja, Beja, Portugal
6 Instituto de Saúde Ambiental, Faculdade de Medicina, Universidade de Lisboa, Lisboa, Portugal
7 William James Center for Research, Instituto Superior de Psicologia Aplicada, Lisboa, Portugal

Correspondence: Adilson Marques, Departamento de Educação, Ciências Sociais e Humanidades, Faculdade de Motricidade Humana, Universidade de Lisboa, Estrada da Costa, 1499-002, Cruz Quebrada, Dafundo, Portugal, Tel: +351 214149100, Fax: +351 214151248, e-mail: amarques@fmh.ulisboa.pt

Background: Monitoring obesity and overweight prevalence is important for assessing interventions aimed at preventing or reducing the burden of obesity. This study aimed to provide current data regarding the prevalence of overweight and obesity of adults, from 20 European countries. **Methods:** Participants were 34 814 (16 482 men) adults with mean age 50.8 ± 17.7. Data from European Social Survey round 7, 2014, were analysed. Body mass index (BMI) was calculated from self-reported height and weight. **Results:** The proportion of underweight was only 2%, and 44.9% for normal weight. Overweight and obese accounted for 53.1%. More men than women were overweight (44.7% vs. 30.5%). Older adults were significantly more overweight (42.4%) and obese (20.9%) than middle age and younger adults. Retired people account for a greater proportion of overweight (42.0%) and obese (21.5%), when compared with employed, unemployed and students. People from rural areas were significantly more overweight (39.1 vs. 36.1%) and obese (17.0 vs. 15.3%) than those who lived in urban areas. The estimates indicate that the highest prevalence of overweight was in Czech Republic (45.2%), Hungary (43.7%) and Lithuania (41.7%). For obesity, Slovenia (20.8%), Estonia (19.7%) and the United Kingdom (19.2%) were the countries with the highest prevalence. **Conclusion:** Even though data was self-reported, and individuals tend to overestimate their height and underestimate their weight, the prevalence of overweight and obesity is considered high. More than half of the European population is overweight and obese. This study strengthens and updates the claims of an excessive weight epidemic in Europe.