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## **DIETARY PATTERNS IN WEIGHT GAIN AND OBESITY INCIDENCE IN CHILDREN AT THE AGES OF 4 AND 7 YEARS IN BIRTH COHORT IN SPAIN**

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## 1. Project summary

Childhood obesity has become one of the most serious public health challenges of the 21st century, and the prevalence has reached epidemic proportions around the world. Rising prevalence rates indicate that modifiable environmental factors in early childhood such as diet and other lifestyles may play a key role in reducing the prevalence and incidence of childhood obesity.

The objectives of this project were 1) to estimate the prevalence of overweight and obesity at 4 years and the incidence of overweight and obesity from 4 to 8 years; 2) to evaluate the reproducibility and validity of a short-frequency questionnaire to assess diet at 8 years of age, 3) to obtain information on nutrients, foods, and dietary patterns at 4 and 8 years, and 4) to explore the association between diet (nutrients, foods and dietary patterns) and other lifestyle patterns in the prevalence and incidence of childhood overweight and obesity.

This project was carried out with the information of approximately 1,800 mother-child couples who participated in the INfancia y Medio Ambiente project (INMA, <https://www.proyectoinma.org/>). This is a multicenter birth cohort study from four geographical areas of Spain whose mothers were recruited during pregnancy; their children were followed from birth to the present. In this specific project we have worked with the information from the visits of 4 and 8 years. Dietary information at the age of 4 and 8 years was collected using a food frequency questionnaire that was created for this project. This information allowed us to estimate the dietary nutrients intake and food groups, and to derive dietary patterns with an a priori approach based on current dietary recommendations and a posteriori approach using multivariate techniques such as factor analysis. Weight and height were measured using standard protocols at the ages of 4 and 8 years, and the body mass index was calculated, which allowed us to assess the prevalence and incidence of obesity.

## 2. Results obtained

1) The prevalence of overweight, obesity and abdominal obesity at 4 years was 14.5%, 6% and 9% respectively. Regarding the incidence of 4 to 8 years, 15% of children with

normal weight at 4 years were overweight at 8 years and 6% who were not obese at 4 years (normal weight or overweight) developed obesity at the age of 8 years.

2) The 46-item food frequency questionnaire developed in the context of this study to measure diet at the age of 8 years is reproducible and valid compared to three 24-hour recalls and biochemical parameters. In summary, the mean of the correlation coefficients for nutrient intake was 0.41 and for food groups 0.45. The validity of the food frequency questionnaire compared to the mean of three 24-hour reminders showed an average correlation of 0.34 and the validity with serum vitamins was 0.38 for beta-cryptoxanthin, 0.26 for lycopene, 0.23 for alpha carotene and 0.15 for beta carotene. Therefore, this food frequency questionnaire can be used to measure the diet of Spanish children at 8 years of age.

3) This project has contributed to the generation of more than a hundred dietary variables that have been made available to all researchers of the INMA project to explore new hypotheses on diet and health. The main nutrients have been estimated, such as the main macronutrients (energy, proteins, carbohydrates, total fats, polyunsaturated fats, monounsaturated fats, total saturated fats, trans fats, omega 3, omega 6, and other fatty acids), the main vitamins and the main minerals and dietary intake by food group.

With the dietary information, three patterns of adherence to a Mediterranean diet have been derived: the Mediterranean Diet Score (MDS), the alternate Mediterranean Diet Index (aMED) and the relative Mediterranean diet Index (rMED). These three indicators include alcohol consumption, which we eliminated as it is not recommended for these ages. As a result of a final Master of Public Health work of Miguel Hernández University and the University of Alicante, we evaluated the reproducibility and validity by comparing the information of these indices with estimates of vitamins obtained from the mean of the 24-hour reminders and biochemical parameters. In this work we saw that the index with the best reproducibility and validity was the rMED.

After a review of the scientific literature and carrying out different data grouping methods such as cluster, principal components and factorial, we derived post-hoc dietary patterns using principal component analysis. Three dietary patterns have been

created that were identified as a Mediterranean, Western, and dairy pattern at 4 and another 3 at 8 years that were similarly named.

4) In this project we have explored how nutrient, food or pattern intake is associated with overweight and obesity.

Industrial trans fats are hydrogenated fats that are incorporated into processed foods such as French fries, industrial pastries, among others, while natural fats are produced naturally in foods from ruminants. Children who were classified in the highest quartile for industrial trans fat intake at 4 years ( $> 0.7$  grams per day) compared to those who were classified in the lowest quartile ( $< 0.4$  grams per day) were 57% more likely to be overweight (OR = 1.57; 95% CI: 1.13, 2.21) and 63% more likely to be obese (OR = 1.63, 95% CI: 1.14; 2.34). Intake of natural trans fats did not influence overweight and obesity at 4 years.

Greater adherence to the Mediterranean diet in pregnancy was associated with a lower risk of having larger offspring at birth, followed by an accelerated increase in body mass index (reference trajectory group: children with average size at birth and subsequent slower increases in body mass index) (relative risk of high versus low rMED score, 0.68; 95% CI: 0.47, 0.99). Greater adherence to the Mediterranean diet in pregnancy was not associated with the cardiometabolic risk score, its components, or related biomarkers.

The consumption of sweetened beverages includes soft drinks, packaged juices and sweetened soft drinks. The average consumption of sweetened beverages was 79.1 mL / day, mainly from packaged juices (80.9%). Children who consumed  $> 1$  drink / day at 4 years of age were more likely to be obese than those who consumed  $< 1$  sweetened drink / day (OR = 3.23; 95% CI: 1.48, 6.98). Likewise, for each packaged juice per day, the child had 58% more likelihood to be obese (OR = 1.55; 95% CI: 1.09, 2.15). A similar effect was observed with soft drinks, although this association was not statistically significant.

We also constructed a lifestyle indicator that ranged from 0 to 10 and consisted of 5 components: three that were favorable (extracurricular physical activity, sleep time, consumption of plant-based foods) and two that were unfavorable (TV time and

consumption of ultra-processed foods). The behavior of the child at 4 years of age was classified as 0, 1 and 2 according to the tertiles of scores for the three favorable components and vice versa for the two unfavorable components. We observed that children who were classified in the highest tertile of this indicator at 4 years of age were less likely to be overweight or obese at 8 years (OR = 0.61; 95% CI 0.39; 0.96) and abdominal obesity (OR = 0.48; 95% CI 0.24; 0.96). It was also explored whether this indicator was associated with the neuropsychological development of the child at 4 years, but the results were not conclusive.

We did not observe an association between adherence to the Mediterranean diet at 4 years of age and overweight, obesity or abdominal obesity. However, having high adherence (11-16 points in rMED) at 4 years compared with having low adherence (0-6 in rMED) was associated with a lower incidence of overweight (HR = 0.38; 95 CI %: 0.21-0.67; p = 0.001), obesity (HR = 0.16; 95% CI: 0.05-0.53; p = 0.002), and abdominal obesity (HR = 0.30; 95% CI: 0.12-0.73; p = 0.008) at 8 years. This preventive effect of the Mediterranean diet was mainly due to a high consumption of vegetables and olive oil and a low consumption of meat.

Finally, we would like to highlight as results of the project the training of new researchers through final master's theses that have been carried out within the framework of this project and the thesis of one of the contractors of this project. In addition, we have carried out various scientific outreach activities such as a workshop for children ¡Como nos mola la dieta Mediterránea! at the Feria de la Ciencia y la Tecnología de Elche/Elx (FeCiTElx), or the Jornada de Puertas Abiertas de la Facultad de Medicina de la Universidad Miguel Hernández. where learning activities about the Mediterranean diet were carried out through a game to place the foods in the Mediterranean diet pyramid according to whether they were foods of the Mediterranean diet or not. In this second workshop, we did a creative drawing contest with food. For these workshops, we created a pamphlet that can be consulted in this [link](#) and we prepared an informative video for children from 4 to 8 years, you can see in this [link](#). An informative video was also made on the result of the packaged juices, which can be consulted in this [link](#).



Workshop: Feria de la Ciencia y la Tecnología de Elche/Elx (FeCiTElx).



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### 3. Relevance with possible future implications

The financing of this project has undoubtedly contributed to the fact that a young epidemiologist has had her first project financed and to the training of new researchers within the framework of the project. In addition, the project allowed us to provide evidence about certain nutrients, foods, and lifestyle and diet patterns that are contributing to the childhood obesity epidemic. Moreover, the large volume of dietary data that has been generated will allow the INMA project to continue answering important questions about children's health and how diet can influence children's health.

Finally, we hope that the informative work that we intended to develop with this project can help the general population to follow a Mediterranean diet whose long-term

effects have already been corroborated with a large epidemiological study, the Predimed project.

#### 4. Scientific bibliography generated

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