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Research Article

Was the COVID-19 Pandemic Responsible for an Increase in the Number of Cases in Malnutrition-Anorexia at our Childhood?

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1. Abstract

The coincidence of COVID-19 and confinement on children's health has been studied. One possible cause of malnutrition is eating disorders.

Big data tools are currently a first-rate tool for assessing population changes and possible causes.

1.1. Main objective: To assess the possible changes in the prevalence of malnutrition in a child population after having suffered the confinement of COVID-19

1.2. Material and methods: Data collected from episodes of computerized medical records, studying the variables sex, age, weight, height, of a pediatric population comparing the situation just before COVID (2020) and after the social isolation measures were completely finished (2022)

1.3. Using big data methods to study variables: Using the Cole-Green LMS algorithm with penalized likelihood, implemented in the RefCurv 0.4.2 software (2020), which allows managing large amounts of data. The hyperparameters have been selected using the BIC (Bayesian information criterion).

To calculate population deviations from the reference, the reference was taken as being below 1.5 standard deviations from the average according to age.

1.4. Results: 66,975 computerized episodes of minors under 16 years of age and a total of 1,205,000 variables studied. The data and comparative graphs between districts of the population studied are represented with respect to the variables analyzed. Due to the COVID effect, an increase of 60 cases/10 5 inhabitants is recorded, in a heterogeneous way, being more in men than women, in rural areas in girls and in urban areas in the case of boys.

1.5. Conclusions: Big data technology allows for more efficient population studies, selecting populations most in need of health intervention, optimizing scarce health resources. In this case, the active search for cases in certain neighborhoods of the city should focus on boys and in certain municipalities on girls, since they may appear as hidden cases.

2. Keywords

big data, malnutrition, children

3. Introduction

Body mass index (BMI) is a common parameter to assess

nutritional status [1-3]. The assessment and detection of BMI changes are important for monitoring and controlling a child population [3,4]. Although most of the work tends to focus on the so-called childhood obesity pandemic [2], we cannot forget another aspect of nutritional reality: low weight for height represented by a low BMI [3]. In the world,

the main cause of a low BMI is malnutrition associated with a lack of food intake due to a lack of resources [2,3] or the disease itself. However, in developed countries there is another situation to take into account, malnutrition associated with mental health. This is why when a case of low weight for height is detected in a child in our environment, the main differential diagnoses range from an underlying organic process, constitutional or functional thinness, nutritional problems of a socio-familial nature or mental disorders that lead to weight loss: anorexia, bulimia with a restrictive component, etc [2,3].

Anorexia nervosa is one of the psychiatric pathologies with the highest mortality rates [5]. It is defined as an exaggerated assessment of the volume and shape of the body, which leads to a relentless search for thinness. It is characterized by excessive voluntary weight loss, through a restrictive diet [5].

The prevalence of anorexia nervosa in adults is 0.6% and has been increasing in the adolescent population [6]. Anorexia nervosa classically presents in girls in early to mid-adolescence, with a higher prevalence in whites and above-average socioeconomic class [7,8].

The average age of presentation is 12.3 years [7]. In our country the data are similar to those presented. What is common in most studies is that after the COVID-19 pandemic [8] there has been an increase in the prevalence of problems associated with the mental health of minors due to the measures taken by governments regarding the limitation of social relations (suspension of classes, social isolation, use of electronic devices...).

So much so that after the COVID-19 pandemic, it is estimated that disorders such as anxiety or depression have increased by between 25% and 27% [9]. After the COVID-19 pandemic, the number of cases, hospitalizations and a decrease in the age of patients have increased, with a prevalence of anorexia nervosa rising to 4% in women and 0.3% in men [9].

To further complicate matters, the COVID-19 pandemic has accentuated the deficiencies of health systems and economic inequalities, especially among adolescents and young people [8-10].

Thinness, apart from being a manifestation of an underlying disease or a physiological condition, can reflect situations of risk of developing an eating disorder. Eating disorders have been associated with a high level of education, a family history of eating disorders, vigorexia, situations of family conflicts or even rejection of puberty itself [8-10]. But we cannot forget that thinness can also express a situation of risk of social or economic exclusion from the family.

In Spain, according to a UNICEF report [11], the prevalence of risk of social exclusion and child poverty

could reach 28%. This could have a clear impact on the nutritional status of these minors.

The electronic medical records of current health systems collect multiple variables in clinical practice, including anthropometric and sociodemographic data.

Different statistical techniques, such as machine learning, allow these data to be exploited from a large number of cases in an almost semi-automated way, providing data of great statistical value.

Although there are studies on this subject in different countries and even international series [10], there are no studies, at least in our environment and nearby population, that assess the situation of malnutrition in a child-youth population; and in no case has the use of new BIG DATA techniques been described for these studies.

4.Goals

4.1.Main Objective: To describe the situation of the prevalence of malnutrition measured as a low BMI level in a pediatric population: Álava, Basque Country, Spain, using a new big data approach at two different historical moments, before and after the lifting of restrictions on social relations caused by the COVID-19 pandemic.

4.2.Secondary objectives: to assess whether there is a causal relationship with the place of residence, average income per person in said district or neighborhood and immigration rate.

5.Material and Methods

5.1.Key Findings

2020: 217 children (106 boys, 111 girls) had a BMI <1.5 SDS (1.46% of the sample).

2022: 233 children (119 boys, 114 girls) had a BMI <1.5 SDS (2.06% of the sample).

Increase of 60 cases per 10,000 inhabitants.

Men showed a larger increase than women (48 vs. 12 cases per 10,000).

5.2.Geographical Variations

Boys: Malnutrition cases increased in urban areas with higher income levels.

Girls: Increases were noted in rural areas and high-income urban districts.

5.3.Statistical analysis

The method based on Dirichlet processes (Dirichlet process, DP) is followed. In this project we will adopt this approach that allows to build Gaussian mixture models (GM). In addition, Gaussian mixture models based on Dirichlet processes (Dirichlet process Gaussian mixture models, DPGMM) are used. A set of populations is also analyzed using Gaussian mixture models based on hierarchical Dirichlet processes (Hierarchical Dirichlet

process Gaussian mixture model, HDPGMM) [12]. Clustering's will be obtained that will inform us about the somatomedin similarities and differences of the population based on the somatomedin variables and the district in which they live [13], incorporating recent methodological innovations on databases similar to ours already described [14-16]. The BMI calculation is performed as weight/height^2 (Kgr/m²). These data are compared with the means and SDS of the studies published to date and reference of our population [4]. Overweight is defined as less than 1.5 SDS with respect to the reference normality for age and sex [4].

The team proceeds to carry out comparative studies using the methodology already applied in previous studies by these same authors (Diez et al) [17]: the so-called Hierarchical Dirichlet process Gaussian mixture model or method, applied to our population vs reference graphs from the Spanish 2010 study and used in the country.

6. Results

Data have been obtained from a total of 67,270 minors.

The sum of all variables studied (some presented in this work and others reserved) amounts to 1,749,020 variables. We present in various tables the results obtained by sex, age and BMI and other variables.

Data from the National Institute of Statistics and EUSTAT indicate that 338,765 people lived in our territory, the province of Alava in the Basque Country - Spain, during the period studied.

The political territory is divided into 7 large districts or groups that include the municipal area of the city of Vitoria, the administrative capital of the Basque Country and main population centre, which brings together more than 255,000 inhabitants.

The income of minors depends on the average family income. The average family income in the Basque Country is 47,005 euros in 2021. The total family income is obtained by aggregating the personal income of the family members, including minors. There are significant differences between districts (Source EUSTAT), with the towns in Álava having the lowest average income of the entire population in the region.

The unemployment rate in the Basque Country is 7.5%, well below the average for the country, Spain. There are significant differences between districts (Source EUSTAT), with some towns in Álava and Vizcaya having the highest unemployment rates.

Regarding the rate of immigrant population in our territory. The average rate is 13% in the Basque Country, but Vitoria is one of the municipalities and the capital with the highest rate of immigrants in relation to the general population, 15%. There are districts of the capital

that exceed 18% and localities that even reach more than 20%.

Available on the web <https://www.vitoria-gasteiz.org/http/wb021/contenidosEstaticos/adjuntos/es/36/18/3618.pdf>. Dec. 2024 and on the EUSTAT website https://www.eustat.eus/estadisticas/tema_131/opt_0/tipo_1/ti_actividad-ocupacion-y-paro/temas.html and on https://www.eustat.eus/elementos/ele0000200/migraciones-de-la-ca-de-euskadi-por-ambitos-territoriales-segun-clase-de-migracion-y-sexo/tbl0000255_c.html Dec.2024

In the first quarter of 2020, pre-pandemic situation, a total of 217 individuals under 16 years of age (106 men, 111 women) were detected with a BMI < 1.5 SDS Kgr/m² for their age/sex. This figure represents 1.46% of all cases studied.

In the first quarter of 2022, post-pandemic situation, a total of 233 individuals under 16 years of age (119 men, 114 women) were detected with a BMI < 1.5 SDS Kgr/m² for their age/sex. This figure represents 2.06% of all cases studied.

Significant differences in both periods and sexes ($p < 0.05$), with an increase of 60 registered cases/10,000 inhabitants between both periods (Figure 1).

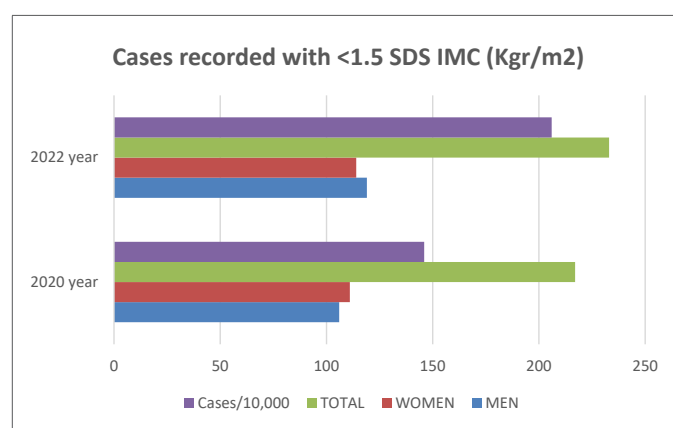


Figure 1: Representation of data for the BMI variable (kg) by sex. Reference to normal population (P50 Carrascosa study). The amount of population whose BMI is below 1.5 standard deviations from the mean for their age is indicated for both study periods 020 vs 2022.

Assessing the distribution of cases, there has been an increase in these cases, especially at the expense of men (48 cases/10,000 inhabitants). Women contribute another 12/10,000 inhabitants to the total.

There appear to be differences in behaviour between districts, with a general increase observed in almost all of them among the male gender, with more heterogeneous behaviour among the female gender.

Having studied the variables BMI and per capita income separately for each district, an assessment is made of those districts in the territory that present a greater proportion of variation in cases 2020 vs 2022 of people

with low BMI in relation to their age and sex according to reference standards Spain – Carrascosa 2010 [4].

6.1.Key Findings:

- 2020: 217 children (106 boys, 111 girls) had a BMI <1.5 SDS (1.46% of the sample).
- 2022: 233 children (119 boys, 114 girls) had a BMI <1.5 SDS (2.06% of the sample).
- Increase of 60 cases per 10,000 inhabitants.
- Men showed a larger increase than women (4.8 vs. 12 cases per 10,000).

6.2.Geographical Variations:

- Boys: Malnutrition cases increased in urban areas with higher income levels.
- Girls: Increases were noted in rural areas and high-income urban districts.

In the case of men, there is an increase of more than 13 total cases in 2022 compared to those detected in 2020. This means that compared to the total sample, the number of cases goes from 1.57% to 2.02%, which represents an absolute increase of 0.48% overall and therefore 28.66% from 2022 to 2020. This increase is heterogeneous according to the district/neighborhood of the city. There are districts with significant increases and above this average, such as Abetxuko, Alegria, Gazalvide, Legutiano, Zaramaga and Zigoitia. These districts are also mostly above an income per capita above the average for the territory; exceptions are Zaramaga and Abetxuko. Others, on the contrary, show a decrease in the number of cases detected, such as the districts of Kanpezu, Lakua or Zabalgana. These differences between districts and neighborhoods are significant ($p < 0.05$).

In the case of WOMEN, we find a heterogeneous distribution across the districts.

There is an increase of 3 total cases in 2022 compared to those detected in 2020. This means that with respect to the total sample, the number of cases goes from 1.98% to 2.10%, which represents an absolute increase of only 0.12% overall and therefore 6.06% for the year 2022 vs 2020. This slight increase is also heterogeneous according to the district/neighborhood of the city.

There are districts with significant increases and above this average, such as Aramizkarra I and II, La Guardia, Olarizu, Otxandio, Zigoitia and Zuya. These districts are mostly located in rural areas and are around the average per capita income of the territory; the exception is the area of Zigoitia, with income much higher than the average. Others, on the contrary, show a decrease in the number of detected cases, such as the districts of Casco Viejo, Olaguibel and Lakua; these first two are well below the average income. These differences between districts and neighborhoods are significant ($p < 0.05$).

7.Discussion

7.1.Big Data in Epidemiological Research and the Impact of COVID-19 on Child Malnutrition

The expansion of big data in epidemiological research has provided new opportunities for understanding public health trends and designing effective healthcare interventions. The ability to analyze vast amounts of real-world data with machine learning has proven beneficial in numerous fields and its application in healthcare is becoming increasingly indispensable.

Somatometry, which assesses body measurements as indicators of health, plays a crucial role in evaluating the well-being of children. In particular, the study of eating disorders and their correlation with various health determinants has gained importance. The COVID-19 pandemic has been the subject of extensive research, with numerous studies highlighting the consequences of prolonged confinement, social isolation and excessive reliance on digital technologies.

The pandemic not only led to a rise in reported cases of malnutrition and eating disorders but also increased the risks of psychological decompensation, suicides and hospitalizations associated with these conditions. Several additional factors have been implicated in the growing incidence of malnutrition, including a family's socioeconomic status, per capita income and the stress caused by unemployment within households. Economic disparities and social instability exacerbate the vulnerability of children and adolescents to nutritional deficiencies.

Our research took these factors into account, identifying low BMI as a key variable and analyzing the potential impact of economic conditions such as average district income and immigration rates. These socioeconomic elements are particularly relevant, as they are frequently associated with larger family sizes, lower household income and higher unemployment rates, all of which contribute to the overall nutritional health of children [16-20].

7.2.Findings on Malnutrition Trends

A significant increase in cases of low BMI was observed across both male and female populations. However, the methodology used in this study does not allow for precise differentiation between cases of true eating disorders, malnutrition due to organic health issues or malnutrition resulting from economic hardships.

Children and adolescents residing in urban areas appear to be more prone to mental health complications, particularly as a consequence of pandemic-related biopsychosocial stressors. Economic difficulties, limited access to basic services and restrictions on social interaction have been linked to heightened levels of anxiety, emotional distress and depression. Moreover, these psychological stressors have been found to increase the likelihood of family conflict and domestic violence, further contributing

to poor nutritional outcomes.

At the onset of the pandemic, anxiety disorders were among the most frequently diagnosed conditions in children and adolescents. The heightened fear of infection, compounded by the grief of losing loved ones, contributed to widespread psychological distress. As social isolation persisted, psychiatric symptoms began to emerge more prominently, including depressive disorders, social anxiety, self-harm tendencies, suicidal ideation and eating disorders. The prolonged lack of socialization, coupled with increased exposure to digital screens and reduced physical activity, created a complex web of health risks affecting the pediatric population.

7.3. Gender and geographic disparities

Our study identified key gender-based and geographic variations in the prevalence of malnutrition:

- **Boys:** The majority of cases occurred in urban settings with higher household incomes. This suggests that boys in these environments may have experienced greater disruptions to their social lives, potentially affecting their dietary habits and mental well-being.
- **Girls:** The highest increases in malnutrition cases were observed in rural areas and affluent urban districts. This may be due to differing social stressors affecting girls in these regions, including lifestyle changes and the potential influence of socio-cultural factors on body image perceptions.

These findings align with previous research, which suggests that boys in urban environments are more dependent on peer interactions, while girls in rural areas may have been disproportionately affected by social isolation. The way children and adolescents relate to their environment varies significantly based on gender, location and socio-economic background, contributing to distinct patterns of nutritional and psychological health outcomes.

7.4. Public health implications

Given the scarcity of healthcare resources, it is imperative to prioritize interventions targeting the most vulnerable population segments. Determining which groups require urgent attention, implementing awareness campaigns and conducting active case searches for malnutrition are all essential steps toward improving pediatric health. Big data presents an efficient and cost-effective solution to obtain real-time insights into population health trends, ultimately facilitating the strategic allocation of limited healthcare resources.

Our findings underscore the presence of high-risk zones, including specific towns, neighborhoods and districts where up to 4% of the child population is affected by malnutrition. This highlights the need for a broader reflection on the methodologies employed to detect these cases, as well as the broader socio-economic conditions

influencing child nutrition.

Additionally, our research points to the significant impact of environmental factors on childhood malnutrition. Socioeconomic determinants—including income levels, food quality and accessibility, participation in extracurricular activities and overall living conditions—play a crucial role in shaping a child's nutritional status. The combination of financial instability, limited educational resources and inadequate healthcare access exacerbates the risks faced by children from underprivileged backgrounds [22–30].

In economically disadvantaged areas, the threat of child poverty remains particularly pressing. Many children from these vulnerable households rely on school meal programs, NGO assistance and social services to meet their basic dietary needs. Furthermore, their limited access to recreational, sports and cultural activities further restricts their overall well-being. These compounding challenges emphasize the necessity of targeted public health strategies that address not only nutritional deficiencies but also the broader social determinants of health [29–31].

7.5. Big data: A tool for health monitoring

The implementation of big data analytics has revolutionized health monitoring, provided real-time assessments of population health and supported the development of effective public health interventions. By identifying at-risk populations and analyzing underlying socioeconomic factors, health authorities can formulate more informed strategies to combat malnutrition and enhance overall child health outcomes [16,20–22].

Through the integration of big data methodologies, researchers and policymakers can better understand the multifaceted nature of malnutrition, optimize resource distribution and implement timely interventions to mitigate its long-term impact on children and adolescents [32–39].

7.6. Key Insights

- COVID-19 pandemic restrictions significantly impacted pediatric nutrition.
- Boys were more affected in urban areas, while girls were more affected in rural settings.
- Socioeconomic factors play a role, with higher risk observed in low-income urban areas and affluent rural areas.
- Health authorities should focus on targeted interventions in high-risk districts.

7.7. Public Health Implications

- Big data can optimize resource allocation for healthcare interventions.
- Identifying hidden malnutrition cases ensures early intervention and prevention.
- Social and economic factors must be considered

when addressing child malnutrition.

8. Limitations And Ethical Considerations

8.1. Study Limitations: Data was extracted from medical records, not originally intended for research.

Potential inaccuracies in data recording and measurement.

8.2. Ethical Compliance: Study follows the Declaration of Helsinki (2013) and European biomedical research regulations.

Approved by CEIC on 03/24/2023 (File 2022-058).

9. Conclusion

- COVID-19 lockdowns led to an increase in pediatric malnutrition cases.
- Socioeconomic disparities contribute to the distribution of cases.
- Big data methodologies are crucial for efficient public health planning.
- Authorities should implement targeted interventions in high-risk areas to mitigate malnutrition among children.

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